2014 NC-2042 Annual Meeting
Nebraska City, NE
Lied Lodge
October 9-10, 2014

Meeting called to order at 8:05am by Stephanie Ward

Attending:
Paul Konnonoff – University of Nebraska
Stephanie Ward – Mississippi State
Jill Anderson – South Dakota State
Ken Kalscheur – USDA FRC - Madison
Dave Beede – Michigan State
Tamilee Nennich – Purdue
Victor Cabrera - Wisconsin
Pete Erickson – New Hampshire
Bob Peters - Maryland
Ed dePeters – UC Davis
Hugh Chester-Jones - Minnesota
Brad Heins - Minnesota
Gonzalo Ferreira – Virginia Tech
Jud Heinrichs – Pennsylvania State
Gustavo Lascano - Clemson
Jeffrey Bewley – Kentucky

No Administration Update

Objective Leader Reports

Looking at trying to increase collaboration between stations
Publications
Grants

Overview of discussion from previous evening (Wednesday Evening 10/8/2014)

- Discussion of objectives and increased collaborations-
- Potential for conference calls mid-year (quarterly) among objective participants
- Work on smaller NIFA grants within sub-objectives
- Start with publications to summarize current data then utilize that information to formulate proposals
- Increase collaborations amongst Universities that have competitive funding process for Hatch dollars
- Share deadlines for internal (and other) grant opportunities

We meet annually, but we need to stay in contact with each other more often

Mid-year conference call by whole group or by objectives
Success rate of NIFA proposals are not very successful

Within each objective, work on funding agency proposals
Put together some publications within objectives that we could use as preliminary data for grant applications

Some universities have competitive HATCH funds; potential collaborations

Collaborations within the project already
    Pete Erickson – graduate student – all committee are NC 2042 members
Proceeding papers – Victor and Albret deVries

We should be attending acknowledging NC-2042 in publications for papers

We could be looking at writing some review papers for each objective for the project

Publications for each objective
    Pete and Hugh and Jud for Objective 1 – calf paper

Review Publications
Objective 1:
    Pete and Hugh – Calf review (2008 to 2013) data
        Conference calls for grou

        Colostrum mgmt. – Pete
        Pre-wean – Hugh
        Post-wean – Stephanie
        Organic aspects of calves

Dave Beede with initiate a review aspect from JDS

Dec 15 – Data, Short literature review collected related to calf nutrition and health

Objective 2:
    Opportunities in non-peer review publications – Hoards, Progressive Dairyman
    Automatic Milking Systems for collaborations
        Data and Modeling

Objective 3: Gonzalo will lead (JDS)
    Review paper focused on dairy sustainability
        Economics – precision dairy and size and scale of farms
        Social component – labor issues, robotics
        Nutrient management component – sustainability of small farms

Discussion of text-book in dairy management

ADSA is developing
There are many textbooks out there, but some are lacking
Ruminant Nutrition

UPDATE FROM DAVE BENFIELD

Report due in 60 days

9 million increase in AFRI, otherwise the rest is low
Capacity formula funds are same

NIFA trying to put more money into foundational grants
Instead of grand challenges

NIFA director – How much funding should be provided in NIFA related to animal breeding program? ½ split, think that most will go to basic research. Beef and swine think that greater need on production side because some much has gone to industry.

Dairy breeding is a need as well.

Business meeting

Called to order at 5:52

Minutes Motion –
Hugh added to minutes and Kalscheur changed and Endres spelled correctly

Hugh moved, peter Erickson second – unanimous with changes

Hugh historian -

Publication talked about when we spoke about objectives

Stephanie will send me minutes from her objective reports

Website:
Share info to Paul and and Victor with information for the website. Link stuff to website

Location for 2015 meeting:

Victor will explore Spain but New Hampshire will be the backup plan for 2015 meeting

Check with Dave Benfield about traveling internationally.
Is there a minimum amount of people to go to travel?

Jeffrey Bewley is new secretary – Unanimous

Pat Hoffman is not on project. Retired from UW

Adjourned

MINNESOTA
OBJECTIVE 1

Annual Project Report – Cooperative Regional Project NC-2042
Year ending September 30, 2014
(Not for Publication)

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

Project Objectives

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

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

Minnesota contribution at Waseca to Objective 1.

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

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

C. Progress of Work and Accomplishments:

Brief overview - Program focus with the SROC Calf and Heifer Research and Extension Facility (CHREF) since 2004 has been with commercial dairy heifer calves from 3 dairies representing 2,000 dairy cows. Calves are picked-up twice weekly at 2-4 days of age. All calves receive 3 feedings of colostrum by 24 hours of age. During the project year 2013-2014, > 1,000 heifer calves have been raised for the 3 dairies. The overall death loss to date for the 9,500 calves that have arrived at SROC is 2.1%. One of the unique aspects of the project is the development of Excel spreadsheets for each dairy tracking every calf that enters and leaves SROC then follow them back to the dairies for first lactation production data. The data set will be used for a met analysis to understand the relationship between calf growth and health to first lactation performance. Preliminary information is shown in Tables 1 to 4 below.

Table 1. Raw means – profiles of dairy heifer calves assigned to SROC nursery studies from 3 commercial dairy farms from 2-5 days up to 6 months of through 2013

Item	Farm A	Farm B	Farm C
No. study heifers	1,156	1,805	1,797
Initial BW, lb	88.3	88.0	86.0
Initial SP, g/dl	5.6	5.5	5.4
Final BW, lb	474	448	452
Final Hip Height, in	45.6	45.1	45
ADG, lb	1.91	1.88	1.89

Table 2.Raw means – profiles of SROC dairy heifer calves in farm A showing relationships of initial serum protein to growth by 6 months of age and by complete lactations on their home through 2013.

Initial SP, g/dl	4 or <	4.1-4.5	4.6 -4.9	5-5.4	5.5 or >
Farm A (1,322)					
% of heifers	2.0	5.1	8.3	32.9	51.7
Final BW, lb	476	465	466	471	473
Final Hip Height, in	45.8	45.2	45.3	45.5	45.5
ADG, lb	1.93	1.90	1.90	1.91	1.93
First calving age	712	718	713	706	703
Final Std ME, lb	27,076	28,997	29,387	29,186	29,270

Table 3. Raw means – profiles of SROC dairy heifer calves in farm B showing relationships of initial serum protein to growth by 6 months of age and by complete lactations on their home through 2013.

Initial SP, g/dl	4 or <	4.1-4.5	4.6 -4.9	5-5.4	5.5 or >
Farm B (2,113)					
% of heifers	3.9	6.6	9.3	30.6	49.6
Final BW, lb	438	443	447	448	444
Final Hip Height, in	44.7	44.7	45	44.9	44.9
ADG, lb	1.84	1.86	1.88	1.89	1.88
First calving age	725	714	711	715	714
Final Std ME, lb	25,691	26,519	26,555	26,203	26,338

Table 4. Raw means – profiles of SROC dairy heifer calves in farm C showing relationships of initial serum protein to growth by 6 months of age and by complete lactations on their home through 2013.

Initial SP, g/dl	4 or <	4.1-4.5	4.6 -4.9	5-5.4	5.5 or >
Farm C (1,595)					
% of heifers	2.4	7	12.8	38.9	38.9
Final BW, lb	458	456	455	459	457
Final Hip Height, in	45.2	45.0	45.1	45.2	45.1
ADG, lb	1.89	1.89	1.89	1.90	1.90
First calving age	723	719	715	717	713
Final Std ME, lb	25,569	27,671	27,972	27,751	27,759

Calf nursery research studies. A target goal for calf performance in the nursery phase is to double the initial body weight by the end of the nursery phase and gain at least 4 inches of frame height in the same time period. It has been suggested that during the first 2 weeks in the nursery a goal is to attain 1 lb/day daily gain to aid in calf health. These goals have been attained in a number of calf groups but there are some variations by season of the year. Prior to February 2010, MR were medicated with 2:1 neomycin (400g/ton):oxytetracycline (200 g/ton; unless noted otherwise). Since 2010, calves have been fed a non-medicated MR supplemented with 1:1 higher concentration of neomycin:oxytetracycline (1600g/ton) for the first 14 days. In the winter months the volume of MR may be increased based on the ambient temperature taken in the morning. This adjustment only occurs from 0^{o} F and below. Calves will remain in their respective pens until 2 weeks after weaning and then transfer to group pens of 6-8 heifers. Occasionally calves have remained in the nursery for up to 70 days. At least 20-25 calves are assigned for each treatment group for nursery studies.

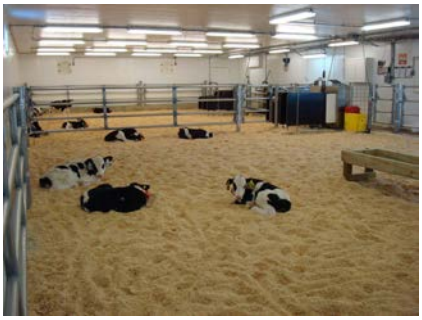
Automatic calf feeding system in a renovated calf room. An Urban automatic calf feeding system at SROC has been functional since September 2011 in a renovated calf room. Calves are placed into the AFR upon arrival to SROC. The Urban feeder is capable of feeding the same or two different milk replacers independently to calves co-mingled in two pens of 23 (32 sq ft/calf). Initially, within each pen automatic grain feeders or bunks were evaluated for calf starter intake. Calves have used the bunk feeder more readily for establishing good feed intake. The initial goal was to use a base conventional program similar to that fed in individual pens so comparisons can be assessed. Calves are fed 3-4 times a day. Calves using the automatic feeder on a conventional program tend to have lower overall gains than those fed in individual pens. Much of this is due to the adjustment to feeding amounts especially during the first 2 weeks. Health costs were higher for calves on the AFM vs. IPF calves. Proper ventilation is very critical to the success of an AFM system. Recent calf groups have been fed more moderate intensive or intensive feeding programs. With good starter intake it is

not necessary to feed over 2 lb of milk replacer powder/day to double birth weight in 56 days. In fact the last group of calves on the AFM fed a conventional program doubled birth weight, weaning at 42 days. Group feeding can be very successful if you can keep calves healthy and get them to eat starter early.

Recent autofeeder program demonstration example July-September, 2014 – 22 calves/pen

- ✓ MR 20:20 1.25 lbs/day 3 feedings vs. MR 28:18 up to 2.2 lbs/day 5 feedings
- ✓ 1-42 Gain 1.53 vs. 1.58 lbs/day
- ✓ 1-56 Gain 1.82 vs. 1.88 lbs/day
- ✓ More than doubled initial BW and over 5 inches HH gain.
- ✓ Calf health very good in this group – this is the most variable aspect of the system

Calf Starter (CS) x2 for conventionally fed calves



SROC Urban computer milk and grain feeders placed in a renovated calf room in 2011 – design by U of MN David Ziegler; ventilation help from Kevin Janni

Recent Feeding Stategies - A series of studies during 2012-2013 evaluated milk replacer feeding strategies to include a conventional vs. moderate intensive or intensive programs. The first in a series included a 20: 20 MR fed at 1.25 lb/day from d 1-35 and 0.625 lb/day from day 36-42; 20:20 MR fed at 1.50 lb/day from day 1-35 and 0.75 lb/day from day 36-42; 24: 20 MR fed at 1.25 lb/day from d 1-35 and 0.625 lb/day from day 36-42; 24:20 MR fed at 1.50 lb/day from day 1-35 and 0.75 lb/day from day 36-42. The results demonstrated that calves fed a conventional MR at different feeding rates with different CP concentrations performed similarly. Calves fed higher CP MR at higher feeding rates had numerically greatest daily gain. A moderate MR feeding program using the 24:20 MR at different feeding rates during

a 56-d nursery study was the next study in the series. An 18% CP texturized calf starter (CS) was offered free choice through d 56. Calves were offered a 24:20 MR fed at 0.625 lb x2 daily for 35 d; a 24:20 MR fed at 0.75 lb x2 daily for 35 d; 24:20 MR fed at 0.75 lb x2 daily for d 1 to 7 and 0.95 lb x2 daily from d 8 to 35 and a 24:20 MR fed at 0.75 lb x2 daily for d 1 to 7 and 1.09 lb x2 daily from d 8 to 35. All calves fed their respective MR x1 daily from d 36 to weaning at 42 d. Feeding calves a 24:20 MR at 1.25 and 1.50 lb daily maintains CS intake to enhance protein and energy intake by calves. Feeding > 1.50 lb daily inhibits CS intake without improving growth rates. The previous studies have demonstrated that a 24:20 MR modified accelerated program fed at higher feeding rates resulted in improved growth performance and feed efficiency but the effect was not linear.

The design of the third study in the series was conducted in the summer months to evaluate performance and health of calves fed a varying levels of protein and fat at different feeding rates in the MR to determine if lowering the fat level or increasing the protein level affects calf performance through 8 weeks of age during the summer months. Comparisons included a 24% protein:20% fat non-medicated all-milk protein milk replacer at 1.25 lb powder daily (reconstituted with water to 14.7% solids) for 35 days and 0.625 lb/ once daily from day 36 to weaning at day 42; a 24:20 MR fed at 1.50 lb daily for 35 days and 0.75 lb once daily from day 36 to 42; a 24:16 MR fed as in treatment 2 vs. 24:16 MR fed as in treatment 3 for 7 days and 1.875 lb from day 8 to 35 and 0.9375 lb once daily from day 36 to 42 and a 26:16 MR fed as in treatment 4. All milk replacers were balanced for essential amino acids. Calves were offered free choice 18% CP texturized calf starter and water daily. Table 5 summarizes the main effects. This study demonstrates that feeding a modified accelerated MR (24:20) at a moderate feeding rate improves ADG compared to calves fed MR having similar or different CP and fat combinations. Frame growth was excellent for all calf groups.

Other nursery studies have continued to evaluate alternative protein sources for milk replacers, strategies for reducing heat stress during the summer months and additives in calf starters to improve feed efficiencies.

Table 5. Daily gain, frame growth, intake of milk replacer (MR), calf starter (CS) gain/feed and water.[1]

Item	24:20 1.25 lb	24:20 1.5 lb	24:16 1.5 lb	24:16 1.875 lb	26:16 1.875 lb	SEM
No. calves	25	25	25	25	26	
ADG, lb/d						
1 to 14 d	0.97^{c}	1.19^{bc}	1.05^{c}	1.31^{ab}	1.43^{a}	0.06
1 to 42 d	1.36^{ab}	1.47^{a}	1.34^{b}	1.41^{ab}	1.45^{a}	0.05
1 to 56 d	1.57^{ab}	1.66^{a}	1.54^{b}	1.56^{ab}	1.58^{ab}	0.06
HH gain, in						
1 to 56 d	4.68^{ab}	4.92^{ab}	4.56^{b}	5.02^{a}	5.05^{a}	0.21
Total MR intake, kg/d						
1 to 42 d	1.13^{a}	1.39^{b}	1.38^{b}	1.63^{c}	1.62^{c}	0.02
Total CS intake, lb/d						
1 to 42 d	1.04^{a}	0.86^{b}	0.82^{bc}	0.64^{cd}	0.60^{d}	0.12
1 to 56 d	2.05^{a}	1.92^{a}	1.83^{ab}	1.65^{bc}	1.59^{c}	0.09
Gain per feed						
1 to 42 d	0.63^{bc}	0.65^{ab}	0.61^{c}	0.63^{ab}	0.66^{a}	0.01
43 to 56 d	0.44	0.44	0.44	0.44	0.43	0.01
1 to 56 d	0.42^{a}	0.42^{a}	0.39^{b}	0.39^{b}	0.39^{b}	0.01
Water intake, L/d						
1 to 7 d	0.96^{w}	1.29^{vw}	1.46^{v}	1.30^{vw}	1.34^{vw}	0.27
8 to 14 d	1.05^{a}	1.28^{b}	1.34^{b}	1.35^{b}	1.43^{b}	0.16
15 to 21 d	1.43	1.58	1.56	1.52	1.62	0.22
22 to 28 d	1.76	1.85	1.63	1.65	1.68	0.23
29 to 35 d	2.44^{vw}	2.57^{w}	2.40^{vw}	2.32^{vw}	2.16^{v}	0.22
36 to 42 d	4.33^{ab}	4.58^{a}	4.03^{ab}	3.19^{c}	3.72^{bc}	0.28
43 to 49 d	7.27^{ab}	7.58^{a}	6.76^{ab}	6.41^{b}	6.59^{b}	0.31
50 to 56 d	8.40^{ab}	8.78^{a}	7.67^{bc}	7.59^{bc}	7.57^{c}	0.32

[1]Adapted from Strayer (2014).

$^{a, b, c, d}$Means differ, $P \leq 0.05$.

$^{v, w}$Means differ $P \leq 0.10$.

Post weaning group housing. Overview Two post weaning barns are used to house heifers until they attain 6 months of age. A new 65 ft x 150 ft curtain side-wall naturally ventilated facility completed in 2004 is located north of the calf nursery barns. This contains 20 12ft x 25 ft pens and a scale with handling area. The front part of each pen is a scrape alley and the rear a manure pack. Heifers are fed through diagonal bars from a central feed alley. The front alley is scraped weekly and the manure pack cleaned out as often as deemed necessary. Pens are re-bedded once or twice weekly. A second post weaning barn is an existing 80 ft x 160 ft manure pack pole barn. The barn contains 20 15 ft x 30 ft pens each with 10ft concrete feed bunks. There is a central scale and heifer handling area. This barn is cleaned out twice annually but pens are re-bedded once or twice weekly. Both barns are used for studies alternating a complete study between each. Heifers are fed once daily and both barns are managed as a continuous flow system.

One post weaning study was conducted in 2013-2014. The results were not presented at Regional or National meetings so an overview is included in this report.

Performance of dairy heifers from 4 to 6 months of age when offered 17% crude protein (CP) alfalfa or fiber blend pellets as a replacement for hay in grower rations (collaborators - University of Minnesota, Minnesota Alfalfa Producers and Ag. Utilization Research Institute).

Eighty-four (84) four month-old dairy heifers were assigned to four replicated pens (Seven heifers/pen) each of three treatments. Heifers were housed in a naturally ventilated curtain side-wall barn. Prior to the study all heifers had been fed a 16% CP corn and pellet grain mix at 5 lbs/head daily with access to free choice hay.

Treatments included:

1), 16% CP corn and pellet grain mix control fed at 4.7 lbs/day for 56 days with hay;
2), 16% CP corn and pellet grain mix fed at 4.7 lbs/head daily with 17% alfalfa pellets replacing a similar amount of hay;
3), 16% CP corn and pellet grain mix fed at 4.7 lbs/head daily with 17% blended fiber pellets replacing a similar amount of hay;

Conclusion - Partially replacing hay in a grower diet with alfalfa or blended pellets enhanced heifer performance compared to those fed a standard grower diet. Heifers fed the blended pellet diet performed better than those fed the alfalfa pellet diet. Some of these difference may be related to the higher energy, lower fiber levels and greater acceptance by heifers fed the blended vs. alfalfa pellet diets. There tended to be more fines in the blended pellet.

Table 6. Nutrient composition of feeds (DM basis) used in the 56 day study

Analyses	Corn	Pellet for Grain Mix	Grain Mix	Hay	Alfalfa[1] Pellet	Blended[1] Pellet
DM, %	85.44	89.81	88.13	87.74	92.40	93.41
CP, %	8.88	37.75	20.92	19.45	18.06	18.33
ADF, %	2.74	13.31	5.53	33.57	42.09	31.43
NDF, %	8.10	19.03	10.66	43.34	53.00	46.62
Fat, %	3.70	2.49	5.15[2]	-----	1.51	4.90
Ca, %	0.02	2.34	0.97	1.62	1.31	0.95
P, %	0.28	1.01	0.57	0.25	0.24	0.40
Mg, %	0.12	0.51	0.27	0.47	0.31	0.34
K, %	0.37	1.50	0.82	1.49	1.92	1.23
TDN, %	87.36	61.63	77.22	62.75	57.48	62.16

[1]Average analyses from MNVAP and SROC data
[2]Additional 1.25% choice white fat added at mixin

Abstract presented at the Midwest 2014 ADSA/ASAS Meeting in Des Moines.

Pre- and post weaning performance and health of calves fed texturized calf starters with different additives during the nursery phase*. H. Chester-Jones, B. Ziegler, D. Schimek, and D. Ziegler.*

One-hundred-thirty-one (2-4 d old) individually fed Holstein heifer calves (39.3 ± 0.66 kg) were randomly assigned to 1 of 5 treatments to evaluate pre- (d 1-42) and post weaning (d 43-56) calf performance and health when fed 18% CP (as-fed) texturized calf starters (CS) with different additives. All calves were fed a non-medicated 20% fat:20% protein milk replacer at 0.284 kg in 1.99 L water (12.5% solids) 2X daily for the first 35 d and 1X daily from d 36 to weaning at 42 d. During the first 14 days of the study, neomycin (1600 g/ton) and oxytetracycline (1600 g/ton) were mixed with the milk replacer to provide 22 mg/kg BW daily to each calf to control diarrhea during this period. Calf starters were fed free choice from d 1 and calves had access to fresh water. The additives in the CS included:1), none (N); 2), decoquinate (DQ) at 49.9mg/kg; 3), monensin (M) at 44 mg/kg; 4), lasalocid (L) at 96.8 mg/kg; and 5), bambermycin (B) at 44 mg/kg. There were no CS gain affects during d 1 to 14 when CS intake was low. Calves fed B had the highest ADG ($P < 0.05$), d 15 to 28. From d 29 to 42 calves fed CS with B, L, and DQ had higher ADG ($P < 0.05$) than those fed M but similar to N calves. Overall pre-weaning daily gains were similar across CS treatments ($P > 0.05$). Pre-weaning CS intakes were higher for calves fed B vs. those fed N and M which reflected ADG differences in the interim weigh periods. Daily gains post-weaning and overall d 1 to 56 were the lowest for calves fed M ($P < 0.05$). Calves fed B had higher ADG ($P < 0.05$) for d 1 to 56 than those fed N. Total d 1 to 56 DMI was the lowest ($P < 0.05$) for calves fed M. Gain/feed was not affected by CS fed. Hip height gain averaged 10.8 cm. Average daily gains for the 56 d study were 0.75, 0.78, 0.69, 0.76 and 0.81 kg for calves fed N, DQ, M, L, and B, respectively. There were no health differences across treatments ($P > 0.05$). Under the conditions of this study, calves fed M had the lowest overall performance. Calves fed DQ, L and B performed similarly.

***Note - Bambermycin was used as an extra label additive as it is only approved for grazing heifers.**

Abstracts presented at the 2014 ADSA/ASAS Meeting in Kansas City.

Development of a modified accelerated milk replacer feeding program for dairy calves. *B. Strayer, D. Ziegler, D. Schimek, B. Ziegler, H. Chester-Jones, J. Anderson, K. Kalscheur, and D. P. Casper.*

Our previous studies have demonstrated that a modified accelerated milk replacer (MR) having a 24:20 crude protein (CP):fat concentration fed at higher feeding rates (FR) resulted in improved growth performance and gain/feed, but not linearly. The current study was to evaluate pre- (d 1-42) and post-weaning (d 43 to 56) calf

performance when modified accelerated MR was fed at higher FR compared to a MR having similar or higher CP and lower fat concentrations. One-hundred thirty (1 to 6 d old) fed Holstein heifer calves (40.1±0.76 kg) were blocked by birth date and randomly assigned to 1 of 5 treatments. Treatments of MR fed at 14.7% solids were: 1) Control (C): all milk 24:20 MR fed at 0.26 kg at 2x/d from d 1 to 35; 2) C+: C MR fed at 0.32 kg 2x/d from d 1 to 35; 3) LF: CP and low fat (24:16) MR fed at 0.32 kg 2x/d from d 1 to 35; 4) LF+: LF MR fed at 0.32 kg 2x/d from d 1 to 7 and at 0.39 kg from d 8 to 35; and 5) HP+: High CP:LF MR (26:16) fed at the rates of LF+. All MR were fed 1x/d from d 36 to weaning at d 42 with water and 18% CP texturized calf starter (CS) offered free choice from d 1 through 56. Calves fed C+ had greater ($P < 0.05$) ADG (0.71, 0.75, 0.70, 0.72, and 0.72 kg/d for C, C+, LF, LF+, and HP+, respectively) from d 1 to 56 compared to calves fed LF, with other treatments being intermediate. Calves fed C+, LF, and HP+ were similar, but taller at the hips ($P<0.05$) than calves fed C and LF+ (98.1, 99.6, 99.8, 98.5, and 99.8 cm) while, calves fed C+ had greater hip widths on d 56 (22.3, 22.6, 21.7, 21.8, and 22.3 cm) and on d 84 (26.2, 26.5, 26.0, 26.2, 26.4 cm) than calves fed other MR. This study demonstrates that feeding a modified accelerated MR (24:20) at a moderate FR improves ADG and frame measurements compared to calves fed MR having similar or different CP and fat concentrations. The development of a modified accelerated feeding program optimized the protein energy ratio for the potential of producing a dairy heifer with a frame that is taller and wider without having a weaning slump.

Pre- and post-weaning performance and health of calves fed milk replacers with two protein concentrations and two feeding rates. *B. Strayer, D. Ziegler, D. Schimek, B. Ziegler, M. Raeth-Knight, H. Chester-Jones, and D. P. Casper.*

One-hundred eight (1 to 5 d old) Holstein heifer calves (39.3±0.66 kg) were randomly assigned to 1 of 4 milk replacers (MR) to evaluate pre- (d 1 to 42) and post- (d 43 to 56) weaning performance in a 2 x 2 factorial design of crude protein (CP) concentrations (20% (CP) and 24% (HP)) with feeding rates (FR; 0.57 (1) and 0.68 (2) kg/d). Treatments were MR fed at 15% solids of: 1) Control (CP1): a 20% CP:20% fat MR fed at 0.284 kg 2x/d for 35 d; 2) CP2: the 20:20 MR fed at 0.34 kg 2x/d for 35 d; 3) HP1: a 24:20 MR fed at CP1 rate; and 4) HP2: the 24:20 MR fed at CP2 rate. All MR's were fed at 1x/d from d 36 to weaning at d 42 with water and 18% CP texturized calf starter (CS) offered free choice through d 56. No significant ($P>0.10$) interactions of CP by FR were detected for growth parameters. During d 1 to 14, calves fed CP2 and HP2 had the greatest ADG (0.36, 0.44, 0.36, and 0.45 kg/d for CP1, CP2, HP1 and HP2, respectively) compared to calves fed CP1 and HP1, but the interaction was non-significant ($P>0.10$). Pre-weaning ADG's (d 1 to 42) were similar ($P > 0.10$). Calves fed HP2 had numerically greatest overall ADG d 1 to 56 compared to calves fed CP1 and HP1 with CP2 being intermediate. Intake of CS from d 1 to 56 was similar ($P>0.10$) for calves fed MR with different CP concentrations (0.77 and 0.78 kg/d), while CS intake (0.81 and 0.74 kg/d) was reduced ($P<0.05$) for calves fed higher MR FR. Feed conversions from d 1 to 56 were similar for calves fed different CP concentrations (0.54 and 0.55 kg/kg), but were improved when fed higher MR FR (0.53 and 0.56 kg/kg). However, a trend

(P<0.11) of CP by FR interaction from d 43 to 56 demonstrated calves fed CP2 having greater feed conversions (0.46, 0.53, 0.46 and 0.49 kg/kg for C-, C+, HP-, and HP+, respectively) compared CP1, HP1 and HP2 calves. Thus, indicating a carryover effect on post-weaning performance for CP2 calves. The results demonstrate calves fed a conventional MR at different FR with different CP concentrations performed similarly. Calves fed higher CP MR at higher FR had numerically the greatest ADG.

Pre- and post weaning performance and health of calves fed 24% crude protein, 20% fat milk replacers at different feeding rates. *B. Strayer, D. Ziegler, D. Schimek, B. Ziegler, M. Raeth-Knight , H. Chester-Jones, and D. P. Casper.*

In our previous work, calves fed greater amounts of milk replacer (MR) and CP demonstrated improved growth. The current study objectives were to evaluate the pre-(d 1 to 42) and post (d 43 to 56) weaning performance and health of calves fed a 24% CP:20% fat MR at different feeding rates (FR). One-hundred eight (1-5 d old) individually fed Holstein heifer calves (40±0.69 kg) were randomly assigned to 1 of 4 treatments. Treatments (all 14.7% solids) were 1) Control, 24% CP:20% fat MR fed at 0.284 kg in water x2 daily for 35 d (MR57); 2) 24:20 MR fed at 0.34 kg fed 2x daily from d 1 to 7; d 8 to 35 0.34 kg MR x2 daily (MR71); 3) 24:20 MR fed as MR71 for d 1 to 7; d 8 to 35 0.43 kg MR fed x2 daily(MR85); 4) 24:20 MR fed as MR71 for d 1 to 7; d 8 to 35 0.497 kg MR fed x2 daily (MR99).All treatments were fed 1x daily from d 36 to weaning at d 42. Calves were offered water and an 18% CP texturized calf starter (CS) free choice. Pre-weaning and overall ADG were higher (P < 0.05) for MR99 calves vs. MR57 control calves with other calves being intermediate. Overall ADG d 1 to 56 was 0.78, 0.82, 0.83 and 0.85 kg/d for MR57, MR71, MR85, and MR99, respectively. Overall d 1 to 56 CS intake was higher (P < 0.05) for MR57 calves vs. other calf groups. There were no differences in total DMI (P > 0.05). Pre-weaning gain/feed was lowest (P < 0.05) for control MR57 calves. Gain/feed d 1 to 56 was higher (P < 0.05) for MR99 vs. MR57 calves with other groups being intermediate (0.49, 0.52, 0.52 and 0.54 kg/kg DM for MR57, MR71, MR85 and MR99, respectively). This study demonstrated that feeding higher FR of a 24:20 MR resulted in higher ADG and gain/feed.

Pre- and Post weaning performance and health of dairy calves fed all-milk protein milk replacers or partially replacing milk protein in milk replacers with plasma, wheat proteins and soy protein concentrate. *D. Ziegler, H. Chester-Jones, B. Ziegler, D. Schimek, M. Raeth-Knight and David Cook.*

One-hundred five (2-5 d old) individually fed Holstein heifer calves (39.8 ± 0.73kg) were randomly assigned to 1 of 4 treatments to evaluate pre- (d 1-42) and post weaning (d 43-56) calf performance and health when fed milk replacers (MR) with alternative protein sources. Calves were assigned to non-medicated MR with 1) All milk protein (AM), 2) 50% of total protein from wheat and plasma (WPL), 3) 50% of total protein from soybean protein concentrate (SPC) and plasma (SPL), and 4) 50% combination of wheat, SPC and plasma (SWP). All calves were fed a non-medicated

20% fat:20% CP MR at 0.284 kg in 1.99 L water (12.5% solids) 2X daily for the first 35 d and 1X daily d 36 to weaning at 42 d. Day 1 to 14, 1:1 neomycin:oxytetracycline was added to the MR solution to provide 22 mg/kg BW/d. Calf starter (CS; 18% CP) and water were fed free choice from d1. Osmolality of the MR were 469, 421, 395 and 412 mOsm/L for AM, WPL, SPL, and SWP, respectively. There were no pre- ($P = 0.11$) or post weaning ($P = 0.30$) ADG differences. Calves averaged 0.74 kg/d gain for the 56-d study. There were no differences in CS ($P = 0.22$) or total DMI intake ($P = 0.33$) which averaged 55.3 and 77.08 kg for the 56-d study, respectively. Pre-weaning gain/feed was higher ($P < 0.05$) in calves fed WPL vs. those fed SPL and SWP but similar to AM calves. There were no overall 56-d differences in gain/feed ($P = 0.19$). Across treatments, calves doubled their initial BW and gained > 10.2 cm in frame growth. Fecal scores d 1 to 14 and overall were higher ($P < 0.05$) for AM fed calves compared to WPL, SPL, and SWP treatments. The number of scouring d pre-weaning were also higher ($P < 0.05$) for AM calves vs. those fed SPL and SWP with WPL calves being intermediate. There were no differences in health treatment costs. Under the conditions of this study, replacing 50% of the total milk protein in MR with alternative sources resulted in calf performance and health similar to all milk protein.

Performance and health of calves pre- and post weaning fed milk replacers with supplements for heat abatement in the summer months. *D. Schimek, B. Ziegler, D. Ziegler, H. Chester-Jones, and M. Raeth-Knight.*

Two studies were conducted in the summer of 2012 and 2013 to evaluate pre- (d 1-42) and post-weaning (d 43-56) calf performance and health when fed milk replacers (MR) with supplements to aid in heat abatement. Calves were fed a non-medicated 20% fat:20% CP MR at 0.284 kg in 1.99 L water (12.5% solids) 2X daily for the first 35 d and 1X daily from d 36 to weaning at 42 d. From day 1 to 14, 1:1 neomycin:oxytetracycline was added to the MR solution to provide 22 mg/kg BW daily. Calf starter (CS; 18% CP) and water were fed free choice d 1 to 56. In study 1, fifty-one (2 to 4 d old) individually fed Holstein heifer calves (38.5±0.96 kg) were assigned to MR supplements as follows: SA1= none; SA2= B-complex vitamin premix fed at 1.42 g/calf daily and SA3= betaine fed at 5 g/calf daily. There were no treatment differences in pre- and post-weaning ADG or total hip height (HH) gain which averaged 0.64 kg and 9.63 cm, respectively. There was a trend ($P< 0.10$) for increased 56-d CS intake when calves were fed the SA2 or SA3 compared to SA1 MR (0.81 vs 0.72 kg DM/d).There were no differences in BW gain, total DMI, gain/feed or scouring days across treatments. Calves fed SA2 had higher ($P < 0.05$) daily health treatment costs vs. SA1 calves but were not different from SA3 calves ($P = 0.07$). In study 2, seventy-five (2 to 4 d old) individually fed Holstein heifer calves (39.4±0.65 kg) were assigned to MR supplements SB1, none; SB2, B-complex vitamin premix fed as in study 1 and SB3, B-complex vitamins as in SB2 plus an electrolyte mix fed at 28 g/calf daily. There were no treatment differences in ADG and HH gain (0.68 kg and 10.85 cm, respectively over the 56-d study). Pre-weaning gain/feed was higher ($P < 0.05$) for SB3 compared to SB1 or SB2 calves. There were no differences in health parameters. A heat index of 90 or more

occurred on 34 d in 2012 and 26 d in 2013 studies, respectively. Under the conditions of these studies, heat abatement supplements added to MR did not consistently enhance calf performance.

Health of dairy calves when using automated feeders in the Midwest United States. *M. Jorgensen, A. Adams Progar, S. Godden, H. Chester-Jones, J. Rushen, A. M. de Passille,and M. I. Endres.*

Research is limited regarding best housing and management practices for automated calf feeding systems, particularly in terms of how these factors influence animal health and welfare. This ongoing study is characterizing health scores, morbidity, and mortality of group-housed calves on U.S. farms and relating these to housing and management practices. Thirty-eight dairy farms in the Midwest United States were visited every 60 d. During each visit, calves (n = 7779) were scored for health using 4 categories: attitude (0 to 4), ears (0 to 4), nose (0 to 3),eyes (0 to3), and cleanliness (an indicator of diarrhea, 0 to 2), with 0 representing a normal, healthy calf. In addition, blood was drawn from any calves 1- to 5-d old (n = 711) and serum protein concentration was used to assess passive immunity transfer. During each season, milk samples were collected from the mixing container inside the feeder and the tube leading to the nipple for measurement of standard plate count (SPC) and coliform count. Pearson's correlation coefficient was used to analyze the relationship between mean SPC and health scores. There was a large variation among farms in calf health. On the10 farms with the best health scores, a mean of 9.7% (range of 2.9 to 12.9) of animals displayed abnormal scores for attitude, 3.7% (1.7 to 5.1) for ears, 12.2% (7.8 to 14.8) for nose, 7.2% (2.0 to 11.9) for eyes, and 26.4% (20.1 to 32.6) for cleanliness. On the 10 farms with the worst health scores, a mean of 22.8% (15.7 to 30.3) of animals displayed abnormal scores for attitude, 14.4% (10.0 to 22.5) for ears, 27.2% (22.8 to 30.6) for nose, 30.3% (22.5 to 36.4) for eyes, and 54.9% (50.6 to 60.3) for cleanliness. Mean serum protein across all samples was 5.40 ± 0.74 mg/dl. Mean serum protein by farm was 5.34 mg/dl (minimum = 4.27, maximum = 6.5). The highest overall bacterial counts were recorded in feeder tube samples (median, coliform = 2550 CFU/ml; SPC = 330,000 CFU/ml; Q3 = 3350,000). No relationship was observed between tube SPC and attitude, ears, nose, or eyes scores; however, SPC was correlated with calf cleanliness scores (r = 0.26, P = 0.002). The variation in health scores among farms shows that welfare in automated feeder systems can be improved. In addition, results indicate that the cleanliness of automated feeder equipment may influence calf health; however, further data collection and analyses of calf morbidity and mortality should provide a more complete understanding of risk factors. This project is supported by Agriculture and Food Research Initiative competitive grant no. 2012–67021–19280 from the USDA National Institute of Food and Agriculture.

Effect of two winter housing systems on production, body weight, somatic cell count, BCS, and dry matter intake of organic dairy cows.

L. S. Sjostrom, B. J. Heins, M. I. Endres, R.D. Moon, U. S. Sorge

Organic cows (n = 83) were used to evaluate the effect of 2 winter housing systems (December 2012 to May 2013) on production, SCC, body weight, BCS, and DMI. Cows were assigned to 1 of 2 treatments (2 replicates per group): 1) outdoor (straw pack, n = 42) or 2) indoor (compost-bedded pack barn, n = 41). There were 21 cows per replicate for the outdoor housing and 21 and 20 cows per replicate for the indoor housing. Cows calved during 2 seasons (March to May 2012 and September to December 2012) at the University of Minnesota West Central Research and Outreach Center, Morris, Minnesota, organic dairy. Organic wheat straw was used as bedding for the 2 outdoor bedded packs, which were 12 m wide by 27 m long, and maintained by farm management to keep cows dry and absorb manure throughout the winter. The open-front compost-bedded pack barn (2 pens in the barn) was bedded with organic approved sawdust, and the bedding material was stirred twice per day with a small chisel plow. Cows were fed a TMR that included organic corn silage, alfalfa silage, corn, expelled soybean meal, vitamins and minerals. Milk, fat and protein production and SCC were recorded from monthly DHIA testing. Body weight and BCS were recorded bi-weekly as cows exited the milking parlor. The PROC MIXED of SAS was used for statistical analysis, and independent variables were fixed effects of season of calving (fall or spring), parity (1, 2, 3+), breed group, housing system, with replicate and cow nested within the interaction of housing system and season as a random effect. Energy-corrected milk and SCC was not different for the outdoor (15.5 kg/d, 206,000 ml) and indoor (16.1 kg/d, 357,000 ml) housing systems, respectively. In addition, outdoor and indoor housing systems were not different for body weight (523 vs. 538 kg) and BCS (3.15 vs. 3.08), respectively. Daily DMI was 17.8 kg/d for indoor cows and 17.6 kg/d for the outdoor cows ($P = 0.47$). Total bedding costs during the winter was $8,275 for the outdoor system and $9,248 for the indoor system. In summary, cows housed outdoors on straw-bedded packs did not differ from cows housed in an indoor compost-bedded pack barn for production and SCC, as well as body weight, BCS, or DMI.

Effect of organic grain supplementation on activity and rumination time of organic dairy cows.

L. S. Sjostrom, B. J. Heins, M. I. Endres, R.D. Moon, J.C. Paulson

Organic cows (n = 57) were used to evaluate activity and rumination time of cows fed 3 grain supplementation strategies during the grazing season. Cows were assigned to 1 of 3 replicate supplementation groups: 1) no corn grain supplementation (100% pasture, GRS, n = 19), 2) low corn grain (2.72 kg/head/day, LOW, n = 19), and 3) high corn grain (5.44 kg/head/day, HI, n = 19), and calved during 2 seasons at the University of Minnesota West Central Research and Outreach Center, Morris, from October to December 2012 and March to May 2013. Supplement (organic corn grain and minerals) was fed with a TMR of corn silage and alfalfa haylage, and at least 30% of diet DMI for LOW and HI cows consisted of organic pasture. Pasture and TMR intake were measured on a group basis, because cows were group

fed. Activity and rumination time (daily and 2-h periods) were monitored electronically using HR-LD Tags (SCR Engineers Ltd., Netanya, Israel) for 125 days. Activity is reported in "activity units" from SCR DataFlow II software. The PROC HPMIXED of SAS was used for statistical analysis, and independent variables were season of calving (fall or spring), month of grazing (June to September), parity (1, 2, 3+), breed group, supplementation group and the interactions of month of grazing and supplementation group, breed group and supplementation group, and parity and supplementation group. Cow and replicate were random effects with repeated measures. The GRS (1,138) cows had greater ($P < 0.05$) daily activity than HI (1,001) cows, but were similar to LOW (1,019) cows. Daily activity was the greatest ($P < 0.05$) during July (1,258) and least during September (819). Rumination was not different for the GRS (397 min/d), LOW (384), and HI (370) cows. Daily rumination was greater ($P < 0.05$) during September (402 min/d) compared to July (361). Daily activity increased rapidly from h 6:00 and 8:00 to h 16:00 and 18:00. From h 18:00 to 20:00, cows had a rapid decline in activity until h 6:00 the next day. All supplementation groups had the greatest rumination during h 2:00 and 4:00 and the least during h 10:00 and 12:00. In summary, GRS cows had greater activity, but not greater daily rumination, compared to LOW AND HI supplemented cows. Monthly activity and rumination patterns of grazing organic cows may have been influenced by the weather and fly populations.

Effect of organic grain supplementation on production, body weight, body condition score, and fatty acid profiles of organic dairy cows.

B. J. Heins, M. I. Endres, J. C. Paulson, R. D. Moon

Organic cows (n = 153) were used to evaluate the effect of grain supplementation levels during 2 grazing seasons (May to September 2012 and May to September 2013) on production, body weight, body condition score (BCS), and fatty acid profiles of organic dairy cows. Cows were assigned to 1 of 3 replicate supplementation groups: 1) no grain supplementation (100% pasture, GRS, n = 51), 2) low grain (2.72 kg/head/day, LOW, n = 51), and 3) high grain (5.44 kg/head/day, HI, n = 51), and calved at the University of Minnesota West Central Research and Outreach Center, Morris, Minnesota. Supplement (organic corn and minerals) was fed with a partial mixed ration (PMR) of corn silage and alfalfa haylage, and at least 30% of diet dry matter intake for LOW and HI cows consisted of organic pasture. Milk production, from daily milk weights, was averaged weekly for cows, and body weight and BCS were recorded bi-weekly. Milk for fatty acid analysis was collected monthly and analyzed at R-Tech Analytical Laboratory (Arden Hills, MN). The PROC MIXED of SAS was used for statistical analysis, and independent variables were fixed effects of year (2012 or 2013), season of calving (fall or spring) nested within year, parity (1, 2, 3+) nested within year, supplementation group, breed group; week nested with supplementation group, with replicate nested within year and cow nested within supplementation group and breed group as a random effect with repeated measures. The GRS (14.4 kg/d) cows had lower ($P < 0.05$) energy-corrected milk than LOW (16.2 kg/d) and HI (17.0 kg/d) cows; however, the LOW and HI cows were not different from each other. The GRS, LOW, and HI cows were not different for body weight across the grazing season (491, 498, 498 kg, respectively); however, GRS (3.05) cows had lower ($P < 0.05$) BCS than

LOW (3.14) and HI (3.15) cows. Milk urea nitrogen was higher ($P < 0.05$) for GRS (19.5 mg/dl) than LOW (12.0 mg/dl) and HI (9.9 mg/dl) cows. Furthermore, omega-3 fatty acid was higher ($P < 0.05$) for the GRS (0.05%) cows compared to the LOW (0.04%) and HI (0.03%) cows. Organic dairy cows that consume 100% pasture had lower production, but milk from cows that consume 100% pasture compared to pasture and PMR had fatty acid composition of potential benefit to human health.

Seasonal changes in DM, CP, NDF, and NDF digestibility of pasture forage in dairy grazing production systems in Minnesota.

J.C. Paulson, B. J. Heins and D.G. Johnson

Nine grazing dairy farms were utilized in a study to measure monthly changes in forage quality of pastures over a two-year period. Farms were from a wide geographical area across Minnesota representing a range in soil type and annual rainfall amounts as well as herd size, pasture size and pasture management. Pasture forage was sampled every two weeks during the growing season and analyzed for DM, CP, NDF, and NDF digestibility concentrations. Data were analyzed using PROC MIXED of SAS. Independent variables for analyses were the fixed effects of farm (n=9), season (spring, summer or fall), year (1 or 2) and their interactions. The DM concentration was different ($P <.05$) between farms. Across the 9 farms, spring pasture DM (23.96%) was higher ($P < 0.05$) than summer (23.52%) and fall (19.76%) pasture DM. Average DM for each year was 22.71% and 22.12% for 2004and 2005, respectively and they were not different. There were ($P<.05$) differences in CP concentrations between farms and across seasons on all farms. Concentrations of CP averaged 21.52% in year 1 and 21.85% in year 2. Seasonal average CP concentrations were 21.01%, 20.11% and 23.93% for spring, summer, and fall respectively. NDF concentration in the pasture forage was different ($P < 0.05$) across the 9 farms, as well as different ($P < 0.05$) for spring, summer, and fall grazing. However, there were no differences within farm and season or across year for NDF. NDF was 46.91% in year 1 and 47.53% in year 2. Seasonal NDF concentrations were 46.63%, 49.25%, and 45.97% for spring, summer, and fall, respectively. There was a difference ($P < 0.05$) across farms for NDF digestibility-30 h and within farm and year. Average NDF digestibility-30 h values for year 1 were 46.33% and for year 2 were 46.55%, and 46.64%, 44.71% and 47.98% for spring, summer, and fall, respectively. In summary, pasture management within a farm can influence the forage quality of pasture forage for grazing dairy animals.

Effect of feeding kelp on growth and profitability of group-fed dairy calves in an organic production system.

B. J. Heins and H. Chester-Jones

Heifer calves (n = 113) were used to evaluate the effect of feeding kelp on growth and economics of calves in an organic group management system. Calves were assigned to replicate feeding groups of 10 in super hutches by birth order during two seasons from

September to December 2012 and March to May 2013 at the University of Minnesota West Central Research and Outreach Center, Morris. Calves in groups were the experimental unit. Breed groups of calves were: Holsteins (HO, n = 16) selected for high production, HO (n = 17) maintained at 1964 breed average level, crossbreds (n = 51) including combinations HO, Montbéliarde, and Swedish Red selected for high production, and crossbreds (n = 29) including combinations of HO, Jersey, Normande, and Swedish Red selected for robustness. Treatment groups were 1) control calf starter (CS; 18% CP as-fed; CON), 2) CS plus 56.7 g kelp/calf daily (Kelp2), or 3) CS plus 113.4 g kelp/calf daily (Kelp4). Calf groups were fed 1.5% DM solids of 13% total solids organic milk of birth weight once daily and then weaned at 60 d when the group consumption averaged 0.91 kg starter/calf daily. Body weight and hip height were recorded at birth, once/wk, at weaning, and at 90 d of age. Data were analyzed using PROC MIXED of SAS. Independent variables for analyses were the fixed effects of birth weight (co-variable), season of birth, breed group, treatment group, along with replicate as a random effect. Calf group ADG to weaning and weaning BW were 0.67, 82.9; 0.63, 79.4 and 0.61, 78.4 kg for CON, Kelp2 and Kelp4, respectively ($P < 0.10$). Hip height at weaning were 93.8, 91.2 and 91.8 cm for CON, Kelp2 and Kelp4, respectively ($P < 0.05$). Daily gain to 90 d were 0.78, 0.74, and 0.68 kg for CON, Kelp2, and Kelp4 respectively, ($P < 0.05$). Total costs (grain, health, and organic milk) to 90 d of age for calf groups were $2,660.20 for CON, $2,711.39 for Kelp2, and $2,718.42 for Kelp4; however, the cost per kilogram of gain was significantly higher ($P < 0.05$) for the Kelp4 ($4.16) group compared to the CON ($3.69) group. In summary, calves fed a control calf starter had higher daily gains than calves fed high kelp calf starter rations. Feeding kelp in calf starter rations for organic dairy calves may not be economically justified.

Current on-going or recently completed studies at SROC where data is being analyzed or preliminary data is available

Impact of Blended Protein Sources in 2 to 4 day-old Holstein Heifers Fed a 22% Crude Protein and 20% Crude Fat Commercial Milk Replacer at the Rate of 1.25 Pounds per Calf per Day (Data analyses complete)

Diets: 26 calves were assigned to each of two milk replacer treatment groups

1 = Control: All-Milk Oxy/Neo w/ Bio-MOS and ClariFly first 14 days, All-Milk Bovatec w/ Bio-MOS and ClariFly to study completion
2 = Treatment Group: Blended Protein Oxy/Neo w/ Bio-MOS and ClariFly first 14 days, Blended Protein Bovatec w/ Bio-MOS and ClariFly to study completion (Blended protein sources, 9% units protein from milk protein sources, 5% units protein from hydrolyzed wheat gluten protein, and 8% protein from units bovine plasma by weight).

Under conditions of this study, calves fed milk replacers with all-milk or alternative blended protein in 22% protein:20% fat milk replacers performed very well for a conventional program during the pre- and post weaning periods. Study completed and paper in progress.

Performance and Health of Calves Pre- and Post-Weaning Fed Milk Replacer versus pasteurized whole waste milk (study to be completed by December 2014).

Animals:
100 Holstein heifer calves from the SROC Calf & Heifer Research Facility will be used in this study.

Diets:
All calves will be fed an 18% crude protein texturized calf starter medicated with decoquinate at 45 grams/ton (product #29850). Calf starter and water will be offered free choice from day 1 to day 56. All calves will be fed diflubenzuron (Elim-A-Fly) at a rate of .10 mg/kg of body weight/day in the milk.

T**reatments** (waste milk picked up from 1 of the cooperating dairies x2 weekly stored in a bulk tank and pasteurized in Waseca):

1. Calves will be fed a 20% protein: 20% fat non-medicated all-milk protein milk replacer (MR) at 0.75 lbs in 5.25 lbs water (12.5% solids) twice daily for 42 days and once daily from day 43 to weaning at 49 days. **(CON)**

2. Calves will be fed a non medicated all milk protein milk replacer containing 26% protein and 31% fat (Waseca WM Rival) at 0.75 lbs solids twice daily as in Treatment 1. This milk replacer will be formulated to include additional essential fatty acids **(MRS)**

3. Calves will be fed pasteurized waste milk at 0.75 lbs solids twice daily as in Treatment 1, actual feeding rate to be adjusted with each new load of waste milk. An Excel spreadsheet will be available after each load of waste milk is received to determine the feeding rate **(WM)**

4. Calves will be fed pasteurized waste milk at 0.50 lbs of solids and .25 lbs of a 24% protein: 7% fat AM replacer (Waseca Balancer) with added water as needed to adjust the solids content. An Excel spreadsheet will be available to determine the amount of water to add to the WM and MR to provide a constant mix of 12.5% solids. This milk replacer will be formulated to include proper levels of vitamins and fat sources. **(WMS)**

SROC is also collaborating with IRTA in Barcelona (Alex Bach and Marta Terres ruminant group). A Ph. D student from IRTA is working in Waseca for 3 months on sample collection to evaluate the effect of feeding calves with waste milk on antibiotic resistance patterns and abundance of antibiotic resistance genes from nasal and fecal bacteria.

Performance and health of calves pre- and post-weanng fed milk replacers with differing protein levels (study complete, and data analyses in progress).

Animals:
100 heifer calves assigned to one of 4 milk replacers (MR).

Treatments:

Treatment 1 (N = 25) – calves fed a non-medicated 24:20 MR at 1.5 lbs daily in 10.50 lbs water split into 2 equal feedings for 35 days and 0.75 lbs once daily in 5.25 lbs water until weaning at 42 days. All MR were mixed for 12.5% Solids. Calves were offered a 18% CP calf starter and fresh water from day 1.

Treatment 2 (N = 25) – calves fed a non-medicated 24:20 MR as for Treatment 1 but milk protein was replaced with 25% plasma. Calves were offered a 18% CP calf starter and fresh water from day 1.

Treatment 3 (N = 25) – calves fed a non-medicated 24:20 MR as for Treatments 1 and 2 but milk protein was replaced with 25% plant peptide powder (Peptide80, International Ingredients Corporation, St Louis). Calves were offered a 18% CP calf starter and fresh water from day 1.

Treatment 4 (N = 25) – calves fed a non-medicated 24:20 MR as for Treatments 1, 2 and 3 but milk protein was replaced with 12.5% plasma an 12.5% plant peptide powder. Calves were offered a 18% CP calf starter and fresh water from day 1.

D. Publications

Bjorklund, E. A., B. J. Heins, and H. Chester-Jones. 2013. Whole milk feeding duration, calf growth, and profitability of group-fed calves in an organic production system. *J. Dairy Sci.* 96: 7363-7370.

Chester-Jones, H., B. Ziegler, D. Schimek, and D. Ziegler. 2014**.** Pre- and post weaning performance and health of calves fed texturized calf starters with different additives during the nursery phase. J. Dairy Sci. 97(Suppl.1):175. Abstract 399.

Chester-Jones, H., D.M. Ziegler, D. Schimek, B. Ziegler, G. Golombeski, M. Raeth-Knight, D. Cook and N. Broadwater. 2014. 10 years of calf research at the Southern Research and Outreach (SROC. Proc. 75th Minnesota Nutrition Conference "Learning from the Past; Preparing for the Future" and Pre-Conference Symposium "Gut Health – Across All Livestock Species" Sponsored by Vi-COR. September 17-18, Mystic Lake Casino Hotel, Prior Lake, MN, University of Minnesota Department of Animal Science and Extension, St. Paul, MN.

Heins, B. J. and H. Chester-Jones. 2014. Effect of feeding kelp on growth and profitability of group-fed dairy calves in an organic production system. J. Dairy Sci. 97 (E-Suppl. 1):282. Abstract. 561

Heins, B. J., M. I. Endres, J. C. Paulson, R. D. Moon. 2014. Effect of organic grain supplementation on production, body weight, body condition score, and fatty acid profiles of organic dairy cows. J. Dairy Sci. 97 (E-Suppl. 1):159. Abstract 323.

Paulson, J.C., B. J. Heins and D.G. Johnson. 2014. Seasonal changes in DM, CP, NDF, and NDF digestibility of pasture forage in dairy grazing production systems in Minnesota. J. Dairy Sci. 97 (E-Suppl. 1):159. Abstract 321.

Schimek, D., B. Ziegler, D. Ziegler, H. Chester-Jones, and M. Raeth-Knight. 2014. Performance and health of calves pre- and post weaning fed milk replacers with supplements for heat abatement in the summer months. J. Dairy Sc. 97 (E-Suppl. 1):84. Abstract 1595.

Sjostrom, L. S., B. J. Heins, M. I. Endres, R.D. Moon, J.C. Paulson. 2014. Effect of organic grain supplementation on activity and rumination time of organic dairy cows. J. Dairy Sci. 97 (E-Suppl. 1):281. Abstract 560.

Sjostrom, L. S., B. J. Heins, M. I. Endres, R.D. Moon, U. S. Sorge. 2014. Effect of two winter housing systems on production, body weight, somatic cell count, BCS, and dry matter intake of organic dairy cows. J. Dairy Sci. 97 (E-Suppl. 1):295. Abstract 588.

Strayer, B.S. 2014. Development of a modified accelerated milk replacer feeding program for dairy calves. M.S. Thesis, Department of Dairy Science, South Dakota State University, Brookings, SD.

Strayer, B., D. Ziegler, D. Schimek, B. Ziegler, M. Raeth-Knight, H. Chester-Jones, and D.P. Casper. 2014. Pre- and post-weaning performance and health of calves fed milk replacers with two protein concentrations and two feeding rates. J. Dairy Sci. 97 (E-Suppl. 1):131. Abstract 1654.

Strayer, B., D. Ziegler, D. Schimek, B. Ziegler, M. Raeth-Knight, H. Chester-Jones, and D.P. Casper. 2014. Pre- and post-weaning performance and health of calves fed 24% crude protein, 20% fat milk replacers at different feeding rates. J. Dairy Sci.97 (E-Suppl. 1):130. Abstract 1653.

Strayer, B., D. Ziegler, D. Schimek, B. Ziegler, H. Chester-Jones, J. Anderson, K. Kalscheur, and D.P. Casper. 2014. Development of a modified accelerated milk

replacer feeding program for dairy calves. J. Dairy Sci. 97 (E-Suppl. 1):108. Abstract 616.

Ziegler, D., H. Chester-Jones, B. Ziegler, D. Schimek, M. Raeth-Knight, and D. Cook. 2014. Pre- and post-weaning performance and health of dairy calves fed all-milk protein milk replacers or partially replacing milk protein in milk replacers with plasma, wheat proteins and soy protein concentrate. J. Dairy Sci. 97 (E-Suppl. 1):131. Abstract 1658.

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

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

NC 1042: 2011-2012 Mississippi Station Report

A. Project Name:

Management systems to improve the economic and environmental sustainability of dairy enterprises (Rev NC-1119)

B. Cooperating Agency and personnel:

Stephanie Hill Ward, Mississippi State University, Department of Animal and Dairy Science

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

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

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

C. Work Progress and Principal Accomplishments

Objective 1:

Project 1 – Fifty-three Holstein calves were fed either two or three times per day and housed either individually or in pairs (2XI, 2XP, 3XI and 3XP). Calves were randomly assigned to treatments at birth and remained on their treatment until 8 weeks of age. At 8 wks of age, calves were moved to a grouped pen and body measures were taken until 10 wks of age. For calves that were on 2XP or 3XP, pairing occurred on d 3 ± 2 d. All calves were fed 3.8L of colostrum within 24h of birth and then fed whole milk. Calf starter (Startena, Purina Mills, 22%CP) was offered from d 3 and increased by 0.45 kg when less than 0.45 kg were left. DMI and respiration and fecal scores were collected daily. Body weight (BW), hip and wither height, heart girth, and hip width were collected weekly. Play behavior, time spent lying, standing, eating and drinking were also measured at weeks 3, 5, and 7. At week 8, latency to feed was observed when calves were released into groups. Data were analyzed using the MIXED procedure of SAS® (Cary, NC). Separation of means were evaluated with the PDIFF procedure of SAS based on Fisher's F-protected least significant difference test. Significance was declared at $P < 0.05$. There was no effect of treatment on BW or measures or ADG. However, in weeks 6, 9, and 10 calves on 3XP had greater ADG than calves on 2XP (1.15, 1.49, 1.38 vs. 0.72, 0.84, 0.47 kg/d, respectively; $P < 0.05$) and 3XI (1.15, 1.49, 1.38 vs 0.87, 0.79, 1.19 kg/d, respectively; $P < 0.05$). In weeks 6 and 10, 3XP calves had greater ADG than 2XI calves (1.15kg, 1.38kg vs .89kg, 1.06kg respectively). There was no effect of feeding frequency on starter intake, however, calves housed in pairs tended to consume more starter than those housed individually (0.79 kg DM/d vs. 0.84 kg DM/d; $P < 0.07$). Analysis of behavior data indicates no impact of housing type on latency to feed, however, calves fed 3X per day consumed feed within 23.5 minutes and calves fed 2X per day consumed feed within 37.5 minutes. Currently, this data demonstrates that, while nutrient values were not different between treatments, both feeding frequency and housing type can impact calf growth and tended to impact intake and latency to feed.

D. Usefulness of Findings

Data from the above studies are still being collected and analyzed.

E. Publications:

Geiger, A. J., **S. H. Ward**, C. C. Williams, B. J. Rude, C. J. Cabrera, K. N. Kalestch, and B. E. Voelz. 2013. *Increasing milk replacer crude protein concentrations with or without direct-fed microbial supplementation on pre-weaned Holstein calves during heat stress*. Journal of Dairy Science. Accepted for publication, 2014.

F. Impact Statement

Objective 1:

In Mississippi, the majority of dairies are grass based with limited housing options for lactating, dry, and young animals. Thus, producers often pair or group house calves which can present a series of problems regarding spread of disease among the herd. However, in a well managed environment, group or paired housing can improve the behavior and well-being of calves and potentially result in faster growth rates. Additionally, calves grouped pre-weaning may perform better when placed in large contemporary groups post-weaning.

G. Leverage

None

H. On-going research

One current project is underway that applies to objective 2 of this project. Cows were fed alfalfa baleage at the expense of concentrate mix to determine to what extent high quality forage to could be utilized to replace grain and not sacrifice milk production. The feeding trial has ended, however, sample and data analysis is underway.

NC 2042: 2014 Kentucky Station Report

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

B. COOPERATING AGENCY and personnel:

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

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

Under Objective 2 of Project:

Somatic cell counts, mastitis infection prevalence, and mastitis pathogen distribution in compost bedded pack and sand freestall farms

Eckelkamp, E.A., J.L. Taraba, R.J. Harmon, K.A. Akers, and J.M. Bewley, *University of Kentucky, Lexington*

The objective of this research was to describe the relationships among SCS, mastitis infection prevalence (**MIP,** percent of cows with SCS>3.9), and mastitis pathogen distribution (**MPD**) in 8 compost bedded pack (**CB**) and 7 sand freestall (**SF**) farms in Kentucky from May 2013 to January 2014. The same observer evaluated cow hygiene scores (**HYS,** Cook and Reinemann, 2007) bi-weekly for 50 cows per herd. Throughout the study, producers collected aseptic milk samples from all quarters displaying clinical mastitis signs for bacteriological culturing. Test-day SCC and MIP were obtained from DHIA. The MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) was used to assess fixed effects of barn type (**BT**), maximum ambient temperature (**MT**), and HYS on SCS and MIP. Stepwise backward elimination removed non-significant interactions ($P \geq 0.05$) with main effects remaining in the model regardless of significance. A χ^2 analysis was conducted using the FREQ procedure of SAS to determine MPD between BT. Maximum temperature × BT was a predictor of MIP ($P < 0.05$). As MT increased, MIP increased more rapidly in CB than in SF ($P < 0.05$). Calculated MIP LSMeans(±SE) for CB and SF herds were 28.68 ± 2.17% and 25.49 ± 2.21%, respectively ($P < 0.05$). Hygiene score and BT × MT were predictors of SCS ($P < 0.05$). With increasing MT, herd SCS increased more rapidly in CB than in SF ($P < 0.05$). Somatic cell score LSMeans(±SE) for CB and SF were 4.25 ± 0.16 and 3.97 ± 0.17 cells/mL, respectively ($P \geq 0.05$). Table 1 summarizes MPD frequency by BT. Results of this study demonstrate potential challenges for managing mastitis in CBP.

Table 1. Frequencies of pathogens isolated from clinical mastitis cases in compost bedded pack (CB) barns and sand freestall (SF) barns[1,2]

Pathogen isolated[1]	CB[2] (Total number of cases = 232) (Mean number of cows = 1208)	SF[2] (Total number of cases = 117) (Mean number of cows = 629)
Coagulase negative staphylococci	17(7%)	5(4%)
Environmental streptococci	33(14%)	26(22%)
Escherichia coli	65(28%)	19(16%)

Gram-positive Bacillus species	4(2%)	2(2%)
Staphylococcus aureus	8(3%)	7(6%)
Yeast species	6(3%)	2(2%)
Klebsiella species	4(2%)	4(3%)
Other gram-negative species	30(13%)	14(12%)
Other gram-positive species	7(3%)	8(7%)
No growth	35(15%)	20(17%)
Contaminated samples	21(9%)	8(7%)
Missing samples	2(1%)	2(2%)

[1] Number of pathogens isolated per species (percent of total samples per barn type).
[2] $\chi 2$ analysis indicated no significant differences for mastitis pathogen distribution between barn types ($P \geq 0.05$).

Keywords: mastitis, sand freestall barn, compost bedded pack barn

Detection of subclinical milk fever and ketosis in fresh dairy cows using rumination time, lying time, reticulorumen temperature, and neck activity

A.E. Sterrett*, B.A. Wadsworth, R.J. Harmon, L.M. Arnold, J.D. Clark, E.P. Aalseth[2], D. L. Ray, J.M. Bewley
University of Kentucky
Earl P. Aalseth, Jr. Dairy Consulting, PLLC[2]

The objective of this study, conducted at the University of Kentucky Coldstream Dairy, was to evaluate changes in rumination time (RU), lying time (LT), reticulorumen temperature (RT), and neck activity (NA) around subclinical hypocalcemia (SHC) and ketosis (SKET) events. Fresh cows (90 Holstein, 19 crossbred, and 11 Jersey cows) were assigned HR Tags (SCR Engineers Ltd., Netanya, Israel), IceQubes (IceRobotics, Edinburgh, Scotland), and DVM boluses (DVM Systems, LLC., Boulder, CO) ≥ 14 days pre-partum. The Milpro P4C (Milkline, Gariga di Podenzano, Italy) system measured milk yield (MY). Blood calcium was measured on 3, 7, and 14 DIM to determine SHC (≤ 1.8 mmol/L). Milk KetoTest (Elanco, Greenfield, IN) and blood Precision Xtra (Abbott Laboratories, Abbott Park, IL) beta-hydroxybuterate tests were analyzed on 3, 7, and 14 DIM to determine SKET (both tests ≥ 1.2 mmol/L). Mean RU, LT, RT, NA, and MY were recorded and summarized for each cow day for the first 7 DIM. The GLM Procedure of SAS (Cary, NC) was used to evaluate the relationship between SKET or SHC presence and RU, LT, RT, NA, and MY. LSMeans NA was less in cows with SHC than cows without SHC (210.30 ± 6.40 and 253.81 ± 3.93, respectively, $P < 0.01$). LSMeans RT was less for cows with SHC than cows without SHC (38.58 ± 0.05 and 39.01 ± 0.03 °C, respectively, $P < 0.01$). No difference was observed for RU (316.99 ± 8.35 and 299.90 ± 5.12 min/d for SHC and non- SHC cows respectively, $P = 0.08$), MY (48.57 ± 1.64 and 50.83 ± 1.14 kg/d for SHC and non- SHC cows respectively, $P = 0.26$), or LT (10.66 and 9.97 h/d for SHC and non-SHC cows, respectively, $P = 0.03$). LSMeans LT was greater for cows with SKET than cows without SKET (10.26 and 9.58 h/d, respectively, $P = 0.04$). LSMeans NA was greater for cows without SKET compared with cows with SKET (258.86 and 236.73, respectively, $P < 0.01$). No difference was observed for RT (38.91 ± 0.04 and 38.93 ± 0.04 °C, for SKET and non-SKET cows respectively, $P = 0.72$), RU (307.11 ± 4.88 and 295.84 ± 8.14 min/d, for SKET and non-SKET cows respectively, $P = 0.24$), or MY (51.64 ± 1.09 and 49.03 ± 1.65 kg/d for SKET and non-

SKET cows respectively, P= 0.19). These parameters may be useful for identifying fresh cow diseases.

Keywords: ketosis, hypocalcemia, fresh cow

Evaluation of cow cleanliness and fly avoidance behaviors among cows with docked, switch-trimmed, and switch-intact tails

E.A. Morabito, D.T. Nolan, and J.M. Bewley

Department of Animal and Food Sciences, University of Kentucky, 407 WP Garrigus Building, Lexington, KY, 40546-0215

Tail docking has become a contentious issue in the dairy industry because of concerns related to pain and inhibition of natural fly avoidance behaviors. The TailWell Power Tail Trimmer (Shoof International LTD, Cambridge, New Zealand) is a cordless drill attachment with circular blades to trim a cows' switch quickly and easily. The objective of this study was to evaluate cow cleanliness and fly avoidance behaviors between 64 cows trimmed with the Tailwell Power Tail Trimmer (**T**), 89 previously docked cows (**D**), and 53 cows with intact switches (**S**). Cow cleanliness was evaluated bi-weekly with separate scores recorded for the flank, leg, and udder using a scoring system ranging from light (**L**) to very heavy (**VH**). Individual teat scores were recorded using a scoring system ranging from 0 (no dirt) to 4 (filthy). Fly avoidance behaviors were monitored for 2 min/cow at each sampling. The MIXED procedure of SAS (SAS Institute Inc., Cary, NC) was used to evaluate the effects of tail status, scoring period, herd, and interactions on udder, flank, leg, and teat cleanliness. Stepwise backward elimination was used to remove non-significant interactions ($P \geq 0.05$). No significant differences were observed among tail status for flank, udder, or leg scores ($P \geq 0.05$); however, significant differences were observed for scoring period, herd, and the interaction of scoring period × herd ($P < 0.05$). Herd was a significant predictor of teat scores ($P \geq 0.05$), however tail status was not ($P \geq 0.05$). The GENMOD procedure of SAS® was used to evaluate fly avoidance behaviors. Cows with docked tails were 2.01 and 2.21 times more likely to have a higher tail swing score than cows with switch-trimmed and intact-switch tails, respectively ($P < 0.01$). The lack of differences among cleanliness supports existing literature suggesting that docking tails does not improve cow hygiene. The observed increase in fly avoidance behavior among docked cows suggests behavioral deprivation for these cows. The Tailwell Power Trimmer provides a way to relieve dairy worker concerns related to intact switches without the perception aspects of tail docking.

Key words: tail trimming, fly avoidance, cow hygiene

Development of a non-invasive system for monitoring dairy cattle sleep

J.M. Klefot[1], J.L. Murphy[2], K.D. Donohue[2], B.F. O'Hara[3], M.E. Lhamon[4], J.M Bewley[1]

[1] Department of Animal and Food Sciences, University of Kentucky, Lexington, KY
[2] Center for Visualization and Virtual Environments, University of Kentucky, Lexington, KY
[3] *Department of Biology, University of Kentucky, Lexington, KY,*
[4] *Digital Key Consulting, Lexington, KY, Lexington, KY*

Lack of sleep in dairy cattle may indicate shortcomings in housing, environment, or increased physiological disturbances. Little research has been conducted to assess sleep in production livestock, primarily because of limitations with monitoring abilities. Consequently, biological understanding of the production circumstances and facility options that affect sleep is limited. The objective of this study was to test a non-invasive system using a three-axis accelerometer monitor to measure head position of the cow in order to classify sleep, and wake behaviors. The duration of the study consisted of two 24-hour periods of observing 4 Holstein dairy cows in September 2013 at the University of Kentucky Coldstream Dairy. The three-axis accelerometers were attached to a harness on the side of each cow's neck to determine head and body movement. Human observation of the animals noted the times of active behaviors and very low activity, or sleep behaviors. Wake behaviors were classified as standing and alert. Sleep was classified with the behaviors of lying with no movement and eyes closed with head rested on the ground or flank. The radial signal was extracted from the xyz components of the accelerometer to obtain a motion signal independent of direction. Radial signal features were examined for maximizing the performance of detecting sleep behavior using a Fishers linear discriminant analysis (LDA) classifier. This study included a total of 652 minutes of high activity behaviors, and 107 minutes of sleep behavior recorded from 2 cows with usable data. Results from a bootstrapping analysis show an agreement between human observation and the LDA classifier of 93.7 ± 0.7% for wake behavior and 92.2 ± 0.8% for sleep behavior, with a 95% confidence interval. This monitor may be used to help understand options for monitoring sleep in research and production settings.

Key words: behavior, sleep, monitor, accelerometer

D. USEFULNESS OF FINDINGS:

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

E. PUBLICATIONS:

Peer-reviewed:

1. Smith, A.C., C.L. Wood, K.J. McQuerry, and J.M. Bewley. 2014. Effect of a tea tree oil and organic acid footbath solution on digital dermatitis in dairy cattle. J. Dairy Sci. 97: 2498-2501.
2. Black, R.A., J.L. Taraba, G.B. Day, F.A. Damasceno, M.C. Newman, K.A. Akers, C.L. Wood, K.J. McQuerry, and J.M. Bewley. 2014. The relationship between compost bedded pack performance and management and bacterial concentrations. J. Dairy Sci. 97: 2669-2679.

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

1. Bewley, J.M., R. A. Black, F. A. Damasceno, E. A. Eckelkamp, G. B. Day, and J. L. Taraba. 2014. Compost bedded pack barns as a lactating cow housing system for the Southeast. Abstract 10. American Dairy Science Association Annual Meeting. Kansas City, MO.
2. Wolf, K. and J.M. Bewley. 2014. Differences in bovine and caprine cheese production. Abstract 15. American Dairy Science Association Annual Meeting. Kansas City, MO.
3. Morabito, E.A. and J.M. Bewley. 2014. Dairy cow welfare: bridging the gap.. Abstract 18. American Dairy Science Association Annual Meeting. Kansas City, MO.
4. Lowe, J.L., K.A. Akers, A.E. Sterrett, J.D. Clark, and J.M. Bewley. 2014. Case study: Effect of alley floor scraping frequency on environmental mastitis-causing pathogen counts. Abstract 29. American Dairy Science Association Annual Meeting. Kansas City, MO.
5. Nolan, D.T. and J.M. Bewley. 2014. A decision support tool to estimate the economic potential of SCC hot sheet data. Abstract 289. American Dairy Science Association Annual Meeting. Kansas City, MO.
6. Dolecheck, K.A., W.J. Silvia, G. Heersche Jr., and J.M. Bewley. 2014. Reproductive performance of timed artificial insemination and activity-based estrus detection. Abstract 344. American Dairy Science Association Annual Meeting. Kansas City, MO.
7. Borchers, M.R., A.E. Sterrett, B.A. Wadsworth, and J.M. Bewley. 2014. Predicting impending calving using automatically collected measures of

activity and rumination in dairy cattle. Abstract 360. American Dairy Science Association Annual Meeting. Kansas City, MO.

8. Eckelkamp, E.A., J. L. Taraba, R. J. Harmon, K. A. Akers, and J.M. Bewley. 2014. Somatic cell counts, mastitis infection prevalence, and mastitis pathogen distribution in compost bedded pack and sand freestall farms. Abstract 557. American Dairy Science Association Annual Meeting. Kansas City, MO.
9. Morabito, E.A., D. T. Nolan, and J.M. Bewley. 2014. Evaluation of cow cleanliness and fly avoidance behaviors among cows with docked, switch-trimmed, and switch-intact tails. Abstract 800. American Dairy Science Association Annual Meeting. Kansas City, MO.
10. Klefot, J.M. , J. L. Murphy, K. D. Donohue, B. F. O'Hara, M. E. Lhamon, and J.M. Bewley. 2014. Development of a non-invasive system for monitoring dairy cattle sleep. Abstract 899. American Dairy Science Association Annual Meeting. Kansas City, MO.
11. Schexnayder, S.M., P. D. Krawczel, M. Fly, L. E. Garkovich, C. S. Petersson-Wolfe, J.M. Bewley, S. H. Ward, G. M. Pighetti, R. A. Almeida, M. Arnold, S. C. Nickerson, A. DeVries, and S. P. Oliver. 2014. Initial assessment of producers' experiences, perceptions and attitudes about mastitis and bulk tank somatic cell count management in the Southeast. Abstract 1040. American Dairy Science Association Annual Meeting. Kansas City, MO.
12. Pighetti, G.M. C. S. Petersson-Wolfe, J.M. Bewley, S. C. Nickerson, S. H. Ward, A. DeVries, P. D. Krawczel, R. A. Almeida, M. Fly, S. M. Schexnayder, L. E. Garkovich, M. Arnold, and S. P. Oliver. 2014. The status of milk quality at the start of the Southeast Quality Milk Initiative. Abstract 1041. American Dairy Science Association Annual Meeting. Kansas City, MO.
13. Wadsworth, B.A. , D. M. Amaral-Phillips, and J.M. Bewley. 2014. An economic impact decision support tool for farm specific estimation of not covering horizontal silos storing corn silage. Abstract 1048. American Dairy Science Association Annual Meeting. Kansas City, MO.
14. Borchers, M.R. and J.M. Bewley. 2014. A producer assessment of precision dairy farming technology use, usefulness, and prepurchase considerations. Abstract 1049. American Dairy Science Association Annual Meeting. Kansas City, MO.
15. Mussell, H.A., J. L. Taraba, K. L. Jacobsen, and J.M. Bewley. 2014. Assessment of the potential for compost bedded pack barns in sustainable organic dairy farming systems. Abstract 1051. American Dairy Science Association Annual Meeting. Kansas City, MO.
16. Weatherly, M.E. , A. M. Gehman, A. M. Lisembee, J. D. Clark, D. L. Ray, and J.M. Bewley. 2014. The effects of feeding an algae supplement on milk yield, milk components, and dry matter intake. Abstract 1146. American Dairy Science Association Annual Meeting. Kansas City, MO.
17. Sterrett, A.E., B. A. Wadsworth, R. J. Harmon, M. Arnold, J. D. Clark, E. P. Aalseth, D. L. Ray, and J.M. Bewley. 2014. Detection of subclinical milk fever and ketosis in fresh dairy cows using rumination time, lying time,

reticulorumen temperature, and neck activity. Abstract 1158. American Dairy Science Association Annual Meeting. Kansas City, MO.

18. Dolecheck, K.A., W. J. Silvia, G. Heersche Jr., A. E. Sterrett, B. A. Wadsworth, and J.M. Bewley. 2014. Changes in behavioral and physiological parameters around estrus in partially synchronized cows. Abstract 1491. American Dairy Science Association Annual Meeting. Kansas City, MO.
19. Thompson, A.C. and J.M. Bewley. 2014. Comparative study between 5% copper sulfate and a β-ionone and limonene solution in a split footbath. Abstract 1503. American Dairy Science Association Annual Meeting. Kansas City, MO.
20. Nolan, D.T., M.J. Bakke, and J.M. Bewley. 2014. Comparison of milk components before and after passing through a novel inline milk filter. Abstract 1504. American Dairy Science Association Annual Meeting. Kansas City, MO.
21. Sterrett, A.E., B.A. Wadsworth, K. Akers, J.D. Clark, C.L. Wood, K.J. McQuerry, R.J. Harmon, L.M. Arnold, W.J. Silvia, and J.M. Bewley. 2014. Milk yield, reticulorumen temperature, rumination time, and neck activity changes around mastitis. Abstract 62. NMC Regional Meeting

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

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

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

1. Bewley, J.M. 2014-2017. $45,000. Accelerometers for mastitis and lameness detection. Alta Genetics.
2. Bewley, J.M. 2014. $7500. Animal position relative to supplement availability. Ridley Feeds.
3. Bewley, J.M. 2014-2015. $13,008. Evaluation of a novel footbath delivery system, GEA Farm Technologies.
4. Bewley, J.M. 2014-2015. $11,338. Evaluation of peroxide teat dip. GEA Farm Technologies.
5. Bewley, J.M. 2014-2015. $37,446. Evaluation of formulations for a dry-off treatment for lactating dairy cows, Amelgo.
6. Bewley, J.M. 2014-2017. $179,092.00. Elanco Dairy Decision Support. Elanco Animal Health.
7. Bewley, J.M. 2014-2017. BHEARD Malawi Graduate Training in Dairy Management Systems. $170,522. Borlaug Higher Education for Agricultural Research and Development.

8. Bewley, J.M., E.A. Eckelkamp, J.L. Taraba, and M.L. Arnold. 2013-2014. Clinical mastitis incidence in compost bedded pack barns as compared to freestall barns. $13,750. Southern Region Sustainable Agriculture Research and Education Program On-Farm Research Grant.
9. Smith, S.M. and J.M. Bewley. 2013. Assessment of heat stress in Kentucky dairy cows. $3,000. Kentucky Academy of Science.
10. Oliver, S., R. Almeida, G. Pighetti, P. Krawczel, M. Fly, C. Petersson-Wolfe, J.M. Bewley, L.M. Arnold, D. Amaral-Phillips, L. Garkovich, S. Nickerson, S. Hill Ward, and A. DeVries. 2013-2018. Southeast Quality Milk Initiative: Implementing science-based recommendations in the field to control mastitis & improve milk quality in the Southeast. $3,000,000 ($597,645 to UK). United States Department of Agriculture, National Institute of Food and Agriculture, Agriculture and Food Research Initiative. Program: Extension-driven Disease Prevention and Control in Animals. Program Area Code A5113. Award number 2013-68004-20424.
11. Meyer, A.L., A. Katchova, E. Ritchey, J.M. Bewley, J. Hunter, S. Isaacs. KYFarmStart II: 2012-2014. A whole farm management education program for beginning farmers. $561,564 ($76,950 to Bewley). United States Department of Agriculture, National Institute of Food and Agriculture, Agriculture and Food Research Initiative. Program Area: Beginning Farmer Rancher Development. Award number 2012-49400-19557.

NC 2042: 2013 – 2014 Station Report (University of California, Davis)

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

B. **COOPERATING AGENCY and personnel:** University of California at Davis, E.J. DePeters

Project Objectives:

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

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

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

Objective 3. Analyze whole farm system components and integrate information into decision-support tools to improve efficiency, enhance profitability, and environmental sustainability.

C. **WORK PROGRESS AND PRINICPAL ACCOMPLISHMENTS:**

Under Objectives 2 and 3 of Project

Study 1: Preparing manuscript of milk composition variability. The aim was to determine the variability of milk fat composition as it might relate to milk fatty acids as predictors of rumen perturbation and low milk fat. The data were reanalyzed this past year (J.G Fadel and T.R. Famula) using a different approach than the original analysis. The goal is to determine the within cow variation to know what type of sampling protocol would be necessary on farm to use milk fatty acids as a marker. Depending on the results, we will follow up with another study to measure with cow variation of milk fatty acids as well as dry matter intake.

Study 2: We developed a whey protein gel to protect dietary beta-carotene from rumen degradation. Whey protein gels were successfully used to protect unsaturated fatty acids from rumen biohydrogenation. Beta carotene will be converted to vitamin A once absorbed. The aims are to (1) determine if whey protein gels will protect beta carotene from rumen degradation based on blood and milk concentrations of beta carotene, and (2) if beta carotene is protected, is immune function enhanced. If immune function is enhanced the ability of the dairy cow or calf to resist infections could reduce the rate of culling and reduce the cost of disease. These impacts would improve the economic

sustainability of the dairy farm and enhance overall animal well-being. We are currently analyzing results, but there appear to be no treatment differences. Milk and blood beta carotene levels did not change and immune function parameters were not different.

D. USEFULNESS OF FINDINGS: Producers will be able to trouble shoot low milk fat situations or changes in feeding management by analyzing bulk tank milk for fatty acids. Strategies will be developed to access management practices and diet formulations to correct the problem to increase milk fat concentration and improve overall farm profitability. If beta carotene delivery to the animal can be increased, immune function may be enhanced, which will reduce the incidence of disease and reduce the costs associated with culling and lost production performance. Enhancing immune function will also benefit animal well-being. Developing management tools assess feed management programs on a dairy farm will improve both economic and environmental sustainability.

E. PUBLICATIONS:

Peer-reviewed/research and extension.

None this year.

F. IMPACT STATEMENT (in lay language for government agencies and elected representatives)
The data will be used to develop tools that will allow dairy producers to maintain overall sustainability by increasing profits, improving animal health and well-being, improving animal productivity, and providing information on feed management programs to address environmental regulations of nutrient excretion. We plan to do a follow up to evaluate the small whey protein gels for efficacy of protecting polyunsaturated fatty acids from rumen biohydrogenation to determine if the gels structure is working.

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

Gifts funds from various groups to support on-going research at UC Davis. Grant from the American Jersey Cattle Foundation.

NC 2042: 2013 – 2014 Station Report (University of California, Davis)

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

B. **COOPERATING AGENCY and personnel:** University of California at Davis, E.J. DePeters

Project Objectives:

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

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

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

Objective 3. Analyze whole farm system components and integrate information into decision-support tools to improve efficiency, enhance profitability, and environmental sustainability.

C. **WORK PROGRESS AND PRINICPAL ACCOMPLISHMENTS:**

Under Objectives 2 and 3 of Project

Study 1: Preparing manuscript of milk composition variability. The aim was to determine the variability of milk fat composition as it might relate to milk fatty acids as predictors of rumen perturbation and low milk fat. The data were reanalyzed this past year (J.G Fadel and T.R. Famula) using a different approach than the original analysis. The goal is to determine the within cow variation to know what type of sampling protocol would be necessary on farm to use milk fatty acids as a marker. Depending on the results, we will follow up with another study to measure with cow variation of milk fatty acids as well as dry matter intake.

Study 2: We developed a whey protein gel to protect dietary beta-carotene from rumen degradation. Whey protein gels were successfully used to protect unsaturated fatty acids from rumen biohydrogenation. Beta carotene will be converted to vitamin A once absorbed. The aims are to (1) determine if whey protein gels will protect beta carotene from rumen degradation based on blood and milk concentrations of beta carotene, and (2) if beta carotene is protected, is immune function enhanced. If immune function is enhanced the ability of the dairy cow or calf to resist infections could reduce the rate of culling and reduce the cost of disease. These impacts would improve the economic

sustainability of the dairy farm and enhance overall animal well-being. We are currently analyzing results, but there appear to be no treatment differences. Milk and blood beta carotene levels did not change and immune function parameters were not different.

D. USEFULNESS OF FINDINGS: Producers will be able to trouble shoot low milk fat situations or changes in feeding management by analyzing bulk tank milk for fatty acids. Strategies will be developed to access management practices and diet formulations to correct the problem to increase milk fat concentration and improve overall farm profitability. If beta carotene delivery to the animal can be increased, immune function may be enhanced, which will reduce the incidence of disease and reduce the costs associated with culling and lost production performance. Enhancing immune function will also benefit animal well-being. Developing management tools assess feed management programs on a dairy farm will improve both economic and environmental sustainability.

E. PUBLICATIONS:

Peer-reviewed/research and extension.

None this year.

F. IMPACT STATEMENT (in lay language for government agencies and elected representatives)
The data will be used to develop tools that will allow dairy producers to maintain overall sustainability by increasing profits, improving animal health and well-being, improving animal productivity, and providing information on feed management programs to address environmental regulations of nutrient excretion. We plan to do a follow up to evaluate the small whey protein gels for efficacy of protecting polyunsaturated fatty acids from rumen biohydrogenation to determine if the gels structure is working.

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

Gifts funds from various groups to support on-going research at UC Davis. Grant from the American Jersey Cattle Foundation.

NC 2042: 2013-2014 Station Report

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

B. Cooperating Agency: New Hampshire Agricultural Experiment Station, Durham.
Personnel: P.S. Erickson, Department of Biological Sciences.

Main objective: To evaluate and develop sustainable management systems for dairy herds that address critical quality and variance control factors with implications to economic efficiencies and environmental impacts. **Sub-objective 1)** to analyze management and nutrition strategies for replacement heifers as they pertain to production and profitability.

C. Work progress and principal accomplishments

1) Nitrogen retention and nutrient partitioning in Holstein dairy calves fed high protein or conventional milk replacer. Colleen E. Chapman and Peter S. Erickson.

This study involved feeding 24 dairy heifers 1 of 3 treatments: 1) 454 g of a conventional MR (**A**; 20% protein and 20% fat), 2) 681 g of an intensified optimum crude protein MR (**B**; 26% protein and 17% fat), or 3) 908 g of an intensified optimum crude protein MR (**C**; 26% protein and 17% fat). All calves had free-choice access to a medicated starter and ad libitum water. For d 43-49 of age, during the weaning period, morning feeding of MR ceased for all treatments and on d 50, all MR feedings ended; however, starter and water intake was continuously recorded until d 56 when they came off study.

Calves were weighed and skeletal measurements were taken initially at birth and every week throughout the 56-d study. When calves turned 5 weeks of age, they were brought to a facility next to the UNH dairy barn to start the total urine collection sampling. Urine was collected through the use of urinary catheters for a total of 3 d to determine urine creatinine, urea, and nitrogen concentration. Chromium oxide was administered by bolus at 2g/calf/day for 7 days for purposes of estimating digestibility. Fecal samples were collected for 4 consecutive days every 12 h for determination of chromium for estimation of fecal DM output. Deuterium oxide (D_2O) dilution methods were used for assessment of body composition during the last week of the study for all calves. Baseline blood samples were taken first followed immediately by injection of 300 mg of D_2O/kg of body weight in sterile physiological saline (0.9%). The D_2O was allowed to equilibrate with body water for 1 hour and then six blood samples were taken over 6 d (1/d) before feeding to estimate the dilution of the tracer.

Starter intake was reduced in calves fed the intensified MR treatment ($P = 0.00210$). Water intake was similar among treatments and was not affected by the amount of MR or starter

consumed (P = 0.61). This does not agree with other research from UNH that showed an increase in water intake when calves were fed a higher level of protein (Guindon, N.E., 2014. MS Thesis, University of New Hampshire). That study fed MR of 28% protein vs 26% in the current study.

There was also an effect of MR on feed efficiency (FE), ADG, and hip height gains; intensified fed calves were heavier, more feed efficient, and taller than control calves.

Results from the digestibly phase of this experiment showed that control calves had higher N efficiency than intensified fed calves, which could be due to the fact that intensified fed calves had a greater urine output, and thereby resulted in a greater urine nitrogen output..The high protein is altering the calves' nitrogen metabolism and more nitrogen is being excreted in the urine meaning the calves are not as efficient in utilizing nitrogen compared to lower protein fed calves. In summary, although feeding an intensified optimum crude protein MR did increase ADG, FE, and hip heights, it reduced starter intake and lowered N efficiency.

Table 1. Preweaning performance

Item	Treatment			SE	*P*		
	C	Ia	Ib		Trt	Week	Int
MR Intake (g/d)	442[c]	667[b]	840[a]	5.2586	<.0001	<.0001	<.0001
Starter Intake (g/d)	539[a]	290[b]	225[b]	57.2715	0.0021	<.0001	0.1374
DMI (g/d)	980	956	1065	70.0024	0.5252	<.0001	0.0004
FE (ADG/DMI)	0.454[b]	0.559[a]	0.571[a]	0.03037	0.0151	0.0348	0.0050
Water Intake (kg/d)	0.335	0.410	0.262	0.1042	0.6108	0.1223	0.2743
Weight (kg)	49.3	51.9	55.0	1.8181	0.1093	<.0001	0.1349
ADG (g/d)	419[c]	599[b]	748[a]	50.7148	0.0007	<.0001	0.0047
Wither Height (cm)	81.4[b]	81.8[b,y]	83.0[a,x]	0.4310	0.0436	<.0001	0.1012
Wither Height gain (cm/d)	0.162	0.193	0.321	0.06113	0.1828	0.0889	0.0071
Hip Height (cm)	85.0	84.7	85.0	0.7172	0.9015	<.0001	0.3396
Hip Height gain (cm/d)	0.194[b]	0.205[b]	0.431[a]	0.06042	0.0195	0.0415	0.4106
Heart Girth (cm)	86.1[b]	87.2[ab]	88.5[a]	0.6981	0.0327	<.0001	0.7881
Heart Girth gain (cm/d)	0.289	0.354	0.355	0.05043	0.5836	0.0056	0.8738
Hip Width (cm)	28.2[b,y]	28.7[a,x]	28.9[a]	0.2396	0.0342	<.0001	0.2469
Hip Width gain (cm/d)	0.046[b]	0.067[a]	0.067[a]	0.004548	0.0086	0.0719	0.6232
Body Length (cm)	68.4	67.6	68.1	1.1717	0.8761	<.0001	0.5403
Body Length gain (cm/d)	0.161[b]	0.196[b]	0.432[a]	0.07348	0.0405	0.1980	0.5071
Blood urea nitrogen (mg/dL)	13.5	15.7	14.8	1.0747	0.3725	0.0193	0.0218
Blood Glucose (mg/dL)	104	105	111	3.0447	0.3047	0.0012	0.5726

a, b, c Means in the same row with different superscripts differ ($P < 0.05$)

x, y, z Means in the same row with different superscripts differ ($P < 0.10$)

Table 2. Perforamnce during the weaning period

Item	**Treatment**			**SE**	***P***		
	C	Ia	Ib		Trt	Week	Int
MR Intake (g/d)	442^{c}	667^{b}	840^{a}	5.2586	<.0001	<.0001	<.0001
Starter Intake (g/d)	539^{a}	290^{b}	225^{b}	57.2715	0.0021	<.0001	0.1374
DMI (g/d)	980	956	1065	70.0024	0.5252	<.0001	0.0004
FE (ADG/DMI)	0.454^{b}	0.559^{a}	0.571^{a}	0.03037	0.0151	0.0348	0.0050
Water Intake (kg/d)	0.335	0.410	0.262	0.1042	0.6108	0.1223	0.2743
Weight (kg)	49.3	51.9	55.0	1.8181	0.1093	<.0001	0.1349
ADG (g/d)	419^{c}	599^{b}	748^{a}	50.7148	0.0007	<.0001	0.0047
Wither Height (cm)	81.4^{b}	81.8^{b,y}	83.0^{a,x}	0.4310	0.0436	<.0001	0.1012
Wither Height gain (cm/d)	0.162	0.193	0.321	0.06113	0.1828	0.0889	0.0071
Hip Height (cm)	85.0	84.7	85.0	0.7172	0.9015	<.0001	0.3396
Hip Height gain (cm/d)	0.194^{b}	0.205^{b}	0.431^{a}	0.06042	0.0195	0.0415	0.4106
Heart Girth (cm)	86.1^{b}	87.2^{ab}	88.5^{a}	0.6981	0.0327	<.0001	0.7881
Heart Girth gain (cm/d)	0.289	0.354	0.355	0.05043	0.5836	0.0056	0.8738
Hip Width (cm)	28.2^{b,y}	28.7^{a,x}	28.9^{a}	0.2396	0.0342	<.0001	0.2469
Hip Width gain (cm/d)	0.0464 b	0.0668 a	0.0670 a	0.004548	0.0086	0.0719	0.6232
Body Length (cm)	68.4	67.6	68.1	1.1717	0.8761	<.0001	0.5403
Body Length gain (cm/d)	0.161^{b}	0.196^{b}	0.432^{a}	0.07348	0.0405	0.1980	0.5071
Blood urea nitrogen (mg/dL)	13.5	15.7	14.8	1.0747	0.3725	0.0193	0.0218
Blood Glucose (mg/dL)	104	105	111	3.0447	0.3047	0.0012	0.5726

Table 3. Postweaning performance

Item	**Treatment**			**SE**	***P***
	C	Ia	Ib		
DMI (g/d)	2276	2213	2184	156.07	0.9138
FE (ADG/DMI)	0.444	0.456	0.599	0.07868	0.3217
Water Intake (kg/d)	2.70	2.72	2.62	0.1981	0.9313
Weight (kg)	75.3	78.0	82.8	3.4237	0.3165
ADG (g/d)	1034	1050	1303	194.08	0.5562
Wither Height (cm)	88.3	89.5	90.8	0.8818	0.1509
Wither Height gain (cm/d)	0.218	0.255	0.153	0.05381	0.4107
Hip Height (cm)	91.5	92.6	94.1	0.9578	0.1746
Hip Height gain (cm/d)	0.248	0.181	0.200	0.06787	0.7787
Heart Girth (cm)	96.0^{b}	$97.6^{b,y}$	$100.6^{a,x}$	1.2114	0.0447
Heart Girth gain (cm/d)	0.226^{b}	0.223^{b}	0.410^{a}	0.06027	0.0630
Hip Width (cm)	30.5	31.2	31.6	0.4546	0.2332
Hip Width gain (cm/d)	0.0875	0.116	0.104	0.02513	0.7233
Body Length (cm)	75.8	77.6	78.3	1.2363	0.3616
Body Length gain (cm/d)	0.315^{ab}	0.461^{a}	0.138^{b}	0.08614	0.0473
Blood urea nitrogen (mg/dL)	21.1	22.2	21.5	2.0634	0.9362
Blood Glucose (mg/dL)	88.3	93.7	91.0	3.8429	0.6131

Table 4. Digestibility results from calves 35 – 42 days of age

Item	Treatment			SE	*P*
	C	Ia	Ib		
DM (%)	79.0^{b}	83.7^{a}	83.9^{a}	0.8615	0.0016
CP (%)	75.0^{y}	79.1^{x}	79.3^{x}	1.3672	0.0743
ADF (%)	48.9^{b,y}	57.0^{xy}	62.4^{a,x}	3.9972	0.0882
NDF (%)	58.1^{y}	69.2^{x}	68.3^{x}	3.3460	0.0627
Starch (%)	96.0^{b,y}	99.1^{a,x}	99.3^{a}	0.5953	0.0008
Fat (%)	93.7^{b}	95.1^{a}	96.0^{a}	0.5151	0.0153
OM (%)	79.8^{b}	84.4^{a}	84.4^{a}	0.8797	0.0026

a,b,c means in the same row with different superscript differ (P< 0.05)

x, y, z Means in the same row with different superscripts differ (P < 0.10)

Nitrogen metabolism results from calves 35 – 42 days of age

Item	**Treatment**			**SE**	***P***
	C	Ia	Ib		
N intake (g/d)	49.9	49.9	53.9	4.6603	0.7871
Urine output (kg/d)	2.07^{c}	3.32^{b}	4.43^{a}	135.53	<.0001
N urine output, (g/d)	11.9^{b}	16.0^{ab}	18.6^{a}	1.0860	0.0050
N in urine (%)	0.559	0.484	0.414	0.04756	0.1499
Fecal DM output, (g/d)	322^{x}	214^{y}	221^{y}	33.5606	0.0600
N Fecal output, (g/d)	12.5	10.1	11.2	1.1648	0.3554
N in feces (%)	4.06^{a}	5.08^{b}	5.15^{b}	0.3250	0.0484
N retention (g)	28.5^{a}	19.8^{b}	24.9^{ab}	2.0516	0.0300
N efficiency (%)	53.1^{a}	43.1^{b}	45.0^{b}	2.1728	0.0164

a, b, c Means in the same row with different superscripts differ ($P < 0.05$)

x, y, z Means in the same row with different superscripts differ ($P < 0.10$)

2. Effects of Feeding Niacin to Prepartum Dairy Cows on Metabolic Disorders, Colostrum Quality and Calf IgG uptake. Kayla Aragona and Pete Erickson

It has been hypothesized that the feeding regimen of the dam likely effects colostrum quality, as well as her calf's ability to absorb the immunoglobulins (Ig) provided from that colostrum. As calves are born agammaglobulinemic, they must consume colostrum that is high in Ig to ensure their survival. Supplementing niacin has shown to increase DMI in prepartum cows, aiding in decreasing metabolic disorders. Niacin has also been shown to increase vasodilation, which may impact colostrum quality by increasing nutrients and Ig, which are transported to the mammary gland during colostrogenesis. This study is a randomized complete block design, using 30 multiparous prefresh Holstein cows. Cows were blocked by expected calving date and began study 4 weeks prior to expected calving dates. Cows were supplemented either 48 g/d of niacin or 0g/day of niacin, both with 52g/d of corn meal as a carrier. Blood samples were taken 3 times a week, at calving and 24 h after calving. Blood will be analyzed for glucose, NEFA and BHBA to aid in determining if Niacin has effects on metabolic issues during the periparturient period. Blood samples were also taken from the calf at birth and 24 hours after birth to determine absorption of IgG from colostrum replacer.

Colostrum will be collected at calving and IgG concentration will be determined. Colostrum samples will also be sent to DairyOne for further analysis. Results from 18 cows (9/treatment) indicate that supplementing prepartum cows with 48 g/d niacin increased IgG concentration, protein content and a trend for increased solids content in those cow's colostrum. There were no differences in IgG yield, colostrum yield or fat content of colostrum between treatments.

Measurement	Treatment		SE	P value
	Niacin	Control		
IgG, g/L	86.7	71.4	5.24	0.0263
IgG Yield, g	690	642.5	97.3	0.7385
Colostrum Yield, L	8.97	9.98	0.68	0.3265
Fat,%	5.28	5.18	1.17	0.9521
Protein, %	20.8	16.5	1.48	0.0491
Solids,%	31.21	26.67	1.69	0.0559

NC 1042: 2014 Station Report

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

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

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

Project Objectives addressed in Maryland:

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

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

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

D. USEFULNESS OF FINDINGS:

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

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

E. PUBLICATIONS:

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

K. M. Moyes, L. Ma, T. K. McCoy, and R. R. Peters. 2014. A survey regarding the interest and concern associated with transitioning from conventional to automated (robotic) milking systems for managers of small- to medium-sized dairy farms. Professional Animal Scientist 2014 30:418-422.

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

Six dairy farms in Pennsylvania and New York are currently participating in this one-year case study research project. Initially survey work has been completed to enroll the producer participants but no results are yet available

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

NC 2042: 2013 - 2014 Station Report

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

COOPERATIING AGENCY: Michigan AgBio Research, East Lansing.

Personnel: D. K. Beede, Department of Animal Science.

WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

Project Objectives addressed in Michigan:

Under Objective 1 of NC-2042 project: Optimize calf and heifer performance through increased understanding of feeding strategies, management systems, well-being, productivity and environmental impact for productivity and profitability

Effects of iron in drinking water on preference, growth, and iron status of pre- and post-weaned dairy calves. Drinking water (generally well water in most commercial dairy farms) with greater than 0.3 parts per million iron may affect drinking preference, water intake, health, and growth performance of young calves. The 0.3 parts per million often listed for livestock is actually the upper threshold guideline for “good quality” for palatability for humans published by the World Health Organization (2006). This research aims to determine if pre-weaned and early post-weaned dairy calves exhibit preference for free-choice drinking water with varying iron concentrations; and, to determine if drinking water with varying iron concentrations affects growth performance and iron status of dairy calves.

Study 1 and 2. Drinking water preference of pre-weaned and post-weaned calves offered water with graded ferrous iron (Fe^{+2}) concentrations.

Hypothesis: dairy calves will progressively discriminate against drinking water with increasing ferrous iron concentrations of 0, 2, 4, 8, 12, and 20 parts per million.

Objective: to determine pre- and post-weaned dairy calves exhibit differential preference when graded concentrations of ferrous iron are present in the drinking water.

Experimental: In each Study 1 (pre-weaning with milk replacer) and 2 (post-weaning using a different group of calves) six Holstein calves of either or both sexes were used. The experimental design was a non-parametric preference ranking design lasting 20 days. In the first of five total experimental periods, six buckets contained drinking water with one of six iron treatment concentrations (0, 2, 4, 8, 12, or 20 parts per million). Treatments were randomly placed (daily) on the long each sides of each calf’s individual pen. Experimental drinking water solutions with different concentrations of iron were made using ferrous lactate and distilled water; small graded amounts of lactic acid were

added to make all treatments iso-lactate. Fresh pre-weighed drinking water treatments in new buckets replaced the previous treatment buckets at time of feedings (morning, afternoon and evening) after milk replacer has been consumed (calves had access to drinking water 24 hours daily). At these times, buckets (previously weighed empty) for water, calf starter pellets, and milk replacer (milk replacer fed in Study 1, but not in Study 2) were weighed and changes in weight were recorded as intake. Starter pellets were weighed after each 24-hour period (every morning) and recorded as daily starter intake. Water buckets with treatment solutions were re-randomized each morning (08:00 hour) in each experimental period.

In period 1, all six treatments were provided in a completely random order each day for the first 6 days separately for each calf. At the end of the 6th day, the drinking water treatment with the greatest total consumption over the previous 6-day period was removed and replaced with an empty bucket. The 5 remaining treatments, as well as an empty bucket to replace the 6th treatment, were re-randomized within the bucket holders in Period 2. The previous steps were repeated with 5 treatments provided for 5 days, 4 treatments provided for 4 days, 3 treatments provided for 3 days, and 2 treatments provided for 2 days (Period 5). An empty bucket replaced each removed treatment(s) bucket in the successive periods to keep spatial relationships within the pen the same among all periods.

All the data from both studies have been collected and data analysis is underway. Day 1 intakes (total water consumed during first 24 hours) from each bucket will be used to rank the calf's initial preference to drinking water with varying concentrations of iron using the Kruskal-Wallis test. Friedman statistical test is used to determine agreement of preference among all successive treatment periods (i.e., 6-, 5-, 4-, 3-, and 2-day periods). Kendall's coefficient of concordance will be used to test for normalcy and agreement among calves.

Study 3: Growth performance of pre-weaned calves offered drinking water and milk replacer with varying ferrous Fe concentrations.

Hypothesis: increasing ferrous iron concentrations (0, 2, 4, 8, and 12 parts per million) in drinking water and the water used for milk replacer will reduce growth and increase blood iron, pack cell volume, and iron protein saturation.

Objective: to determine if pre-weaned calves show biological responses (growth performance and (or) blood iron, PCV, and blood iron protein saturation) to increasing iron concentrations in drinking water and that used in preparation of milk replacer (0, 2, 4, 8, and 12 parts per million).

Experimental: Sixty calves of both sexes and 28 days of age will be used in a randomized complete block design consisting of five iron treatments and 12 replicates. Calves are on study 28 through 56 days of age. Calves of each sex are blocked (bull block or heifer block) as available chronologically and within block assigned randomly to one of five drinking water and milk replacer solutions with different ferrous iron

concentrations (0, 2, 4, 8, or 12 parts per million). Calves are assigned to the same treatment for the entire study. Iron concentrations are varied using ferrous lactate and all treatments are iso-lactate using graded additions of lactic acid as needed. Milk replacer feedings are made using respective solutions containing the iron treatments. Milk replacer (containing the iron treatments) is fed three times per day and drinking water and starter are placed inside the hutches.

New drinking water treatment solutions will be offered at each feeding (three times a day) and water intake and milk replacer intake will be recorded at each of these times. Starter intake will be measured once per day at 08:00 hour.

Calves are weighed and measured (wither height, heart girth, hip width, and body length) once per week to monitor growth. Three blood samples are taken via jugular puncture at 08:00 hour on days 0, 14 and 28 of the study. Blood is analyzed for serum iron, packed cell volume, and iron binding protein saturation.

Study 3 is on going; about half the calves have completed the study. Data will be analyzed by least-squares analysis of variance using the MIXED procedure (SAS, version 9.1.3; SAS Institute Inc., Cary, NC).

Under Objective 2 of NC-2042: Improve dairy cow management decisions through nutrient utilization and profitability.

Hepatic triglyceride concentration and fatty acid profile in early lactation Holstein cows fed saturated medium- or long-chain fatty acids. Partitioning of medium-chain fatty acids (FA) in lactating dairy cows is not well understood. We examined hepatic triglyceride concentration ([TG]) and FA profile of early lactation cows fed two sources of saturated FA. Dietary treatments were: no added fat (CTRL); 2.7% of DM as saturated long-chain FA (Energy Booster 100; EB); 2.7% as mostly saturated, medium-chain FA (coconut oil; CNO); or, a 2.7% mixture of EB and CNO (1:1; INT). The CNO diet had 47 g C12:0/kg and 30 g C14:0/kg. The CTRL diet contained 36% NDF (77% from forage), 41% NFC, and 16.5% CP, DM basis. Multiparous (MP; n = 36) and primiparous (PP; n = 31) Holstein cows 10 to 14 DIM were fed 1 of 4 dietary treatments for 16 wk. Hepatic tissue was biopsied before treatment diets were fed, and then on d 14, 28, and 112. Main effects of treatment, biopsy day (repeated measure), and their interaction were tested separately for MP and PP by least squares ANOVA. Dietary CNO concentration increased hepatic [TG] linearly (CNO > INT > EB; $P < 0.001$). In MP, [TG] decreased linearly from d 14 to d 28 and 112 ($P < 0.001$). In PP [TG] was similar across time ($P > 0.05$). Increasing hepatic [TG] related positively to concentrations of C14:0, C16:0, C16:1, or C18:1 *cis*-9 in total hepatic FA, but negatively to C18:0, C18:2, or FA longer than 18 C ($P < 0.01$). Cows fed CTRL or EB had less than 0.1% C12:0 of total hepatic FA. In contrast, CNO increased hepatic C12:0 to 0.9% (MP) or 0.5% (PP) regardless of day of experiment. Hepatic C14:0 accumulated over time with CNO. MP cows fed EB or CTRL versus INT or CNO had greater increase in C16:0, C16:1, and C18:1 *cis*-9 as hepatic [TG] increased (interaction of [TG] by treatment; $P < 0.02$). In MP, CNO decreased C18:0 concentration ($P < 0.01$). Concentration of C18:2 *trans*-10

cis-12 in hepatic FA accumulated in CNO and over time, presumably indicative of ruminal biohydrogenation. Dietary CNO increased hepatic [TG] in early lactation cows. Greater hepatic accumulation of C14:0 versus C12:0 (opposite of dietary concentrations) indicated different physiological partitioning of these different fatty acids.

USEFULNESS OF FINDINGS:

Objective 1: Drinking water (generally well water in most commercial dairy farms) with greater than 0.3 parts per million iron may affect drinking preference, water intake, health, and growth performance of young calves. The 0.3 parts per million often listed for livestock is actually the upper threshold guideline for "good quality" for palatability for humans published by the World Health Organization (2006). Findings of these studies are forthcoming to determine if drinking water with varying iron concentrations affects drinking preference, growth performance and iron status of pre- and post-weaned dairy calves.

Objective 2: Partitioning of medium-chain fatty acids in lactating dairy cows is not well understood. We compared hepatic triglyceride concentrations and fatty acid profiles of early lactation cows fed medium-chain (predominantly C14:0 and C12:0) or long-chain (C16:0 and greater) saturated fatty acid sources. Concentrations of C18:2 *trans*-10 *cis*-12 increased in livers of cows fed medium-chain fatty acids is presumably indicative of ruminal biohydrogenation. Medium-chain fatty acids also increased liver triglyceride concentrations. Greater accumulation of C14:0 vs. C12:0 in livers of cows indicates different physiological partitioning of these fatty acids compared with long-chain fatty acids fed to cows. 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, it also causes undesirable effects in liver metabolism of early lactation cows and 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.

PUBLICATIONS:

Refereed Scientific Articles:

Genther*, O. N., and D. K. Beede. 2013. Preference and drinking behavior of lactating dairy cows offered water with different concentrations, valences, and sources of iron. J. Dairy Sci. 96:1164-1176.

Hollmann*, M., W. J. Powers, A. C. Fogiel, J. S. Liesman, and D. K. Beede. 2013. Response profiles of enteric methane emissions and lactational performance during habituation to dietary coconut oil. J. Dairy Sci. 96: 1769-1781.

Conference Proceedings:

Shire, J. A., and D. K. Beede. 2013. DCAD Revisited: Prepartum Use to Optimize Health and Lactational Performance. Proc. Southwest Nutrition and Management Conf. pp 1 – 18.

Shire, J. A., and D. K. Beede. 2013. Revisiting Prepartum DCAD: Reducing Hypocalcemia in Transition Cows. Proc. Penn. Dairy Cattle Nutr. Workshop. pp 15 - 22.

Beede, D. K. 2013. What Can We Do about Water Quality? Proc. Penn. Dairy Cattle Nutr. Workshop. pp 53 - 58.

Shire, J. A., and D. K. Beede. 2013. Influence of DCAD on Lactational Performance: A Review of Some Practical Considerations. Proc. Penn. Dairy Cattle Nutr. Workshop. pp 91 - 98.

Book Chapter

Beede, D. K. 2013. Animal Agriculture: How Can It Be Sustainable In the Future? (Chapter 18). *In:* Sustainable Animal Agriculture. E. Kebreab, ed., CABI Publishing, CAB International, Wallingford, Oxfordshire, OX10 8DE, UK. pp. *284-311.* ISBN-13: 978 1 78064 042 6

Popular Press/ Magazines

Shire, J. A., and D. K. Beede. 2014. Hypocalcemia is more than a “low calcium” problem. Hoard’s Dairyman (February 10) 159 (3): 81.

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

Objective 1.The practical implications and impact of results of these studies is forthcoming. The central practical question is if drinking water with greater than typically recommended (0.3 parts per million iron) may affect drinking preference, water intake, health, and growth performance of young dairy calves.

Objective 2. 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, it also causes undesirable effects in liver metabolism of early lactation cows and 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.

NC 2042: 2013- 2014 Station Report

A. PROJECT NAME: Strategies to Improve Economic and Environmental Sustainability of Dairy Enterprises (Rev. NC-1042)

B. COOPERATING AGENCY and personnel:

1. Station Reporting: Indiana

2. Personnel reporting from experiment station: Tamilee D. Nennich

Project Objectives for NC-1042

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

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

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

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

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

Under Objective 1 of Project:

Impact of increased dietary grain inclusion on growth performance of prepubertal dairy heifers. *T. S. Dennis, J. E. Tower, H. Schmitz, A. Mosiman, and T. D. Nennich.* The objective of this study was to evaluate the impact of increasing dietary grain:forage ratio on growth, dry matter intake (DMI), and feed efficiency of prepubertal dairy heifers. Seventy-eight Holstein heifers (133.1 ± 27.4 kg, 125 ± 22 d of age) were randomly allocated by body weight (BW) to 1 of 15 pens. Pens were randomly assigned to dietary treatments balanced for CP and ME containing grain:forage ratios of 80:20 (80%), 60:40 (60%), or 40:60 (40%) and fed for 56 d. Following the treatment period, all pens were switched to a common diet containing 40% grain and 60% forage and fed for an additional 56 d. Heifers fed 80% were 13.7 and 27.1 kg heavier than 60% and 40%, respectively, at the end of the treatment period ($P < 0.01$). Similarly, ADG, DMI, feed efficiency, and skeletal growth were improved during the treatment period for 80% compared with 60% and 40% ($P < 0.01$). Feed efficiency was improved for heifers fed 60% compared to 80% on d 84 of the common period, with 60% averaging 0.166 compared to 0.125 kg ADG/kg DMI for 80% ($P = 0.04$). Dairy heifers had greater ADG when fed high amounts of grain, but ADG and feed efficiency were reduced compared with heifers fed moderate to low amounts of grain after switching to a high-forage diet.

Effect of milk feeding frequency and weaning age on growth and intake of dairy calves. *McCullough S. A., T. S. Dennis, S. E. Fraley, B. Houin, and T. D. Nennich.* The objective of this study was to determine the effects of milk feeding frequency and weaning age on growth, intake, and feed efficiency of

dairy calves on a commercial dairy. In this randomized complete block design with a 3 × 2 factorial arrangement of treatments, 162 Holstein heifers (BW = 40.5 ± 5.18 kg) were blocked in groups of 6 by birth date and hutch type. Heifers were assigned to either two (2x), three (3x), or four (4x) times per day milk feeding and either seven (7WK) or nine wk (9WK) weaning times. Calves were fed whole milk and allowed ad libitum access to starter. Body weight at wk 10 was the greatest for 4x with calves weighing 95.6, 93.5, and 91.4 kg for 4x, 3x, and 2x, respectively ($P < 0.001$). Average daily gain (ADG) was greater ($P < 0.01$) for 4x calves than 2x calves with 3x being intermediate (0.79, 0.73, and 0.76 kg/d, respectively). At wk 10, calves fed 4x were taller at the hip ($P < 0.008$) and withers ($P < 0.01$) than 2x. Calves weaned at 9WK were heavier at the end of the study than those weaned at 7WK (95.0 and 92.0 kg, respectively; $P < 0.001$), and overall ADG was greater for 9WK calves at 0.78 kg/d as compared to 0.74 kg/d for 7WK ($P < 0.02$). Feeding calves milk 4 times per day improved calf growth as compared to feeding milk 2 times per day.

Impact of providing shade on the growth performance of grazing dairy heifers during 2 summers. *M. W. Sahar, T. S. Dennis, J. E. Tower, A. Mosiman, and T. D. Nennich.* Shade is recommended for grazing animals and is considered important for their wellbeing and productivity. The objective of this study was to determine the effects of shade on the growth performance of grazing Holstein dairy heifers throughout the summer months for 2 years. Seventy-six (n = 44 in 2012 and n = 32 in 2013) Holstein heifers were randomly assigned to 1 of 4 groups according to BW (389.2 ± 35.9 lb, 147 ± 16 d of age). Groups were assigned to 1 of 2 treatments: no shade (NOSHADE) or 1.7 m^2 shade/heifer for year 2012 and 2.3 m^2 shade/heifer for year 2013 (SHADE). Body weight at the end of the summer ($P = 0.63$) and ADG ($P = 0.81$) of heifers were similar between treatments. Skeletal measurements, including HH, HW, and HG, were similar ($P > 0.14$) between treatments both years; however, heifers on the SHADE treatment tended to be taller ($P = 0.07$) at the withers at the end of the study (117.4 and 118.6 cm, for NOSHADE and SHADE, respectively). Providing shade did not improve the growth performance of Holstein dairy heifers in this study.

Starter crude protein concentrations on growth and intake of dairy calves. *S. A. McCullough, B. Houin, and T. D. Nennich.* The objective of this study was to determine the effects of starter CP levels on growth, intake, feed efficiency, and plasma urea nitrogen (PUN) concentrations of dairy calves on a commercial dairy. In this randomized complete block design, 120 Holstein heifers (BW = 40.3 ± 4.9 kg) were blocked by birth date. Heifers were assigned to starter CP levels of 18, 20, 22, or 24% (as fed). At 12 wk, BW was greater ($P < 0.01$) for 24% compared to 18% calves (106.9 and 101.4 kg, respectively) with 20% and 22% (103.7 and 104.1 kg, respectively) being similar to all treatments. Overall average daily gain (ADG) for 20% and 22% (0.74 and 0.75 kg/d, respectively) were similar to 18% and 24%, but 18% and 24% (0.72 and 0.78 kg/d, respectively) were different ($P < 0.05$). Starter intake over the study was similar among treatments at 0.80, 0.83, 0.87, and 0.91 kg/d for 18, 20, 22, and 24%, respectively ($P > 0.23$). Overall feed efficiency was similar ($P > 0.45$) among treatments at 1.78, 1.83, 1.92 and 2.0 kg DM intake/kg gain, respectively. As CP levels increased from 18% to 24%, PUN concentrations increased among treatments (11.8, 13.1, 15.2, and 16.4 mg/dL, respectively; $P < 0.001$). Feeding calves increasing levels of CP in starter did not result in differences in skeletal growth, feed efficiency, or overall starter intake.

Influence of dietary carbohydrate fractions on growth and development of prepubertal dairy heifers. *T. S. Dennis, J. E. Tower, A. Mosiman, and T. D. Nennich.* Manipulating carbohydrate fractions in growing dairy heifer diets can potentially influence growth and development due to changes in energy availability in the rumen. The objective of this study was to evaluate the effects of altering dietary non-fiber carbohydrates (NFC) content on prepubertal dairy heifer growth, dry matter intake (DMI), feed efficiency, and blood and rumen metabolites. Ninety Holstein heifers (145.3 ± 25.4 kg, 144 ± 26 d of age) were randomly allocated

by body weight (BW) to 1 of 15 pens. Pens were randomly assigned to dietary treatments of high NFC (HNFC; 40.7% of diet DM), low NFC (LNFC; 31.4% of diet DM) and low NFC plus fat (LNFC+; 31.9% of diet DM). Diets were formulated to be isonitrogenous, with lower calculated ME for LNFC compared with HNFC and LNFC+. Heifers were fed diets for 112 d, and forage:concentrate ratios were increased from 35:65 to 60:40 on d 57 of the study. Feeding LNFC+ resulted in heifers that were 4.8 kg ($P < 0.10$) and 8.8 kg heavier ($P < 0.01$) at the end of the study compared with HNFC and LNFC, respectively. Average daily gains ($P < 0.01$) and feed efficiency ($P < 0.10$) were greatest for LNFC+ from d 0 to 56; however, no treatment differences were observed from d 57 to 112. Intake as a percent of BW was greatest for HNFC (3.3%) compared with LNFC (3.1%) and LNFC+ (3.1%) throughout the study ($P < 0.01$). Unexpectedly, increasing dietary NFC did not improve growth compared to lower NFC diets despite increased DMI, indicating that total dietary energy availability may have greater impacts on growth than carbohydrate fractions in the diet.

Under Objective 2 of Project:

D. PUBLICATIONS:

Peer-reviewed/ research and extension.

1) Shroer, R. C., T. D. Nennich, T. S. Dennis, M. M. Schutz, S. S. Donkin, and D. Little. Intake and growth of prepubertal dairy heifers fed reduced fat dried distillers grains. Prof. Anim. Sci. 30:93-98.

Abstracts:

1) Dennis, T. S., H. Schmitz, A. Mosiman, J. Tower, T. Nennich. 2013. Impact of providing shade on grazing dairy heifer performance. J. Dairy Sci. 96(Suppl. 1):90.
2) Dennis, T. S., J. E. Tower, H. Schmitz, A. Mosiman, and T. D. Nennich. 2013. Impact of increased dietary grain inclusion on growth performance of prepubertal dairy heifers. J. Dairy Sci. 96(E-Suppl. 1):717.
3) McCullough, S. A., T. S. Dennis, S. E. Fraley, B. Houin, and T. D. Nennich. 2013. Effect of milk feeding frequency and weaning age on growth and intake of dairy calves. J. Dairy Sci. 96(E-Suppl. 1):221.
4) Sahar, M. W., T. S. Dennis, J. E. Tower, A. M. Mosiman, and T. D. Nennich. 2014. Impact of providing shade on the growth performance of grazing dairy heifers. J. Dairy Sci. 97(Suppl. 1):118.
5) Dennis, T. S., J. E. Tower, A. M. Mosiman, and T. D. Nennich. 2014. Influence of dietary carbohydrate fractions on growth and development of prepubertal dairy heifers. J. Dairy Sci. 97(E-Suppl. 1):347.
6) McCullough, S. A., B. Houin, and T. D. Nennich. 2014. Starter crude protein concentrations on growth and intake of dairy calves. J. Dairy Sci. 97(E-Suppl. 1):346.

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

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

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 calves and heifers will improve the economic sustainability of dairy operations. A study found that feeding heifers 80% grain increased growth, but their intake, though growth rate slowed when they quickly transitioned to a higher forage diet. Overall, heifers fed a 60% diet had the least cost per kg of gain. When dairy heifers were fed diets containing either low NFC levels, high NFC levels, or low NFC levels with added fat, heifers fed the low NFC diets with added fat had greater gains at the end of the study and had lower cost per kg of gain.

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

Impact of fiber digestibility on dairy heifer growth and rumen development. 2013. Mary S. Rice Grant. $7,250.

Evaluating parasite control on dairy heifer performance and water intake in rotation grazing systems. 2014. Mary S. Rice Grant. $4,050.

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

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

Objectives

The overall objective of this project is to increase the awareness of the importance of adequate forage quality and management on profitability in dairy farming systems. Specifically, the objectives of this project are:

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

Time period: 10/01/2013 to 9/30/2014

Outputs

Three workshops, titled *"Forage Quality and Management"*, were presented in different regions within the State of Virginia (specifically, Franklin, Rockingham and Amelia Counties). These workshops involved discussion about the economic impact of forage management in dairy farming systems, as well as hands-on activities to determine silage density and dry matter concentration using microwave oven.

One experiment is undergoing to evaluate the use of remote sensing techniques to anticipate the variation of forage quality from the field. For this experiment vegetation index maps from three areas in Virginia (specifically Montgomery, Pittsylvania and Washington Counties) were developed. Whole-plant corn samples were harvested. The nutritional quality of plants harvested in different environments within a cornfield is being determined within the laboratory.

Another experiment is undergoing to evaluate the effect of plant density of corn on dry matter yield and nutritional quality of corn whole-plant for silage. For this, corn plots were planted at four different densities in a commercial farm. The preceding crop was ryegrass for silage. The nutritional quality of plants harvested in different environments within a cornfield is being determined within the laboratory.

Results from these projects have not been presented yet, other than in the Newsletter from the Department of Dairy Science from Virginia Tech.

Impacts

Through the educational workshops, we are increasing the awareness of the importance of forage quality and management in dairy farming systems. In addition to this, we trained different players of the dairy industry, such as dairy farmers and nutritional consultants, to determine on-farm dry matter concentration using microwave oven. It was interesting to observe their surprise about how simple is this technique.

The plant density study intends to bring solutions to post-drought scenarios, so that dairy farmers can replenish their forage stocks. While we are still determining the nutritional quality of the forages, we know that increasing plant density does not increase dry matter yield when having double-cropping rotations. The great conclusion from this study is forage management in dairy farms is not about managing the crop as such, but rather as a crop within a crop rotation system.

Publications

1. **Ferreira, G.** (2014). It's not about the crop...it's about the crop rotation *VT Dairy Pipeline*, Oct. Virginia Cooperative Extension, DASC-52NP.

Participants

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

Target Audience

The target audiences are dairy farmers in general, extension agents, consultants, and government agents.

NC2042 Station Report

2013 – 2014

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

B. COOPERATING AGENCY and personnel: Utah State University, Allen Young

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

Under Objective 2 of Project:

1. Effects of altering alfalfa hay quality when feeding steam-flaked versus high-moisture corn grain on ruminal fermentation and lactational performance of dairy cows.

An experiment was performed to test a hypothesis that nutritive benefits of feeding high-moisture corn (HMC) would be different when fed with different qualities of alfalfa hay (AH) due to associative effects on ruminal fermentation and nutrient utilization efficiency. Eight multiparous lactating Holstein cows were used; 4 were surgically fitted with ruminal cannulas. Days in milk averaged 184 ± 10.7 at the start of the experiment. The experiment was performed in a duplicate 4 × 4 Latin square design. Within each square, cows were randomly assigned to a sequence of 4 diets during each of the four 21-d periods (14 d of treatment adaptation and 7 d of data collection and sampling). A 2 × 2 factorial arrangement was used; fair-quality AH [FAH; 39.6% neutral detergent fiber (NDF) and 17.9% crude protein (CP)] or high-quality AH (HAH; 33.6% NDF and 21.9% CP) was combined with steam-flaked corn (SFC) or HMC to form 4 treatments: FAH with SFC, FAH with HMC, HAH with SFC, and HAH with HMC. The AH was fed at 32% dry matter (DM) content, whereas SFC or HMC was included at 17% DM content. Quality of AH did not affect DM intake, whereas feeding HMC decreased DM intake, regardless of quality of AH. Digestibility of DM was greater for cows fed HAH compared with those fed FAH (70.1 vs. 67.6%). Digestibility of NDF increased by feeding HMC (67.6 vs. 58.4%), but not by quality of AH. Under FAH, starch digestibility decreased by feeding HMC compared with SFC (85.7 vs. 95.0%), but it was similar under HAH, resulting in an interaction between quality of AH and type of corn grain (CG). Feeding different qualities of AH did not affect milk yield; however, feeding HMC decreased milk yield in FAH diet, causing an AH × CG interaction. Efficiency of milk yield/DM intake was improved due to feeding HMC, regardless of the quality of the AH. In addition, dietary N utilization for milk N tended to increase by feeding HMC, but it was not influenced by quality of AH. Yield of microbial protein increased by feeding HAH diets compared with FAH diets, whereas feeding the HMC diet increased microbial protein yield under the HAH diet, leading to an interaction between and AH and CG.

2. Feeding protein supplements in alfalfa hay-based lactation diets improves nutrient utilization, lactational performance, and feed efficiency of dairy cows.

Due to the increasing cost of soybean meal and concerns of excess N being excreted into the environment, new protein supplements have been developed. Two products that have shown potential in increasing N utilization efficiency are slow-release urea (SRU; Optigen; Alltech Inc.,

Nicholasville, KY) and ruminal-escape protein derived from yeast (YMP; DEMP; Alltech Inc.). The objective of this study was to assess the effects of feeding these 2 supplements in alfalfa hay-based [45.7% of forage dietary dry matter (DM)] dairy diets on nutrient utilization, feed efficiency, and lactational performance of dairy cows. Twelve multiparous dairy cows were used in a triple 4 × 4 Latin square design with one square consisting of ruminally cannulated cows. Treatments included (1) control, (2) SRU-supplemented total mixed ration (SRUT), (3) YMP-supplemented total mixed ration (YMPT), and (4) SRU- and YMP-supplemented total mixed ration (SYT). The control consisted only of a mixture of soybean meal and canola meal in a 50:50 ratio. The SRU and the YMP were supplemented at 0.49 and 1.15% DM, respectively. The experiment consisted of 4 periods lasting 28 d each (21 d of adaptation and 7 d of sampling). Cows fed YMPT and SYT had decreased intake of DM, and all supplemented treatments had lower crude protein intake compared with those fed the control. Milk yield tended to have the greatest increase in YMPT compared with the control (41.1 vs. 39.7 kg/d) as well as a tendency for increased milk fat and protein yields. Feed efficiencies based on yields of milk, 3.5% fat-corrected milk, and energy-corrected milk increased at 10 to 16% due to protein supplementation. Cows fed protein supplements partitioned less energy toward body weight gain, but tended to partition more energy toward milk production. Efficiency of use of feed N to milk N increased by feeding SRUT and YMPT, and milk N-to-manure N ratio increased with YMPT.

D. USEFULNESS OF FINDINGS:

1. Overall results in this experiment indicate that feeding HMC in AH-based diets improved feed efficiency as well as N utilization efficiency, regardless of quality of AH.

2. Overall results from this experiment indicate that replacing the mixture of soybean meal and canola meal with SRU and YMP in alfalfa hay-based dairy diets can be a good approach to improve nutrient utilization efficiencies in lactating dairy cows.

E. PUBLICATIONS

Two papers, that report the results of this research, are currently in press at Journal of Dairy Science.

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

Dairy farms are under pressure to increase production, but reduce input costs. Feed costs are the single highest expense on a dairy and increasing. Feeding high moisture corn or commercial protein replacements, under western U.S. conditions, can improve nitrogen utilization efficiency.

NC 2042: 10/01/2013-09/31/20134 Pennsylvania State University Station Report

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

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

Project Objectives

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

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

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

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

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

Under Objective 1 of Project:

Effect of heat treatment and bacterial population of colostrum on passive transfer of IgG

Heat treatment of colostrum has been shown to increase apparent efficiency of IgG absorption (AEA) in newborn dairy calves. It has been hypothesized that this may be partially due to reduction in bacteria that occurs during heat treatment. This study's objective was to test the effect of bacteria concentration in unheated and heat-treated colostrum on IgG absorption. Colostrum treatments were created by pooling colostrum from individual cows to create a single batch. Half of the colostrum was heated to 60^{o} C and held for 30 min before cooling and rebottling (heat-treated). The remaining half of the colostrum was rebottled without heating (unheated). Half of each treatment was frozen immediately after bottling. Remaining heat-treated colostrum was inoculated with 20 mL of unheated colostrum. Remaining unheated and inoculated heat-treated colostrum were stored at 20^{o} C for 60 and 72 h, respectively, to achieve similar final bacteria populations and subsequently frozen until needed for feeding. Samples were collected from each colostrum treatment for IgG and bacteria analysis prior to freezing. Bull calves (n = 104) were randomly assigned to treatment at birth. Plasma samples were collected 48 h after birth and assessed for IgG concentration. Data were analyzed using the mixed procedure in SAS. Initial SPC was 4.59 log cfu/mL and reduced to 2.79 log cfu/mL following heat treatment. High bacteria treatments of unheated and heat-treated colostrum contained 8.65 and 8.56 log cfu/mL, respectively. Mean AEA (48-h plasma IgG concentration) was 31.25% (20.7 mg/mL) and 15.86% (10.4 mg/mL) in calves fed unheated colostrum of low and high bacteria concentration, respectively; and 37.27% (24.0 mg/mL) and 13.94% (9.3 mg/mL) in calves fed heat-treated colostrum of low and high bacteria concentration, respectively. Bacteria level significantly reduced AEA and 48-h plasma IgG concentration (P < 0.01). No effect of heat treatment was

observed for 48-h IgG concentration or AEA (P = 0.42 and 0.36, respectively); however, there tended to be an interaction between bacterial population and heat treatment for AEA (P = 0.08). Slicing the interaction indicated a tendency of heat-treatment to increase 48-h IgG concentration and AEA in low bacteria colostrum treatments (P = 0.10 and 0.07, respectively). In this study, concentration of bacteria in colostrum had greater effect on calves' ability to absorb IgG than heat treatment of colostrum.

Whole or Ground Oats in Calf Starters: Effects on Rumen Fermentation and Rumen Development

A series of 3 trials were conducted to determine effects of whole or ground oats in starter grain on rumen fermentation and development of pre-weaned calves. Male Holstein calves (43.1 ± 2.3 kg BW at birth; n = 8, 9, and 7 for trials 1, 2, and 3 respectively) were housed in individual pens in a heated facility; bedding was covered with landscape fabric to avoid any consumption of bedding. In trials 1 and 2 only, calves were fitted with a rumen cannula by wk 2 of life. Water was offered free choice, and milk replacer was fed to 12% of birth BW. In all trials a fixed amount of starter (containing 25% oats either ground and in the pellet or whole; 18.7% CP, 12.7% NDF) was offered daily based on average intakes of calves on similar milk replacer diets; orts were fed through the cannula in trials 1 and 2. Calves were randomly assigned to all pelleted starter (Ground; n = 11) or pellets plus whole oats (Whole; n = 13). Rumen contents (trials 1 and 2) were sampled weekly at -8, -4, 0, 2, 4, 8, and 12 h after grain feeding for pH and VFA determination. Calves were euthanized 3 wk (trial 1) or 4 wk (trials 2 and 3) after grain was offered; organs were harvested, emptied, rinsed, and weighed to gauge digestive organ development. Experimental design was complete randomized block. Starter intake was not different between treatments by design (P > 0.05); weekly intakes were 481 ± 24; 1,575 ± 30; 3,176 ± 48; 4,656 ± 143 g for wk 1 to 4 of grain feeding. Weekly measurements of rumen digesta pH and molar proportion of individual VFA did not change with diet. Molar proportion of butyrate and pH linearly decreased with age while acetate proportion increased. Reticulorumen weight (569 Ground vs. 503 Whole ± 24 g) and papillae length (0.75 Ground vs. 0.68 Whole ± 0.03 mm) tended to be greater for Ground (P < 0.1) while abomasum weight (240 Ground vs. 274 Whole ± 9 g) was greater for Whole (P< 0.05). Liver and omasum weights were not different. Under the conditions of this study physical form of oats in starter grain did not affect rumen fermentation parameters; greater rumen weight and papillae length in Ground may be a result of greater nutrient availability of ground oats.

Feeding lactating dairy cattle long hay separate from the TMR can maintain DMI during incidents of low rumen pH

The objective of this study was to investigate effects of orchardgrass hay (H) quality and feeding method on rumen pH and feed preference in lactating dairy cows. Eight rumen-cannulated Holstein cows (104 ± 34 DIM, 601 ± 116 kg, and parity of 2.38 ± 1.69; mean ± SD) were used in a replicated 4 × 4 Latin Square. Each period encompassed 21 d divided into 5 phases: adaptation, d 1 to 14, ad libitum TMR; baseline, d 15 to 17, ad libitum TMR; restricted feeding, d 18, cows fed for 75% of baseline DMI; challenge, d 19, 4 kg (as-fed) fine ground wheat mixed into the digesta of each cow via rumen cannula before feeding; and recovery, d 20 to 21, ad libitum TMR. Cows were assigned to squares by parity and randomly assigned to treatments. Treatments were: corn silage (CS) with coarse H TMR (CC), CS and fine H TMR (CF; both hays chopped and included in TMR), CS TMR with 5.2% supplemental long coarse H (TMR+C), and CS TMR with 5.2% supplemental long fine H (TMR+F; both hays fed separate from TMR). Coarse H was 8.6% CP and 67.1% NDF, fine H was 14.4% CP and 56.2% NDF.

Animals were housed individually, milked 2X/d, and fed 1X/d for 10% refusal rate. Data was analyzed using MIXED procedure of SAS. Rumen challenge decreased weighted average rumen pH from 5.72 to 5.51. Cows fed TMR+C had higher rumen pH compared to CC and TMR+F on d 19. During d 20, cows fed H had higher rumen pH than cows fed supplemental long H. Cows fed supplemental long H had greater DMI during baseline and challenge d compared to TMR H treatments. Minimal differences among diets were found for TMR particle size selection during challenge d; however, cows had a greater preference for fine long H during recovery d. Milk production averaged 38.3 kg/d and did not differ among treatments. Fat, protein, and lactose yields were also not different among treatments. Milk fatty acid profile was altered by treatment. The TMR+C and CF treatments increased production of conjugated linoleic acid (CLA) *cis*-9, *trans*-11 ($P = 0.02$). Results of this study indicate that feeding TMR plus supplemental long H can maintain DMI during incidents of and recovery from periods of low ruminal pH.

Effect of Diet Particle Size on Sorting, Eating Rate, Rumen pH and Digestibility in Dairy Heifers

Eight cannulated dairy heifers (19.3 ± 0.8 mo of age and 524.51 ± 10.01 kg of BW) were fed either a long or short cut corn silage (LCS or SCS) at 1.65% BW (limit feeding) to determine eating behavior and digestion parameters. Diets consisted of 70% corn silage, 11% ground corn, 8% citrus pulp, 6% canola meal, 2% soy bean hulls, 1.2% Optigen and 2% mineral/vitamin mix fed once daily. Heifers were subject to a cross over design study with 18-d periods; 14 d adaptation 4 d sampling. Particle size (PS) was measured at 0 and 2 h after feeding. Feces were collected (d 14 to 18) to determine DM digestibility. Rumen contents were sampled (d 17 to 18) to measure pH at 0, 1, 2, 4, 8, 12, 16, 20 and 22 h after feeding. Data were analyzed with Mixed procedure of SAS 9.4. The LCS ration had an increase of 91% of long (>19 mm) feed particles 2 h after feeding with no change in feed particles on the SCS diet. Feed particles retained on the 8-, 4-mm and pan sieves decreased 7, 30 and 35% respectively. The overall rate of eating was not different between treatments (2.75 vs 2.37 kg/h SCS and LCS respectively). Rumen pH changed throughout the day from 7.1 to 4.7 from feeding to 8 h post feeding but was not different between treatments. It is likely that these variables were not different because the heifers were fed a restricted diet (8.73 ± 0.19 kg of DMI) that was consumed by 4 h after feeding. The DM digestibility of diets (75.24 ± 2.2 %) was not different. In conclusion, these results highlight the importance of providing adequate bunk space when restricting DMI for heifers fed high energy diets with long feed particle size. Inadequate feed bunk space promotes competition and selective consumption of feed particles by the more dominant heifers, which could lead to inappropriate and variable nutrition for heifers within a group.

Under Objective 3 of Project:

A Survey of Feeding Management Practices and By-product Feeds Usage on Pennsylvania Dairy Farms

Feed management is an important daily activity on dairy farms. Due to tight profit margins and higher feed costs, many producers incorporate by-product feeds into their rations. Dairy industry experts offer many suggestions about ration formulation and

feeding management; however, it is unclear what practices are being followed with regard to either ration formulation or the use of by-product feeds. This study used an electronic survey to gather information about feeding management and the use of by-product feeds in rations for a subset of Pennsylvania dairy farms in 2013. The survey was sent to 200 dairy farms via email, and 41 surveys were completed. The survey was first sent out in November 2013, and the last response was received in April 2014. All survey responses were based on the month of September, 2013. This was not a random sampling. These herds were selected from the Penn State Extension database and those from the database willing to take surveys. Most (97.6%) survey respondents fed a total mixed ration (TMR). About half (48.8%) fed one TMR to all their lactating cows, and about half (48.8%) fed more than one TMR to all their lactating cows. Over half (58.5%) of the respondents fed a 60:40 forage to concentrate ratio for the ration. Distillers grains and brewer's grains and yeasts were the most commonly used by-product feeds. Responding producers analyzed dry matter most frequently biweekly (34.1 %) or when switching feeds (34.1 %) and at least once a week (26.8%). However, 60.9% of respondents tested dry matter the recommended interval of biweekly or once a week. Most TMR and forage nutrient testing was done when switching feeds, except for by-product commodity feeds, which most producers never nutrient tested. This study summarizes feeding management practices used by responding Pennsylvania dairy farms with regard to nutrient content testing. Dairy producers that responded to the survey were successful at feed management, but increasing the amount of nutrient testing on by-product feeds and the use of dairy data analysis tools could improve their success.

Impact of Dairy Advisory Teams on Farm Improvement in Pennsylvania Dairies

Dairy producers continuously seek ways to improve their farm, and many choose to form a dairy advisory team (DAT) to improve management. The objectives were: (1) to compare key measures before and after the team in order to determine if the use of a DAT was effective and (2) to compare a group of 24 herds with a DAT to Pennsylvania (PA) averages for key measures. Teams were formed between May 2008 and January 2013. The range in herd size was 32-608±13.96 cows. Herd size, milk yield, somatic cell score (SCS), peak milk yield, age at first calving (AFC), days in milk (DIM), pregnancy rate and cull and mortality rates were key measures analyzed. The changes in key measures, after using DAT for at least one year, were analyzed using a general liner models and contrasts. After DAT use for one year, herds had significantly ($P<0.05$) higher percent of herd with SCS 1-3 of 76.92 vs 73.79 % and higher peak milk in the third plus lactation with 45.60 vs. 43.30 kg. After DAT use for more than one year, herds had significantly ($P<0.05$) higher milk yields of 33.56 vs. 31.13 kg. As well as lower AFC of 25.50 vs. 24.45 months and higher percent of herd with SCS 1-3 of 79.85 vs. 73.4 %. After use of DAT for more than one year, herds had lower days in milk (DIM) of 173 vs. 187 and higher peak milk in the third plus lactation of 47.4 vs. 43.3 kg. The DAT herds' January Dairy Herd Improvement Association (DHIA) test data were compared to Dairy Metric's PA average for January 2014 using a one-sample t-test. Farms with DAT had significantly ($P<0.05$) higher milk yield of 33.9 vs. 31.9 kg and peak milk yield for first lactation with 36.1 vs. 33.9 kg. There was no significant difference between the averages for DAT herds and PA herds for peak milk yield in older cows,

but DAT herds had numerically higher peaks (44.3 vs. 42.7 kg and 47.4 vs. 45.9 kg for 2nd and 3rd lactation, respectively) in older cows. Herds with DAT had significantly (P<0.001) lower AFC of 24.4 vs. 25.6 months and higher percentage of herd with SCS 1-3 79.85 vs 73.4%. There were no differences for pregnancy rate, DIM, cull or mortality rates. Use of DAT led to greater milk yield, lower AFC and better SCS. Herds with DAT had higher milk yield, lower AFC and better SCS compared to PA averages. Use of a DAT was beneficial to dairy farms.

D. USEFULNESS OF FINDINGS:

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

The form of calf starter ingredient appear to have little to no effect on reticulorumen weight or rumen papillae size in young calves. Since the size or particle size of ingredients have little impact, more work can be focused on nutrient levels of calf starters.

Diet particle size will impact the ability of a dairy heifer or cow to sort her ration. In respect to limit fed heifers, this may mean that some heifers will be able to drastically change their diet, especially if they have feed available < 8 hr. per day. In lactating dairy cows that may have high concentrate diets either occasionally or consistently, the animal's ability to sort may be beneficial to rumen pH, DMI, and milk production if they have the ability to sort their ration for longer feed particles or are offered long dry hay free-choice.

Survey data indicated many positive feeding management practices on dairy farms, but improvement in the frequency of nutrient testing, especially with by-product feeds could improve overall farm feeding management. Nutrient variability, especially in by-product feeds, may be contributing to lower income over feed costs in some herds.

Use of dairy advisory teams showed marked advantages when measured both before and after team implementation and as compared to Pennsylvania dairy farm averages. Dairy farms using teams had larger herd sizes, higher milk production, lower age at first calving and lower somatic cell scores. Use of dairy advisory teams on dairies will improve farm productivity and profitability.

E. PUBLICATIONS:

Peer-reviewed/ research and extension.

Suarez-Mena, F. X., G. J. Lascano, and A. J. Heinrichs. 2013. Chewing activities and particle size of rumen digesta and feces of precision-fed dairy heifers fed different forage levels with increasing levels of distillers grains. J. Dairy Sci. 96:5184-5193.

Maulfair, D. D., K. K. McIntyre, and A. J. Heinrichs. 2013. Subacute ruminal acidosis and total mixed rations preference in lactating dairy cows. J. Dairy Sci. 96:6610-6620

Heinrichs, A. J., C. M. Jones, S. M. Gray, P. A. Heinrichs, S. A. Cornelisse, and R. C. Goodling. 2013. Identifying efficient dairy heifer producers using production costs and data envelopment analysis. J. Dairy Sci. 96: 96:7355-7362.

Heinrichs, A. J., B. S. Heinrichs, and C. M Jones. 2013. Fecal and saliva IgA secretion when feeding a concentrated mannan oligosaccharide to neonatal dairy calves. Prof. Animal Scientist 29:457-462.

Pino, F. H., and A. J. Heinrichs. 2014. Comparison of on-farm forage dry matter methods to forced air oven for determining forage dry matter. Prof. Animal Scientist 30:33-36.

Gelsinger, S. L., S. M. Gray, C. M. Jones and A. J. Heinrichs. 2014. Heat treatment of colostrum increases immunoglobulin G absorption efficiency in high, medium, and low-quality colostrum. . J. Dairy Sci. 97:2355-2360.

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

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

Buza, M. H, L. A. Holden, R. A. White, and V. A. Ishler. 2014. Evaluating the effect of ration composition on income over feed cost and milk yield. J. Dairy Sci. 97: 3073-3080

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

Suarez-Mena, F. X., A. J. Heinrichs, C. M. Jones, T. M. Hill, and J. D. Quigley. 2014. Whole or ground oats in calf starters: Effects on rumen fermentation and rumen development. J. Dairy Sci. 97 (E-Suppl. 2):185 (Abst.)

Kimicikewycz, A. D., and A. J. Heinrichs. 2014. Feeding lactating dairy cattle long hay separate from the TMR can maintain DMI during incidents of low rumen pH . J. Dairy Sci. 97 (E-Suppl. 2):302 (Abst.).

Elizondo-Salazar, J. A., O. A. Vargas-Villalobos, L. Noguera-Solera, and J. Heinrichs. 2014. Passive transfer of immunity of dairy calves in the central northern region of Costa Rica. J. Dairy Sci. 97 (E-Suppl. 2):427 (Abst.).

Elizondo-Salazar, J. A., J. J. Arroyo-Arroyo, J. Sanchez-Salas, and J. Heinrichs 2014. Immune status of dairy heifer calves in the northern plains of Costa Rica. Year III. J. Dairy Sci. 97 (E-Suppl. 2):540 (Abst.).

Gelsinger, S. L., A. M. Smith, and A. J. Heinrichs. 2014. Comparison of radial immunodiffusion and enzyme-linked immunosorbant assay for quantification of bovine IgG in colostrum and plasma. J. Dairy Sci. 97 (E-Suppl. 2):577(Abst.).

Gelsinger, S. L., and A. J. Heinrichs. 2014.) Effect of heat treatment and bacterial population of colostrum on passive transfer of IgG. J. Dairy Sci. 97 (E-Suppl. 2):578(Abst.).

Pino, F. H., A. J. Heinrichs, and C. Castro. 2014. Effect of diet particle size on sorting, eating rate, rumen pH, and digestibility in dairy heifers. J. Dairy Sci. 97 (E-Suppl. 2):815(Abst.).

Heinrichs, A. J., and C. Jones. 2013. Age at calving is on the descent. Hoards Dairyman. 158:305.

Heinrichs, A. J., and C. Jones. 2013. Dairy cattle nutrition workshop- an educational tradition. Farmshine 33 (12) : 22.

Heinrichs, A. J. 2014. Precision-feeding dairy heifers. Progressive Dairyman. 28 (10):20-21.

Gelsinger, S. and A. J. Heinrichs. 2014. Research explores treatment options for waste milk. Farmshine 35 (31) : 18.

Heinrichs, A. J., and C. Jones. 2014. Feeding dairy heifers… precisely. Hoards Dairyman. 159 (9):345. Translated for Hoard's Dairyman en espanol 159: 140; Also translated for Hoard's Dairyman Japan 159:145.

Kmicikewycz, A. D. and A. J. Heinrichs. 2014. Can Ration Sorting Benefit Lactating Dairy Cattle? Lancaster Farming 17 May: E6.

Buza, M. H., L. A. J. Holden, and R. C. Goodling. 2014. The impact of dairy advisory teams on farm improvement in Pennsylvania dairies. J. Dairy Sci. 97 (E-Suppl. 2):365(Abst.).

F. IMPACT STATEMENT

Heat treating colostrum to reduce bacteria numbers will increase IgG absorption in neonate calves and allow a higher efficiency of IgG absorption in their blood which will influence and improve the health of dairy calves.

The ability of dairy heifers and cows to sort their ration, given a variety of particle sizes in their ration, can be useful if well managed by the famer to allow the animal to have more correct rumen pH and dry matter intakes; thus making these animals healthier and more productive.

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

G. Leverage

Effects of TMR particle size and forage to concentrate ratio on rumen pH and feed preference in lactating dairy cows. Taxon Biosciences, Inc. $40,900.

Novel feed manufacturing process on feed intake and rumen development in dairy calves. Archer Daniels Midland Inc., $12,000.

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

NC 2042: 2013 - 2014 Station Report

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

B. COOPERATING AGENCY: University of Nebraska-Lincoln, Lincoln NE

Personnel: P.J. Kononoff, Department of Animal Science.

Project Objective:

Main objective: *To evaluate and develop sustainable management systems for dairy herds that address critical quality and variance control factors with implications to economic efficiencies and environmental impacts.* ***Sub-objectives: 2)*** *to optimize lactating and dry cow decision-making as it relates to animal health, nutrient utilization, milk production, reproduction, and profitability (cows)*

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

Under Sub-objectives 2:

Energy Content of reduce fat DDGS Eight Holstein and 8 Jersey multiparous, lactating cows were used to complete 56 energy balances to determine the energy content of reduced-fat distillers grains and solubles (RFDDGS). A repeated switchback design was used to compare treatments with and without RFDDGS. Diets consisted of 24.2 % corn silage, 18.4 % alfalfa hay, 6.94 % brome hay with either 22.9 % rolled corn and 14.8 % soybean meal (Control), or 8.95 % rolled corn, 28.8 % RFDDGS, and 0 % soybean meal (Co-P; DM basis). The inclusion of RFDDGS did not affect DMI averaging 21.4 ± 0.53 kg DM (P = 0.86) for all cows but milk production tended (P = 0.10) to increase from 29.8 to 30.9 ± 1.46 kg/d for Control and Co-P treatments. There was no difference in milk fat percentage but 3.5 % FCM also tended (P = 0.10) to increase from 32.9 to 34.2 ± 1.27 kg/d, for Control and Co-P diets, respectively. Milk protein was significantly (P < 0.01) decreased by the Co-P treatment (3.56 and 3.41 ± 0.08 % for Control and Co-P treatments) but protein yield was not affected (P = 0.51). Milk energies were 1.40 Mcal/d higher with Co-P (P = 0.01). Energy lost as methane was reduced (P < 0.01) by 0.31 Mcal/d with the addition of RFDDGS to the diet. Heat loss averaged 29.9 ± 0.55 Mcal/d and did not differ by diet (P = 0.49). Average energy retained as tissue energy was found to be -2.99 ± 0.93 Mcal/d (P = 0.73). Intake of digestible and metabolizable energies were not significantly different (P = 0.16 and 0.14) between the Control and Co-P treatments, averaging 2.68 and 2.31 Mcal/kg DM, respectively. Net energy of lactation values of Control and Co-P diets were calculated to be 1.43 and 1.47 Mcal/kg DM (P = 0.10).

Energy efficiency of Holstein and Jersey dairy cows offered diets containing reduce fat distillers grains RFDDGS Fifty six energy balances were completed with 8 Holstein (H) and 8 Jersey (J) multiparous lactating cows to examine the effect of breed on the efficiency of milk production and energy use. Treatments were applied in a repeated switch back design to compare genotypes. Treatments consisted of 24.5% corn silage, 18.4% alfalfa hay, 6.9% grass hay, with either 22.9% rolled corn and 14.8% soybean meal or 4.51% rolled corn and 14.5% RFDDGS (dry matter basis). Diets were offered ad libitum for a 28 d adaptation period and 95% ad libitum for a 4 d collection period. During the collection days, ration digestibility and energy use was measured, indirect calorimeter respiration head boxes were used to determine heat production. Across the two treatments, Holstein cows had a significantly higher gross energy (GE) (30 ± 3.96 Mcal/d; P=<.01), and higher energy output in feces, urine, methane, heat production (HP), and milk energy (6.5 ± 1.24, 0.11 ± 0.11, 1.2 ± 0.15, 8.95 ± 0.74, and 8.54 ± 1.27 Mcal/d, respectively; P= < 0.01) than did Jersey cows. Jersey cows produced milk with higher fat (4.96% and 3.69% ± 0.19 for Jersey and Holstein, respectively; p=<0.01), protein (3.75% and 3.20% ± 0.1 for Jersey

and Holstein, respectively; p=0.0009), and energy concentrations, compared with those of the Holstein cows. Metabolizable energy (ME) and digestible energy (DE) intake as a proportion of GE intake were significantly higher for Holstein cows (0.03 ± 0.01 and 0.03 ± 0.01, respectively; P=0.01 and 0.02). However, cow genotype had no significant effects on ME/DE (0.88 ± .01), HP/ME (0.56 ± .02), DE/DMI (2.78 ± .06), ME/DMI (0.45 ± .06), methane energy/DE (0.08 ± .004), and urine energy/DE (0.04 ± .002). No significant interaction was found between cow genotype and treatment for any of the efficiency variable examined. In addition, no significant effects on energy partitioning between milk (milk energy/ME intake) (0.40 ± .18), and body tissue (retention energy/ME intake) (0.04 ± .0034) were found between Holstein and Jersey dairy cows. In conclusion, genotype has no effect on the overall production efficiency of dairy cows in terms of efficiency of ME use for lactation, and energy partitioning between milk and body tissue.

Methane production in cows consuming reduce fat DDGS A study using 4 ruminally cannulated multiparious Holstein dairy cows was conducted to determine the impact of conventional and reduced fat dried distillers grains and solubles (DDGS) on milk production, composition, and methane production. A 4 × 4 Latin square was utilized and included 4 treatments, namely a zero control (C) and diets that contained 30% of the diet DM as either conventional DDGS (ConDG), or 15% reduced fat DDGS (RFDG) or a mixture (Mix) of 15% conventional DDGS and 15% reduced fat DDGS. In all three treatment diets DDGS were included in replace of corn and soybean meal. Cows were housed and fed in individual stalls and fed once per day and milked twice per day for 4 28 d periods. During the last two days methane production was measuring using indirect calorimeters. As has been observed previously, cows consuming DDGS consumed more feed (P = 0.048) (22.2, 24.8, 26.4 and 27.3 ± 1.57 for the C, RFDG, Mix and ConDG respectively). Likely in response feed intake, milk yield was also affected (P = 0.008) by feeding DDGS (29.4, 39.4, 28.0, and 38.2 ± 3.22 for the C, RFDG, Mix and ConDG respectively). Although total methane was not (P = 0.688) was not different across treatments averaging 443.8 ± 20.6 L/d, cows consuming DDGS produced less (P = 0.011) per unit of milk produced (14.6, 11.3, 12.1 and 12.1 ± 0.84 kg milk/kg feed for the C, RFDG, Mix and ConDG respectively). Results of this study further support the notional that DDGS may be used to replace both corn and soybean meal in dairy rations and also suggest that doing may also result in less methane per unit of milk produced.

D. USEFULNESS OF FINDINGS:

The estimated energy content for reduced fat were determined to be 3.82 Mcal/kg DE at 1 × maintenance, 3.41 Mcal/kg ME at 1 × maintenance, and 2.03 Mcal/kg NEL at 3 × maintenance. These values are lower than values determined for distillers grains containing more fat.

The inclusion of DDGS into dairy rations results in less methane produced per unit of milk produced.

Dairy breed does not appear to affect efficiency of utilization of metabolizable energy.

E. PUBLICATIONS:

Paz, H.A., P.J. Kononoff. 2014. Lactation responses and amino acid utilization of dairy cows fed low-fat distillers dried grains with solubles with our without rumen-protected lysine supplementation. J. Dairy Sc. In Press.

Ramirez Ramirez , H.A., E. Castillo Lopez, K. J. Harvatine , and P.J. Kononoff. 2014. Fat and starch as risk factors for milk fat depression in dairy diets containing corn dried distillers grains with solubles. J. Dairy Sci. Submitted.

Paz, H.A., T. J. Klopfenstein, E. Castillo-Lopez, and P. J. Kononoff. 2014. Evaluation of ruminal and intestinal digestion of protein and amino acids in feedstuffs used as protein supplements in dairy rations. J. Dairy Sci. In Press.

Castillo-Lopez, E, K.J. Clark, H.A. Paz, H.A. Ramirez Ramirez, T.H. Klusmeyer, G.F. Hartnell, and P. J. Kononoff. 2014. Performance in dairy cattle fed silage and grain produced from second-generation insect-protected (B.t.) corn (MON 89034), parental line or reference corn. J. Dairy Sci. 97: 3832 – 3837.

Castillo-Lopez, E., T. J. Klopfenstein, C. L. Anderson, N. D. Aluthge, S. C. Fernando, T. Jenkins, and P. J. Kononoff. 2014. Effect of feeding dried distillers grains with solubles on rumen biohydrogenation, intestinal fatty acid profile and gut microbial diversity evaluated through DNA pyro-sequencing. J. Anim. Sci. 92: 733-743.

Castillo-Lopez, E., T. J. Klopfenstein, S. C. Fernando, and P. J. Kononoff. 2014. 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. Can. J. Anim. Sci. 94: 349-356.

Paz, H. A. and P. J. Kononoff. 2014. Technical Note: Effect of feeding free lysine or rumen-protected lysine on duodenal flows of essential amino acids in ruminants. Prof. Anim. Sci. 30:266-269.

Paz, H.A., M. J. de Veth, R. Ordway, and P. J. Kononoff. 2013. Evaluation of rumen protected lysine supplementation to lactating dairy cows consuming increasing amounts of distillers dried grains with solubles. J. Dairy Sci. 96: 7210-7222.

Castillo-Lopez, E., T. J. Klopfenstein, S. C. Fernando, and P. J. Kononoff. 2014. Ration formulations containing reduced fat DDGS and their impact on lactation performance, rumen fermentation and intestinal flow of microbial nitrogen in Holstein. J. Dairy. Sci. 97: 1578-1593.

Abstracts

Paz Manzano, H.A., E. Castillo-Lopez, T. J. Klopfenstein, and **P. J. Kononoff**. 2014. Ruminal degradation and intestinal digestibility of crude protein and amino acids and correction for microbial contamination in rumen-undegradable protein. J. Dairy Sci. 97: Suppl 1: 753.

Paz Manzano, H.A., T. J. Klopfenstein, and **P. J. Kononoff**. 2014. Rumen-undegradable protein of blood meal, canola meal, low-fat distillers dried grains with solubles, soybean meal, and expellers soybean meal determined using in sit and in vitro ammonia release procedures. J. Dairy Sci. 97: Suppl 1: 762.

Ramirez Ramirez, H.A., and **P.J. Kononoff**. 2014. Effects of forage particle size and corn oil supplementation related to milk fat depression in dairy cows consuming reduce fat dried distillers with solubles. J. Dairy Sci. 97: Suppl 1: 778-779.

Foth, A., G. Garcia Gomez, T. Brown-Brandl, H.C. Freetly, and **P.J. Kononoff**. 2014. Energy content of reduced-fat distillers grains for lactating dairy cows. J. Dairy Sci. 97: Suppl 1: 171.

Garcia Gomez, G., A. Foth, **P.J. Kononoff**, T. Brown-Brandl, and H.C. Freetly. 2014. Comparison of effiency of energy use in Holstein and jery dairy cows offered diets containing reduced fat distillers grans (RFDDGS). J. Dairy Sci. 97: Suppl 1: 825.

MacDonald, J.C., G.E. Erickson, **P.J. Kononoff**, and T.J. Klopfenstein. 2014. Optimizing the use of fibrous residues in beef and dairy diets. J. Dairy Sci. 97: Suppl 1: 156.

Ramirez Ramirez, H.A., C.J. R. Jenkins, S.C. Fernendo, C.L. Anderson, N.D. Aluthge, and **P.J. Kononoff**. 2014. Ruminal bacterial community structure of dairy cows fed conventional and reduced-fat dried distillers with solubles. J. Dairy Sci. 97: Suppl 1:916.

Kononoff, P.J. 2014. Measuring forage quality of corn silage and understanding the impacts on rumen fermentation in lactating dairy cattle. J. Dairy Sci. 97: Suppl 1:22

Grants

Kononoff, P.J. 2014. Methionine activity from different protected methionine sources. Novus International. $ 60, 000. Funded.

Kononoff, P.J., S.C. Fernando, and T. Burkey. 2014. Understanding the interaction between rumen microbes and host metabolism during milk fat depression in dairy cows. $499,242. Submitted.

Kononoff, P.J., and S.C. Fernando. 2014.Methane moitigation in cattle. $348, 298. Submitted.

Annual Project Report
North Central Cooperative Research Project NC-2042
Year ending September 30, 2014

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

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

Personnel: J.L. Anderson, NC-2042 (new member)
Dairy Science Department
K. F. Kalscheur, NC-2042 member
Dairy Science Department (now at USDA-ARS, DFRC, Madison, WI)

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

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

C. Work progress and principal accomplishments:

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

1. Growth performance and total tract nutrient digestion for Holstein heifers precision-fed diets high in distillers grains with different forage particle size.
This study evaluated dairy heifer growth performance and total tract nutrient digestion when fed diets high in dried distillers grains with solubles (DDGS) with different forage particle size, achieved by utilizing alfalfa hay that was processed differently. An 8-wk randomized complete block design study was conducted using twenty-two Holstein heifers (123 ± 32 d of age; initial body weight (BW) of 140±23.5 kg). Treatments were either 15% chopped (**CHOP**) or 15% pelleted (**PELL**) alfalfa hay on a dry matter (DM) basis. Both diets also contained 30% DDGS, 53.75% corn silage, and 1.25% mineral mix. Rations were precision-fed for a dry matter intake (DMI) of 2.3% of BW. Frame sizes, BW, and body condition scores (BCS) were taken on two consecutive days during wk 0, 2, 4, 6 and 8. During wk 8, titanium dioxide was fed and fecal grab samples were collected to measure total tract nutrient digestion. Heifer DMI increased ($P<0.01$) when fed CHOP versus PELL (4.42 and 4.19 kg/d for CHOP and PELL, respectively). Body weights (167.4 and 164.0 kg) and average daily gain (0.83 and 0.96 kg/d) were similar ($P>0.05$) between treatments. Gain to feed was less ($P<0.01$) in CHOP versus PELL

(0.21 and 0.25). Hip height (110.7 and 110.9 cm), wither height (106.7 and 106.6 cm), and body length (95.1 and 94.9 cm) were similar between treatments. Paunch girth (153.6 and 150.4 cm), heart girth (122.4 and 120.4 cm), and hip width (30.2 and 29.6 cm) were greater (P<0.05) for CHOP versus PELL. Body condition score was less (P<0.01) for CHOP compared to PELL (3.03 and 3.09). For growth measurements there were no significant treatment by week interactions or differences in average daily changes. Total tract digestibility of DM (67.5 and 67.3 %), neutral detergent fiber (51.2 and 50.1 % of DM), and crude protein (68.3 and 67.9 % of DM) were similar between treatments. Heifers fed diets containing 30% DDGS with 15% chopped or pelleted alfalfa hay had similar total tract nutrient digestion and growth performance, with some very minor differences in frame growth and feed to gain. Overall, this study demonstrated that feeding dairy heifers diets with different forage particle sizes, achieved by inclusion of chopped or pelleted alfalfa hay, does not affect utilization of DDGS.

2. **Evaluation of growth performance, nutrient utilization, metabolic profile, and onset of puberty in dairy heifers fed reduced fat distillers grains in replacement of forage in limit-fed rations.** This study evaluated dairy heifer growth performance when heifers were fed reduced-fat distillers dried grains with solubles (RFDDGS) in replacement of forage. A 16-wk randomized complete block design study was conducted using 48 Holstein heifers (199 ± 1.92 d of age; initial body weight (BW) of 266±4.98 kg). The study was conducted from September 2013 to September 2014. Treatments diets were: 1) 30% RFDDGS with 68.5% grass hay (**30DG**); 2) 40% RFDDGS with 58.5% grass hay (**40DG**) and 3) 50% RFDDGS with 48.5% grass hay (**50DG**) on a DM basis. All diets also contained 1.5% mineral mix. Rations were precision-fed so that the amount of feed offered as a percentage of BW decreased across treatments as the dietary percentage of RFDDGS increased. Rations were offered at 2.65, 2.50, and 2.35% of BW on a DM basis for 30DG, 40DG and 50DG, respectively. This allowed for similar intakes of crude protein and energy across treatments. Frame sizes, BW, body condition scores (BCS), and back-fat thickness were measured on two consecutive days during wk 0, 2, 4, 6, 8, 12, 14, and 16 of the feeding period. There were interactions of treatment by week for any of the parameters measured. Heifer DMI linearly decreased (P<0.01) with increasing concentrations of RFDDGS in the diet (6.49, 6.21, and 5.84 kg/d for 30DG, 40DG, and 50DG, respectively). Body weights (264.1, 266.2, and 266.4 kg) and average daily gain (0.89, 0.94, and 0.97 kg/d) were similar (P>0.05) among treatments. Gain to feed (0.14, 0.16, and 0.18 kg) linearly increased (P<0.01) with increasing concentrations of dietary RFDDGS (P<0.01). Hip height (124.8, 124.7, and 124.8 cm), hip width (35.6, 35.8, and 35.8 cm), and back-fat measurements (27.6, 26.7, and 26.9 mm) were similar among treatments (P>0.05). There was a tendency (P= 0.06) for a linear increase in body length (112.5, 112.9, and 113.1 cm) as dietary concentrations of RFDDGS increased (P<0.05). There was a quadratic effect for wither height (120.9, 121.7, and 121.6 cm), paunch girth (172.5, 173.9, and 172.5 cm), and BCS (3.11, 3.12, and 3.07), and a quadratic tendency for heart girth (140.9, 140.6, and 140.9 cm). Precision-feeding diets with higher inclusion rates of RFDDGS resulted in improved gain to feed rations without increased back-fat accretion. Overall, this study demonstrated that replacing forage with RFDDGS does not negatively affect heifer growth performance. During the feeding study blood, fecal, rumen, and feed samples were collected. Analysis of these samples will be

conducted over the next six months to a year. Data is also being collected on reproductive and lactation (first 90d) performance post-trial.

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

1. **Ruminal degradability and intestinal digestibility of protein in canola meal.** Differences in processing by different plants may result in canola meal (CM) with varying nutritional composition. The Dairy NRC (2001) estimated CM to be 35.7% rumen undegradable protein (RUP) with an intestinal digestibility of 75% when DMI was set at 4% of BW. Seven CM samples were obtained from different processing plants and 1 soybean meal (SBM) to evaluate the variability in ruminal degradability and intestinal digestibility of CP. Dacron bags containing 5 g of each feed were incubated in the rumen in duplicate for 0, 2, 4, 8, 12, 16, 24 and 48 h using three ruminally cannulated lactating cows. The rate of passage was calculated at 6.6%/h. The A fraction (rapidly degradable CP) varied from 26.6% to 17.8%, respectively, for CM10 and CM5 ($P<0.05$). The B fraction (slowly degradable CP) was highest for CM5 (79.9%) and lowest for CM12 (62.4%), whereas the C fraction (undegradable CP) was highest for CM12 (14.6%) and lowest for SBM (0.6%). The rate of degradation of B fraction, Kd (%/h) was highest for SBM (11.1%/h) and lowest for CM12 (4.0%/h). The RUP (% of CP) was highest for CM12 (53.8%), whereas lowest for SBM (31.0%), while the IDP (measured by pepsin-pancreatin digestion) ranged from 94.5% for SBM to 71.6% for CM10. The total digestible protein (TDP) was highest for SBM (98.2%) and CM ranged from 85.1% to 90.8% for CM12 and CM10 ($P<0.01$), respectively. The mean ruminal and intestinal digestibilities of CM are in agreement with NRC, however considerable variation exists between CM processing plants.

	Feeds[1]								
Item[2]	SBM	CM5	CM6	CM7	CM9	CM10	CM11	CM12	SEM
A, %	23.0^{c}	17.8^{b}	21.7^{bc}	26.4^{c}	24.8^{c}	26.6^{a}	25.1^{a}	23.1^{ab}	1.18
B, %	76.5^{ab}	79.9^{a}	76.8^{ab}	66.3^{cd}	69.8^{bcd}	69.6^{bcd}	72.6^{abc}	62.4^{d}	1.84
C, %	0.6^{b}	2.3^{b}	1.5^{b}	7.4^{b}	5.4^{b}	3.8^{b}	2.3^{b}	14.6^{a}	1.42
Kd, % h	11.1^{a}	5.6^{bc}	5.2^{c}	9.1^{ab}	4.6^{c}	9.7^{ab}	6.2^{bc}	4.0^{c}	1.32
RUP, % of CP	31.0^{d}	46.1^{b}	44.8^{b}	35.4^{cd}	46.6^{b}	32.3^{d}	40.8^{bc}	53.8^{a}	2.05
IDP, %	94.5^{a}	76.8^{bc}	75.8^{bcd}	72.0^{de}	77.4^{b}	71.6^{e}	75.3^{bcde}	73.0^{cde}	2.50
TDP, %	98.2^{a}	89.3^{bc}	89.1^{c}	90.1^{bc}	89.4^{bc}	90.8^{b}	89.3^{bc}	85.1^{d}	0.73

[a-e] Means in rows with different superscripts differ significantly ($P < 0.05$)

2. **Effect of feeding distillers grains with different forage concentrations in lactating dairy cow diets on milk fatty acid composition.** The objective of this study was to evaluate the effect of dried distillers grains with solubles (DG) on milk fat depression and the fatty acid (FA) composition of rumen digesta and milk when fed with different forage concentrations. This study was part of a larger companion study which evaluated the effect of diet on production measures (Ranathunga et al 2010). It was hypothesized that cows fed high forage (HF) diets with DG would not decrease milk fat composition whereas cows fed low forage (LF) diets with DG would decrease milk fat and alter milk fatty acid composition compared to cows fed diets formulated with no DG. Sixteen Holstein cows (121 ± 45 DIM) which included 4 fistulated cows were assigned to a

multiple 4 × 4 Latin square design. Four diets were formulated: 1) LF diet with 0% DG (0DG), 2) LF diet with 18% DG (18DG), 3) HF diet with 0DG, and 4) HF diet with 18DG. Diets with LF were balanced to contain 17% forage NDF (41:59 forage: concentrates ratio) and HF were balanced to contain 25% forage NDF (60:40 forage: concentrates ratio). Ground corn and soybean feeds were partially replaced by DG from 0DG to formulate 18DG. Feed intakes of individual cows were recorded daily. Daily milk production was recorded and milk samples were collected during week 3 and 4 of each period. Ruminal digesta samples were collected at 0, 4 and 8 h after feeding on d 24 of each period. Milk and ruminal digesta were analysed for FA composition. Data were analysed using the mixed procedures of SAS (ver 9.3) to evaluate the main effects of forage concentration, DG inclusion, and their interaction.

A companion study investigating the effect of DG on milk production using non-cannulated cows demonstrated that DMI was not affected by diets; however milk yield was greater when cows were fed LF compared with HF regardless of the addition of DG (43.3 vs 41.5 kg/d). Whereas milk fat percentage (3.03 vs 3.38%) was lesser for cows fed LF compared with HF, milk fat yield was not affected by the diets. The addition of DG did not affect milk fat concentration or yield. Low and high forage diets contained similar proportions of saturated (SAT; 37.6 vs 37.8 g/100 g of FA) and unsaturated (62.5 vs 62.4 g/100 g of FA) FA. However, 0DG contained a numerically lesser proportion of unsaturated FA (59.1 vs 65.9 g/100 g of FA) compared with 18DG. The proportion of total C18:1 FA was numerically greater for LF vs HF (18.7 vs 15.7 g/100 g of FA) and was numerically lesser for 0DG vs 18DG (16.3 vs 18.1 g/100 g of FA). Cows fed LF and HF received similar proportion of C18:2 FA (30.9 vs 32.4 g/100 g of FA) whereas cows fed 0DG received numerically lesser proportions of C18:2 FA compared with cows fed 18DG (28.0 vs 35.1 g/100 g of FA). Overall, proportions of SAT, monounsaturated (MUFA), polyunsaturated (PUFA), and total C18:2 FA of rumen digesta were not affected by the diets and averages were 68.9, 18.6, 9.63, 8.09 g/100 g of FA, respectively. Rumen digesta from cows fed LF had a greater ($P<0.005$) proportion of total C18:1 compared with HF (14.2 vs 12.5 g/100 g of FA). Altered dietary conditions were reflected in the milk FA composition. Cows fed LF had lesser ($P=0.001$) proportions of SAT FA of milk fat compared with those fed HF (62.0 vs 64.3 g/100 g of FA) where it was greater ($P=0.001$) for cows fed 0DG compared those fed 18DG (64.3 vs 62.0 g/100 g of FA). Contrarily, the proportions of MUFA of milk fat were greater ($P=0.01$) for LF compared to HF (30.5 vs 29.0 g/100 g of FA) whereas it was lesser ($P=0.006$) for cows fed 0DG compared with 18DG (28.9 vs 30.6 g/100 g of FA). Similarly, the proportions of PUFA of milk fat were greater ($P<0.001$) for LF compared with HF (6.34 vs 5.51 g/100 g of FA) where it was lesser ($P<0.001$) for cows fed 0DG compared with 18DG (5.61 vs 6.24 g/100 g of FA). There was no forage concentration effect on the proportion of total C18:1 FA of milk fat, however it was lesser ($P=0.002$) for 0DG compared with 18DG (24.9 vs 26.6 g/100 g of FA). Total C18:2 of milk fat was greater ($P<0.001$) for LF vs HF (5.69 vs 4.96 g/100 g of FA) and lesser ($P<0.001$) for 0DG vs 18DG (5.67 vs 4.98 g/100 g of FA). Similarly, the proportions of total C18:3 of milk fat were greater ($P=0.001$) for LF vs HF (0.48 vs 0.43 g/100 g of FA), but it was greater ($P<0.001$) for 0DG compared to 18DG (0.52 vs 0.40 g/100 g of FA). Feeding LF increased the trans-10 C18:1 FA in milk fat compared with HF (1.54 vs 0.16 g/100 g of FA). A greater proportion of trans-10, cis-12 C18:2 was measured with milk fat of cows fed LF compared to HF (0.05 vs 0.02 g/100 g of FA) and 0DG compared to 18DG (0.02 vs 0.05 g/100 g of FA). Results

shows that forage NDF concentration had an effect on reducing milk fat percentage, but inclusion of DG did not. However, both forage and DG concentrations do affect FA composition of rumen digesta and milk of lactating dairy cows.

D. Usefulness of findings:

Feeding dairy heifers diets with different forage particle sizes, achieved by inclusion of chopped or pelleted alfalfa hay, does not affect utilization of DDGS.

Precision-feeding diets with higher inclusion rates of RFDDGS in replacement of forage resulted in improved gain to feed ratios without increased back-fat deposition. Overall, this study demonstrated that heifers can be fed high amounts of RFDDGS without negatively affecting growth performance.

The mean ruminal and intestinal digestibilities of CM are in agreement with NRC, however considerable variation exists between CM plants, which may need to be considered in ration formulation.

Results demonstrate that forage NDF concentration had an effect on reducing milk fat percentage, but inclusion of DG did not. However, both forage and DG concentrations do affect FA composition of rumen digesta and milk of lactating dairy cows.

E. Publications:

Abstracts

1. Anderson, J. L. 2014. David J. Schingoethe Syposium-Invited: How much fat should growing dairy heifers be fed? J. Dairy Sci. 97 (E-Suppl.1):18 (Abstr 043).

2. Jayasinghe, N., K. F. Kalscheur, J. L. Anderson, and D. P. Casper.2014. Ruminal degradability and intestinal digestibility of protein and amino acids in canola meal. J. Dairy Sci. Vol. 97, E-Suppl. 1: 566 (Abstr. M126)

3. Lawrence, R. D., J. L. Anderson, T. J. Vanderwerf, A. K. Manthey, K. F. Kalscheur, and D. P. Casper. 2014. Growth performance and total tract nutrient digestion for Holstein heifers precision-fed diets high in distillers grains with different forage particle size. J. Dairy Sci. Vol. 97:(E-Suppl.1):825 (Abstr. T299).

4. Ranathunga, S.D. and K.F. Kalscheur. 2014. Effect of feeding distillers grains with different forage concentrations in lactating dairy cow diets on milk fatty acid composition. Animal Production in Australia Proceedings. Joint International Symposium on the Nutrition of Herbivores/International Symposium on Ruminant Physiology (ISNH/ISRP) in Canberra, Australia, Sept. 8-12, 2014.

5. Strayer, B.M., D. Ziegler, D. Schimek, B. Ziegler, H. Chester-Jones, J. L. Anderson, K. F. Kalscheur, and D. Casper. 2014. Development of a modified accelerated milk replacer feeding program through 8 wk of age. J. Dairy Sci. 97: (E-Suppl.1) 309 (Abstr. 0616).

Theses

1. Jayasinghe, N.K. 2014. Ruminal degradabilities and intestinal digestibility of canola meal and the production response of cows fed canola meal with varying concentration of starch sources. M.S. Thesis, South Dakota State University, Brookings.

2. Manthey, A.K. 2014. Effect of yeast-derived microbial protein in low and high forage diets on the performance of dairy cows. M.S. Thesis, South Dakota State University, Brookings.

3. Ranathunga. S.D. 2014 Dried distillers grains with solubles as a non-forage fiber source in lactating dairy cow diets. Ph.D. Thesis, South Dakota State University, Brookings.

4. Strayer, B.M. 2014. Development of a modified accelerated milk replacer feeding program for dairy calves. M.S. Thesis, South Dakota State University, Brookings.

F. Impact statement:

Research conducted at South Dakota State University demonstrated that:

- Particle size of the ration has limited effects on heifer growth and utilization of diets with DDGS as the main ingredient in the concentrate mix.
- Peri-pubertal heifers maintain their growth performance and have improved gain to feed ratios when reduced-fat DDGS replaces hay in precision-fed diets.
- Ruminal degradabilities of canola meal can vary across processing plants and are greater than what is published in feed libraries. Intestinal digestibilities are more consistent across plants, are in line with previously published literature.
- Forage NDF concentration reduced milk fat percentage, but inclusion of distillers grains did not. However, both forage and DG concentrations do affect FA composition of rumen digesta and milk of lactating dairy cows.

G. Leverage:

Maximize the use of canola meal in dairy feeds. $25,000.

Feeding reduced-fat DDGS to dairy heifers. $83,340.

Feeding non-food oilseed meals to dairy heifers. $29,254.

NC 2042: 2013 - 2014 Station Report

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

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

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS and

D. USEFULNESS OF FINDINGS:

Associations between age at first calving, rearing average daily weight gain, herd milk yield level and dairy herd production, reproduction, and profitability of costs.

Krpalkova, L, V. E. Cabrera, J. Kvapilik, J. Burdych, and P. Crump. The objective of this study was to evaluate the associations of variable intensity in rearing dairy heifers on 33 commercial dairy herds including 23,008 cows and 18,139 heifers for age at first calving (AFC), average daily weight gain (ADG), and milk yield (MY) level on reproduction traits and profitability of costs. Milk yield during the production period was analyzed relative to reproduction and economic parameters. Data were collected during 1 yr period (2011). The farms were located in 12 regions in the Czech Republic. The results show that those herds with more intensive rearing periods had lower conception rates among heifers at first and overall services. The differences in those conception rates between the group of greatest ADG (≥0.800 kg/d) and the group of least ADG (≤0.699 kg/d) were approximately 10 percentage points in favor of the least ADG. All the evaluated reproduction traits differed between AFC groups. Conception at first and overall services (cows) was greatest in herds with AFC ≥ 800 d. Shortest days open (105 d) and calving interval (396 d) were found in the middle AFC group (799 to 750 d). The highest number of completed lactations (2.67) was observed in the group with latest AFC (≥800 d). The earliest AFC group (≤749 d) was characterized by the highest depreciation costs per cow at CZK 8,275 (US$ 414), and the highest culling rate for cows of 41%. The most profitable rearing approach was reflected in the middle AFC (799 to 750 d) and middle ADG (0.799 to 0.700 kg) groups. Most MY (≥8,500 kg) occurred with earliest AFC of 780 d. Higher levels of MY led to lower conception rates in cows, but the most MY group also had the shortest days open of 106 d, and calving interval of 386 d. The same MY group had the highest cow depreciation costs, net profit, and profitability of costs without subsidies of 2.67%. We conclude that achieving low AFC will not always be the most profitable approach, which will depend upon farm-specific herd management. The level of MY is a very important factor for dairy farm profitability of costs. The group of farms having the most MY achieved the highest net profit despite having greater fertility problems.

Feeding strategies and manure management for cost effective mitigation of greenhouse gas emissions from dairy farms in Wisconsin.

Dutreuil, M., M. Wattiaux, C. A. Hardie, and V. E. Cabrera. Greenhouse gas (GHG) emissions from dairy farms are a major concern. Our objectives were to assess the impact of mitigation strategies on GHG emissions and net return to management on 3 distinct farm production systems of Wisconsin. A survey was conducted on 27 conventional farms, 30 grazing farms and 69 organic farms. The data collected were used to characterize 3 feeding systems scaled to the

average farm (85 cows and 127 ha). The Integrated Farm System Model was used to simulate the economic and environmental impacts of altering feeding and manure management in those 3 farms. Results showed that incorporation of grazing practices for lactating cows in the conventional farm led to a 27.6% decrease in total GHG emissions (-0.16 kg CO_2eq/kg of energy corrected milk (ECM)) and a 29.3% increase in net return to management (+$7,005/year) when milk production was assumed constant. For the grazing and organic farms, decreasing the forage to concentrate ratio in the diet decreased GHG emissions when milk production was increased by 5% or 10%. The 5% increase in milk production was not sufficient to maintain the net return; however, the 10% increase in milk production increased net return in the organic farm but not on the grazing farm. A 13.7% decrease in GHG emissions (-0.08 kg CO_2eq/kg of ECM) was observed on the conventional farm when incorporating manure the day of application and adding a 12-mo covered storage unit. However, those same changes led to a 6.1% (+ 0.04 kg CO_2 eq/kg ECM) and a 6.9% (+0.06 kg CO_2 eq/kg ECM) increase in GHG emissions in the grazing and the organic farms, respectively. For the 3 farms, manure management changes led to a decrease in net return to management. Simulation results suggested that the same feeding and manure management mitigation strategies led to different outcomes depending on the farm system; and furthermore, there were effective mitigation strategies to reduce GHG emissions while maintaining profitability within each farm.

Feeding strategies on certified organic dairy farms in Wisconsin and their impact on milk production and income over feed costs.

Hardie, C., M. Wattiaux, M. Dutreuil, R. Gildersleeve, N. Keuler, and V. E. Cabrera. The purposes of this study were (1) to analyze and categorize certified organic Wisconsin dairy farms based on general farm characteristics and feeding strategies during the course of 2010 and (2) to evaluate herd milk production and income over feed costs (IOFC). An on-site survey containing sections on farm demographics, feeding, grazing, and economics was conducted on 69 farms (12.6% survey response rate). A non-hierarchical clustering method using 9 variables related to general farm characteristics, feed supplementation, and grazing was applied to partition the farms into clusters. A scree plot was used to determine the most appropriate number of clusters. Dry matter intake was approximated based on farmer-reported total amounts of feed consumed (feed offered less refusals). Milk production was evaluated using reported milk rolling herd averages (RHA). Income over feed costs was calculated as milk sales minus feed expenses. The farms in clusters 1 (n=8) and 3 (n=32), the large and small high-input farms, respectively, included more feed ingredients in their lactating cows' diets and relied more heavily on concentrates than farms in other clusters. Cows on these farms were predominantly Holstein. Clusters 1 and 3 had the highest RHA (6,878 and 7,457 kg/cow per yr, respectively) and IOFC ($10.17 and $8.59/lactating cow per d, respectively). The farms in cluster 2 (n=5) were completely seasonal, extremely low-input farms, that relied much more heavily on pasture as a source of feed, with 4 out of the 5 farms having all of their operated land in pasture. Farms in cluster 2 relied on fewer feeds during both the grazing and non-grazing seasons compared with farms in the other clusters. These farms had the lowest RHA and IOFC at 3,632 kg/cow per yr and $5.76/lactating cow per d, respectively. Cluster 4 (n=24), the semi-seasonal, moderate-input, pasture-based cluster, ranked third for RHA and IOFC (5,417 kg/cow per yr and $5.92/lactating cow per d, respectively). Breeds other than Holstein were used more prevalently on farms in clusters 2 and 4. Results indicated extreme variation in animal breed, structure and feeding strategies among Wisconsin organic dairy farms. .Feeding strategies appeared to be major determinants of RHA and IOFC. These findings may serve current organic

and transition farmers when considering feeding management changes needed to meet organic pasture rule requirements or dealing with dietary supplementation challenges.

Economics of fertility in high-yielding dairy cows on confined TMR systems.

Cabrera, V. E. The objective of this review paper was to summarize the latest findings in dairy cattle reproductive economics with an emphasis on high-yielding, confined TMR systems. The economic gain increases as the reproductive efficiency improves. These increments follow the law of diminishing returns, but are still positive even at high reproductive performance. Reproductive improvement results in higher milk productivity and, therefore, higher milk income over feed cost, more calf sales and lower culling and breeding expenses. Most high-yielding herds in the USA use a combination of timed artificial insemination (TAI) and oestrous detection (OD) reproductive programme. The ratio of achievable pregnancies between OD and TAI determines the economic value difference between both and their combinations. Nonetheless, complex interactions between reproductive programme, herd relative milk yield, and type of reproductive program are reported. For example, higher herd relative milk yield would favour program relying more on TAI. In addition, improved reproductive efficiency produces extra replacements. The availability of additional replacements could allow more aggressive culling policies (e.g., less services for non-pregnant cows) to balance on-farm supply and demand of replacements. Balancing heifer replacement availability in an efficient reproductive programme brings additional economic benefits. New technologies such as the use of earlier chemical tests for pregnancy diagnosis could be economically effective depending on the goals and characteristics of the farm. Opportunities for individual cow reproductive management within defined reproductive program exist. These decisions would be based on economic metrics derived from the value of a cow such as the value of a new pregnancy, the cost of a pregnancy loss, or the cost of an extra day open.

Impact of prepubertal and postpubertal growth and age at first calving on production and reproduction traits during the first 3 lactations in Holstein dairy cattle.

Krpalkova, L, V. E. Cabrera, M. Vacek, M. Stipkova, L. Stadnik, and P. Crump. The objective of this study was to evaluate the effect of body condition score (BCS), body weight (BW), average daily weight gain (ADG) and age at the first calving (AFC) of Holstein heifers on production and reproduction parameters in the 3 subsequent lactations. The data set consisted of 780 Holstein heifers calved at 2 dairy farms in the Czech Republic from 2007 to 2011. Their BW and BCS were measured at monthly intervals during the rearing period (5 to 18 mo of age), and the milk production and reproduction data of the first 3 lactations were collected over an 8 yr period (2005 to 2012). The highest milk yield in the first lactation was found in the group with medium ADG (5 to 14 mo of age, 0.949 to 0.850 kg/d ADG). The highest average milk yield over lifetime performance was detected in heifers with the highest total ADG (≥0.950 kg/d). Difference in milk yield between the evaluated groups of highest ADG (in total and postpubertal growth ≥0.950 kg/d and in prepubertal growth ≥0.970) and the lowest ADG (≤0.849 kg/d) was approximately 1,000 kg/305 d per cow. The highest milk yield in the first lactation was found in the group with the highest AFC ≥751, for which fat and protein content in the milk was not reduced. Postpubertal growth (11 to 14 mo of age) had the highest impact on AFC. The group with lowest AFC ≤699 d showed a negative impact on milk yield but only in the first 100 d of the first parity. Highest ADG was detrimental to reproduction parameters in the first lactation. Highest BW at 14 mo (≥420 kg) led to lower AFC. Groups according to BCS at 14 mo showed no differences in AFC or milk yield in the first lactation

or lifetime average production per lactation. We concluded that low AFC ≤699 d did not show a negative impact on subsequent production and reproduction parameters. Therefore, a shorter rearing period is recommended for dairy herds with suitable management.

Prediction of retention pay-off using a Machine Learning algorithm.

Shahinfar, S, A. Kalantari, V. E. Cabrera, K. Weigel. Replacement decisions have a major effect on dairy farm profitability. Dynamic programming (DP) has been widely studied to find the optimal replacement policies in dairy cattle. However, DP models are computationally intensive and might not be practical for daily decision making. Hence, the ability of applying machine learning on a pre run DP model to provide fast and accurate predictions of nonlinear and intercorrelated variables makes it an ideal methodology. Milk class (1 to 5), lactation number (1 to 9), month in milk (1 to 20), and month of pregnancy (0 to 9) were used to describe all cows in a herd in a DP model. Twenty seven scenarios based on all combinations of 3 levels (base, 20% above, and 20% below) of milk production, milk price, and replacement cost were solved with the DP model, resulting in a data set of 122,716 records, each with a calculated retention pay-off (RPO). Then, a machine learning model tree algorithm was used to mimic the evaluated RPO with DP. The correlation coefficient factor was used to observe the concordance of RPO evaluated by DP and RPO predicted by the model tree. The obtained correlation coefficient was 0.991, with a corresponding value of 0.11 for relative absolute error. At least 100 instances were required per model constraint, resulting in 204 total equations (models). When these models were used for binary classification of positive and negative RPO, error rates were 1% false negatives and 9% false positives. Applying this trained model from simulated data for prediction of RPO for 102 actual replacement records from the University of Wisconsin-Madison dairy herd resulted in a 0.994 correlation with 0.10 relative absolute error rate. Overall results showed that model tree has a potential to be used in conjunction with DP to assist farmers in their replacement decisions.

Prediction of insemination outcomes in Holstein dairy cattle using alternative Machine Learning algorithms.

Shahinfar, S., D. Page, J. Guenther, V. E. Cabrera, P. Fricke, and K. Weigel. When making the decision about whether or not to breed a given cow, knowledge about the expected outcome would have an economic impact on profitability of breeding program and net income of the farm. The outcome of each breeding can be affected by many management and physiological factors that vary between farms and interact with each other. Hence, the ability of machine learning algorithm to accommodate complex relationships in the data and missing values for explanatory variables makes these algorithms well suited for investigation of reproduction performance in dairy cattle. The objective of this study was to develop a user friendly and intuitive on-farm tool to help farmers make reproduction management decisions. Several different machine learning algorithms were applied to predict the pregnancy status of each cow after breeding based on phenotypic and genotypic data. Data from 26 dairy farms in the Alta Genetics Advantage Progeny Testing Program were used, representing a ten-year period from 2000 to 2010. Health, reproduction, production, data were extracted from on-farm dairy management software and estimated breeding values were downloaded from USDA_ARS Animal Improvement Programs Laboratory (Beltsville, MD) databases. The edited data set consisted of 129,245 breeding records from primiparous

Holstein cows and 195,128 breeding records from multiparous Holstein cows. Each data point in the final data set included 23 (25) features (explanatory variables) and one binary outcome for primiparous (multiparous) cows respectively. The best performance was exhibited by a random forest algorithm with 0.723±0.21 (0.736±0.28) classification accuracy and are under the curve (AUC) of 0.756±0.005 (0.736±0.005) for primiparous (multiparous) cows, respectively. Whereas naïve bayes, bayesian network and decision trees algorithm showed somewhat poorer classification performance. An information-based variable selection procedure identified herd average conception rate, incidence of ketosis, number of previous (failed) inseminations, days in milk at breeding, and mastitis as the most effective explanatory variables in predicting pregnancy outcome.

From hot to cold: a preliminary analysis of climatic effects on the productivity of Wisconsin dairy farms.

Lingqiao, Q., B. E. Bravo-Ureta, and V. E. Cabrera. This study examines the effect of climatic variables on dairy farm productivity using panel data for the state of Wisconsin along with alternative stochastic frontier models. A noteworthy feature of this analysis is that Wisconsin is a major dairy producing area where winters are typically very cold and snowy, and summers hot and humid. Thus, it is an ideal geographical region for examining the effects of a range of climatic factors on dairy production. This paper presents a preliminary analysis of the climatic effect on the productivity of Wisconsin farms. We identify the effect of temperature and precipitation, both jointly and separately, on milk output. The analysis shows that increasing temperature in summer or in autumn is harmful for dairy production, while warmer winters and warmer springs are beneficial. By contrast, more precipitation has a consistent adverse effect on dairy productivity. Overall, in the past 17 years, climatic conditions have had a negative impact on the dairy farms in Wisconsin and the data reveals a mild negative trend.

Optimizing concurrently dairy farm productivity and environmental performance.

Liang, D., and V. E. Cabrera. The objective of this analysis was to assess economic and environmental impacts of a dairy farm milk production using the Integrated Farm System Model (IFSM, version 4.0, University Park, PA). The IFSM was applied to integrate crop growth, feed storage, machinery usage, and herd management to simulate the highest possible milk production with the available on-farm resources and purchased feed. A representative Wisconsin dairy farm system was defined as a typical farm with 100 milking cows and 247 acres of cropland. Farm performance was then simulated using 25 yr of daily weather data (1986 to 2010). A sensitivity analysis was conducted by increasing the input target milk production starting at 9837 kg/cow per yr. The fat-protein-corrected milk production (FPCM) increased linearly as the target milk production was increased to 10,457 kg/cow per yr. Followed, the FPCM increased nonlinearly (at a decreasing rate) until the target milk production was increased to 10,980 kg/cow per yr. Thereafter, FPCM remained flat regardless of higher target milk production input. The per-kg FPCM net return ($/kg FPCM) showed a similar trend, increasing from $4.08 ± 2.32 to $6.20 ± 2.19, and then to $6.78 ± 2.18, respectively. Given the farm carbon footprint (kg CO2eq/kg FPCM) as the result of dividing the net greenhouse gas emission (including methane, nitrous oxide, and carbon dioxide) by the FPCM, it decreased from 0.69 ± 0.04, to 0.67 ± 0.04, and then to 0.65 ±

0.04, respectively, as the FPCM and the net return increased. We concluded that increasing productivity using only farm available resources would elevate the net return and decrease carbon footprint at the same time. Further research is required to explore management strategies that determine increased productivity within farm-specific conditions.

Premium beef semen on dairy calculator.

Lopes, G., and V. E. Cabrera. Producers are searching for alternatives to increase net income of their operations. Genetic companies are partnering with livestock sales companies, and offering alternatives to help dairy producers to receive premium payment for crossbred calves when switching the conventional AI to semen provided by beef breeds. Our objective was to develop a decision support tool to analyze the net income of switching inseminations from conventional or sexed sorted dairy semen to beef semen considering the genetic value of animals and a premium received for beef offspring. The tool was conceived to help producers on their decision-making if to use beef semen. Inputs from the farm, as herd size and herd structure, culling rate, pregnancy rate, number of virgin heifers being inseminated with female sexed sorted semen, percentage of stillborn, and calf mortality are used to calculate the number of replacements needed to maintain herd size, and to determine the number of eligible animals for the beef program. Different prices of semen (conventional dairy, sexed sorted dairy, and conventional beef), and different prices paid for the offspring (female dairy, male dairy and female/male crossbred) were taken in consideration. Animals were grouped on stage of lactation (virgin heifer, first, second and greater than second lactations), and within each stage of lactation further sub-divided in number of insemination received (first, second, third and greater than third services). The selection of animals could be made in two different ways: (1) by genetic merit or (2) by reproductive performance. After the decision of how animals are divided to receive either dairy or beef semen, the tool will calculate and show the number of replacements that will remain on the herd to maintain its size. Further, it will show the profitability of selling crossbred calves at a premium price, showing the dollar return for the crossbred animals, and the net return for the dairy as a whole. Farms will also face faster enhance in genetic gain with this strategy by generating future replacements from genetically superior heifers and cows. The tool will soon be openly and freely available from the UW-Dairy Management Website for use. Some case studies with real farm data using the tool will be featured during the presentation.

Strategies to improve economic efficiency of the dairy.

Cabrera, V. E., and A. Kalantari. An opportunity to increase dairy farm economic efficiency exists by considering additional nutritional grouping for lactating cows. Nutritional grouping that supports herd diets closer to cow's requirements saves feed costs and increases herd income over feed costs. Gains on income over feed costs with additional nutritional grouping far exceeds possible additional expenses of management, labor, or machinery and potential milk losses due to cows' social interaction at regroupings. Additional benefits of nutritional grouping include: decreased environmental concerns because of tighter nutrient balances and improved herd health because of less over conditioned cows

E. PUBLICATIONS:

Peer-reviewed research and extension Journal papers

1 Krpalkova, L, V. E. Cabrera, J. Kvapilik, J. Burdych, and P. Crump. 2014. Associations between age at first calving, rearing average daily weight gain, herd milk yield level and dairy herd production, reproduction, and profitability of costs. *Journal of Dairy Science 97:6573-6582.*

2 Dutreuil, M., M. Wattiaux, C. A. Hardie, and V. E. Cabrera. 2014. Feeding strategies and manure management for cost effective mitigation of greenhouse gas emissions from dairy farms in Wisconsin. *Journal of Dairy Science 97:5904-5917.*

3 Hardie, C., M. Wattiaux, M. Dutreuil, R. Gildersleeve, N. Keuler, and V. E. Cabrera. 2014. Feeding strategies on certified organic dairy farms in Wisconsin and their impact on milk production and income over feed costs. *Journal of Dairy Science 97:4612-4623.*

4 Cabrera, V. E. 2014. Economics of fertility in high-yielding dairy cows on confined TMR systems. *Animal 8:211-221.*

5 Krpalkova, L, V. E. Cabrera, M. Vacek, M. Stipkova, L. Stadnik, and P. Crump. In press. Impact of prepubertal and postpubertal growth and age at first calving on production and reproduction traits during the first 3 lactations in Holstein dairy cattle. *Journal of Dairy Science 97:3017-3027.*

6 Shahinfar, S, A. Kalantari, V. E. Cabrera, K. Weigel. 2014. Short communication: Prediction of retention pay-off using a Machine Learning algorithm. *Journal of Dairy Science 97:2949-2952.*

7 Shahinfar, S., D. Page, J. Guenther, V. E. Cabrera, P. Fricke, and K. Weigel. 2014. Prediction of insemination outcomes in Holstein dairy cattle using alternative Machine Learning algorithms. *Journal of Dairy Science 97:731-742.*

Contributed papers or abstracts research and extension

1 Cabrera, V. E. 2014. Impact of decision support tools available for dairy farm management. *Animal Science* 92 (E-Suppl. 2):293.

2 Cabrera, V. E. 2014. Economics of fertility in high-yielding dairy cows on confined TMR systems. In Proceedings. *International Cow Fertility Conference, New Science – New Practices.* Westport, Mayo, Ireland. 18-21 May 2014.

3 Lopes, G., and, V. E. Cabrera. 2014. Premium beef semen on dairy calculator. *Journal of Animal Science* 92 (E-Suppl. 2):288.

4 Dutreuil, M., M. Wattiaux, R. Gildersleeve, and V. E. Cabrera. 2014. Modeling the impact of feeding and manure management strategies on Wisconsin organic, conventional and grazing farms to mitigate greenhouse gas (GHG) emissions. In Proceedings The Midwest Organic and Sustainable Education Service Conference. La Crosse, WI. 27 February to 1 March 2014.

5 Krpalkova, L, V. E. Cabrera. J. Kvapilik, J. Burdych, and P. Crump. 2014. Effect of rearing period of heifers and herd level of milk yield on performance and profitability. In Proceedings 65th Annual Meeting of the EAAP. Copenhagen, Denmark. 25-29 August 2014.

6 Cabrera, V. E., and A. Kalantari. 2014. Dietary grouping strategies to improve profitability on dairy farms. In Proceedings XIX International Congress ANEMBE of Bovine Medicine, pp. 151-159, Oviedo, Spain, 25-27 June 2014.

7 Cabrera, V. E. Using simulators to improve profitability on dairy farms. In Proceedings XIX International Congress ANEMBE of Bovine Medicine, pp. 160-170, Oviedo, Spain, 25-27 June 2014.

8 Cabrera, V. E., and A. Kalantari. 2014. Strategies to improve economic efficiency of the dairy. In Proceedings Western Canadian Dairy Seminar, Red Deer, Alberta, Canada, (WCDS) Advances in Dairy Technology 26:45-55.

9 Lingqiao, Q., B. E. Bravo-Ureta, and V. E. Cabrera. From hot to cold: a preliminary analysis of climatic effects on the productivity of Wisconsin dairy farms. In Proceedings 2014 Agricultural and Applied Economics Association Annual Meeting. Minneapolis, MN. 27-29 July 2014.

10 Shahinfar, S., J. N. Guenther, D. Page, A. Samia-Kalantari, V. E. Cabrera. P. M. Fricke, and K. A. Weigel. 2014. Optimization of reproductive management programs using lift chart analysis and cost sensitive evaluation of classification errors. Animal Science 92 (E-Suppl. 2):576.

11 Liang, D., and V. E. Cabrera. 2014. Optimizing concurrently dairy farm productivity and environmental performance. Animal Science 92 (E-Suppl. 2):571.

12 Lingqiao, Q., B. E. Bravo-Ureta, and V. E. Cabrera. A preliminary analysis of climatic effects on the productivity of Wisconsin dairy farms. In Proceedings VI Congreso de Eficiencia y Productividad. Cordoba, Spain. 26-28 May 2014.

13 Cabrera, V. E., and M. Dutreuil. 2014. Implementation of greenhouse gas mitigation strategies on organic, grazing and conventional dairy farms. In Proceedings 11th European International Farming System Association Symposium of the Farming and Rural Systems. Berlin, Germany. 1-4 April 2014.

14 Bytyqi, H., M. Thaqi, F Hoxha, A. Misini, B. Haxhija, H. Mehmeti, V. E. Cabrera. 2014. Economic assessment of dairy farm production in Kosovo. In Proceedings 11th European International Farming System Association Symposium of the Farming and Rural Systems. Berlin, Germany. 1-4 April 2014.

15 Kalantari, A., and V. E. Cabrera. 2013. Stochastic economic evaluation of dairy farms' reproductive performance. *Journal of Animal Science 91 (E-Suppl. 2):791.*

Decision Support Tools:

1 Cabrera, V. E., L. Armentano, and R. D. Shaver. 2014. *FeedVal2012 Beta*. Estimates the market value of dairy feed ingredients.

2 Shahinfar, S., A. Kalantari, V. E. Cabrera, and K. A. Weigel. 2014. *Retention pay-off (RPO) calculator*. Calculates the expected profit of keeping a cow compared with immediate replacement.

3 Cabrera, V. E., and G. Lopes. 2014. *Premium beef on dairy program*. Designed to maximize revenue and profit from the total calves born on a dairy.

4 A. Kalantari, and V. E. Cabrera. 2014. *Milk curve fitter (online)*. Converts observed dairy herd milk production data into a prediction function.

5 N. Gaspar, and V. E. Cabrera. 2014. *Economic evaluation of CholiPEARL use on preventing subclinical ketosis*. Calculates the return over investment of a given technology that claims to be effective preventing a disease (subclinical ketosis) with known economic effects.

6 V. E. Cabrera. 2014. *Bulk tank SCC and milk value*. Determines the potential economic impact of retiring milk from some high SCC cows.

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

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

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

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

Cabrera, V. E., and K. A. Weigel. (Co-PDs). 2013-2014. Development of a genomic testing decision support tool for Jersey dairy calves. American Jersey Cattle Association Research Foundation. $11,000.

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

VandeHaar, M. (PD), K. A. Weigel, L. E. Armentano (WI-PD), D. Moody Spurlock, R. Tempelman, R. Veerkamp, V. E. Cabrera, M. Worku, M. Hanigan, C. Staples, D. Beede, R. D. Shaver, M. A. Wattiaux, J. Dijkstra, R. Pursley, and M. Weber Nielsen. 2011-2016. Genomic selection and herd

management tools to improve feed efficiency of the dairy industry. USDA National Institute of Food and Agriculture, Agriculture and Food Research Initiative Competitive Grants Program: Improving Sustainability by Improving Feed Efficiency of Animals. $5,000,000.

Cabrera, V. E. (PD), P. M. Fricke, P. L. Ruegg, R. D. Shaver, K. A. Weigel, and M. C. Wiltbank. 2010-2015. An integrated approach to improving dairy cow fertility. USDA National Institute of Food and Agriculture, Agriculture and Food Research Initiative Competitive Grants Program: Integrated Solutions for Animal Agriculture. $1,000,000.

Cabrera, V. E. (PD), R. R. Gildersleeve, M. A. Wattiaux, and D. K. Combs. 2010-2015. Strategies of pasture supplementation on organic and conventional grazing dairies: Assessment of economic, production and environmental outcomes. USDA National Institute of Food and Agriculture Organic Agriculture Research and Extension Initiative. $575,000.