Trends in Dairy Calf Nutrition

Tom Earleywine Ph.D.
Director of Nutritional Services

LAND O LAKES ANIMAL MILK PRODUCTS CO.

Our objective: **Do what's right for the calf** by continuing to lead the industry towards improving the health, performance and profitability of raising calves and heifers.

Special Thanks to:

Dr. Mike Van Amburgh (Cornell)

Dr. Don Sockett (Wisconsin Veterinary Diagnostic Lab)

LAND O LAKES ANIMAL MILK PRODUCTS CO.

CURRENT CALF MILK REPLACER RESEARCH EFFORT

- Moderate Health
  - 24 Trials per Year
  - 6 Groups
  - 1668 Calves
- High Health
  - 3-5 Trials per Year
  - 300+ Calves
  - Heifers & Bulls

Research Partnerships

Past Goals

- Keep them alive
- Minimize Treated Calves
- Get them to weaning as fast as possible
- Growth???

Improving Calf Health

- Reduce Failure of Passive Transfer (FPT): Gram negative sepsis
- Does fixing this stop all calf health issues?
- Why Not?

Improving Calf Health

- Higher plane of nutrition at right temp.
  - Consistent milk/milk replacer
  - High quality water
    - Free Choice & mixing
    - Electrolytes
    - Cleaning water

Improving Calf Health

- Proper Cleaning & Sanitation
  - Anything that touches calf – especially hands & feet of people
  - Chlorine dioxide – breaks down biofilms & kills crypto
- Dry, Well Ventilated Calf Housing
  - Better options for people & calf

What is a Higher Plane of Nutrition?

- Is this enough?

Temperature °F	32
100 lb. Bodyweight	
Dry Matter	**1.5**
Qts/day	6.0
Qts/fdg (2X)	3.0
Qts/fdg (3X)	2.0
Qts./fdg (2X) at *15% Solids*	2.3

Other than Temperature - What Else Impacts Energy & Protein Needs?

- Short of bedding one day
- Out of grain/water for a short time
- Changes in weather
- Scours – even minor cases
- Respiratory disease – even minor cases
- Moderate infections increase energetic needs by 150 to 200%

* Lochmiller, R. L. and Deerenberg, C. 2000. Trade-offs in evolutionary immunology: just what is the cost of immunity? – Oikos 88: 87-98.

Rate of Gain at Different Stress (scours, draft, poor bedding, etc.) Levels.

Assumptions

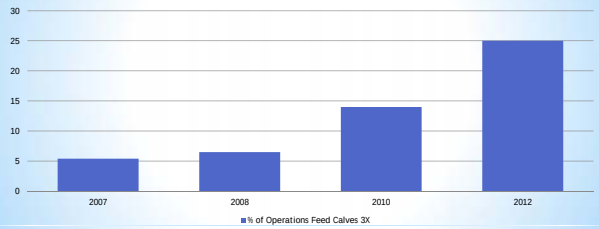
Temperature °F	32	Rate Of Gain		
100 lb. Bodyweight				
Dry Matter	**1.5**	No Add'l Stress	Low level of Added Stress	Moderate Added Stress
Qts/day	6.0			
Qts/fdg (2X)	3.0	Maintenance Needs Increase	0%	25%	50%
Qts/fdg (3X)	2.0			
Qts./fdg (2X) at *15% Solids*	2.3	Daily Gain Lb.	0.68	0.14	Wt. Loss

And this is with what appears to be a "good" plane of nutrition!!!

So should I just add Fat?

- Typically added fats are 7% protein and 60% fat
  - It is not a balanced diet!
  - Will quickly be short of protein
  - Shorter, fatter calves – poorer feed efficiency
  - Fat adds to total solids, causes mixing and cleaning problems
  - Fat is not quickly nor efficiently utilized by the calf!
  - Fat above 20% of diet dry matter hinders starter intake
- Best option is to feed more milk/milk replacer!!

Feeding 3X Daily



- Coincidence or trend? Trying to do what is best for the calf!
  - 2007 - DCHA data 5.4%
  - 2008 - Personal research - 6.5%
  - 2010 - ISP research - 14%
  - 2012 - DHM - 25% + 36% Considering

LAND O LAKES ANIMAL MILK PRODUCTS CO.

Consider an automated calf feeding system?

- An efficient tool for delivering a higher plane of nutrition
- Land O'Lakes has 7 years of research on the feeders (>2100 calves)

ANIMAL MILK PRODUCTS CO.

Body Condition

Evaluate energy reserves "fat storage".

Good

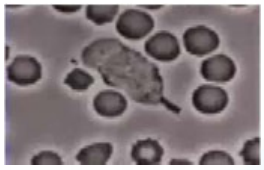
Body Condition

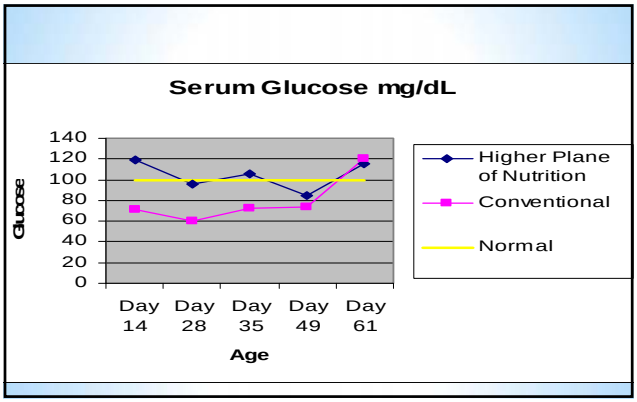
Poor

Ever heard someone say "Look at my skinny baby!"

Fowler 2004

Phagocytosis





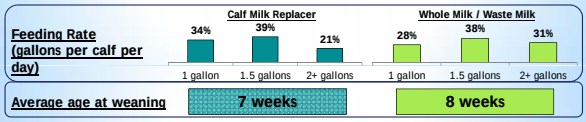
Ballou et al. 2015

- "These data also indicate that the innate leukocytes of Jersey calves fed a higher plane of nutrition are increased more rapidly after an oral challenge with a *Salmonella typhimurium*. The more active innate leukocyte responses likely reduced the incidence of systemic inflammation."

Profiling CMR Users vs. Pasteurizer Users (all with 100+ calves)

- Compared to CMR Users, Pasteurizer Users are larger, use a higher feeding rate, and wean later.

	Calf Milk Replacer Users (n=294)	Pasteurizer Users (n=93)
# Calves Raised Annually		
Heifer Calves	Mean = 341 / Median=150	Mean=765 / Median=350
Bull Calves Raised for Beef	Mean = 116 / Median=50	Mean=172 / Median=25



22

ADSA Full Potential

- Abstract 24 Brown at Guelph 8 better (19.6# bigger at 70 days) than 6 week weaning when feeding 2.6 lb/d CMR
- Abstract 619 Hammon German/Slovakia Title: Intensive milk feeding (vs. 1.65# CMR) in calves affects growth performance, metabolic and endocrine traits, but not rumen development. Better growth, no diff in starter intake.

Milk Yield Response to Increased Pre-weaning Milk or Milk Replacer Nutrient Supply

Study	Milk yield, lb
Foldager and Krohn, 1991	3,092[s]
Bar-Peled et al., 1998	998[t]
Foldager et al., 1997	1,143[t]
Ballard et al., 2005 (@ 200 DIM)	1,543[s]
Shamay et al., 2005	2,162[s]
Rincker et al., 2006 (proj. 305@ 150 DIM)	1,100[ns]
Drackley et al., 2007	1,841[s]
Raith-Knight et al., 2009	1,582[ns]
Terre et al., 2009	1,375[ns]
Morrison et al., 2009	0[ns]
Moallem et al., 2010	1,600[s]
Soberon et al., 2011	1,216[s]

Milk response is the difference between treatment milk yield minus control
[s] $P < 0.05$. [t] $P < 0.1$. [ns] $P > 0.1$

Soberon & Van Amburgh 2013 JAS 91:706-712

Impact on Milk Production

- 11/12 University Trials show improved milk production (1000 to 3000 lb. more milk in 1st lactation) by providing a higher plane of nutrition in the first 8 weeks of life of the heifer.
- New Data:
  - Daniels LACTATION BIOLOGY SYMPOSIUM The long-term impact of epigenetics and maternal influence on the neonate through milk-borne factors and nutrient status 2013 JAS 91 673-675
  - Soberon LACTATION BIO SYM The effect of nutrient intake from milk or milk replacer of dairy calves on lactation milk yield as adults - A meta-analysis of current data 2013 JAS 91 706-712
  - Margerison The effect of increasing the nutrient and amino acid concentration on intake, growth, development, and lactation performance 2013 JDS 96 96 6539-6549
  - Piantoni Daniels Level of nutrient intake affects mammary gland gene expression profiles in preweaned calves 2012 JDS 95-2550-2561

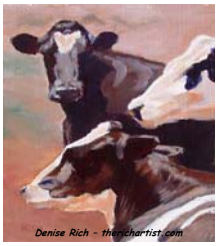
Economic Comparison of Conventional vs. Intensive Heifer Rearing Systems

(with new higher feed prices, $175 calf, 7% interest, $18 milk)

Michael Overton, DVM, MPVM

The University of Georgia

Elanco KNOWLEDGE SOLUTIONS



Michael Overton, DVM, MPVM 2013

Summary of Results

Based on the current assumptions used in this model:

		Advantage
Feed costs	($61)	Conventional
Labor costs	$29	Intensive
Health/ vet med	$11	Intensive
Interest cost	$10	Intensive
Reproductive culls	$10	Intensive
Other costs	$33	Intensive
Lost investment (dead calves)	$12	Intensive
Calf investment cost	$4	Intensive
Net Result - Savings:	**$47**	**Intensive**

- Add in value of additional milk in 1st lactation of $152 and the average advantage for **Intensive Rearing ~ $199**

That's All Fine But…

- How do I get it done?
- What about the cost??

It was a good 6 Months!

Will Future Milk Replacers be all-milk Protein?

- Not likely but will perform as good or better than all-milks at significantly lower cost!
- Will use less alternatives than they have in the past.
- Ask for the research!

CT 02-13, 11-13, 17-13, 05-14 & 08-14a

	Full Potential	Full Potential Protein Blend	P Value
Number Calves	142	141	
Avg. Period Gain, lbs.			
Week 1	5.78	5.23	-
Week 2	13.23	13.12	-
Week 3	12.30	12.95	-
Week 4	12.63	12.68	-
Week 5	12.40	12.81	-
Week 6	14.96	14.86	-
Week 7	11.63	12.87	0.08
Total Gain	**82.93**	**84.52**	-

31

The Effects of Supplementing Two Pasteurized Milk Balancer Products to Pasteurized Whole Milk on the Health and Growth of Dairy Calves

ADSA 2014 Abs. 336

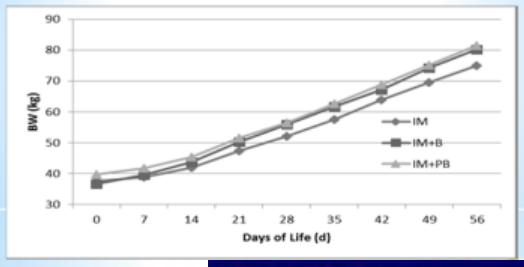
K. Glosson[1], B. Hopkins[1], S. Washburn[1],S. Davidson[1], G. Smith[1], T. Earleywine[2], and C. Ma[1]

[1]*North Carolina State University, Raleigh*

[2]*Land O'Lakes Animal Milk Products, St. Paul, MN.*

NC STATE UNIVERSITY

Figure 2. BW through the preweaning period



NC STATE UNIVERSITY

"Calves receiving supplemental milk balancer products resulted in greater growth rates with similar overall calf health. The similarity of calves receiving either of the two supplemental balancers in all growth measurements analyzed, combined with similar health data, indicates that there were no adverse effects when using the more economical protein blend balancer alternative over the all-milk balancer product."

NC STATE UNIVERSITY

What is this New Formulation System -Protein Blend?

- Utilizes a similar approach as is used in baby formulas
- Based on a blend of highly digestible proteins that complement each other

35

Why Does it Work?

- WELL RESEARCHED!
- Still include technologies we always have such as;
  - Beta glucan – for immunity
  - FOS – for proper gut microbial growth
  - MOS – gut protection
  - Many other technologies – fatty acid formulation, etc.
- We make formulation adjustments to assure performance

36

Summary - Trends

- Feeding More!
  - Calves need nearly 2 gallons of milk/milk replacer daily in 2 to 3 feedings to survive and thrive
- New Formulation Options of milk replacers.
  - need to be well researched
  - These options are the future of milk replacer

37

Summary - Trends

- Water Quality Analyses
- Cleaning & Sanitation Protocols
- Enhancing Pasteurized Milk Nutrition with Powder/Technologies
- Better Housing Options

38

He had balanced nutrition & perfect ventilation, however…

Do what's right for the calf by continuing to lead the industry towards improving the health, performance and profitability of raising calves and heifers.

LAND O LAKES
ANIMAL MILK PRODUCTS CO.


Thank You!
7636
7636
LAND O LAKES
ANIMAL MILK PRODUCTS CO.
41

Calf Management in the First 60 Days: Opportunities to Improve Health and Performance

Sheila M. McGuirk, DVM, PhD
University of WI-Madison
School of Veterinary Medicine
Madison, WI
mcguirks@vetmed.wisc.edu

Introduction

The components of a successful calf raising operation are health, performance, production and profitability of the replacement heifers. Returns on the significant investment made to maximize each of these important components may be delayed but do reward the significant commitment to provide a comprehensive care package to all calves. The care package includes colostrum, a high plane of nutrition, an optimal calf environment and intensive health management. The goal of this presentation is to provide a practical approach to maximize performance in the first 60-days of the calf's life, with an emphasis on ideas to improve colostrum, nutrition, environmental management and health in the first 60 days.

Reducing Mortality in the First 24-hours of Life

Most calves that die within the first 24-hours of life are alive at birth and simple strategies that do not rely on drugs or oxygen delivery may prevent death. Of foremost importance to improved survival in the first 24-hours is unassisted vaginal delivery of calves. With a normal presentation and sustained progress, observe calving from a distance and provide no assistance. For calving cows that are moved during second stage labor, expect labor to stop temporarily and allow time for labor to resume before providing assistance. In a recent study (Schuenemann et. al.), 65 minutes was suggested as the time from the appearance of feet outside the vulva to intervention for cows that need calving assistance.

After delivery, calving attendants should watch closely for behavior indicative of normal adaptation to life outside the uterus.

- Head righting begins within minutes.
- The calf is sitting in a sternal position within 5 minutes.
- The calf makes standing attempts made within 15 minutes.
- Shivering begins within 30 minutes of delivery.
- The calf is standing by 1 hour.
- The calf is suckling within 2 hours of delivery.

Without appropriate movement and reflex activity, the newborn calf's body temperature declines from an elevated level at birth to 101-102° F within an hour. It will continue to decline if the calf is not active and shivering. Death due to hypothermia can occur within 1 to 2 hours, especially when the environmental temperature is below 58° F, the low end of a calf's thermal neutral zone.
For calves that have flaccid muscles, are unresponsive to stimulation, have blue membrane color or are breathing irregularly, simple techniques may be used to revive the calf and stimulate regular breathing. Place the calf on a low platform, cart or table to facilitate the following procedures.

- Place the calf's head over the edge of the raised platform for 10 to 15 seconds to get postural fluid drainage from the mouth and nose.
- Place the calf in a sitting position if possible. Take a clean, dry towel and rub the topline of the calf from the tailhead to the poll.
- Use the towel to stimulate the ears, eyelids and nose of the calf.
- Ice water can be poured onto the head or into the ear of the calf to stimulate breathing.
- Compress and then shake the trachea (wind pipe) high up in the neck to stimulate a cough reflex.

- Place pinpoint pressure right in the center of the muzzle between the nostrils or place finger pressure across the nasal septum where nose tongs would be placed to further stimulate breathing.

Put Colostrum Testing into Action

Failure of passive transfer of immunity (FPT) is recognized as a major problem that has negative short- and long-term consequences for the health and productivity of herd replacements. Many dairy calf raisers routinely monitor serum total protein (STP) concentration of calves but use the results in a limited way. Results can be used to classify individuals as high risk calves when STP concentration is ≤ 5.0 gm/dl. High-risk calves can be marked so that intensified health screening procedures are used on these individuals.

To classify a herd as an FPT herd, a minimum of 10 to 12 STP results from calves less than 7 days of age are needed. When more than 20% have STP < 5.5 gm/dl or more than 10% have STP < 5.2 gm/dl, the colostrum program needs attention. When using STP data from refractometer readings, it is imperative that the refractometer is calibrated. The simplest calibration step is to verify that the specific gravity scale of the refractometer reads 1.000 after application of distilled water. Adjust as necessary. At least every 6 months, split serum samples and correlate STP concentrations between an accredited laboratory and the refractometer. Perform serum testing at room temperature.

A systematic review of colostrum protocols on the dairy usually is necessary to find the reason for herd based FPT. Colostrum volume, quality, cleanliness and absorption factors should be reviewed to find potential problems.

- Inadequate volume of colostrum is administered.
  - Less than 4-quarts of colostrum is administered with an esophageal feeder.
  - Less than 3-qt of colostrum is given to calves that suckle.
- The colostrum quality is inadequate. Common reasons for reduced quality include:
  - High producing cows – colostrum dilution occurs soon after calving
  - Delayed milking – time between calving and milking exceeds 4 hours.
  - Calving cows are suckled before colostrum collection (Note: calves that remain with the cow for 30 to 60 minutes after birth frequently have suckled before they are removed from the pen.)
  - Calving cow has leaked milk or been pre-milked before calving.
  - The dry period length was less than 30 days.
  - There are significant nutritional problems with the close-up dry cows (Note: this problem usually results in reduced colostrum volume rather than the quality)
  - There are significant health problems in the calving cows (Note: the effect is usually reduced volume rather than the quality).
  - Limited or poor vaccination program (Note: Vaccination of the dry cows is important for immunity to specific diseases of calves. Vaccination does not have a quantitative impact that can be measured by colostrometer or Brix refractometer)
- Colostrum immunoglobulin absorption is impaired.
  - Colostrum feeding is delayed ≥ 4-hours after birth.
  - There is excessive bacterial contamination (> 100,000 cfu/ml) of colostrum (Note: probiotics should not be added to colostrum)
  - Colostrum supplement or replacement powder is added to colostrum.
  - There is a high level of calving assistance

Train Calf Care Providers to Use the Esophageal Feeder

Comfort with proper use of the esophageal feeder amongst calf workers will improve herd FPT problems and reduce mortality due to diarrhea-induced dehydration. For colostrum administration, use a 4-quart capacity esophageal feeder. For the administration of an oral electrolyte solution, use a 2-quart esophageal feeder. Never use the esophageal feeder in a calf that cannot maintain sternal recumbency (standing position is preferred), in a calf that is having

respiratory difficulty, or that has abdominal distension. While passing the esophageal feeder, maintain the head of the calf in a neutral position so that the nose is below the plane of the ears.

Esophageal feeders should be cleaned and soaked in a disinfectant between uses. Therefore, have as many esophageal feeders as will be used (maximum use) in a day. Do not use the esophageal feeder to force feed milk or milk replacer without a protocol from your veterinarian and an established limit to the number of successive forced feedings.

Nutrition

Have a nutritional plan that will allow calves to double birth weight by 60 days of age. Whether the diet is whole milk or milk replacer, use the Nutrient Requirements of Dairy Cattle (NRC) to make the feeding plan. Implement a winter-feeding program when the temperature falls below 55° F and determine what milk or milk replacer intake is needed to meet weekly goals for average daily gain (ADG). A winter feeding plan for calves on whole milk in Wisconsin may look like the one shown in Table 1.

Table 1. Whole Milk Winter Feeding Plan for Holstein Calves in Wisconsin

Age	**Whole Milk Volume**
0-3 days	2 quarts twice daily
3-10 days	3 quarts twice daily
10-49 days	4 quarts twice daily
49-56 days	4 quarts once daily
56-63 days	No milk

Understand what milk or milk replacer and starter intakes are needed to meet weekly goals for gain to double birth weight by 60 days. The NRC calculator can be used to estimate the protein and energy allowable ADG, using calf weight and environmental temperature as variables. Feeding to meet the targeted weekly ADG's shown in Table 2 can result in doubling the birth weight of an 80 lb Holstein calf at 56 days of age.

Table 2. ADG expectations when using the NRC calculator to assess calf feeding management

Week	**Body Weight**	**Estimated Starter Intake (lb)**	**Average Daily Gain (lb/day)**
1	Ave birth wt	0.25	1.0
2	Birth wt +7	0.5	1.2
3	Week 2 + 8.4	0.75	1.6
4	Week 3 + 11.2	1.0	1.8
5	Week 4 + 12.6	1.5	2.0
6	Week 5 + 14	2.0	2.0
7	Week 6 + 14	3.0	1.4

Monitor feeding consistency on a regular basis. Calculate and measure milk or milk replacer total solids delivered in each batch of liquid feed. Consistency of the liquid feed (less than 1% difference) from the first calf fed to the last, from one feeding to the next and between feeders will reduce the risk for nutritional diarrhea, bloat, ulcers and abomasitis. Total solids should never be greater than 18%. Brix readings can be used to monitor liquid feed consistency.

Monitor the bacterial quality of the milk or milk replacer being fed to calves. Standard plate counts and selective bacterial counts can find post-pasteurization contamination of milk or contaminated nipples at automatic feeder stations. Bacterial contamination of milk or milk replacer puts calves at high risk for infection and may affect the nutritional value of the feed. Table 3 shows the effect of dirty nipples at automatic feeding stations on the bacterial quality of pasteurized whole milk.

Table 3. Milk replacer culture results

Select Microorganisms Counts (CFU/ml)	Pen 1-1	Pen 1-2	Pen 2-1	Pen 2-2	Goal Levels
Total Plate Count (CFU/ml)	5,400,000	6,250,000	5,150,000	1,300,000	**< 10,000**
Coliforms (lactose-positive)	1,750,000	150,000	2,550,000	200,000	**< 100**
Gram negative rods (lactose-negative)	0	3,400,000	350,000	300,000	**< 5,000**
Streptococci (non-agalactiae)	3,350,000	2,600,000	2,000,000	750,000	**< 5,000**
Staphylococci (coagulase-negative)	300,000	100,000	200,000	50,000	**< 5,000**
Comments	Several lactose + morpholo-gies	Probable *Pseudo-monas spp*	*Pseudo-monas* and many lac + morpholo-gies	*Pseudo-monas* and many lac + morpholo-gies	

Health Screening

One of the biggest challenges of raising calves is early detection of health problems. Instituting regular health screening exercises will reduce mortality, shorten disease duration and improve treatment outcomes. In the absence of activity, appetite, or fever monitoring technology, a daily chore is to find abnormal calves, calves that remain standing after feeding when 90% of the calves are sleeping, calves with diarrhea, sunken eyes, eye or nasal discharge, abnormal head posture (tilted or star-gazing) or coughing frequently. This daily observation can be coordinated with the pick up of refused feed. The abnormal calves, the pen or the calf hutch of the abnormal calves are marked, indicating that these calves need a complete examination by the trained individual(s) assigned to that duty. The components of the basic exam are:

- Head position (tilted, star-gazing)
- Eye or nasal discharge – color, consistency and amount
- Temperature
- Fecal consistency
- Breathing pattern (abdomen vs. chest) and effort (inspiration vs. expiration)
- Navel exam (diameter, temperature, exudate)
- Fecal consistency
- Lameness, joint swelling
- Abdominal size and contour

On a twice a weekly basis, a more detailed calf health (Calf health scoring app – I-tunes store) or respiratory disease screening (http://www.vetmed.wisc.edu/dms/fapm/fapmtools/8calf/calf_respiratory_scoring_chart.pdf) is recommended for all calves. For health screening, it is estimated that an additional 0.5 full time equivalent (FTE) is needed for each 150 to 200 calves. For all calves that die, a post mortem examination is recommended. Farm staff can be trained to open, examine and take pictures of lesions that can be routinely reviewed by the farm's veterinarian. Samples from dead calves can be a valuable tool to refine protocols, identify training needs or diagnose herd problems.

Safe, Smart and Strategic with Calf Vaccinations

The goals for vaccinating young calves are to provide optimal immunity to the disease agents that calves are most likely to encounter so that they can be protected during the period of maximum challenge. In the face of maternal immunity from colostrum, the vaccination route is likely to be intranasal or oral. Vaccination is for healthy calves on a good plane of nutrition. Avoid repeated (weekly or every other week) vaccinations. Don't use half-dose or alternate vaccination routes unless there is good evidence for safety, effectiveness and disease protection. At the very least, do no harm.

Summary
Maximize performance, health, welfare and profitability of replacement heifers by focusing on the first 60 days of the calf's life: newborn survival, colostrum, nutrition, optimizing the calf environment and regularly screening for health problems.

Management of Calf Autofeeders: What Have We Learned?

Alyssa Dietrich
Graduate Student
Virginia Tech Dept. of Dairy Science

Objectives

- Autofeeder functions
- VT and U of MN research study
- Management observations:
  - How are producers managing autofeeders?
  - What's working/not working?

INTRODUCTION TO AUTOFEEDERS

Available Autofeeders

- Biotic: ID-TEK
  - Simplest machine
  - Low cost
  - Few feeding plan options

http://www.biotic.com/proddetail.php?prod=idtek

Available Autofeeders

- Sophisticated autofeeders
  - Manufacturers
    - Urban
    - Förster Technik (Lely, DeLaval, GEA)
  - Recognize calves by RFID tag or collar
  - Fed according to feeding plan controls
  - Ability to control many features

Sophisticated Autofeeders

- Urban Calf Mom

http://www.urbanonline.de/calfmom-paula-details.html

Sophisticated Autofeeders

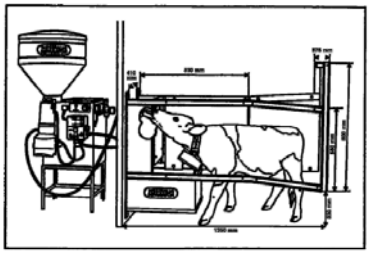
- Urban Calf Mom

http://www.urbanonline.de/calfmom-paula-details.html

Sophisticated Autofeeders

- Förster Technik

FT Autofeeder



Adapted from Kung et al., 1997

http://www.foerster-technik.de/website/en/home.php

Feeding Plan Example

	Feed			Concentration			Min.quantity		
Period	Days	Start qu	Final qu	Days	Start qu	Final qu	Days	Min.	Max.
	Group A								
1	3	6.0 L	6.0 L	48	150 g	150 g	3	1.5 L	2.0 L
2	10	6.0 L	8.0 L	0	0 g	0 g	10	1.5 L	2.0 L
3	25	8.0 L	10.0 L	0	0 g	0 g	25	1.5 L	2.5 L
4	10	10.0 L	2.5 L	0	0 g	0 g	10	1.5 L	2.0 L
5	0	0.0 L	0.0 L	0	0 g	0 g	0	0.0 L	0.0 L
Total	48		373 L	48		56 kg	48		

Feeding Plan Example

	Feed			Concentration			Min.quantity		
Period	Days	Start qu	Final qu	Days	Start qu	Final qu	Days	Min.	Max.
	Group A								
1	3	6.0 L	6.0 L	48	150 g	150 g	3	1.5 L	2.0 L
2	10	6.0 L	8.0 L	0	0 g	0 g	10	1.5 L	2.0 L
3	25	8.0 L	10.0 L	0	0 g	0 g	25	1.5 L	2.5 L
4	10	10.0 L	2.5 L	0	0 g	0 g	10	1.5 L	2.0 L
5	0	0.0 L	0.0 L	0	0 g	0 g	0	0.0 L	0.0 L
Total	48		373 L	48		56 kg	48		

Quantity per day: Total allotment

Feeding Plan Example

	Feed			Concentration			Min.quantity		
Period	Days	Start qu	Final qu	Days	Start qu	Final qu	Days	Min.	Max.
	Group A								
1	3	6.0 L	6.0 L	48	150 g	150 g	3	1.5 L	2.0 L
2	10	6.0 L	8.0 L	0	0 g	0 g	10	1.5 L	2.0 L
3	25	8.0 L	10.0 L	0	0 g	0 g	25	1.5 L	2.5 L
4	10	10.0 L	2.5 L	0	0 g	0 g	10	1.5 L	2.0 L
5	0	0.0 L	0.0 L	0	0 g	0 g	0	0.0 L	0.0 L
Total	48		373 L	48		56 kg	48		

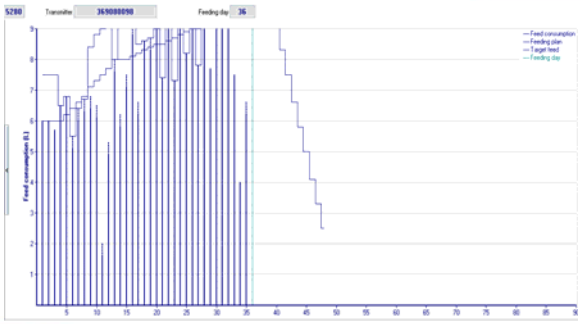
MR Concentration

Feeding Plan Example

Period	Feed			Concentration			Min.quantity		
	Days	Start qu	Final qu	Days	Start qu	Final qu	Days	Min.	Max.
	Group A								
1	3	6.0 L	6.0 L	48	150 g	150 g	3	1.5 L	2.0 L
2	10	6.0 L	8.0 L	0	0 g	0 g	10	1.5 L	2.0 L
3	25	8.0 L	10.0 L	0	0 g	0 g	25	1.5 L	2.5 L
4	10	10.0 L	2.5 L	0	0 g	0 g	10	1.5 L	2.0 L
5	0	0.0 L	0.0 L	0	0 g	0 g	0	0.0 L	0.0 L
Total	48		373 L	48		56 kg	48		

Meal size

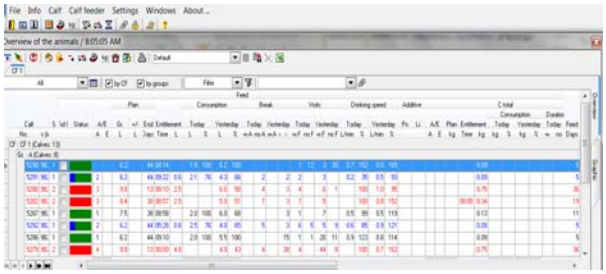
Feeding Plan Example



Data and Software

- Handheld device
- Connect machine to PC
- Keep track of:
  - Alarms
  - Consumption (today and over time)
  - Drinking speed
  - Visits
  - Break offs
- Input other calf records manually

Animal Overview



Calf Alarms

Feed alarm	Today	Yesterday
Feed consumption	☐	☑
Drinking speed	☑	☐
Break without additive	☐	☐
Break with additive	☐	☐
Robbery	☐	☐
Powder additive too high	☐	☐
Liquid additive too high	☐	☐
Powder additive too low	☐	☐

DAIRY SCIENCE

UNIVERSITY OF MINNESOTA
COLLEGE OF VETERINARY MEDICINE

OBSERVATIONAL RESEARCH STUDY

University Study

- Observational study conducted by:
  - University of Minnesota College of Veterinary Medicine
  - Virginia Tech Department of Dairy Science
- Objectives
  - To investigate the application of feeding behavior to predict morbidity in group housed calves
  - Identify cleaning management factors associated with the level of bacteria in calf autofeeders

Farm Visits

- VA farms visited biweekly spring to fall 2014
- MN farms visited weekly winter to summer 2014
- Farms
  - VA: 6 farms, 7 FT autofeeders
  - MN: 4 farms, 7 FT autofeeders
- Over 1300 calves represented

Data Collection

- Milk/milk replacer samples
  - At each visit from each feeder
  - For 4-week period each day before and after circuit cleaning (VA farms)
- Calf weights/heights
- Blood for serum protein analysis
- Calf feeding data exported from machine
- Calf treatment records
- Various observations of facilities

FINDINGS:
Machine Sanitation

Sanitation Management

- Producer has control over:
  - Cleaning agents and amount used
  - Frequency of cleanings
  - Hose type and frequency of replacement
  - Mixer and hose drainage

Autofeeder Cleaning

- Circuit cleaning – manually initiated
  - Pre-clean rinse
  - Placement of feeding hoses into mixer to form "circuit"
    - Wash cycle using detergent
    - Mixer and feeding hoses cleaned together
  - Return hoses for water rinse

Autofeeder Cleaning

- Mixer cleanings - automatically or manually initiated
  - Pre-clean rinse
  - Clean with detergent
  - Water rinse
  - Units that feed waste milk have a similar heat exchanger cleaning

Cleaning Agents

- Förster Technik recommends:
  - Ability to function at 40-50°C
  - No corrosive effect on machine materials (specifically chlorine)

Common Cleaning Agents

- Alkaline detergents – saponify fat so it can be removed with water
  - BouMatic System Shock™
    - Sodium hydroxide
  - DeLaval RTD™
    - Chlorinated alkaline detergent
    - Functions at water temp of 45°C

(Thomas and Sathian, 2014)

Common Cleaning Agents

- Acid detergents
  - Remove mineral deposits
- Chlorine bleach
  - Sanitizing agent
  - Works best at 75° - 100°F
  - Used in combination with other cleaning agents

(The Dairy Research & Information Center)

Use on Study Farms

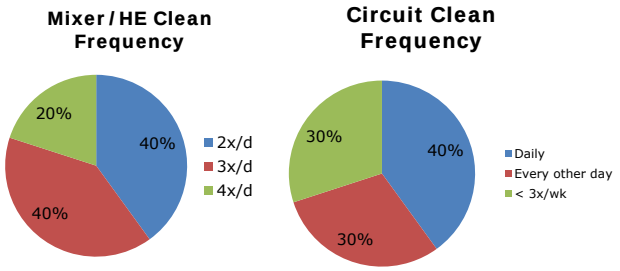
Cleaning Agent	Number of Farms
BouMatic System Shock	3
DeLaval RTD	6
Acid detergent	3
Chlorine bleach	4

Frequency of Cleanings

- Recommendation:
  - Daily circuit clean + 2x/d mixer/HE clean

    OR
  - Every other day circuit clean + 3x/d mixer/HE clean
- 4/10 study farms did not meet either recommendation

Cleaning Frequency



Feeding Hoses

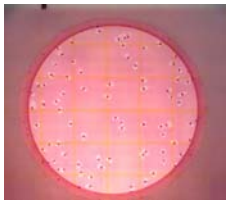
- Vinyl, silicon, or plastic
- Replacement frequency
  - Recommend changing every 1-2 weeks
  - Varies between farms from every 2 weeks to a few times a year
  - Costs about 30¢/ft from Lowe's

Mixer Hose

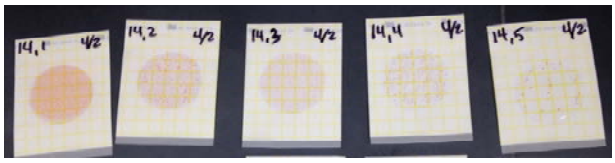
- Should be purchased through dealer
- Producers replace much less frequently

Bacteria Counts

- Plated on 3M Petrifilms
  - Aerobic Plate Count (SPC)
  - Coliform Count

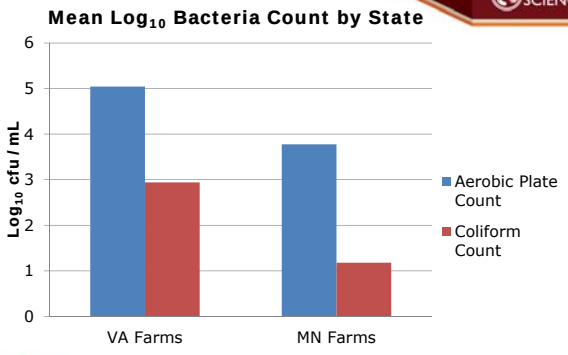


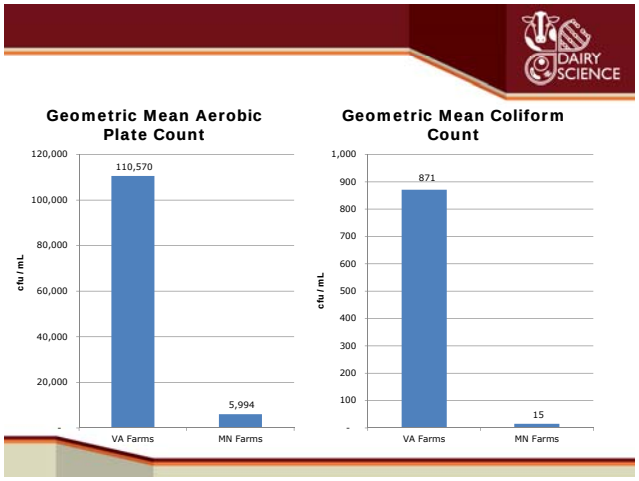
Bacteria Counts

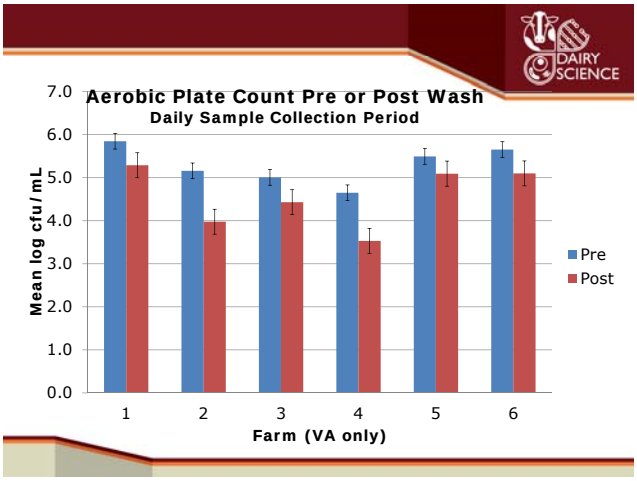


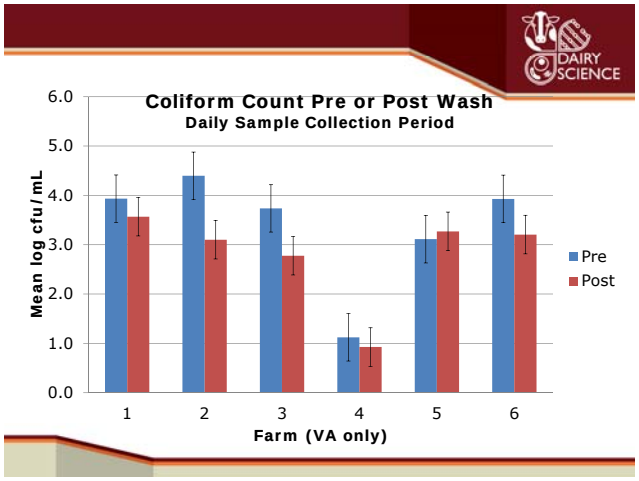
Overall Summary Table

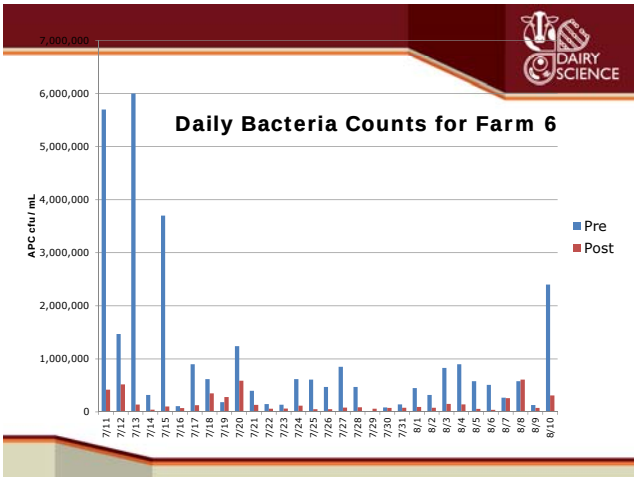
	Geometric Mean cfu / mL	
Farm	**Aerobic Plate Count**	**Coliform Count**
VA-1	280,000	1,100
VA-2	50,000	6,500
VA-3	75,000	1,900
VA-4	18,000	<10
VA-5	259,000	1,900
VA-6	239,000	1,600
MN-1	11,000	<10
MN-2	2,000	<10
MN-3	37,000	100
MN-4	3,000	<10
Overall Mean	33,000	90
Range	160 - 13,000,000	0 – 370,000

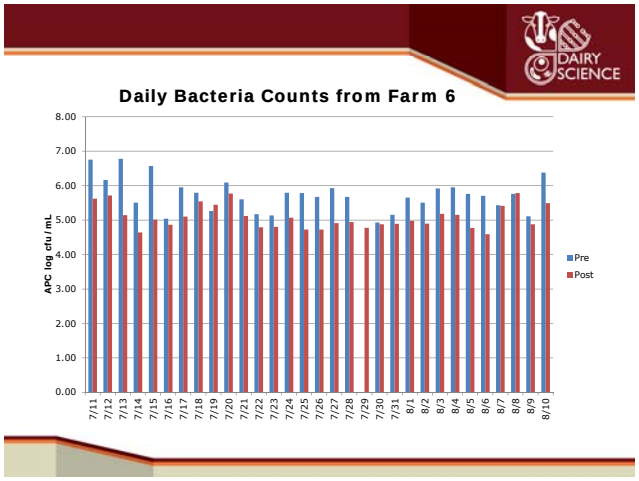


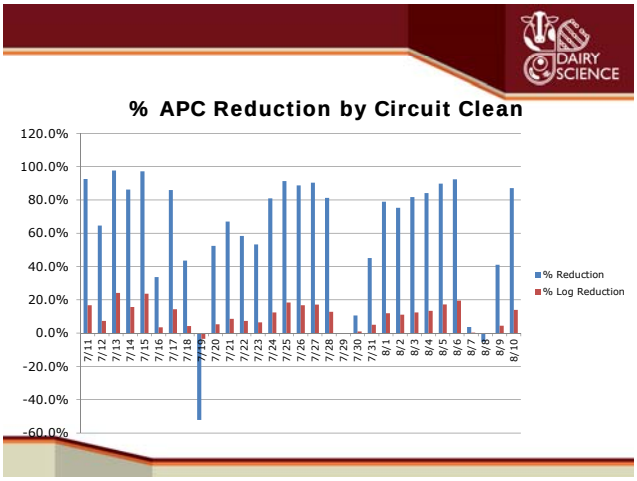

Geometric Mean Aerobic Plate Count
cfu / mL
120,000
100,000
80,000
60,000
40,000
20,000
-
110,570
5,994
VA Farms
MN Farms
Geometric Mean Coliform Count
cfu / mL
1,000
900
800
700
600
500
400
300
200
100
-
871
15
VA Farms
MN Farms

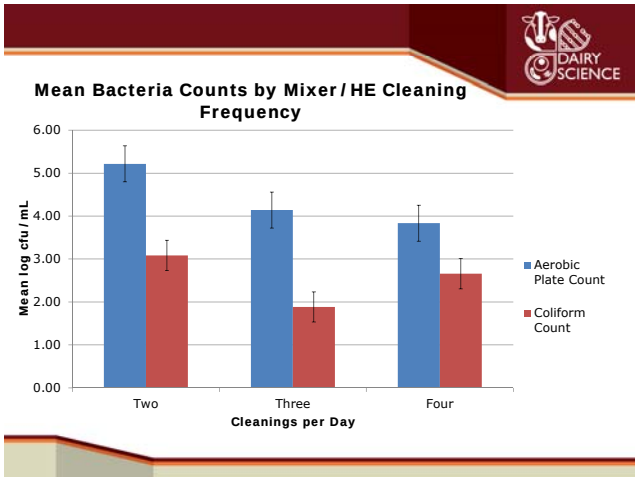

Aerobic Plate Count Pre or Post Wash
Daily Sample Collection Period
Mean log cfu / mL
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1
2
3
4
5
6
Farm (VA only)
Pre
Post

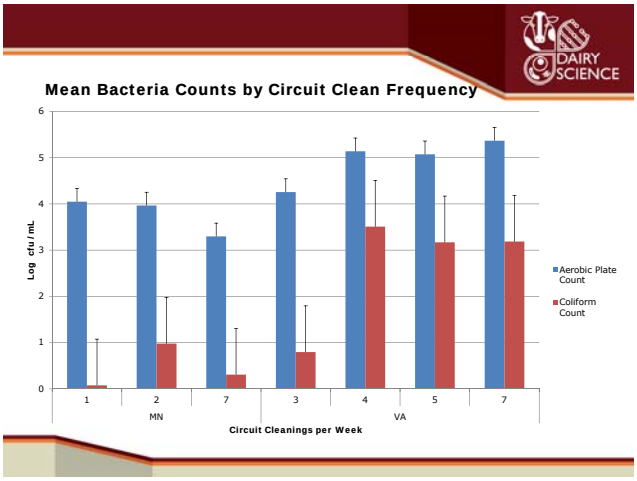

Coliform Count Pre or Post Wash
Daily Sample Collection Period
Mean log cfu / mL
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1
2
3
4
5
6
Farm (VA only)
Pre
Post

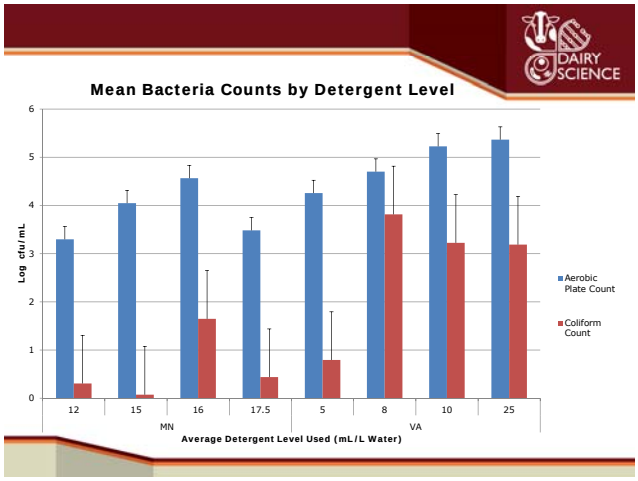

Daily Bacteria Counts for Farm 6
APC cfu / mL
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
7/11
7/12
7/13
7/14
7/15
7/16
7/17
7/18
7/19
7/20
7/21
7/22
7/23
7/24
7/25
7/26
7/27
7/28
7/29
7/30
7/31
8/1
8/2
8/3
8/4
8/5
8/6
8/7
8/8
8/9
8/10
Pre
Post


Daily Bacteria Counts from Farm 6
APC log cfu / mL
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Pre
Post
7/11 7/12 7/13 7/14 7/15 7/16 7/17 7/18 7/19 7/20 7/21 7/22 7/23 7/24 7/25 7/26 7/27 7/28 7/29 7/30 7/31 8/1 8/2 8/3 8/4 8/5 8/6 8/7 8/8 8/9 8/10


% APC Reduction by Circuit Clean
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
-20.0%
-40.0%
-60.0%
% Reduction
% Log Reduction
7/11 7/12 7/13 7/14 7/15 7/16 7/17 7/18 7/19 7/20 7/21 7/22 7/23 7/24 7/25 7/26 7/27 7/28 7/29 7/30 7/31 8/1 8/2 8/3 8/4 8/5 8/6 8/7 8/8 8/9 8/10


Mean Bacteria Counts by Mixer / HE Cleaning Frequency
Mean log cfu / mL
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Aerobic Plate Count
Coliform Count
Two
Three
Four
Cleanings per Day


Mean Bacteria Counts by Circuit Clean Frequency
Log cfu / mL
6
5
4
3
2
1
0
Aerobic Plate Count
Coliform Count
1 2 7 3 4 5 7
MN
VA
Circuit Cleanings per Week



Feed Contamination

- Main concern – disease caused by ingestion of pathogens or toxins
- Means of contamination
  - Water for milk replacer
  - Processing/storage of waste milk
  - Biofilms in mixer, hoses, nipples

"Safe" bacteria levels?

- Grade A pasteurized milk cannot exceed:
  - 20,000 cfu/mL total bacteria
  - 10 cfu/mL coliforms (USPHS, 2009)
- McGuirk (2003) recommended goals:
  - < 10,000 cfu/mL total bacteria
  - 0 cfu/mL fecal coliforms
- These goals are achievable!

Discussion on Sanitation

- Circuit cleaning appears to reduce bacteria levels, but is variable in day-to-day effectiveness
- Increasing frequency of mixer/HE cleanings appears to keep bacteria levels lower

FINDINGS:
Group Housing

Ventilation

- Critical for success!
- Tube ventilation highly recommended if properly installed
- At start of study, 2 VA farms had tube ventilation. By end, 3 more were in the process of installing it.

Pen Management

- Dynamic groups
  - 2 pens/machine; calves sorted by age
  - All VA farms on study use this method
- All in/all out
  - Add new calves to a pen until full
  - Calves do not leave pen until weaned
  - Appropriate for larger farms
  - May allow for easier sanitizing of pens between groups

Cross-sucking

- Not usually an issue if calves are allotted enough feed
  - Feed restriction may be related to non-nutritive sucking (Jensen, 2003)
- Less cross-sucking in calves fed via teat compared to calves fed via bucket (Jensen, 2003)

Bedding

- Same rules apply for all calves – bedding must be clean, dry, and abundant!
- Types for group-housed calves
  - Sawdust + straw appropriate for all seasons
  - Sand appropriate during warm weather

FINDINGS: Feeding Plan Management

Feeding Plan Management

- Variety of feeding plans represented in study

Calf Growth Across Study Farms (lb)	
Average Daily Gain	1.66
Range	1.25 – 1.99
Standard Deviation	0.27

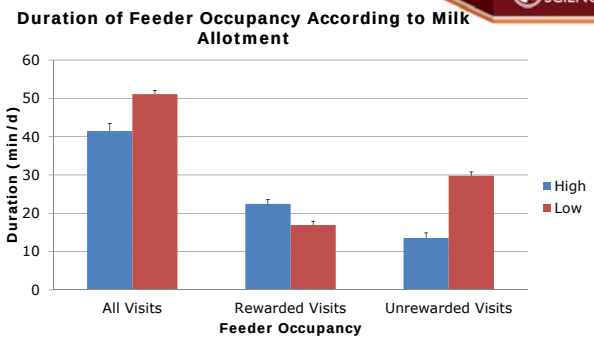
Effect of Feeding Plan

- Restricted feeding plans not fit for autofeeders
  - Hungry calves spend more time trying to eat, less time resting
  - High incidence of feeder occupancy

Effect of Feeding Plan

Jensen, 2006

Milk Allotment Treatments		
Breed Type	**High**	**Low**
Large Breed	8.0 L/d	4.8 L/d
Jersey	6.4 L/d	3.8 L/d



All differences significant ($P < 0.001$)

Effect of Group Size

More calves = more competition

(Jensen, 2004)

- Compared behavior of calves in groups of 12 or 24
- Calves in large group:
  - Made more attempts to enter occupied feeder ($P = 0.02$)
  - More often displaced calves occupying feeder ($P = 0.03$)

Effect of Group Size

- Calves in group of 24 consumed feed faster and in fewer visits than calves in group of 12 (Jensen, 2004)
- Larger max meal size helps reduce feeder occupancy in large groups
  - Calves can consume feed in fewer visits
  - Calves will leave the feeder sooner if they're full (Jensen, 2004)

Effect of Portion Size

- As calves' natural feeding behaviors develop, they consume total allotment in fewer meals (Jensen, 2009)
- Important to have a high enough max meal size (>2.0L), especially for older calves

FINDINGS: Autofeeder Management

Autofeeder Location

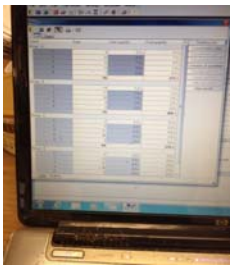
- Commonly housed in separate room
  - AC units reduce humidity, flies
  - Heating can prevent frozen hoses
  - Windows let you view calves
  - Computer setup nearby

Drainage

- Front of feeding stall to drain liquid from feeding
- Back of stall to drain manure
- Grate size must be large enough
- Concrete floors allow for much easier cleaning

Adding New Calves

- Most producers add calves at 3-7 d
- May skip morning feeding so calf is hungry for autofeeder
- May have to help her feed for 1-2 d, but most catch on surprisingly quick



CALF MONITORING

Design an Routine

- Autofeeders do not babysit calves!
- Managers must be extra-observant
  - Calves bawling?
  - Calves crowding feeder?
- Most managers check calves and machine at least 3x/d
- Stick with a routine cleaning schedule

Monitoring with Software

- Autofeeder handheld device
  - Control panel
  - Info on consumption, visits, drinking speed, break-offs, alarms determined by machine
- Kalb Manager software for computer
  - Better for looking at performance over time
  - Can export to Excel

Monitoring with Software

- Monitoring preference varies between managers
  - Computer disconnects are discouraging
  - Data-oriented managers prefer Kalb Manager

Monitoring with Software

- Top data utilized by managers:
  - Consumption for current day
  - Alarm calves
  - Current data compared to previous day's
  - Drinking speed

Closing Thoughts

- Machine sanitation
  - Low bacteria counts are achievable
  - Cleaning cycle effectiveness is limited
  - Recommend replacing machine hoses and parts frequently to reduce biofilms
- Calf/feeding management
  - Adequate nutrition, ventilation, bedding necessary for success
  - Research in progress on monitoring calves via software

QUESTIONS?

References

The Dairy Research & Information Center. Cleaning and Sanitizing of Containers and Equipment. Vol. 2015. University of California, Davis.

Jensen, M. B. 2003. The effects of feeding method, milk allowance and social factors on milk feeding behaviour and cross-sucking in group housed dairy calves. Applied Animal Behaviour Science 80(3):191-206.

Jensen, M. B. 2006. Computer-Controlled Milk Feeding of Group-Housed Calves: The Effect of Milk Allowance and Weaning Type. Journal of Dairy Science 89(1):201-206.

Jensen, M. B. 2004. Computer-Controlled Milk Feeding of Dairy Calves: The Effects of Number of Calves per Feeder and Number of Milk Portions on Use of Feeder and Social Behavior. Journal of Dairy Science 87(10):3428-3438.

Jensen, M. B. 2009. Short communication: Milk meal pattern of dairy calves is affected by computer-controlled milk feeder set-up. J Dairy Sci 92(6):2906-2910.

McGuirk, S. M. 2003. Solving Calf Morbidity and Mortality Problems. Proceedings of the American Association of Bovine Practitioners 36th Annual Conference.

Thomas, A. and C. T. Sathian. 2014. Cleaning-In-Place (CIP) System in Dairy Plant-Review. IOSR Journal of Environmental Science, Toxicology and Food Technology 8(6):41-44.

USPHS. 2009. Grade "A" Pasteurized Milk Ordinance. F. USPHS, ed.

Virginia State Feed Association & Nutritional Management "Cow" College

Tom Fuhrmann, DVM
DairyWorks
February 19, 2015

DairyWorks
MANAGEMENT SYSTEM

Frank Cardoza
Gumaro Gonzalez
Steve Riesenbeck
Tom Fuhrmann, DVM

DairyWorks
MANAGEMENT SYSTEM

"To be the premier provider of practical management information for dairymen and dairy industry professionals."

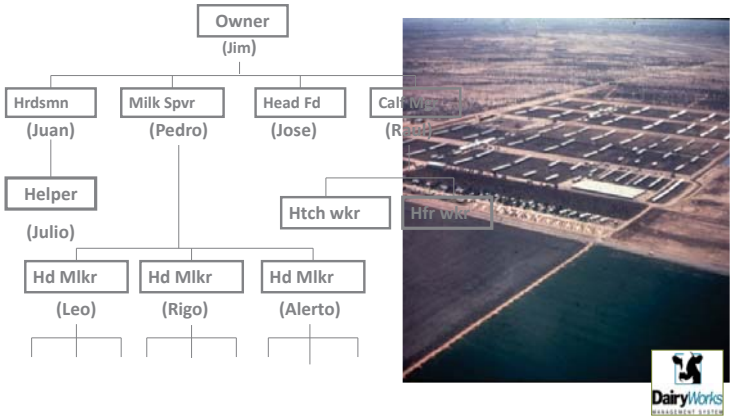
"Leading and Managing Your Workers"

The DairyWorks Team

"Managing Workers"

- **Good leaders can be POOR Managers**
- **Good Managers are generally GOOD Leaders**
- **Bosses are Managers of people:**
  - Bad bosses are either poor leaders or they are good leaders who don't know/use proven management principles
  - Good bosses are good leaders that use management principles

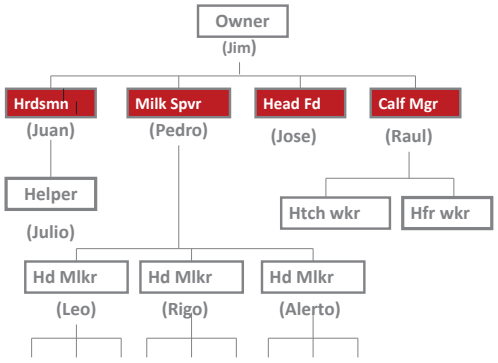
How to Lead and Manage Workers



Groups of Workers = TEAMS

1. **Players** → **Workers**
2. **Coach** → **Supervisor, Boss (Leader)**
3. **Rules** → **Protocols, SOP's**
4. **Results (Win)** → **Goals, KPI's**

How to Find & Develop Supervisors



Supervisors

The "connection" between the owner and workers

Who is most suitable to manage and lead them?

Lots of good Hispanic Workers:

How to Find & Develop Supervisors

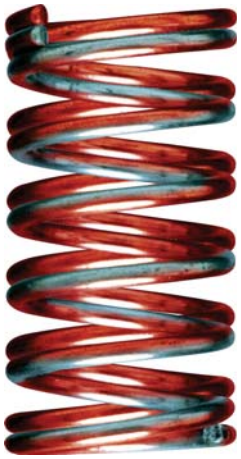
- Leadership vs. Management
- Leadership "buckets"
- Developing Supervisors

How to Find & Develop Supervisors

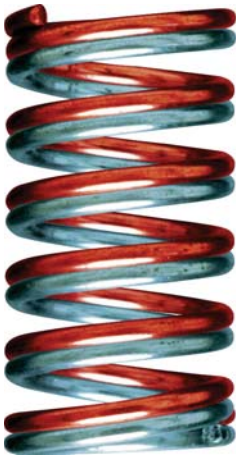
- Leadership vs. Management

LEADERSHIP/MANAGEMENT MATRIX

LEADERSHIP/MANAGEMENT MATRIX



LEADERSHIP MANAGEMENT



Leadership and Management

Leadership

- A relationship between people
- Influence others
- Based on "Trust"
- Skills (buckets)
- Others choose to follow

Management

- Organizing work and workers
- Training and Monitoring
- Feedback for results

MANAGEMENT

SYSTEMS .....that are in control

(Work)

PEOPLE .....that implement systems correctly

(Workers)

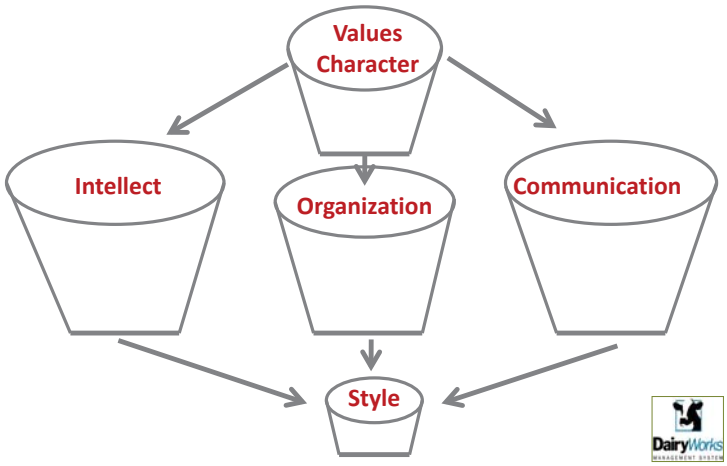
MONITORING to assure that both people and systems are in control

(Results)

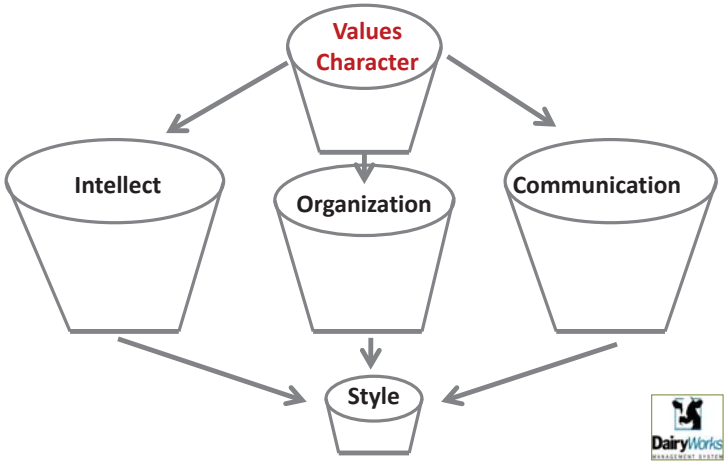
How to Find & Develop Supervisors

- Leadership vs. Management
- Leadership "buckets"

"LEADERSHIP"



"LEADERSHIP"



"LEADERSHIP"

B E H A V I O R

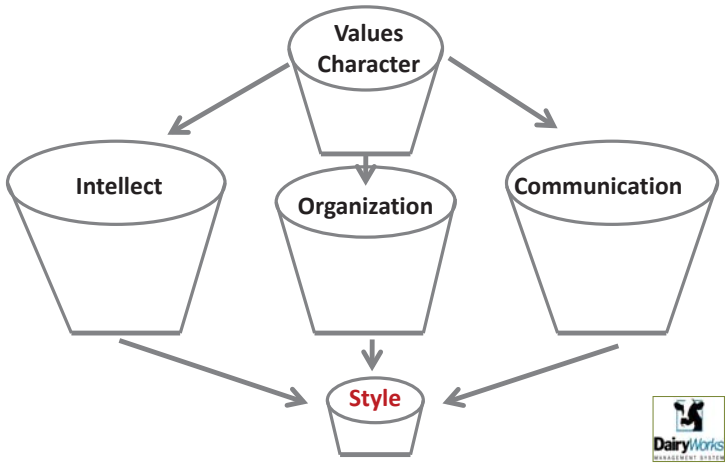
"Leadership is in the eyes of others; they determine you as their LEADER"

"LEADERSHIP"

Values/Character

Intellect	Organization	Communication
Curiosity	Simple, Clear	Care
Initiative	Order	Thoughtful
Creativity	Efficient	Talk Simply
Learn	Prioritize	Prep Msage
Vision	Direction	Precise
Standards	Delegate	Listen
Confidence	Focus	Conflict
KNOW	Pressure	Tactful

"LEADERSHIP"



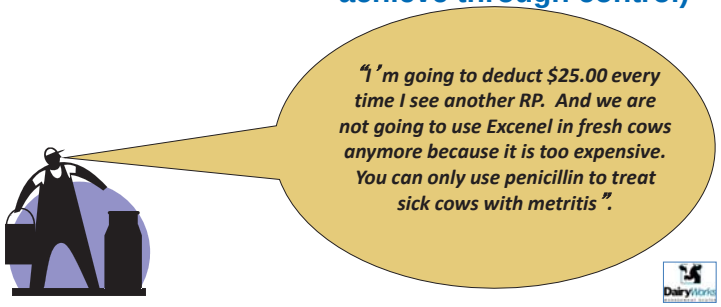
The 6 LEADERSHIP STYLES:

Perceived Patterns of Behavior

1. **Coercive:** Leader demands immediate compliance
2. **Authoritative:** Leader mobilizes followers toward a vision
3. **Affiliative:** Leader values individuals and creates harmony
4. **Democratic:** Leader builds consensus through participation
5. **Pacesetting:** Leader expects to excel and directs others this way
6. **Coaching:** Leader develops followers to higher roles, expectations

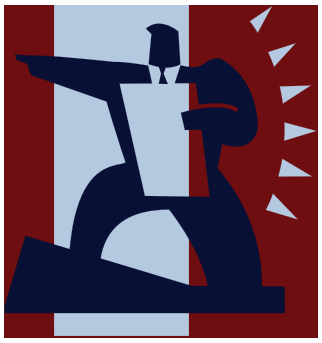
A dairyman leads with his/her dominant leadership style: followers recognize and respond positively or negatively

1. Coercive style: (intense drive to achieve through control)



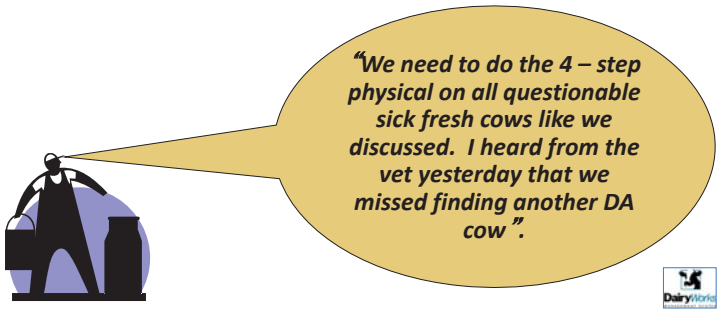
Coercive style: (intense drive to achieve thru control)

- Works:
  - get attention
  - set standards
- Doesn't work:
  - workers reluctant to talk
  - workers stray when leader is absent



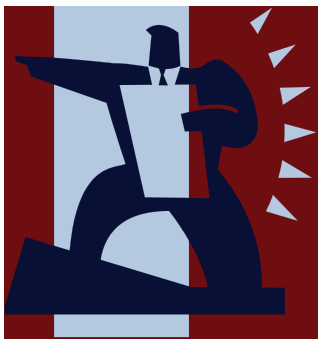
A dairyman leads with his/her dominant leadership style: followers recognize and respond positively or negatively

2. Authoritative style: (firm but fair)



Authoritative style: (firm but fair)

- Works:
  - need for clear direction
  - commit to goals
- Doesn't work:
  - can be overbearing
  - when leader isn't as experienced as workers

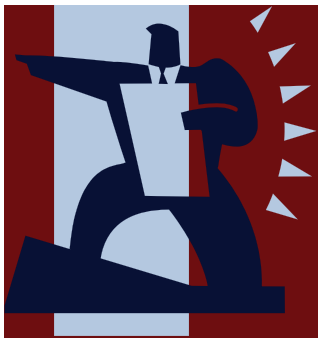


A dairyman leads with his/her dominant leadership style: followers recognize and respond positively or negatively

3. Affiliative style: (wants to be liked)

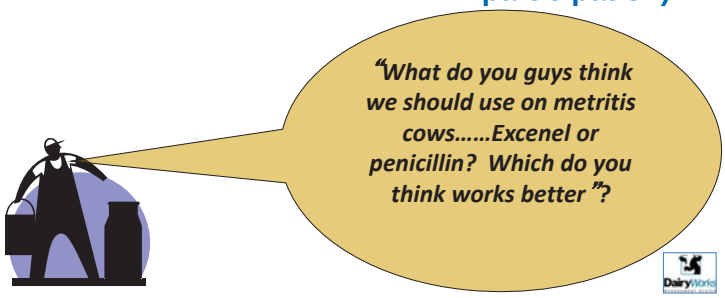
Affiliative style: (wants to be liked)

- Works:
  - to build positive attitude
  - to reinforce success
- Doesn't work:
  - mediocrity tolerated
  - praise allows poor performance to go uncorrected



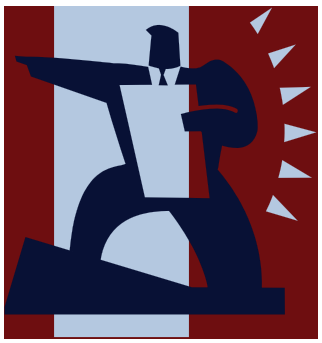
A dairyman leads with his/her dominant leadership style: followers recognize and respond positively or negatively

4. Democratic style: (wants worker participation)



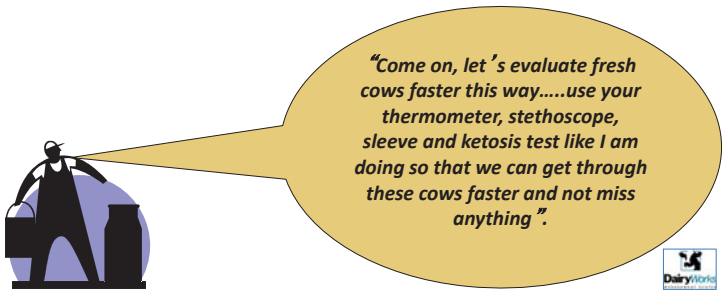
Democratic style: (wants worker participation)

- Works:
  - when leader is uncertain
  - to get fresh ideas
- Doesn't work:
  - time consuming
  - resistor can sabotage
  - making decisions that are not best for profit



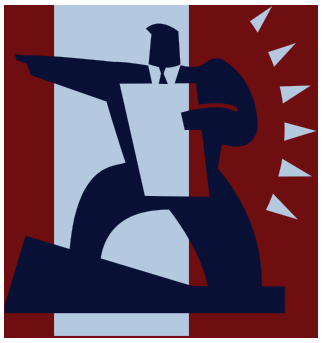
A dairyman leads with his/her dominant leadership style: followers recognize and respond positively or negatively

5. Pacesetter style: (role model; lead by example)



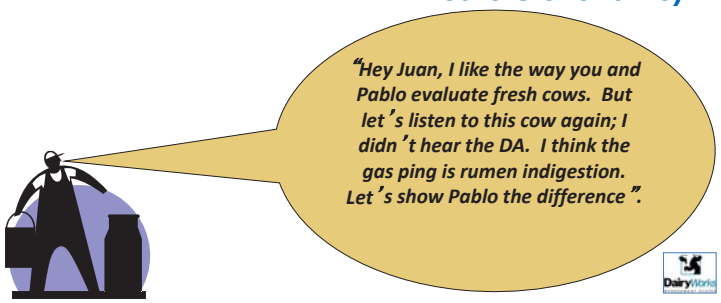
Pacesetter style: (role model; lead by example)

- Works:
  - with skilled, motivated workers
  - for technical aspects of work
- Doesn't work:
  - when leader is absent
  - when workers are not committed



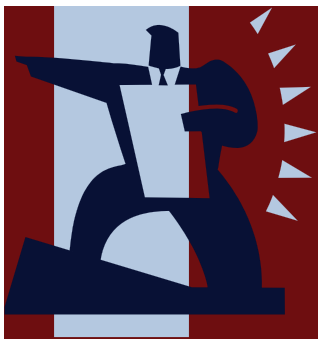
A dairyman leads with his/her dominant leadership style: followers recognize and respond positively or negatively

6. Coaching style: (teacher; develop others over time)



Coaching style: (teacher; develop others over time)

- Works:
  - to grow middle managers
  - to teach how and why for protocols
- Doesn't work:
  - time consuming when need to get things done now
  - costs more when there is high turnover



The 6 LEADERSHIP STYLES:

Perceived Patterns of Behavior

1. **Coercive:** Intense drive to succeed though control
2. **Authoritative:** Leader is firm but fair
3. **Affiliative:** Leader creates harmony and wants to be liked
4. **Democratic:** Leader builds consensus through participation
5. **Pacesetting:** Role model; leads by example
6. **Coaching:** Teacher; develops followers

How to Find & Develop Supervisors

- Leadership vs. Management
- Leadership "buckets"
- Developing Supervisors

Leadership & Management

Manager	Supervisor
• Organizes Work	• Learns the work system from the Manager • Trains workers
• Relies on the Supervisor to train workers	
• Monitors results by comparing these to goals; communicates results to supervisor	• Monitors workers and work; focuses his workers on standards of performance

Your Role to Develop Supervisors

1. You identify your "Diamonds in the Rough"
   1. Review the "buckets"
   2. Bilingual Hispanics
2. Ask, Discuss and Sell your potential Leader on the opportunity
3. "Anoint" him/her
4. "Management Energy"

Supervisor Development

Skills to be an Effective Supervisor

1. You have to make a connection with your workers
2. You have to teach and direct workers
3. You have to evaluate and assess work and workers
4. You have to communicate to influence, transmit trust and teach
5. You have to take initiative
6. You have to show results

Supervisors must learn that goals are achieved by the standards they set:

GOALS	STANDARDS
• SCC < 200,000	• Clean teats on cows on opposite side of parlor
• Heat Detection > 75%	• Crayon placement
• Pg rate > 22%	• ALL ovsynch injections
• D&C < 60 DIM < 7%	• Appetite, attitude, eyes
• DOA's < 6%	• Learn stages of labor
• Death loss < 8%	• Feed & water for downers; concern
• Calf death loss < 2%	• Milk mixing spotless

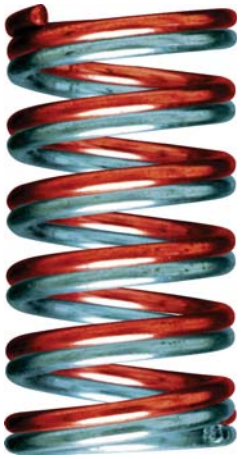
Working Supervisor

- **Worker: using your experience and getting the work done**
- **Supervisor: Your skills provide the help and direction the rest of your workers need**

How to Find & Develop Supervisors

- Leadership vs. Management
- Leadership "buckets"
- Developing Supervisors

LEADERSHIP **MANAGEMENT**



LEADERSHIP/MANAGEMENT MATRIX

DairyWorks MANAGEMENT SYSTEM

Advances in Colostrum Management

Sandra Godden DVM, DVSc
Department of Veterinary Population Medicine
University of Minnesota

Acknowledgements

- Funding and in-kind support:
  - USDA – CSREES
  - JDIP
  - MN Rapid Agricultural Response Fund
  - Merck Merial Summer Scholars Program
  - DairyTech, Inc. (Greely, CO)
  - Saskatoon Colostrum Company (Saskatoon, SK)
- Participating dairy farms and staff
- Student and laboratory technicians

UNIVERSITY OF MINNESOTA
Driven to Discover℠

Key Management Areas for Preweaned Calves

- Maternity pen management
- Care of newborn calf
- **Colostrum management**
- Housing and sanitation
- Preweaning nutrition
- Disease detection and treatment

UNIVERSITY OF MINNESOTA
Driven to Discover℠

- Goals for the colostrum program:
  - > 90% of calves with serum IgG > 10 mg/mL
  - Get 150 – 200 g IgG into the calf ASAP
- The 5 Q's of a colostrum management program
  - Quality: > 50 g/L IgG
  - Quantity: 10% BWt (~4 qts)
  - Quickness: 1-2 hrs (< 6 hrs)
  - SQueeky clean (bacterial contamination)
  - Quantifying passive transfer (monitoring)

UNIVERSITY OF MINNESOTA
Driven to Discover℠

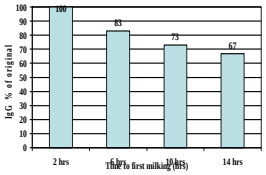
Outline

- New tools for monitoring:
  - Colostrum quality
  - Passive transfer in calves
  - Wet lab
- Methods to reduce microbial exposure:
  - Use of Colostrum replacers:
  - Heat-treating colostrum:

UNIVERSITY OF MINNESOTA
Driven to Discover℠

Colostrum Quality

- Goal:
  > 50 g/L IgG in colostrum
- Factors affecting quality:
  - Dry cow vaccination program
  - Feed balanced dry cow ration
  - Avoid dry cow stress (heat, crowding)
  - Avoid short dry periods (< 21 days)
  - Milk cows within 1-2 hrs (max 6 hrs)



Moore et al., J.A.V.M.A. 2005. 226:1375
13 cows – 52 quarters

Cow-side Tests of Colostrum Quality: Colostrometer or Brix Refractometer

	Instrument Cutpoint Used	Sensitivity (%)	Specificity (%)	Cost	Pros / Cons
Colostrometer IgG < 50 g/L (Chigerwe, JAVMA 233: 2008)	Green	75% (recc: cutpoint 70)	87%	$40	Rapid, Simple / Fragile, Temperature dependent
Optical Brix Refractometer IgG > 50 g/L (Bielmann JDSci. 2010)	≥ 22% Brix scale	90.5%	85%	$80 - $300	Rapid, Simple, Not temp. dependent

Cow-side Tests of Colostrum Quality: Colostrometer or Brix Refractometer

	Instrument Cutpoint Used	Sensitivity (%)	Specificity (%)	Cost	Pros / Cons
Colostrometer IgG < 50 g/L (Chigerwe, JAVMA 233: 2008)	Green	75% (recc: cutpoint 70)	87%	$40	Rapid, Simple / Fragile, Temperature dependent
Optical Brix Refractometer IgG > 50 g/L (Bielmann JDSci. 2010)	≥ 22% Brix scale	90.5%	85%	$80 - $300	Rapid, Simple, Not temp. dependent

MISCO Palm Abbe Digital Refractometer

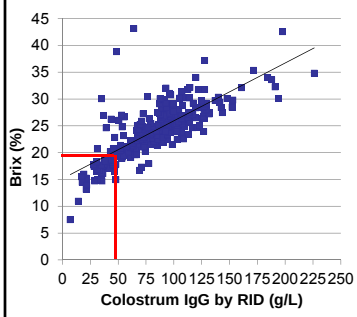
- $300 - $500
- Rapid
- Simple
- Durable
- Samples should be at room temp.

Scales:

1. Brix (%) * :
   i) Estimate colostrum IgG
   ii) Estimate milk TS
   iii) Estimate serum IgG
2. Serum Total Protein (g/dL) *
3. Predicted colostrum IgG (g/L) **
4. Predicted serum IgG (mg/mL) **

* Validation looks good.
** Very poor scales – Don't use.

Results: Colostrum
Palm Abbe Brix (%) vs IgG by RID (g/L)



Accuracy to Diagnose good colostrum (IgG ≥ 50 g/L) was best with Brix cutpoint of ≥ **19%**:

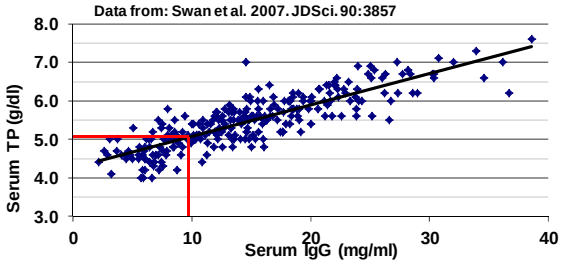
True prevalence= 83%

Sensitivity = 98%
Specificity = 76%
Overall accuracy = 94%
PPV = 95%
NPV = 90%

UNIVERSITY OF MINNESOTA
Driven to Discover℠

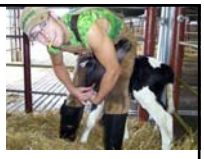
On-farm monitoring of serum total protein to evaluate the colostrum program

refractometer



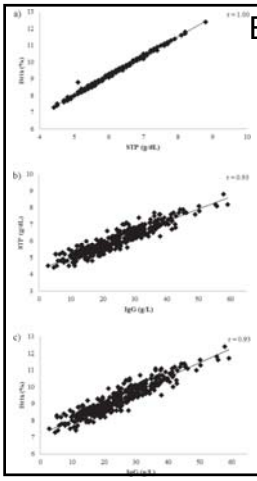
- 5.0 or 5.2 g/dL STP value to predict serum IgG of 10 mg/ml:
  (Calloway, et al., 2002)

On-farm monitoring of serum total protein to evaluate the colostrum program



- How?
  - Bleed 12 clinically normal calves 24 hrs – 7 d old
  - Let blood clot, test serum with refractometer
  - Interpret results at the group level

- Goal:
  ≥ 90% of calves should have TP ≥ 5.2 g/dl
  (Tyler. 2003. p.c.)
  or ≥ 80% of calves should have TP ≥ 5.5 g/dl
  (McGuirk, 2006)
- Is higher better? **YES**



Brix (%) or STP (g/dL) can Estimate Serum IgG

(Deelan et al., JDSci. 2014. 97:in press)

400 calves sampled 3-6 days old

STP Refractometer:
- Cutpoint 5.5 g/dL
  - SE = 76.3%
  - SP = 94.4%

MISCO Brix:
- Cutpoint 8.4%
  - SE = 88.9%
  - SP = 88.9%

Summary: Uses of refractometers?

- Optical or digital
- STP scale (g/dL):
  - Estimate serum IgG in calves: 10 g/L IgG ≥ 5.2 g/dL (group level interpretation)
- Brix scale (%):
  - Estimate TS in whole milk or milk replacer
  - Identify high vs low quality colostrum: 50 g/L IgG ≥ 19%
  - Estimate serum IgG in calves: 10 g/L IgG ≥ 8.4% (group level)
- MISCO Palme Abbe digital refractometer serum IgG and colostrum IgG scales: Don't use (grossly underpredict IgG)

Outline

- New tools for monitoring:
  - Colostrum quality
  - Passive transfer in calves
  - Wet lab
- Methods to reduce microbial exposure:
  - Use of Colostrum replacers:
  - Heat-treating colostrum:

How often do producers feed contaminated colostrum?

- Goal:
  - TPC < 100,000 cfu/ml
  - TCC < 10,000 cfu/ml

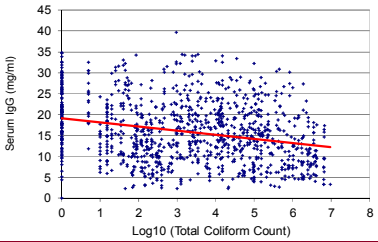
Sheila McGuirk
UWI-Madison

Sam Leadley
Attica Vet, NY

- National study: 43% of 827samples from 67 herds exceeded limit
  (Morrill et al., 2012. JDSci 95:3997)

Consequences of microbial contamination of colostrum?

- Pathogens may cause disease
  (e.g. *E. coli*, *Salmonella* spp., *Mycoplasma* spp., *M. avium* subsp. *paratuberculosis*)
- Bacteria counts are associated with ↓ serum IgG levels
  James et al., JDSci 1981; Poulson et al., ACVIM 2002; Godden et al., JDSci 2012



Critical Control Points to Reduce Contamination


- Cow
  - Identify infected cows (MAP)
  - Don't let calf suckle dam
  - Udder prep
  - Don't pool raw colostrum



- Equipment
  - Sanitation of milking, storage & feeding equipment


- Proliferation
  - Feed ASAP (< 1-2 hrs)
  - Refrigerate (< 48 hrs)
  - Freeze
  - Preservatives
- Replacers, Heat-treating

Colostrum Supplements and Replacers: Outline

- Definitions & places for use on dairies
- Manufacture & licensing
- Evaluating efficacy
- Monitoring pasive transfer

Colostrum Supplements

Calf's Choice Total Gold – 60 g
Saskatoon Colostrum Co.

- $9 to $18 USD per dose
- Lacteal or serum-derived IgG
- 25 to 60 g IgG per dose
  - Inadequate IgG and nutrients if fed alone
- Intended to supplement poor quality or inadequate volume of maternal colostrum:
  - No value to supplementing high quality MC
  - Useful if supplementing low quality MC
    (Thompson and Heusel, AABP, 2014)

Lifeline Protect- 50g
APC, Inc.

Colostrum Replacements

- $25-40 USD per dose
- Lacteal or serum-derived IgG
- 100 to 150+ g IgG per dose
- Includes nutrients
- To replace maternal colostrum (MC):
  - Convenient: mix & feed
  - Use if inadequate supply of MC
  - Infectious disease control (e.g. Johne's)

Land O' Lakes CR – 100 g
Saskatoon Colostrum Co.

Calf's Choice Total HiCal
100 g; Sask. Colostrum Co.

Colostrx 130 - 130g
APC, Inc.

Manufacture

- Lacteal-derived products:
  - Fresh frozen colostrum from Grade A dairies
  - Pooled, heat-treated, spray dried, packaged
  - Non-Ig components (e.g. nutrients) unchanged

Land O' Lakes CR – 100 g
Saskatoon Colostrum Co.

- Serum-derived products:
  - Collect blood at USDA inspected abattoirs
  - Centrifuge to separate serum, spray dry serum to 20% Ig powder,
  - No nutrients: must add nutrient pack

Colostrx 130 - 130g
APC, Inc.

CVB-Licensed CR or CS Products

- CFIA (all) or USDA Center for Veterinary Biologics (CVB)
- From bovine colostrum
- Can claim 'for prevention or treatment of FPT'
- Accepted protocols for manufacture & testing
- Each batch tested by CVB lab to guarantee:
  - Purity: Specified TPC; NO Coliforms, Salmonella or fungi
  - Potency: Minimum IgG content
  - Efficacy: ≥ 10 mg/ml serum IgG) in 90% of calves
  - Traceability
- Annual plant inspection by CVB
- Some do additional testing
  (e.g. Sask. Colostrum Co. tests each batch for *M. paratuberculosis*)

Selected examples of CVB-licensed colostrum replacement (CR) or supplements (CS)

CR's

Calf's Choice
Total HiCal – 100 g
Saskatoon Colostrum Co.

Land O' Lakes CR – 100 g
Saskatoon Colostrum Co.

Colostrum Plus 100
La Belle Associates

CS's

Calf's Choice Total Gold – 60 g
Saskatoon Colostrum Co.

Kid or Lamb's Choice Total
Saskatoon Colostrum Co.

Immu-Start 50 Bovine IgG
Immu-Tek

Non-Licensed CR or CS Products

- AAFCO Guidelines (Assoc. Am. Feed Control Officials):
  - Not a feed, but is being used in feeds
  - Each State (Dept. of Ag) adopts its own guidelines
  - No federal or state system to regulate or test
  - No product testing or plant inspections unless complaints brought to State Dept. of Ag.
  - Internal quality testing program at manufacturer's discretion
- Cannot claim 'for prevention of FPT'
- Ig may be from bovine colostrum or serum

Selected examples of non-licensed colostrum replacement (CR) or supplements (CS)

CR's

Lifeline Rescue, 150g; APC, Inc.

Colostrx 130 APC, Inc.

150 Benefit La Belle Associates

First Day Formula 150g; Milk Products

CS's

Lifeline Protect, 50g; APC, Inc.

Colostrx Multi Species 20g; APC, Inc.

Ranch 40 La Belle Associates

First Day Formula 60g; Milk Products

Dose of IgG (g) Fed

Land O' Lakes CR – 100 g Saskatoon Colostrum Co.

- Most CR products include 100-130 g IgG

but

- Really need 150-200 g IgG if expect ≥ 90% calves to pass (serum IgG ≥ 10 mg/mL)

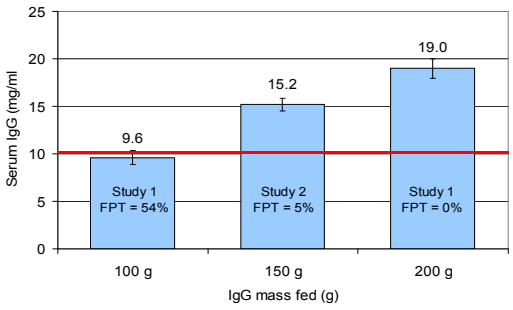
Land O' Lakes CR Tub Saskatoon Colostrum Co.

- How to get to 150-200 g IgG?
  - Some products provide larger dose (e.g. 150 g/dose)
  - Large tubs: Operator determines the dose
  - Feed multiple doses

Calf's Choice Total Gold – 60 g Saskatoon Colostrum Co.

Dose response of serum IgG to IgG mass fed

(Godden et al., 2009. JDSci. 92:1750-1757)



Conclusion: Producers wishing to reduce the risk of FPT may opt to feed higher doses IgG (150-200 g) in Colostrum Replacers

Comparing Efficacy of Supplement and Replacement Products

- Ask for the data:
  - Many products are untested
  - Head-to-head controlled trials needed to make comparisons
- Factors to evaluate:
  - Serum IgG in calves (mg/mL)
    - Dose of Ig (g) fed
    - Efficiency of absorption of IgG (%)
  - Calf health
  - Future performance
  - Disease control (e.g. Johne's)

Sample of Colostrum Replacement Product Comparative Efficacy Studies

Study	Tx Group	IgG fed (g)	AEA (%)	Serum IgG (mg/mL)
Godden et al., JDSci 2009	MC – 3.8 L (71 g/L)	271 g	32%	20.7 [a]
	LOL CR-1 dose	100 g	36%	9.6 [b]
	LOL CR-2 doses	200 g	37%	19.0 [a]
Place et al., AABP 2010	LOL CR-1.5 doses	150 g	38% [a]	14.7 [a]
	Colostrx 130 – 1 dose	130 g	28% [b]	9.6 [b]
Priestley et al., JDSci 2013	MC – 3.8 L (NR)	NR	NR	21 [a]
	Calf's Choice Tot Silver -1 dose	100 g	38.8% [a]	11.4 [b]
	Acquire 150 – 1 dose	150 g	21.6% [b]	9.3 [b]

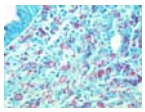
Final serum IgG is a function of dose fed (g) and absorption (%)

Role of Colostrum Replacements in Disease Control Programs?

- Though fecal-oral transmission is most common, MAP can be shed in colostrum and milk of subclinically infected cows

  (Sweeney et al. J.Clin.Micro. 1992. 56; Streeter et al., J. Clin. Micro. 1995. 30)

  - Can one feeding of colostrum cause infection with MAP?
  - Will use of a colostrum replacer prevent MAP transmission?



Risk of MAP Infection in Calves Fed Raw Colostrum or a Colostrum Replacer

(Pithua et al. 2009.J.A.V.M.A. 234:1167-1176)

Newborn heifer calves from 12 herds (N = 497)

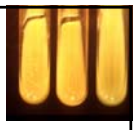
maternal colostrum (n = 261)

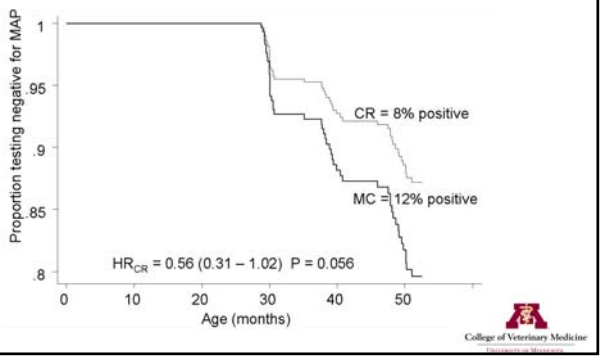
colostrum replacer (n = 236)

Acquire / Secure APC, Inc.

Adult Period: 1st calving to 54 mos:
- Fecal culture and serum ELISA for MAP at 30, 42 and 54 mos.

Results:
Calves fed a colostrum replacer had reduced risk for MAP infection





College of Veterinary Medicine

Monitoring Serum Total Protein Measures when Feeding Colostrum Replacers

- Maternal colostrum:
  - STP 5.0 or 5.2 g/dL ≈ 10 mg/mL IgG

- Colostrum-derived colostrum replacers:
  - STP 5.0 or 5.2 g/dL ≈ 10 mg/mL IgG
- Serum-derived colostrum replacers:
  - STP ??? = 10 mg/mL IgG
  - STP values vary between 4.2 to 5.4 g/dL between studies and products:
    - e.g. 4.75 g/dL for Colostrx 130 (Place et al., 2010)
  - If STP values are not published for a specific product, do direct testing of IgG (ELISA, RID, zinc sulfate-turbidity)

Summary on Selection and Use of Colostrum Supplements and Replacers

- Supplements are NOT replacers
- Must feed 150-200 g IgG for acceptable passive transfer.
- Considerations in selecting a product:
  - Ask for the data: independent research describing efficacy?
    - IgG Dose; AEA (%); Passive transfer levels in calves
    - Must have head-to-head studies to make direct comparisons
- Monitoring FPT using STP: Cutpoints will depend on CR product type

Outline

- New tools for monitoring:
  - Colostrum quality
  - Passive transfer in calves
  - Wet lab
- Methods to reduce microbial exposure:
  - Use of Colostrum replacers:
  - Heat-treating colostrum:

University of Minnesota
Driven to Discover℠

Outline: Heat-treating Colostrum

- Review of effects of heat-treatment on:
  - Colostrum characteristics
  - Calf health
- Novel methods to treat colostrum – Do they work?
  - Perfect Udder Bag
  - UV treatment
- 'Must do's" when heat-treating colostrum

Developing a Method to Heat-treat Colostrum

- Traditional Pasteurization (PMO):
  - Continuous flow (72 °C x 15 sec) or Batch (63 °C x 30 min)
  - Unacceptable thickening
  - 25-32% [illegible] (mg/ml)
  - Lower serum IgG in calves

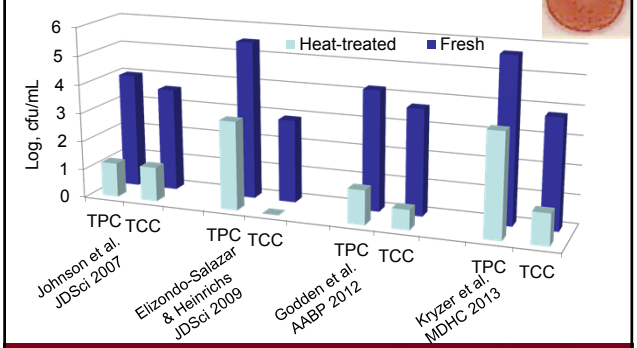
(Gre[illegible]al. [illegible]i. 2003. 86:246; Go[illegible]n et al. [illegible]ci. 2003. 86:1503)

- Heat-treat: 60 °C (140 °F) x 60 min
  - No viscosity changes
  - No change in colostrum IgG (g/L)
  - Significantly reduce or eliminate *MPTB, Salmonella, Mycoplasma, E. coli*….

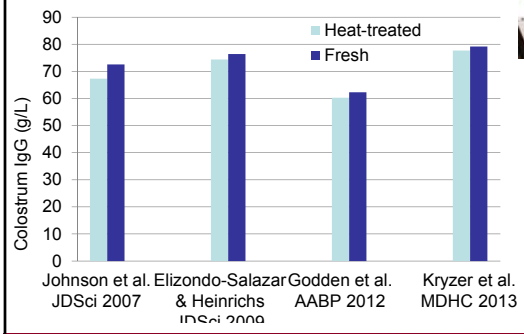
(McMartin et al. JDSci. 2006. 89:2110

Heat-treatment reduces colostral bacteria counts

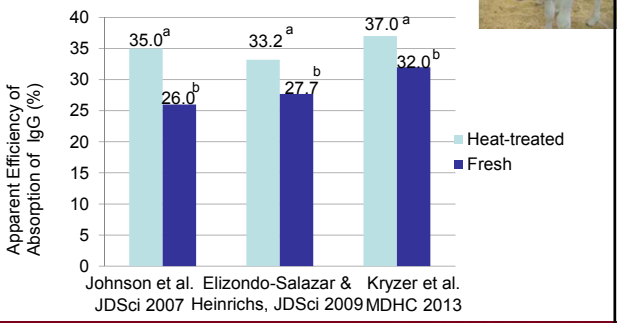
(TPC = Total Plate Count; TCC = Total Coliform Count)



No effect of heat-treatment on colostral IgG levels

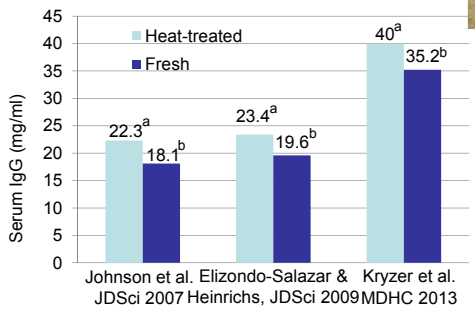


Calves fed heat-treated colostrum have improved absorption of IgG (%)



UNIVERSITY OF MINNESOTA Driven to Discover℠

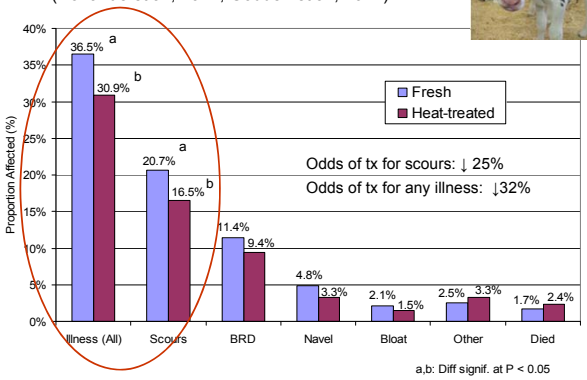
Calves fed heat-treated colostrum have increased serum IgG levels (mg/ml)



UNIVERSITY OF MINNESOTA Driven to Discover℠

Reduced Morbidity in Calves fed Heat-treated Colostrum

(Donahue et al., 2012; Godden et al., 2012)



Novel Techniques to Treat Colostrum – Do they work?

- Perfect Udder System

- UV treatment of colostrum

Dairy Tech Perfect Udder® System

(DairyTech, Inc., Greeley, CO)

Works equally well as compared to batch pasteurization

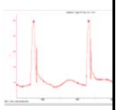
(Kryzer et al., AABP. 2013)

Summary of UV Research

- UV light passed through column of milk (200 to 280 nm = germicidal range)
- UV treatment of milk:
  - Intermediate ability to inactivate 'regular' bugs (e.g. *E. coli*, *S. aureus*, Environmental Strep. spp.)
  - Poorer efficacy vs heat-based pasteurization methods: UV: 3.3 log reduction; HTST: 5.2 log reduction (Bicalho et al., 2013)
  - Poor ability to inactive MAP (Johne's)
- UV treatment of colostrum:
  - 43-50% denaturation of IgG

(Reinemann et al., 2006; Altic et al., App Env Micro.2007.73:3728; Donaghy et al.,2009. Bicalho et al., 2013; Pereira et al., 2014; Gelsinger et al., 2014)

"Must do's" to heat-treat colostrum



- Methods:
  - Batch design or Perfect Udder System (DairyTech, Inc.)
  - NOT Ultraviolet treatment: 43-50% loss of IgG
- Constant agitation
- Active (not passive) heating and cooling
- Monitoring:
  - Times & temps:
    - 60 ºC x 60 minutes: No fluctuations above 61 ºC
  - Periodic culture of heat-treated colostrum:
    - TPC < 20,000 cfu/ml; TCC < 1,000 cfu/ml
  - Calves: STP, morbidity, mortality

Summary

- New tools (e.g. Brix) for monitoring:
  - Colostrum quality
  - Passive transfer in calves
- New methods to reduce microbial exposure:
  - Use of Colostrum replacers:
    - Ask for the data
  - Heat-treating colostrum:
    - Batch or Perfect Udder System

College of Veterinary Medicine
University of Minnesota

Thank you!

Questions?

University of Minnesota
Driven to Discover℠

Dairy Stockmanship – Empowering People and Cattle
Humane Livestock Handling: Practical Applications of Animal Behavior and Welfare Science

North Carolina State University - College of Veterinary Medicine Outreach
Don Höglund MS, DVM
dlhoglun@ncsu.edu

Introduction

The veterinary profession and dairy producers have taken a strong interest in dairy stockmanship – the interactions that occur between people and cows. The daily management of a dairy operation requires personnel to interact with the cattle many times a day. Dairy stockmanship is the implementation of low-energy cow handling techniques to improve the outcomes for both the people and the cattle.

Dairy Stockmanship

In stockmanship terms stimulation of any kind on livestock is often referred to as a form of pressure. Behaviorists prefer to use the word stimulus instead of mental pressure. Stimulus can be quantified whereas assessments of mental pressure are hard to measure. In discussions on stockmanship or cattle handling people frequently refer to flight or escape zones of an animal as an arbitrary measure of how much stimulus or encroachment an animal will endure prior to fleeing or fighting. Conceptually, the flight or escape zone can be thought of as being an animal's personal space and when that space is violated the animal may determine that it is no longer safe and react. In practical terms, as a human approaches livestock the animal begins to feel stimulus from human encroachment. The exact flight distance and the extent of the response to human presence may vary animal to animal or within the same animal depending on the various factors influencing the animal, such as, prior animal experiences, previous human interaction, the distance between the human and animal, natural or artificial boundaries, husbandry practices, age of the animal, other competing environment stimuli, health and well-being of the animal(s) in general, and even the time of day. By closely observing the response of the animal approached, livestock handlers can be able to observe and learn from the effects of the stimulus on animal behavior. Alternatively, by moving away from animals some or all of the stimulus may be relieved and understanding this animal behavior will also be useful to livestock handlers. The key point is that handlers can induce animals to move, turn, or stop by exerting and manipulating stimulus.

Every interaction between people and cows shapes the future behavior of both. These interactions can be positive or negative but are very rarely neutral. The concept of stockmanship, or low-energy handling of livestock helps people become aware of human behavior and the impact it has on livestock. With proper handling cattle are easier to work and move and that creates a desirable environment for both cattle and people. In the dairy industry people interact with cows several times a day and these situations present opportunities to create positive, human and animal interactions.

General Stockmanship Concepts

There are a few general concepts about cow behavior stock handlers should keep in mind. Livestock derive information from the environment through their five senses: sight, hearing, smell, touch and taste. Cows do not use language to communicate with people so stock handlers must communicate with cows by stimulating the senses of the animal. The two most important senses a cow uses to understand what is going on in her environment are sight and hearing.

Cows consistently look at what is stimulating them. Because the eyes and ears of the cow are positioned on the side of the skull, cows have excellent peripheral vision and hearing. There is a narrow blind spot directly behind her rump. A good general rule is that if the handler can see the cow's eyeball she can probably see the handler. Therefore, the human should approach the animal from a position where her eyeball can be seen, in this manner she can probably see and hear the handler. Surprising livestock is never a good idea, so let them see the handler if possible and if not, let them gently hear who approaches them.

Cows tend to move in an arc around whatever they perceive as stimulus. This allows them to keep an eye on what is stimulating them as they move around or away from it. Cows tend to follow other cows. These two concepts are invaluable when emptying a cattle pen or loading a transport with cattle. If the handler can create positive motion at the front of the herd and then avoid doing anything to slow or stop the flow, cows will tend to move in the direction they are facing while following the cow in front of them. If, for example, handlers are moving animals into the parlor, the task will be accomplished more efficiently if the handler induces the animals to face the opening into the parlor. If the handler causes the animals to turn back toward the crowd gate, flow stops and the cattle tend to bunch. Handlers need to pay close attention to their position in relationship to the direction of cow movement. It is most important not to over-stimulate or to apply stimulus in an unpredictable manner to the animal. Extreme examples of over-stimulation are shouting, arm waiving, and hitting animals or using electric prods to get them to move. Cows do not respond positively when over-stimulated, they exhibit agitation and may run potentially leading to harm. These examples of too much stimulus can be called high-energy cow handling techniques.

Herding a cow properly involves the right approach angle, speed, and timing. There is no complicated or magic formula. The cow's behavior will inform the handler if the angle, speed,

and timing were correct. If she didn't respond as the handler intended, then the handler should back along the same line as the approach, change the angle and the speed of approach. However, one concept has universal importance in moving cattle and it is that driving cattle from directly behind them, in their blind spot, causes the animal to turn and face the handler in order to get at least one eye on the stimulus. That handling mistake stops the forward motion of cattle because a cow tends not to walk far with her head turned. Cows seem to follow their eyes.

Cows walk at about two-miles per hour (mph) while people tend to walk about three to four mph. Handlers walking at their normal pace and parallel with cows will eventually overtake the cow, first slowing them and then stopping forward motion altogether. Handlers need to recognize this and slow their walking speed in order to move at the same pace as calm cows. Since it generally takes more stimulus to start a cow moving than it does to keep her moving, once cow motion begins the handler should slow or pause momentarily in order to create some distance between themselves and the moving cow. The handler then continues to apply only the stimulus needed to keep the cow moving calmly. Over-stimulating in order to start motion or during movement frequently causes cows to over-react and run. This is often seen when moving heifers.

Walking parallel against the flow of cows tends to speed them. This works because cows want to go the direction they are facing and they want to get away from the human stimulus; especially the human face and eyes. Walking parallel against the flow of cattle can help load or unload a chute, transport, or parlor, and is valuable when encouraging cows to exit the return alley. If more than one person is in the vicinity of the same animal or group of animals, it is best that one person stimulate at a time. With two or more handlers, it is very easy to apply conflicting stimulus to the cattle. Understandably, this would result in conflicting stimuli to the cows and results in poor communication to the animal. Consistent handling methods allow the cows to know what will happen next and that seems to have a calming effect on herd animals.

A good time to work animals is when they first arrive to a new pen or facility. Examples of this are during weaning of heifers from hutches into group pens or immediately after springing heifers arrive at a facility new to them. Spending 10-20 minutes allows handlers to develop a calm relationship with the new cattle while introducing the animals to the new environment. This also creates a great opportunity to examine those animals for any health problems.

As people learn to apply stockmanship skills on cattle operations a frequent question arises about what to do with new cattle? As simple as it may sound, the answer is that the behavior of the animals will tell handlers what should done with them. For example, if cattle run, back and forth or circle non-stop, the handlers need to slow that motion. If the cows bunch in a corner and have no movement, a handler or at most a few handlers should create slow movement that involves teaching new cattle to accept human stimulus. This also helps animals learn the boundaries of their new confinement while teaching them where food and water exists. Each

time cattle are worked properly they learn and become easier to work the next time. That is to say that animals learn calm handling if handled calmly. When livestock operations only consider working cattle if specific tasks are to be accomplished (such as vaccinating) a negative impression of handling can be imprinted in the cows' memory. Naturally, negative interactions can make cows become harder to handle over time. Frequently, we find that the older cows in a herd can be difficult to move. We must understand that their current behavior is the sum total of the interactions with humans over her lifetime; positive and negative. Dairy stockmanship is about reconnecting people with dairy cows for positive outcomes and it is fundamentally about learning how cows respond to the behaviors of people in a dynamic environment.

The Concept of Stress in Dairy Cattle

The general concept of low-stress handling is being widely discussed in the dairy industry today. The National Dairy FARM Program: Farmers Assuring Responsible Management ^{SM}, created by the National Milk Producers Federation (NMPF) with support from Dairy Management Inc. (DMI), specifically states as a best management practice "Employees should be properly trained to handle animals with a minimum of stress to the animal, and the consequences of inhumane handling should be known and enforced." The National Dairy FARM Program is designed to demonstrate that U.S. milk producers are committed to providing the highest standards of animal care and quality assurance. This voluntary program, available to all producers, provides a consistent on-farm animal well-being program that includes education, on-farm evaluations and third-party verification. Whether it be dairy stockmanship training or a program like FARM, the increased usage of the term "low-stress cattle handling techniques" has raised the questions of what exactly is stress, and how do we determine if it is "low" or "high"?

If you ask twelve people to define "stress" you would likely get 12 different answers. This creates an interesting challenge for us if we are going to attempt to determine the level of animal stress on a particular farm and whether the stress level is "low" or "high". If we struggle to define stress, how can we measure it? One of the goals of this paper is to introduce the reader to the scientific study of stress biology and to suggest that farm managers and advisors can utilize this understanding to assist in the evaluation whether cow handling stress is "low" or "high" on a dairy operation. A lengthy list of references is provided at the end of the paper for those interested in researching further into the concepts of animal stress biology.

A brief history of stress research pioneers will be helpful to understand how the term came into such widespread use. Hans Seyle (1907-1982) is generally recognized for being the first researcher to demonstrate the existence of biological stress. In 1936 Seyle defined stress as "the non-specific response of the body to any demand for change." Seyle demonstrated in his research that a wide variety of noxious stimuli caused a very consistent set of pathologic

changes in laboratory rats. Seyle's work created much interest and discussion in the scientific community.

The work of Robert Sapolsky is also useful in understanding the concept of biological stress. Sapolsky suggests a very useful approach by differentiating a "stressor" from the body's "stress response". Sapolsky defined a stressor as anything that disrupts physiological balance. A stress response is defined as the body's adaptations designed to re-establish the balance. Discussions at the 2011 Trends in Stress Biology course taught at Aarhus University suggested some slight refinements to the definitions.

- Stressor = event threatening or potentially threatening the homeostatic balance
- Stress Response = the bodies attempt to re-establish the homeostasis after encountering a stressor.

Stressor's can be described by their characteristics such as: duration, frequency, intensity, predictability, and ability to be controlled. It is important to note that while stressors can be physical things (heat, cold, starvation, etc.) psychological factors can also trigger the stress response in an animal in the absence of anything physically threatening to an animal.

Sapolsky in his writings proposes that the stress response evolved as adaptive survival mechanism for animals. It is now increasingly recognized that the consequences of the stress response can be maladaptive and that there is a "biological cost" to the animal for mounting a stress response. It is actually incorrect to state that stress makes an animal sick. To be correct, one should state that the stress response makes you more likely to get diseases that make you sick.

There is no single litmus test for stress because of the multiple ways the body responds to stressors. Since stressors will result in both behavioral responses and physiological responses on the part of the animal proper assessment of an animal's stress response requires one look both. One cannot interpret physiological test results without knowing the behavior.

An understanding of stockmanship principles will help one to be aware of behavior responses in animals. The physiological components of the stress response are significantly influenced by the endocrine system. Broadly speaking, all stressors provoke some degree of cortisol secretion as well as a multitude of other physiologic responses. The exact orchestration the many hormones involved will vary depending on the stressor. In this way, different stressors have a different "stress signature" that describes the overall stress response. Work in this area is very interesting and in the future will most certainly allow us to improve and refine our evaluation of the physiological response to stress.

It is still our present understanding that glucocorticoids (cortisol) and catecholamine's (adrenalin) together mediate most of the changes that form the stress response. Today,

measuring cortisol remains the gold standard to evaluate the physiologic response to stressors. Researchers are actively engaged in searching for additional physiologic measures, but it is clear that cortisol does play an important role. Understanding the Hypothalamic-Pituitary-Adrenal axis (HPA axis) is critical to understanding the physiology of the stress response.

Blood sampling has been the traditional measure used to evaluate the cortisol level in an animal. However, plasma cortisol evaluation is not without issues. For example, obtaining a blood sample in itself can be stressful, especially in wildlife or zoo animals. Dr. Rupert Palme (Dept. Biomed. Sciences/Biochemistry,University of Veterinary Medicine, Vienna) and other researchers have been actively looking into alternatives to blood sampling. Cortisol is metabolized in the liver and cortisol metabolites are excreted in the urine and feces. Measuring cortisol metabolites in the feces (FCM's) has received a significant amount of attention. Since 1997, over 130 publications have used the measurement of FCM's on a wide variety of animal species, including dairy cattle.

The positive impact of better cow handling has been clearly demonstrated by Australia's Animal Welfare Science Centre, a joint organization with Australia's University of Melbourne, Monash University and the Victorian State Department of Primary Industries. The Centre is internationally recognized as a leading research and educational facility of animal welfare topics. Interested readers are directed to the Hemsworth references included in this paper for more detailed information.

Dairy veterinarians are frequently involved in on-farm training programs for dairy owners and their employees. Delivering effective training programs for dairy workers is a very valuable production medicine service to offer to dairy clients.

Our long-term goal is to develop useful training resources that dairy veterinarians will be able to utilize to improve their own stockmanship skills as well as use to facilitate on-farm training with dairy clients. In addition, we are actively developing a research program to study the cow behavior responses to stockmanship techniques.

References

Brown RE. 1994. An introduction to neuroendocrinology, chapters 1-4, Cambridge University Press, p. 1-55.

Cohen S, Kessler R, Gordon LU. *Measuring Stress: A Guide for Health and Social Scientists*. (1997, Oxford University Press) ISBN 978-0-19-512120-9

Hansen SW, Malmkvist J, Palme R, Damgaard BM. 2007. Do double cages and access to occupational material improve the welfare of farmed mink? Anim. Welf. 16, 63-76

Hayward LS, Wingfield (2004). Maternal corticosterone is transferred to avian yolk and may alter offspring growth and adult phenotype. Gen. Comp. Endocrinol. 135, 365-371.

Hemsworth, P.H., Barnett, J.L., Tilbrook, A.J., Hansen, C., 1989. The Effects of Handling by Humans at Calving and During Milking on the Behaviour and Milk Cortisol Concentrations of Primiparous Dairy Cows. Appl. Anim. Behav. Sci. 22, 313-326.

Hemsworth, P.H., Coleman, G.J., Barnett, J.L., Borg, S., 2000. Relationships between human-animal interactions and productivity of commercial dairy cows. J. Anim. Sci. 78, 2821-2831.

Hemsworth, P.H., 2007. Ethical stockmanship. Aust. Vet. J. 85, 194-200.

Herskin MS, Jensen KH. 2002. Effects of open field testing and associated handling v. handling alone on the adrenocortical reactivity of piglets around weaning. J. Anim. Sci. 74, 485-491.

Jarvis S, Moinard C, Robson SK, Baxter E, Ormandy E, Douglas AJ, Seckl JR, Russell JA, Lawrence AB. 2006. Programming the offspring of the pig by prenatal social stress: Neuroendocrine activity and behaviour. Horm. Behav. 49: 68-80.

Jensen P, Toates FM. 1997. Stress as a state of motivational systems. Appl. Anim. Behav. Sci. 53, 145-156.

Jensen P, Andersson L. 2005. Genomics meets ethology: A new route to understanding domestication, behavior, and substainability in animal breeding. Ambio 34, 320-324.

Joëls M, Karst H, DeRijk R, de Kloet ER. 2007. The coming out of the brain mineralocorticoid receptor. Trends Neurosci. 31, 1-7.

Laviola G, Hannan AJ, Macrí S, Solinas M, Jaber M. 2008. Effects of enriched environment on animal models of neurodegenerative diseases and psychiatric disorders. Neurobiol. Disease 31, 159-168.

Macrí S, Mason GJ, Würbel H. 2004. Dissociation in the effects of neonatal maternal separations on maternal care and the offspring's HPA and fear responses in rats. Eur. J. Neurosci. 20, 1017-1024.

Macrí S, Pasquali P, Bonsignore LC, Pieretti S, Cirulli F, Chiarotti F, Laviola G. 2007. Moderate neonatal stress decreases within-group variation in behavioural, immune and HPA responses in adult mice. PLoS ONE 2(10): e1015. doi:10.1371/journal.pone.0001015., 1-9

Macrí S, Würbel H. 2006. Developmental plasticity of HPA and fear responses in rats: A critical review of the maternal mediation hypothesis. Horm. Behav. 50, 667-680.

Malmkvist J, Damgaard BM, Pedersen LJ, Jørgensen E, Thodberg K, Chaloupkova H, Bruckmaier, RM. 2009. Effects of thermal environment on HPA-axis hormones, oxytocin and behavioral activity in periparturient sows. J. Anim. Sci. 87, 2796-2805.

Malmkvist J, Palme R. 2008. Periparturient nest building: implications for parturition, kit survival, maternal stress and behaviour in farmed mink (Mustela vison). Appl. Anim. Behav. Sci. 114, 270-283.

Mateo JM, Cavigelli SA. 2005. A validation for extraction methods for noninvasive sampling of glucocorticoids in free-living ground squirrels. Physiol. Biochem. Zool. 78, 1069-1084.

Mellor DJ, Cook CJ, Stafford KJ. 2000. Quantifying some responses to pain as a stressor. Chap. 9 in GP Moberg and JA Mench (eds.), The biology of animal stress, CAB international, 171-198.

Herskin MS, Munksgaard L, Ladewig J. 2004. Effects of acute stressors on nociception, adrenocortical responses and behaviour of dairy cows. Physiol. Behav. 83, 411-420.

Heistermann M, Palme R, Ganswindt A. *Comparison of Different Enzymeimmunoassays for Assessment of Adrenocortical Activity in Primates Based on Fecal Analysis.* American Journal of Primatology 68:257–273 (2006)

Moberg GP. 2000. Biological response to stress: Implications for animal welfare. Chapter 1 in GP Moberg and JA Mench (eds), The biology of Animal Stress, CAB international, p. 1-21.

Mormede P, Andanson S, Auperin B, Beerda B, Guemene D, Malmkvist J, Manteca X, Manteuffel G,Prunet P, van Reenen CG, Richard S, Veissier I. 2007. Exploration of the hypothalamic-pituitaryadrenal function as a tool to evaluate animal welfare. Physiol. Beh. 92, 317-339.

Morrow CJ, Kolver ES, Verkerk GA, Matthews LR. *Fecal Glucocorticoid Metabolites as a Measure of Adrenal Activity in Dairy Cattle.* General and Comparative Endocrinology 126, 229-241 (2002)

Möstl E, Rettenbacher S, Palme R. 2005. Measurement of corticosterone metabolites in birds' droppings: An analytical approach. Annals New York Acad. Sci. 1046, 17-34.
Palme R. 2005. Measuring fecal steroids: Guidelines for practical application. Annals New York Acad. Sci. 1046, 75-80.

Palme R, Rettenbacher S, Touma C, El-Bahr SM, Möstl E. 2005. Stress hormones in mammals and birds: Comparative aspects regarding metabolism, excretion and noninvasive measurement in fecal samples. Trends in Comparative Endocrinology and Neurobiology. Annals New York Acad. Sci. 1040**,** 162-171.

Palme R, Robia C, Baumgartner W, Mostl E. *Transport stress in cattle as reflected by an increase in faecal cortisol metabolite concentrations.* Veterinary Record (2000) 146, 108-109

Parker KJ, Maestripieri D. 2010. Identifying key features of early stressful experiences that produce stress vulnerability and resilience in primates. Neurosci. Biobehav. Rev. In press, doi: 10.1016/j.neubiorev.2010.09.003. 18pp

Sapolsky RM. 2002. Endocrinology of the Stress-Response. Chapter 11 in J. B. Becker, M. Breedlove, D. Crews, M. M. McCarty, Behavioral Endocrinology. 2nd edition. MIT Press, London, UK.

Sapolsky, R. *Why Zebras Don't Get Ulcers* (1994, Holt/Owl 3rd Rep. Ed. 2004) ISBN 978-0-8050-7369-0

Touma C, Palme R. 2005. Measuring fecal glucocorticoid metabolites in mammals and birds: The importance of validation. Annals New York Acad. Sci. 1046, 54-74.

Selye H. 1936. A syndrome produced by diverse nocuous agents. Nature 138, 32.

Weis JM. 1968. Effects of coping responses on stress. J. Comp. Phsyiol. Psychol. 65, 251-260.

Weis JM. 1971. Effect of coping behaviour in different warning signal conditions on stress pathology in rats. J. Comp. Physiol. Psychol. 77, 1-13.

Wolfer DP, Litvin O, Morf S, Nitsch RM, Lipp H-P, Würbel H. 2004. Cage enrichment and mouse behaviour. Nature 432, 821-822

NOTES

VIRGINIA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES

Challenges in Animal Agriculture

Virginia State Feed Association and the Virginia Tech Dairy Nutrition Cow College Annual Meeting

February 19, 2015

Richard L. Wilkes, DVM
State Veterinarian
Director, Division of Animal and Food Industry Services

VDACS MISSION

- Promote economic growth in agriculture
- Provide consumer protection and public health
- Protect animal health and welfare

- Belly buttons
- Opinions
- Facts

CHALLENGES

- Common to agriculture or larger economies
- Animal agriculture

CHALLENGES TO AGRICULTURE

- Demographics
- Economy
- Food safety

DIVERSITY + COMPLEXITY = VULNERABILITY

- Pork shoulder (Canada via Iowa)
- Garlic (US - California)
- Water (US - Illinois)
- Salt (US - Ohio)
- Ground black pepper (India)
- Pecorino Romano cheese (Italy)
- Sausage casing (Canada via Iowa)
- Hot red pepper flakes (Malaysia)

CHALLENGES TO AGRICULTURE

- Agroterrorism
- Information

CHALLENGES: ANIMAL AGRICULTURE

- Economies of scale
- Biosecurity
- Vectors
- Response preparedness

DISEASE PREPAREDNESS – SECDV

CHALLENGES: ANIMAL AGRICULTURE

- Animal Welfare and Transparency

"….in today's highly urbanized culture most young adults have little connection to or knowledge about farming and farming practices. This lack of knowledge deprives them of context when it comes to understanding a video clip involving farm animals. " Grandin

CHALLENGES: ANIMAL AGRICULTURE

- Dietary and consumption decisions
- Production and consumption preferences
- Small, local, direct to market farmers

CHALLENGES: ANIMAL AGRICULTURE

- Distrust of ~~regulators~~, ~~government~~, ~~professionals~~?
- Communications

DISCUSSION AND QUESTIONS

VIRGINIA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES