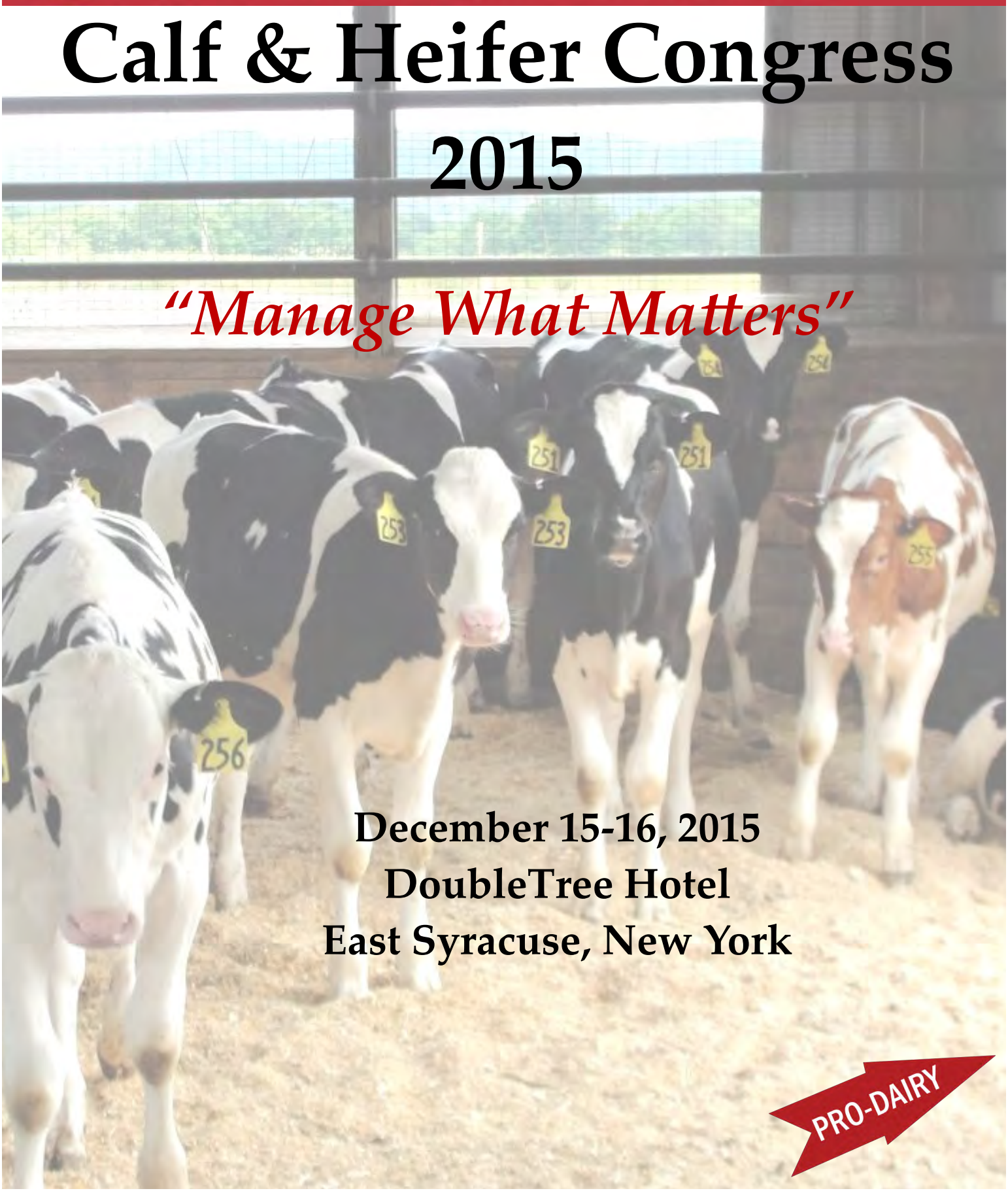
Cornell University
Cooperative Extension
Northwest New York Dairy, Livestock & Field Crops Team

Calf & Heifer Congress 2015

"Manage What Matters"



December 15-16, 2015
DoubleTree Hotel
East Syracuse, New York

PRO-DAIRY

PROCEEDINGS

CALF & HEIFER CONGRESS 2015

"Manage What Matters"

December 15 - 16, 2015

Doubletree Hotel

East Syracuse, New York

Presented by:

Northwest New York Dairy, Livestock & Field Crops Team
Cornell University Cooperative Extension
In conjunction with Cornell University / PRO-DAIRY

Conference Speakers, Producer Panellists & Staff

Conference Speakers

Dwight Bruno, New York State Department of Ag & Markets
Bob Corbett, Dairy Health Consultation
Franklyn Garry, College of Veterinary Medicine, Colorado State University
Carol Gillis, New York Beef Council
Curt Gooch, Cornell University PRO-DAIRY
Rob Lynch, Zoetis
Sheila McGuirk, School of Veterinary Medicine, University of Wisconsin
Kim Morrill, NNY Regional Dairy Specialist
Mike Van Amburgh, Cornell University
Nevin Wagner, Ag-One Associates

Producer Panel

Emily Beller – Beller Farms, Carthage, NY
Luke Getty – Ideal Dairy, Hudson Falls, NY
Kelly Hendrickson – Broughton Farms Operations, LLC., Silver Springs, NY
Mary Kelly – Rensselaer Falls Dairy, Rensselaer Falls, NY
Kazzie Nero – Oakwood Dairy, Auburn, NY
Shelley Reynolds – Reycrest Farms, Corfu, NY

Program Committee

Jerry Bertoldo – Conference Chair
Libby Eiholzer – Conference Co-Chair
Cathy Wallace – Conference Coordinator
Curt Gooch
Jason Karszes - moderator
Kim Morrill
Chris Rossiter Burhans - moderator
Mike Van Amburgh

Calf & Heifer Congress - 2015

"Facilities, Environment and Health"

Tuesday, December 15

Moderator: Jerry Bertoldo, DVM & Libby Eiholzer

12:50 – 1:00 p.m.	**Welcome & Opening Remarks**
1:00 p.m.	**Effects of Environment on Calf Health** *Shelia McGuirk, DVM, School of Veterinary Medicine, University of Wisconsin*
1:50 p.m.	**Calf Facility Evaluation Research Project in Northern NY** *Kim Morrill, PhD, NNY Regional Dairy Specialist*
2:10 p.m.	**Swine & Poultry Ventilation: It Works for Them, It Can Work for Us, Too!** *Nevin Wagner, Ag-One Associates*
2:50 p.m.	**BREAK**
3:15 p.m.	**Calf Housing Systems That Work: Options & Management** *Curt Gooch, MS, Cornell University PRO-DAIRY*
4:00 p.m.	**Virtual Tour & Discussion of Well-Designed Calf Barns, Producer Panel** *Chris Rossiter Burhans, VMD, MS, moderator, Poulin Grain, Inc.*
5:00 p.m.	**RECEPTION / CASH BAR / BUFFET DINNER**
6:45 p.m.	**Antibiotic Stewardship: Using Treatment Protocols & the Veterinary Feed Directive in Heifer Raising** *Rob Lynch, DVM, Zoetis*
7:45 p.m.	**Antibiotic Residues: Records, Assumptions and Reality** *Dwight Bruno, DVM, New York Department of Ag & Markets*
8:15 p.m.	**The Bob Calf Challenge** *Carol Gillis, Executive Director, New York Beef Council*
8:40 p.m.	**Speaker Question & Answer Session**
9:00 p.m.	**Conclude**

Calf & Heifer Congress - 2015

"The Anatomy of a Successful Heifer Enterprise"

Wednesday, December 16

Moderator: Jerry Bertoldo, DVM & Libby Eiholzer

9:00 a.m.	**Welcome & Opening Remarks**
9:10 a.m.	**Physiologic Changes & Risks Associated with Dystocia** *Franklyn Garry, DVM, College of Veterinary Medicine Colorado State University*
10:00 a.m.	**Strategies & Risk Assessment for Infectious Diseases** *Sheila McGuirk, DVM, School of Veterinary Medicine, University of Wisconsin*
11.00 a.m.	**BREAK**
11:20 a.m.	**Identification & Management of Calf Scours** *Franklyn Garry, DVM, College of Veterinary Medicine Colorado State University*
12:15 p.m.	**LUNCH**
1:15 p.m.	**A Comprehensive Approach to Achieving the Benefits of Superior Growth** *Mike Van Amburgh, PhD, Cornell University*
2:05 p.m.	**Nutrition & Management of the Dairy Replacement from Birth to Calving** *Bob Corbett, DVM, Dairy Health Consultation*
2:55 p.m.	**BREAK**
3:25 p.m.	**Economics of Traditional vs. Intensively Managed Heifer Programs** *Bob Corbett, DVM, Dairy Health Consultation*
4:05 p.m.	**Incorporating Conference Information into My Operation, Producer Panel** *Jason Karszes, MS, moderator, Cornell University PRO-DAIRY*
5:00 p.m.	**Adjourn**

Table of Contents

Presentation Layout

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- **Indoor pen considerations**
  - **Group size**
  - **Age at introduction to group pen**
  - **Delivery of clean, nutritional feed**
- **Feeding consistency**
- **Cross sucking**
- **Weaning strategy**
- **Screening for health and performance**
- **Summary and conclusions**

Trend Toward Inside Calf Housing

USDA, 2011 Heifer Raisers

- Inside individual housing
  - 7.1% West
  - 43.5% East
- Inside group housing
  - 0 in West
  - 21% East
- Outside individual housing
  - 93% West
  - 30% East

Wisconsin

- 2014 and 2015 Survey Data of 344 farms (inside and outside pens)
  - 79% (272/344) single calf pens
  - 24% (84/344) group pens
    - Only 9% are groups of 5 or more calves

Indoor Calf Housing Considerations

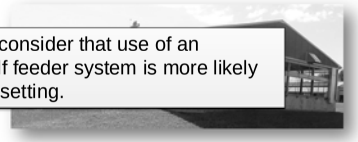
Individual Pens

- Health advantages
  - Limited calf-to-calf contact
  - Decreased disease transmission
  - Individual calf observation and attention
- Starter and water consumption may be monitored more easily
- Managing individual calf milk or milk replacer (MMR) delivery may be easier to control
- Individual calf handling fa

Group Pens

- Labor efficiencies for feeding time
- Automatic calf feeding allows calf control of its feeding pattern and volume
  - Remote monitoring
- Cleaning pens and bedding management is easier
- Socialization advantages for calves

For this talk, consider that use of an automatic calf feeder system is more likely in group pen setting.



Excellent Husbandry Is Required in All Types of Calf Housing

- Perinatal calf management
- Colostrum
- Nutrition
- Environment
- Health screening and management

Group Pen Size

- Ranges from 2 to 40 calves per pen
- ACF companies often recommend 25 to 30/pen
- 20/pen is a very common size
- Groups > 12/pen have compromises

Offering more space per calf doesn't solve a big group pen issue – wet bedding, competitive interactions, or access to feeder

Group Pen Size Considerations (2)

- Too many calves in a pen:
  - Competitive interactions
  - Decreased feeding time
  - Decreased milk intake

(von Keyserlingk, 2004)

- Difficult to detect sick calves in large groups
- Large groups have wider age range
- There can be up to 4 nipples/ACF
  - Typically 2 nipples/feeder and 1 nipple/pen
  - Usually 1 calf drinks at a time despite 2 nipples/feeder

Group Pen Size Considerations (3)

- Groups with <12-18 calves
  - Less pneumonia
  - ↑ADG

(Svensson, 2006)

- Socially stable groups, ↑ ADG
- Continuous additions, ↓ ADG

(Pederson, 2009)

- Bedding management is key
  - More animals, more feed = more urine and more manure

Age at Introduction to Group Pen

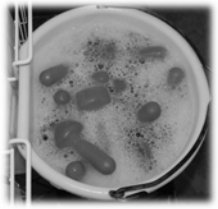
- Age at introduction varies from 2 – 21 days
- Young calves do not compete well and need more guidance
  - Lower intakes and ADG (6 vs 14 days at introduction)
  - If moving young – monitor closely
  - Assist 1-2 times/day for first week if previous 24h consumption < 50% allotment
  - A little help is good, more is not better
- Avoid introduction during scours' risk period

Nutrition Before Group Pen Introduction

- Avoid underfeeding
- Be consistent with group feeding
  - Same MMR
  - Same total solids
  - Same meal size
- Provide starter
- Provide water
- Plan any necessary transitions

Cleaning Considerations

- Not just a bucket and whisk anymore…
- Producer choices
  - Brand and volume of cleaning agent
  - Frequency of cleanings
    - Circuit, mixer/HE, hoses, nipples, unit
  - Hose type and frequency of hose replacement
- Assign people to roles and develop a schedule
- Routine oversight to ensure clean is clean is necessary



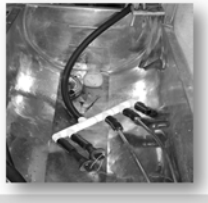
Cleaning Considerations

Clean-In-Place Process (CIP)

- Pre-rinse with water
- Heated alkaline wash (70-80°C)
- Alkaline rinse – 2 times
- Heated acid rinse
- Final water rinse or recycling of sanitizer

Automatic Calf Feeder Cleaning

- Fewer steps
- Lower temperatures
- Circuit and mixer cleanings are on different schedules
- Manual and/or automatic features need to be managed



ACF Cleaning Considerations

- Water temperature
- Alkaline or acidic cleaning agents
- Circuit clean daily
- Mixer/HE clean 2-4x/d
- Replace feeder hoses q 1-2 weeks
  - Many are replacing every other day
- Clean and disinfect nipples 2-3x/d
  - Replace q 1-2 weeks
- Clean around the mixer
- Standard plate counts

Total bacterial counts < 20,000 cfu/mL
Fecal coliforms = 0 cfu/mL
Recommended and achievable

Automatic Calf Feeder Anatomy

Nutritional Considerations

- Group housing advantages with computer-controlled automation
  - Offer more milk and increased feeding frequency
  - Precision and phase-feeding
  - Offers a gradual weaning process
  - Offers feeding alarms to aid in disease detection
- Potential disadvantages
  - Feeding competition
  - Cross sucking
  - Bacterial contamination of MMR

Feeding larger volumes of MMR does not require ACF's but it favors their use.

Nutritional Considerations (2)

- Not all group housed calves are computer fed
- Calves in individual pens can be computer fed
- Consumption of more milk improves ADG, which is positively correlated with milk production
- Ad-lib access to good quality MMR promotes feeding frequency that mimics natural suckling of cow-calf pair
- Larger MMR volume improves digestion and feed efficiency
- Increased number of MMR meals may lower risk for abomasal ulcers

Nutrition by ACF

- **Consider all of the variables:**
  - Volume consumed
  - Meal size
  - Nutrient density
  - Milk type and components
  - Group housing dynamics
  - Group size
  - Number and type of feeding stations
  - Calf factors
    - Vigor
    - Immune status and health
    - Age at introduction
    - Adaptation to group housing

With feed allowance ≥ 10L and group size < 24, competition is limited and unrewarded visits are low.

Things to Know about ACF's

- Milk portions range between 0.5 and 3.0 L
- Time lag between meals range between 30 and 240 minutes
- Increasing meal size and lowering the number of visits may lower competition for feeder access
- Estimated that time commitment (labor) per calf for feeding is 1 minute
- Precision feeding of milk, nutritional supplements or medications
- Phase feeding, commonly done for poultry and pigs, can be done for calves
- Combination feeders (MMR and pelleted feed) may become more common
- Calf-rail automatic feeders for in[illegible]sed calves
- Water meters, measured starter [illegible]dy scales are coming

Automatic Calf Feeders

- Most ACF's deliver whole milk or milk replacer
- But, there are 3 diets:
  - Paper diet
  - Diet delivered through the feeder
  - Diet consumed

ADG Expectation: 1.6 to 2.3 lbs. (0.7-1.0 kg)

Make a Nutritional Plan

Ration Results

Milk Dry Matter Intake : 1.50 (lbs/day)

Starter Dry Matter Intake : 0.45 (lbs/day)

Energy Allowable Gain : 1.81 (lbs/day)

Diet ME : 2.00 (Mcal/lbs)

Diet NEm : 1.68 (Mcal/lbs)

Diet NEg : 1.34 (Mcal/lbs)

Diet CP : 19.5%

Diet DCP : 17.4%

ADP Allowable Gain : 1.16 (lbs/day)

- NRC Simulation Program
- Goal: Double birth weight by 60 days
- Use actual ration inputs
- Adjust for weight of calf
- Input environmental temperature

Average Daily Gain (lb/day)
1.0
1.2
1.6
1.8
2.0
2.0
1.4

NRC Calf Calculations: 100 lb Holstein (0.5 lb starter and 65°F)

Whole Milk	5 L per Day	10 L per Day
Energy allowable ADG	1.63 lb/day	3.52 lb/day
ADP allowable gain	1.35 lb/day	2.75 lb/day
Growth limiting nutrient	Protein	Protein
Crude protein balance	-34 gm/day	-90 gm/day
20:20 Milk Replacer	**5 L per Day**	**10 L per Day**
Energy allowable ADG	1.51 lb/day	3.33 lb/day
ADP allowable gain	1.12 lb/day	2.30 lb/day
Growth limiting nutrient	Protein	Protein
Crude protein balance	-48 gm/day	-122 gm/day

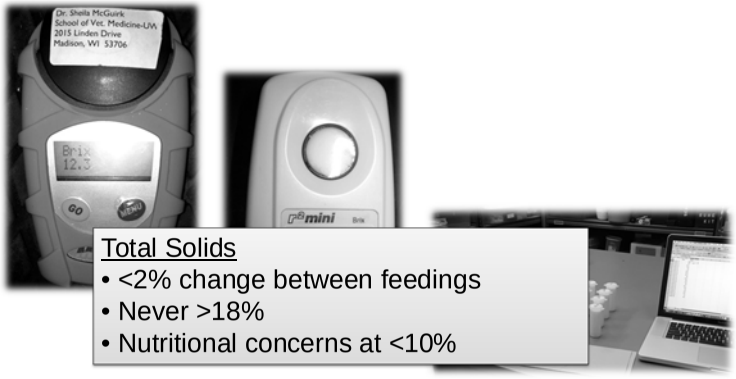
Feeding Consistency is a Priority

- Total solids
- Temperature
  - Mixing
  - Feeding
- Delivery – same feed from first to last calf and from one feeding to the next
- Between feeders (non-automated)
- Additives
- Timing
- Water availability within 20 to 30 minutes of MMR feeding

Towards Becoming More Consistent in Calf Feeding

- Timing, temperature, weights
- Total solids at calf level
- Additive effects – medications, supplements, vitamins or minerals
- Keeping liquid feed agitated during delivery
- Clean mixing, delivery and feeding equipment
- Nipple height
  - 15 cm above mixer outlet
  - 60-70 cm above nursing platform

Total Solids is a Convenient Monitoring Tool for Feeding Consistency

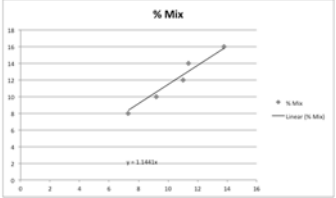


Total Solids
- <2% change between feedings
- Never >18%
- Nutritional concerns at <10%

Relationship Between Milk/Milk Replacer Brix Readings and Actual Total Solids

	Standard Curve	Verified
Whole milk	Y=0.998x + 2.077	Moore DA, et. al. 2009
28:20 Milk replacer	Y= 0.9498x – 1.3894	McGuirk unpublished data
20:20 Milk replacer	Y= 1.2865x – 3.5322	McGuirk unpublished data

Y = Total solids



X = Brix reading

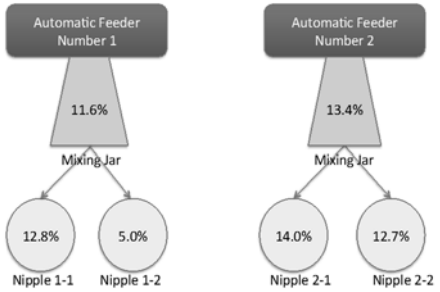
ACF Milk Replacer Mixing

Expectation: 160 gm in 1 L Water

- Expected Total Solids: 160 gm/1 L solution = 16%
- Actual Mix: 80 gm/580 ml solution = 13.8%
- Default setting for Förster Technik ACF's: 150 gm powder plus 1,000 gm water = 13% solids

Total Solids Consistency of MMR

- What is calculated
- What is in the machine or bucket
- What the calf drinks

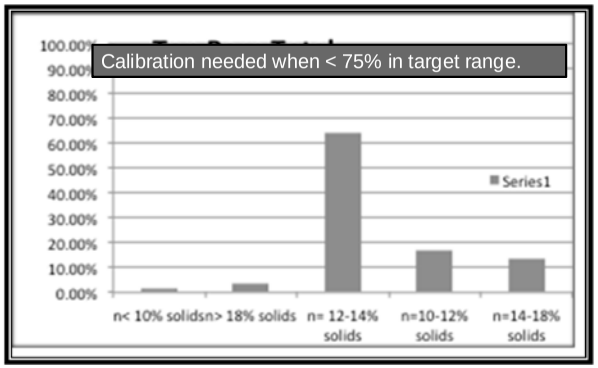


Daily Monitoring of MR Brix Readings

# fills	brix 1	brix 2	brix 3	initials			
2	9.5	9.5		bw			total percent
2	10.5	10.5		bw	n< 10% solids	2	1.31%
3	10.6	10.5	10.4	bw	n> 18% solids	6	3.92%
3	9.1	12.8	12.9	shu	n= 12-14% solids	98	64.05%
2	12.5	12.6		shc	n=10-12% solids	26	16.99%
2	13.5	16.1		bw	n=14-18% solids	21	13.73%
3	13.6	15.2	16.8	bw			
2	17.9	19.2		bw	total readings= 153	153	
2	16.9	16.8		shu			
2	9	11.1		shc			

Inconsistencies and missed targets provide alerts:
- Calibration
- Cleaning frequency and effectiveness
- Needed changes in nipples, feeding or mixer hoses
- Nipple height

Daily Monitoring of MR Brix Readings



Regularly Assess Standard Plate Counts

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	

ACF Labor Efficiency

ACF: 1 minute per calf for feeding

- Whole milk pasteurization, storage and delivery or loading milk replacer into ACF
- Review computer alerts and check calves in pen

- Monitor TS
- Activate cleaning cycles
- Monitor SPC's
- Replace nipples, feeding and mixer hoses
- Walk pens for health screening

Individual Calf Feeding: 10 min per calf

- Preparation
  - Mixing
  - Feeding equipment
- Delivery

Pick up
Water delivery
Cleaning and washing

Monitor feed TS and SPC
Health screening

Cross Sucking

- More common in group pens
- Directed towards pen or calves
  - Udder
  - Navel
  - Ears

Unwanted Consequences of Cross Sucking

- Hair loss
- Inflammation
- Teat or udder injury
- Mastitis
- Decreased milk production or persistence as a cow

Limiting Cross Sucking in Pens

- Increase milk allowance
- Prolong meal duration to a minimum of 10 to 15 minutes by reducing milk flow (nipples with smaller orifice)
- Protected feeding stalls
- Reduce group size
- Feed water through a teat or nipple
- Access to high energy, high quality solid feed
- Implement programmed, gradual weaning

Weaning Strategy

- Gradual milk step-down process avoids weaning stress, post weaning growth depression, and cross sucking
- ACF's offers flexibility in creation of gradual step-down while providing multiple rewarded feeding visits during the day
- Weaning duration is longer but provides gradual reduction in energy intake that encourages starter intake, limits number of unrewarded visits to feeder, reduces vocalization and cross sucking

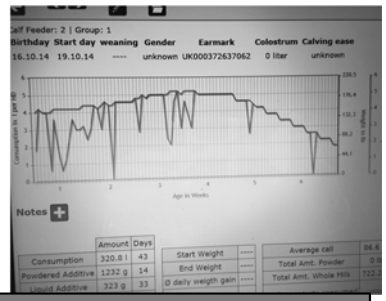
Disease Risk in Group Pens

- Group pen housing generally associated with increased morbidity for enteric and respiratory disease
  - Calf contact
  - Shared nipples
  - Cross sucking
  - Communal bedding
  - Shared aerosol

Of particular concern when:
- Group size exceeds 12 per pen
- In overcrowded pens: space per calf < 30 sq feet/calf
- High rate of failure of passive transfer of immunity (FPT)
- Age span within a group > 5 days
- No all in-all out pen management

Appetite Based Health Screening

- In ACF group pens, preset alarms are frequently the primary method of disease detection
  - Reduced intake
  - Reduced visits
  - Slow drinking
- Unrewarded visit frequency may be a more sensitive indicator
- In-pen screening is needed
- In-pen examinations are necessary



Appetite based detection compromised when allotment/day <10L

Have a screening plan for health and performance

- Walk pen first
- Check computer alerts second

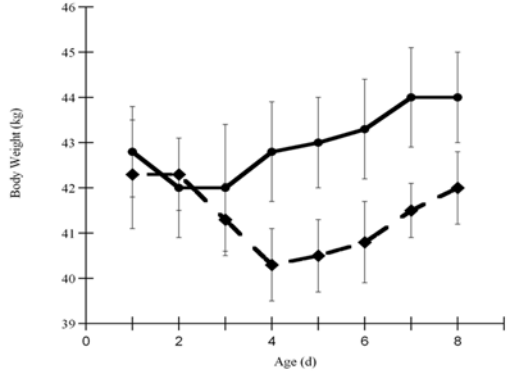
Treatment Protocols

- Need VCPR
- Must be dynamic, flexible, responsive and monitored
  - Consistency
  - Compliance
  - Record-keeping
- Frequent side-by-side work with the veterinarian
- Most ACF's provide targeted provision of oral medication but not parenteral treatment

What Should be Monitored?

- Critical control points
  - Colostrum program
  - Group size
  - Stocking density
  - Health screening
- Control points specific to feeding program
  - MMR standard plate counts
  - Consistency in total solids
  - Calf performance (ADG)

Are calves successful?



Solid – 1.8 lb MR
Dash – 1.0 lb MR

Inside Individual vs. Group Pens

Individual Pen Advantages Summarized

- More forgiving of FPT
- Less calf-to-calf contact and disease transmission
- Less respiratory and enteric disease
- MR total solids control
- Adaptable to paired calf raising
- Disease screening and detection may be easier
- Easier handling for exam and treatment
- Less bacterial contamination of calf MMR
- Less cross sucking
- Earlier weaning

Inside Individual vs. Group Pens

Group Pen Advantages Summarized

- More frequent feeding = more MMR consumed
- Individualized feeding plans
- Individualized feeding behavior is supported
- Feeding alarms detect sick calves
- Consistent milk delivery
- Gradual weaning
- Socialization
- Easier pen cleaning and bedding
- Increased abomasal pH (theoretically) may prevent ulcers

Inside Individual vs. Group Pens: No Clear Advantage

- Both can deliver calves that reach ADG of 1.6 lb (0.73 kg)
- Both can achieve starter intakes at weaning of 3-5 lb (1.4-2.3 kg)
- Both can achieve weaning at 7 weeks
- Both can deliver consistently good quality MMR
- While labor efficiency for calf feeding may be reduced in automatic feeding systems, other details related to ACF system management require labor reallocation that might negate any advantage
- Total solids variability can occur in both settings
- Increased feed allowance facilitates appetite-based disease detection

Considering a Change from Individual to Group Pens Inside?

- Still have individual pens for 7 to 14 days
- Don't consider it until colostrum program consistently meets goals
- Don't do it strictly for reduced labor input
- Plan weaning strategy
- Plan for health screening
  - Inside pen
  - Computer alarms
- Plan for ideal environment
  - Manageable feeding system
  - Bunk space for grain; water location and access
  - Bedding type and nesting
  - Space
  - Calf number
  - Air quality
  - Age span within a group
  - Time between successive occupants
  - Cleaning strategy

Summary and Conclusions

- Indoor calf raising has many advantages where there are climatic extremes, land-base limits and labor limitations
- There are advantages and disadvantages in both inside individual and group pen settings
- Labor efficiencies of group pen housing may be over-estimated
- Greater MMR consumption improves health, performance, production and welfare
- Calf monitoring, health screening, individual calf contact, trained treatment crews, established protocols and good records are needed in all calf operations

Advancing animal and human health with science and compassion

CALF FACILITY EVALUATION RESEARCH PROJECT IN NORTHERN NEW YORK

K. M. Morrill
Regional Dairy Specialist
Cornell University

ASTRACT

This was an observation study in which calf facilities (n=29) were evaluated on a single day (snapshot evaluation) throughout the month of June, 2015 across Northern New York **(NNY)**. Housing included hutches (n = 9), individual pens in a calf barn (n = 11), and group pens in a barn (n = 9). Ventilation systems included natural ventilation, natural ventilation + fan and natural ventilation + tube. Evaluation included an environmental evaluation of the facility, calf pen, calf health scoring, bedding and airborne bacteria.

The objectives of this project were 1) evaluate air quality parameters (including temperature, humidity, air flow, airborne microbial concentration and ammonia levels) in calf housing on NNY dairy farms; 2) evaluate how air quality parameters affect calf morbidity and calf mortality on NNY dairy calves; 3) compare air quality parameters in different types of calf housing typically seen in NNY, including calves raised outside in hutches compared to calves raised in enclosed barns; and 4) increase awareness on the importance of air quality for healthy calves on dairy farms in NNY.

A total of 437 pre-weaned calves were evaluated on 29 dairy farms across NNY in June, 2015. Respiratory scores averaged 2.47 with a range of 0 to 9; 13.33% of calves evaluated scored greater than 5, indicating they likely have a respiratory challenge and should be treated. Incidence of respiratory illness in pre-weaned calves ranged from 0 to 50% of calves evaluated on a per farm basis (mean 11.05% of calves/farm), with 44.82% of farms having no respiratory illness (based on score) and 10.32% of farms having 30 to 50% of evaluated calves exhibiting signs of respiratory illness. There was no difference in respiratory score by housing system (hutch, individual pen or group pen), bedding type (sand, wood, straw or hay), ventilation system, environmental humidity or barn airflow, only environmental temperature impacted respiratory scores.

The data collected from the 2015 calf housing evaluation study suggests that respiratory illness continues to be a challenge on NNY dairy farms even when the climate is temperate (average temperature = 75.5 F; average humidity = 45.7% and an average heat index of 70.6). Additional research is needed to determine if respiratory illness is an even greater challenge when calves experience cold stress, and what factors increase the risk of infection (environmental measurements, management strategies, housing, bedding quality and airborne bacteria) and what strategies can be developed to reduce the risk of respiratory illness in pre-weaned calves.

INTRODUCTION

With the increasing cost production and decreasing margins, there is continued interest to cost effectively raise healthy productive calves for the future milking herd. In 2012, a study by Jason Karszes, Cornell University, concluded the costs of raising heifers on New York dairy farms ranged from $1860 to $2263.

According to the most recent USDA – National Animal Health Monitoring System (NAHMS) report, 12.47% of pre-weaned heifers in the U.S. are affected by respiratory illness, with 93.4% of these calves being treated with antibiotics. Calf respiratory disease is associated with decreased average daily gain, increased age at first calving, decreased milk production in first lactation and

increased culling in the first 30 days. All of these factors lead to an increase cost of production and decreased revenue. The other benefit of raising healthier calves is the opportunity to use fewer antibiotics on young stock. Minimizing the use of antibiotics on the farm has two benefits—one is financial and two, our industry is under increasing pressure from the FDA to limit use of antibiotics and thereby limit drug residues.

Many farmers are willing to invest in their calves, if they know there will be a strong return on investment. Calf housing and ventilation systems have been two areas many producers are looking at to hopefully improve calf health, especially during the pre-weaning period. Calf housing and its impact on calf health is often debated. Hutches have been associated with lower morbidity and mortality in dairy calves (Waltner-Toew et al., 1986). But as a convenience, or compromise to labor, farms will house calves either in the main barn or build a separate calf barn. As calves have been moved into housing, the industry has promoted the use of ventilation to improve air quality. Stationary warm air can potentially contain harmful gases (i.e., ammonia), odor, dust, and microorganisms (e.g., fungal spores, viruses, and bacteria).

Many farms have gone to improving calf ventilation with various types of systems to improve air quality. Calf barns use a negative pressure ventilation system (i.e., tunnel ventilation), positive pressure ventilation system (i.e., tube systems) or a neutral pressure ventilation system. These systems depend on the installation of fans and/or tubes to continually supply ventilation to calves without creating significant drifts. No matter what the housing system or type of ventilation in place, calves should be viewed for clinical signs of respiratory disease. The calf health scoring system developed by McGuirk (2005) can be easily utilized to help track respiratory disease in calves. The scoring system evaluates: rectal temperature, cough (spontaneous or induced), eye scores, ear scores and nasal discharge. The score is the sum of points from the five categories of clinical signs. The higher the value indicates greater risk of poor calf health, and should be further evaluated or treated for respiratory disease.

Providing calves with the best environment (housing & ventilation) and developing management protocols are key aspects to managing heifer rearing costs. In order for this to occur, current calf environments in NNY need to be evaluated on how they impact calf health, specifically rates of respiratory illness.

MATERIALS & METHODS

Barn selection:

The study population was a sample of barns referred by practicing veterinarians and extension dairy specialists who were contacted in the spring of 2015 for assistance in locating suitable buildings. Three types of pre-weaned calf facilities located in NNY, each housing a minimum of 12 preweaned calves were evaluated: hutches, individual calf housing in a naturally ventilated barn and group calf housing in a naturally ventilated barn. Ventilation system was further broken down by only natural ventilation (curtains, sidewalls or outside), natural ventilation + fans, and natural ventilation + tube ventilation.

A single visit was made to each farm. During the initial telephone contact with the owner to schedule the visit, an inquiry will be made whether the calf health at the time was representative of the season (i.e., not a current outbreak). The inquiry was then repeated with the owner, manager, or caregiver on the date of the visit to ensure normal management was occurring.

Environmental Assessment of Barns:

Dimensions of the barn, alleys-ways, and calf pens or hutches were measured. Building and pen construction materials were recorded. Temperature, humidity, ammonia concentration, dew-point, barometric pressure and heat index were recorded for outside the calf facility, in alley ways of the calf facility at calf height (and at worker height. Difference between outside and inside variables was calculated.

Environmental Assessment of Calf Pens

Depending on the number of preweaned calves in the barn, a minimum of seven and maximum of 26 calves were selected at evenly distributed locations around the barn to be evaluated and have their pens evaluated. The type of bedding was recorded (wood, sand, hay or straw), and a nesting score was assigned to each pen based upon an estimate of the ability of the calf to nestle into the bedding. Nesting score 1 was assigned when most of the calves appeared to lie on top of the bedding with legs exposed. Score 2 was assigned when calves would nestle slightly into the bedding, but part of the legs were visible above the bedding. Score 3 was assigned when the calf appeared to nestle deeply into the bedding material and legs were not visible. A facility nesting score was as then assigned to each farm.

A composite bedding sample from the pens of subject calves on each farm was collected using a bulb planter inserted to a depth of approximately 10 cm in the center of the pen. The sample was submitted to the Quality Milk Production Services laboratory (Canton, NY) for analysis to determine if the following pathogens were present, and at what concentration (CFU/g): Strepococcus spp., Staphylococcus spp., E. Coli, Klebsiella spp., other coliforms, gram negative bacillus, gram positive bacillus, Corynebacterium spp., Pseudomonas spp., yeast, mold, total CFU Streptococcus spp., total CFU Staphylcoccus spp., Total CFU Coliforms, total CFU other bacteria, total CFU other organisms and total number of CFU.

Air from each subject pen and central alleyway were sampled to determine the concentration of airborne bacteria. Airborne bacterial samples were collected using an impaction-type air sampler (airIDEAL, bioMe´rieux, Inc., Hazelwood, MO). Five liters of air was sampled onto a sheep blood agar plate (BAP) for total bacterial counts and 50 L of air was sampled onto an eosin methylene blue agar plate (EMB) for gram-negative bacterial counts. The pen samples were collected by moving the calf quietly to the front of the pen. The air sampler was positioned approximately 0.6 m above the bedded surface, 0.75 m from the rear side of the pen, and at least 1 m from the calf with the air sampler intake plate directed away from the calf. Alley samples were collected in the center of the alley of the facility or hutches. Inoculated plates were incubated at 35 ± 2°C for 48h before bacterial colonies were counted. The bacterial counts (cfu per cubic meter of air) were estimated by counting the clusters of colonies on the agar and using the conversion table in the user's manual (airIDEAL, 2001). The maximum count measurable by the air sampler is 326,418 cfu/m3.

Temperature, relative humidity and heat index were measured in each subject pen at the time of air microbiological sampling using a handheld temperature and humidity indicator (SPER SCIENTIFIC, Scottsdale, AZ). Ammonia concentrations were measured using a TOXIRAE II Ammonia Monitor. Samples were collected approximately 0.25 m above the bedding near the center of each selected pen.

Calf Respiratory Disease Assessment:

The total numbers of calves in each barn and pen were counted. In each selected pen, calf ID, birth date and body weight were recorded. A respiratory disease score was assigned based the calf health scoring guide (McGuirk, 2005). A calf was considered "positive" for respiratory disease if she

had a respiratory score of 5 or greater. Prevalence of respiratory illness was calculated for each facility.

RESULTS

A total of 437 calves were health scored and 29 pre-weaned calf raising facilities were evaluated across Northern New York in June, 2015. Pre-weaned housing facilities included hutches (n = 9), calves raised in individual pens in a barn (n = 11) and calves reared in group pens in a barn (n = 9). Ventilation was classified as natural (n = 17), natural + fan (n = 7) and natural + tube ventilation (n = 5). Hutches were classified as naturally ventilated. The 29 facilities presented considerable differences in many of the variables evaluated from an environmental, calf health and management stand-point.

Calf Health Evaluation:

A total of 437 calves were health scored in 27 facilities, with an average of 15.55 calves evaluated per farm. The mean respiratory score was 2.47 with a range of 0 to 9; 13.33% of calves evaluated scored $\geq$ 5, indicating they have a respiratory challenge and should be treated. Prevalence of respiratory illness among calves ranged from 0 to 50% on a farm basis (mean 11.87%), with 10 (37.04%) farms having no respiratory illness, and four (14.18%) farms having 30 to 50% of evaluated calves exhibiting signs of respiratory illness. Only pen temperature impacted the respiratory score of calves. There was no difference in respiratory score by housing type, bedding source, ventilation system, relative humidity or pen airflow.

Environmental Evaluation of Calf Facilities:

Temperature was greatest in hutches as compared to individual and group pens; it was also greater in naturally ventilated pens without additional fans or tube systems. Temperature varied by location (both in- and outside the facility). Humidity was greater in hutches and group pens as compared to individual pens. Heat index was similar across all three housing systems and location within the facility.

Airborne Bacterial Counts:

A total of 194 airborne total bacterial count **(TBC)** samples and 182 airborne gram negative bacterial counts **(GNBC)** from calf pens, alley ways and outside were evaluated. The difference between the TBC and GNBC was due to 12 GNBC plates exhibiting contamination and were not included in the final data set. Airborne TBC were greatest in the alley ways at a human height and lowest outside. Samples taken in the pen, regardless of if it was a hutch, individual pen, laying area of group pens or feeding area of group pen, had similar TBC and were greater than those observed in the alley at calf level and outside. Gram negative bacterial counts were greatest in the laying and feeding areas of group calf pens.

Type of housing and ventilation system impacted both TBC and GNBC; however bedding material utilized did not impact either count. There was a strong correlation between temperature range and GNBC (R^2 = 0.99) and a moderate correlation between airflow and GNBC (R^2 = 0.44). No significant correlation was observed between TBC and temperature range or airflow.

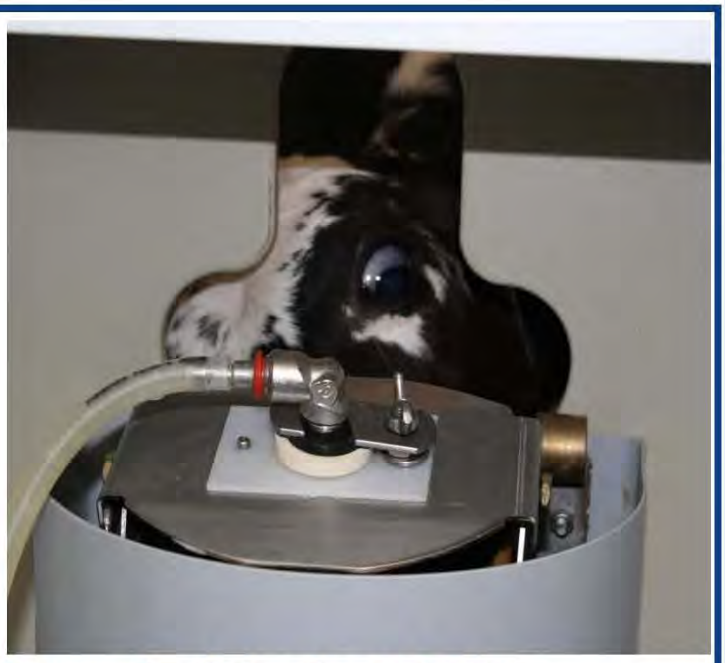
Bedding Evaluation:

A total of 354 bedding samples were evaluated from the 29 facilities. If a facility utilized multiple types of bedding, a sample of each bedding type was collected. Only samples with detectable concentrations of organisms were included in mean calculations. Streptococcus spp., Staphylococcus spp., and Coliform bacteria were found in all bedding samples, while Corynebacterium spp., Pseudomonas spp., yeast and mold were found in fewer than 10 samples, respectively.

FUTURE RESEARCH

This study was conducted to provide a “local perspective” to NNY dairy producers. The data collected from the 2015 calf housing evaluation study suggests that regardless of pre-weaned housing system, respiratory illness continues to be a challenge on NNY dairy farms even when the climate is temperate (average temperature = 75.5 F; average humidity = 45.7% and an average heat index of 70.6). Additional research is needed to determine if respiratory illness is an even greater challenge when calves experience cold stress, and what factors increase the risk of infection (environmental measurements, management strategies, housing, bedding quality and airborne bacteria) and what strategies can be developed to reduce the risk of respiratory illness in pre-weaned calves.

Future work in this area will continue as we determine seasonal variation of respiratory illness, identify management practices and/or environmental stressors that impact calf health during the summer vs. winter months and develop management strategies to reduce the risk of respiratory illness in pre-weaned calves across Northern New York.



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Calf & Heifer Congress 2015

Antibiotic Stewardship

Using Treatment Protocols & the Veterinary Feed Directive in Heifer Raising

Robert A. Lynch, DVM
Managing Veterinarian
Zoetis Dairy Technical Service

robert.a.lynch@zoetis.com
610.858.0985

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Overview

- Stewardship
- Treatment Protocols
  - Why
  - How
- Metaphylaxis
- Medicated Feed Additives
  - Recent VFD Changes
  - What do you need to know?

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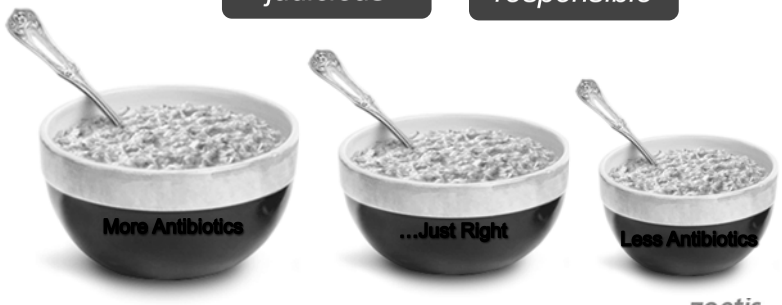
What does "antibiotic stewardship" mean to you?

prudent *appropriate*

judicious *responsible*



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Antimicrobial Resistance

- Presence of the drug serves as a selecting mechanism
- Spontaneous mutations are transmissible vertically
- Resistance can develop as a result of transfer of genetic material between bacteria

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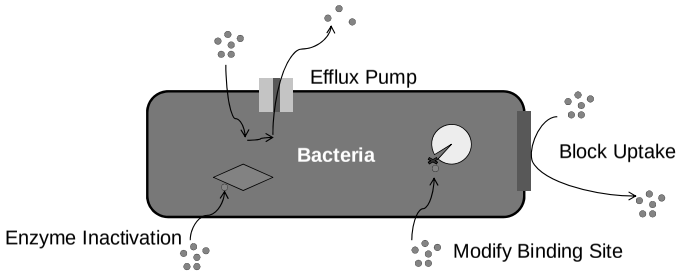
Antibiotic Resistance Mechanisms



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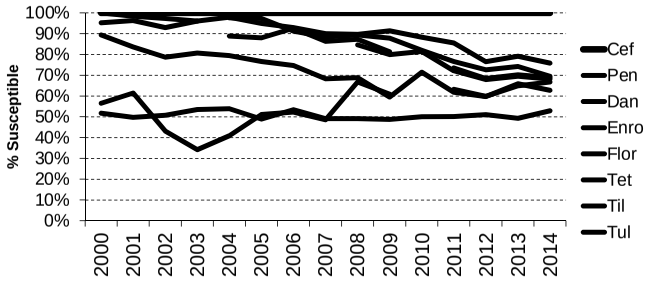
Pfizer/Zoetis BRD Pathogen Susceptibility Surveillance Program 2000*-2014

- *M. haemolyctica* % Isolates Susceptible by Year



Portis, et al, *J VET Diagn Invest* 2012 24: 932
Summary Sheets: 2012,2013, 2014

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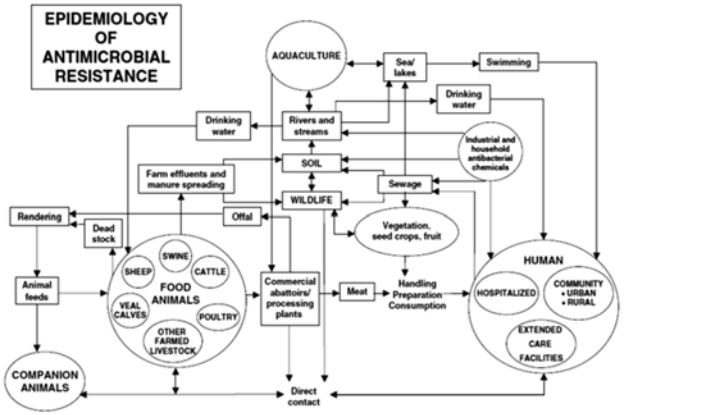
Proposed mechanisms of transmission of antibiotic resistance



Health Canada, Veterinary Drugs Directorate. Uses of antimicrobials in food animals in Canada: impact on resistance and human health. June 2002

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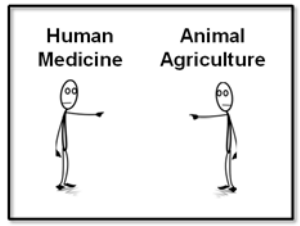
Human Health Implications

- U.S. Centers for Disease Control and Prevention (CDC)
  - ~ 2M people in this country are infected with drug resistant bacteria each year
  - ~ 23,000 die as a direct result
  - MRSA, MDR-TB
- Root causes contentious



www.reuters.com/article/2015/10/10/us-usa-livestock-antibiotics87

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THE JOINT APLU | AAVMC TASK FORCE ON ANTIBIOTIC RESISTANCE IN PRODUCTION AGRICULTURE

Educational & Outreach Programs	Basic & Applied Research Programs	Operationalizing Recommendations
Producers	Better Understanding Of Resistance Mechanisms	Form National Consortium of Experts & Researchers
Healthcare Providers	Improved Understanding of Risks	Engage with International Organizations
General Public	Develop Alternatives	Work with Congress & USDA
		Create a University Research Organization

Report from the Joint APLU | AAVMC Task Force on Antibiotic Resistance in Production Agriculture, Oct 2015

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AABP/AVMA Judicious Therapeutic Use of Antimicrobials in Cattle

- The production of safe and wholesome beef and dairy products for human consumption is a primary goal of the AABP.
- Committed to disease prevention through management practices including the use of vaccines, parasiticides, stress reduction, management of the animal's environment, and proper nutritional management.
- Antimicrobials remain a necessary tool to prevent, control and treat infectious disease in beef and dairy herds.
- Prudent use of antimicrobials is encouraged in order to:

Reduce animal pain & suffering	Protect the economic livelihood of beef & dairy producers	Ensure continued production of safe & wholesome foods of animal origin	Minimize the development of antibiotic resistance

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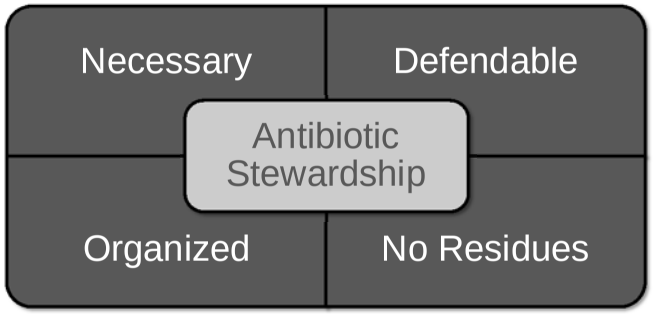
Animal Agriculture Antibiotic Use



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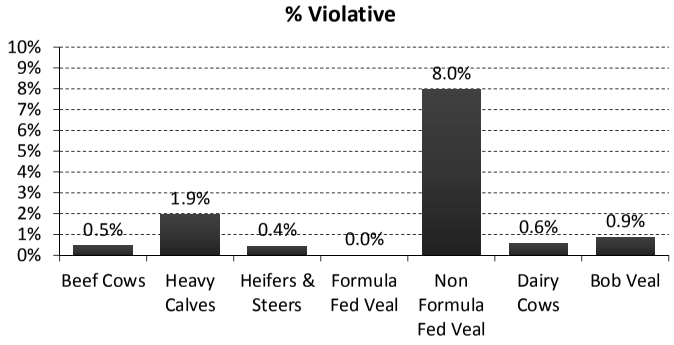
2014 FSIS Inspector Generated % Carcass Violative Residue (of # Samples)*



USDA Quarterly Reports: Q1-Q4 2014

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Protocols

Disease Incidence	Treatment Success	Residue Avoidance
• Improved Accuracy • Identify Changes Sooner	• Correct Dosing • Employee Compliance	• Better Treatment Candidates • Known Withhold Periods • Culling SOP

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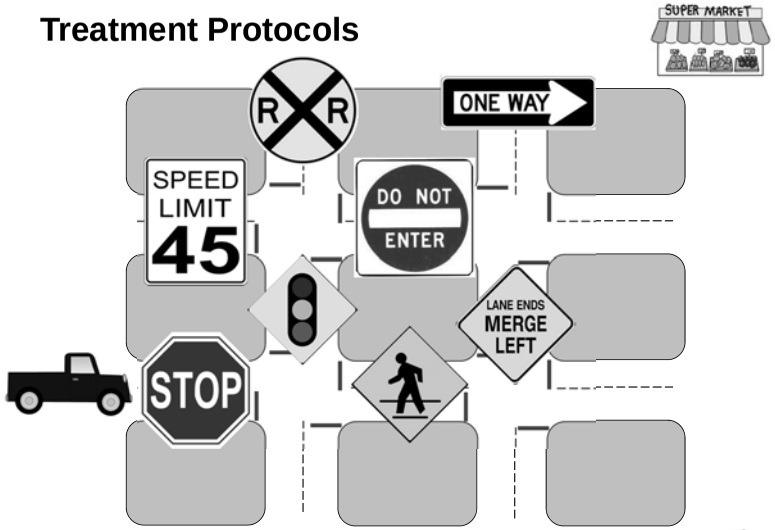
Treatment Protocols



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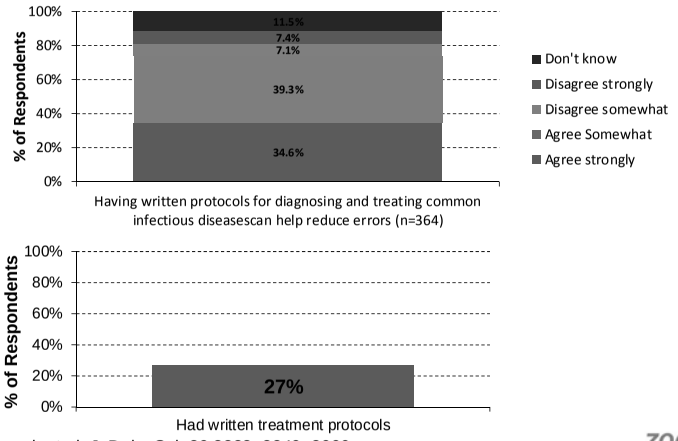
Assessment and Promotion of Judicious Antibiotic Use on Dairy Farms in Washington State



Raymond, et al, J. Dairy Sci. 89:3228–3240, 2006

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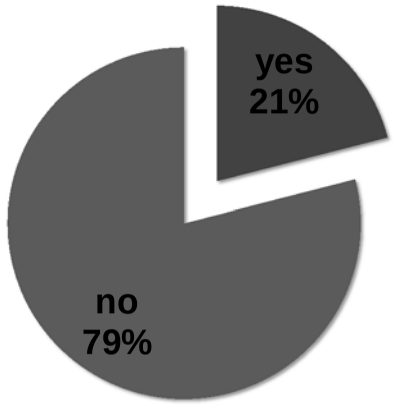
Written plans for treating sick animals with antibiotics?



A.A. Sawant, et al. J. Dairy Sci. vol 88, 2005

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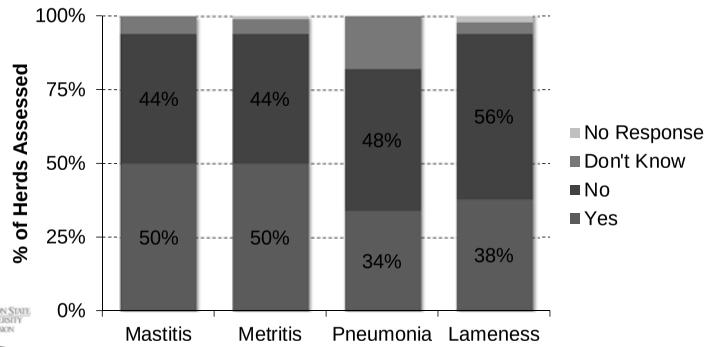
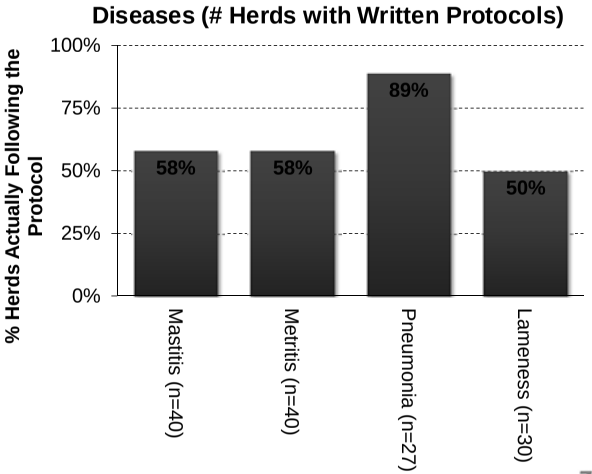
Northwest and Northeast Dairies



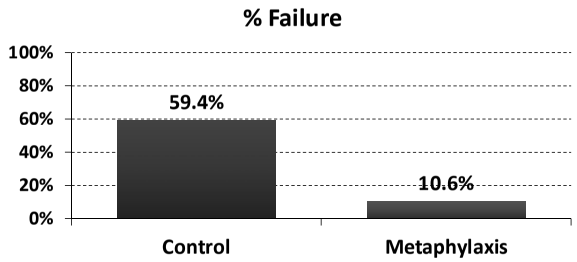
• N=80

Northwest and Northeast Dairies



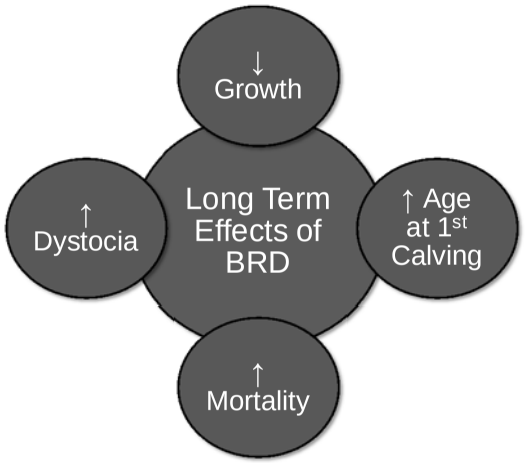
Preventing BRD Through Metaphylaxis

- Medicating entire at-risk group in advance of challenge
- Tulathromycin BRD Control



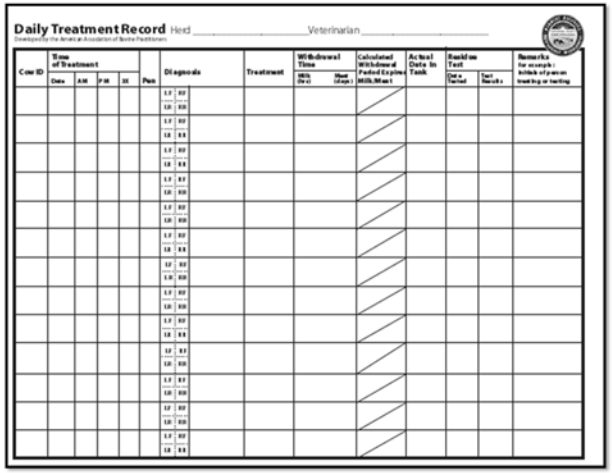
DRAXXIN Injectable Solution (tulathromycin) NADA 141-244, 2005

Effects of BRD - Dairy Replacements



Stanton, JDS, 2011

Daily Treatment Recording


Daily Treatment Record Herd _____ Veterinarian _____

Cow ID	Time of Treatment: Date	AM	PM	Other	Pen	Diagnosis	Treatment	Withdrawal Time: Milk (hrs)	Withdrawal Time: Meat (days)	Calculated Withdrawal Period Expires: Milk/Meat	Actual Date In Tank	Ranking on Test: Date Tested	Ranking on Test: Test Results	Remarks (for example: initials of person treating or testing)

Milk and Dairy Beef Residue Prevention Manual, 2015

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New York State Cattle Health Assurance Program (NYSCHAP)

- Objectives
  - increase the herd's health, productivity and profitability
  - assure food safety, public health, and consumer confidence in dairy products
  - promote environmental stewardship
- To enroll in NYSCHAP, contact your herd veterinarian

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New York State Cattle Health Assurance Program (NYSCHAP)

- Food Safety and Drug Residue Avoidance Module

Cull Dairy Cow for Tissue Residue Risk Assessment & Pre-Market/Slaughter Checklist	Record Keeping Tips	Animal Treatment Plan Form
Dairy's Approved Drug List Form	Daily Treatment Record Form	VCPR Form

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Food Armor® WVMA HAACP for Proper Drug Use

- HAACP: Hazard Analysis & Critical Control Points
- Change Control
- Proactive
- Science based
- 3rd Party Validation

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Principles of the HACCP System

1. Conduct a hazard analysis.
2. Determine the Critical Control Points (CCPs).
3. Establish critical limit(s).
4. Establish a system to monitor control of the CCP.
5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.
6. Establish procedures for verification to confirm that the HACCP system is working effectively.
7. Establish documentation concerning all procedures and records appropriate to these principles and their application.

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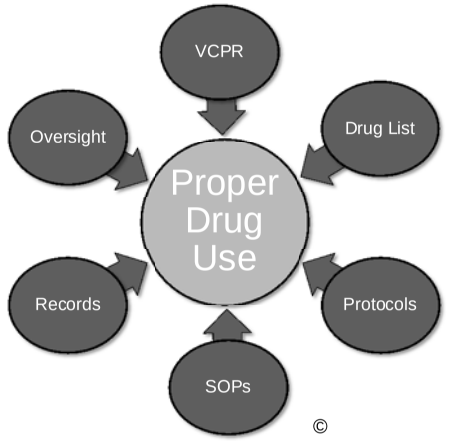
Food Armor® WVMA HAACP for Proper Drug Use



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Food Armor® WVMA HAACP for Proper Drug Use

- Food Armor® Farm Certification
  - Veterinarian of Record
  - Owner
  - Management Team
  - Food Armor® Accredited Veterinarian
- www.foodarmor.org
  - Dr. Katie Mrdutt, WVMA Food Armor®Outreach Specialist
- NEDPMS – Food Armor® Phase 1 Training for Veterinarians
  - March 18, 2016, East Syracuse, NY

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How to Start?

- Current Inventory
- Document all treatments & meds used
  - Necessary?
  - Management options for prevention?
  - Legal?
  - Efficacious?

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Write protocols as a team

- What & who will be treated?
- With what **(Protocol)** & how **(S.O.P.)**
  - Include when to seek help
- How will treatments be recorded?
- How will success be monitored?

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Changes to the Veterinary Feed Directive (VFD)

- Growth promotion and feed efficiency label claims removed
- Remaining therapeutic uses in feed & water under the supervision of licensed veterinarians
  - Provides veterinarians in all states with a framework for authorizing the use of medically important antimicrobials in feed when needed for specific animal health purposes.
  - Continues to require veterinarians to issue all VFDs within the context of a veterinarian-client-patient-relationship (VCPR)

FDA: Veterinary Feed Directive Producer Requirements

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VFD

- What is a VFD drug?
  - a drug intended for use in or on animal feed that is limited to use under the professional supervision of a licensed veterinarian.
- What is a combination VFD drug?
  - an approved combination of new animal drugs intended for use in or on animal feed under the professional supervision of a licensed veterinarian, and at least one of the new animal drugs in the combination is a VFD drug.

FDA: Veterinary Feed Directive Producer Requirements

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How do I know if a drug is a VFD drug?

- "Caution: Federal law restricts medicated feed containing this veterinary feed directive (VFD) drug to use by or on the order of a licensed veterinarian."

FDA: Veterinary Feed Directive Producer Requirements

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Dairy Heifer MFAs

Excluded from VFD Order*
- Bovatec (lasalocid)
- Rumensin (monensin)
- Ampromed (Amprolium)
- Deccox (decoquenate)
- Gainpro (bambermycins)

Effective Oct 1, 2015

Tilmicosin
- Pulmotil

Effective Jan 1, 2017

Colortetracycline
- Auereomycin
- Chlormax
- Penchlor

Neomycin & Oxytetracycline
- Neo-Oxy
- NT Concentrate

Oxytetracycline
- Pennox

Sulfamethazine & Chlortetracycline
- Aureomycin S 700
- Pennchlor-S

* Not Medically Important Antibiotics, WILL require a VFD if combined with a VFD drug.

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What is a VFD?

- A written (nonverbal) statement issued by a licensed veterinarian in the course of the veterinarian's professional practice that authorizes the use of a VFD drug or combination VFD drug in or on an animal feed.
- This authorizes the client to obtain and use animal feed bearing or containing a VFD drug or combination VFD drug to treat the client's animals only in accordance with the conditions for use approved, conditionally approved, or indexed by the FDA.

FDA: Veterinary Feed Directive Producer Requirements

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What should be on a VFD Order?

Name & Contact Info
- Vet
- Client
- Premise where animals housed

Date
- Issuance
- Expiration

Drug(s) Info
- Product
- Withdrawal
- Special Instructions
- Cautionary Statements

Animal Info
- Species
- Production Class
- # Animals to be fed by expiration date

Use
- Indication
- Level
- Duration
- # Refills

Statement
- "Use of feed containing this veterinary feed directive (VFD) drug in a manner other than as directed on the labeling (extralabel use), is not permitted"

Intent Statement & Signature
- Affirmation of intent for combination VFD drugs
- Signature (written or electronic)

Optional
- More specific animal location
- Approximate animal age and/or size
- Anything else the vet deems appropriate

FDA: Veterinary Feed Directive Producer Requirements

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Producer Responsibilities

Feeding
- Only feed animal feed bearing or containing a VFD drug or a combination VFD drug to animals based on a VFD issued by a licensed veterinarian
- Not feed a VFD feed or combination VFD feed to animals after the expiration date on the VFD

Records
- Maintain a copy of the VFD order for a minimum of 2 years
- Provide VFD orders for inspection and copying by FDA upon request.

FDA: Veterinary Feed Directive Producer Requirements

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Steps to obtain a VFD Order

1. Contact your veterinarian with whom you have a valid VCPR.
2. The veterinarian determines whether conditions warrant use of a VFD drug or feed.
3. the veterinarian issues a written and signed VFD order containing information specified by regulations.
4. The veterinarian retains a copy of the VFD order and gives the completed, signed original and a copy to the client.
5. The client keeps the copy and gives the original signed VFD to the feed mill/feed distributor supplying the VFD feed. The VFD order allows the feed to be released to the client.
6. Depending on the specific VFD drug, and the conditions outlined by the veterinarian, separate VFD orders may be required for different groups of livestock and, new VFD orders may be required to extend the treatment duration (depends on "refill" specifications).

F.T. McCollum III, PhD, PAS-ACAN
Texas A&M AgriLife Extension Service
Sep, 2015

zoetis

FeedLINK®

- Digital Veterinary Feed Additive Software System
  - Ease the burden of paperwork while establishing a best practice protocol
  - Provide a reliable and controlled source of documentation.
  - Enhance communication with key stakeholders.
  - Strengthen your Vet-Client-Patient-Relationship (VCPR) commitment.
- www.GlobalVetLink.com

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Questions?

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Antibiotic Residues: Records, Assumptions and Reality

NYS Department of Agriculture
Division of Animal Industry
Dwight Bruno BSc, DVM

Some of The Topics We'll Be Addressing

- What's driving the flurry of activity about food animal drug use best practices ?
- Has USDA / FDA changed their approach ?
- How has NYS Department of Agriculture / Division of Animal Industry been involved in food animal residue avoidance ?
- What are some of the things we are seeing that have resulted in 'violative' tissue residues ?
- How can we lessen the chances of causing a violative tissue (or milk) residue ?

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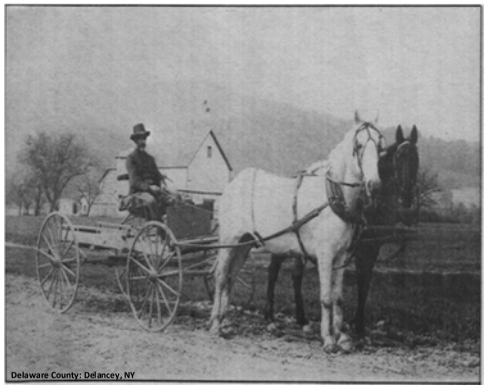
Along with the obvious technological changes we've seen in agriculture over the past 100 years or so, there are subtle ones that we may not think about.



Delaware County: Delancey, NY

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Just like a GPS system used in planting crops, or a robotic milking system, the tools that are available to keep food animals healthy & productive have come a long way.

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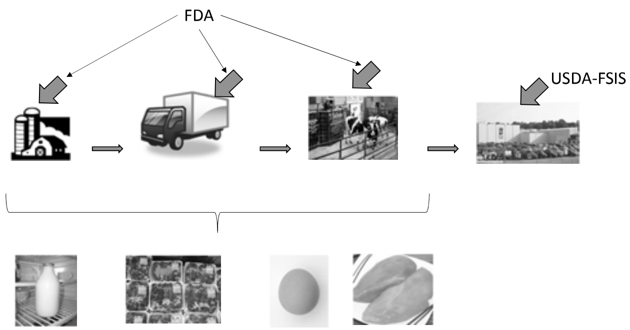
Quality Control: From Farm To Table



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Some Of the Forces Driving A Heightened Concern About Tissue Residues

- Public Health concerns (antibiotic resistant bacteria)
- Consumer demands which will push processors/distributors-companies-restaurants & government to act.

Food Safety News

McDonalds Plans to Phase Out Chicken Fed Medically Important Antibiotics

By Lydia Zuraw | March 5, 2015

Fast-food giant McDonald's announced Wednesday that, within two years, all of the chicken served at its 14,000 U.S. restaurants will come from farms which raised the birds without medically important antibiotics……..

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In 2012, USDA-FSIS Introduced Major Changes To It's Residue Testing Logistics & Methodology


WASHINGTON STATE UNIVERSITY

ag animal health spotlight

VETERINARY MEDICINE EXTENSION

July 2012

WASHINGTON STATE UNIVERSITY EXTENSION & WSU COLLEGE OF VETERINARY MEDICINE

New Meat Residue Testing Program - 2012

Dale A. Moore, DVM, MPVM, PhD

What are the different ways samples are taken?

What is the new testing methodology?

For what chemicals are they capable of testing?

- In July of 2012, USDA announced new chemical residue testing strategies & methods.
- Current random & at risk testing (determined by USDA plant veterinarian), will be increased.
- Targeted area testing:
  - ✓ Farm level
  - ✓ Region level.
- New ways of testing:
  - ✓ Multi-residue screening methods
  - ✓ Testing will be much more precise & will identify more compounds (**not just antibiotics**)
  - ✓ Testing turn-around times will be shortened

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November 19, 2015

FSIS RESIDUE VIOLATION INFORMATION SYSTEM

06:10:01

WEEKLY RESIDUE REPEAT VIOLATOR FOR USE BY FSIS INSPECTION PROGRAM PERSONNEL

Part I: This part is intended to assist Inspection Program Personnel to identify producers with more than one residue violation in the last 12 months either in the same establishment or different establishments.

Source Name By State	Plant Name / ID	Sample ID / Date Collected / Tags	Tissue	Residue	Value (ppm)	Tolerance (ppm)
			KIDNEY	SULFAMETHOXAZOLE	DETECTED	0
			KIDNEY	SULFAMETHOXAZOLE	DETECTED	0
			KIDNEY	SULFAMETHOXAZOLE	DETECTED	0
			KIDNEY	DESFUROYLCEFTIOFUR	5.89	.4
			KIDNEY	DESFUROYLCEFTIOFUR	7.86	.4
			LIVER	FLUNIXIN	0.131	.125
			KIDNEY	SULFADIMETHOXINE	DETECTED	0
			MUSCLE	FLUNIXIN	0.075	.025
			LIVER	FLUNIXIN	1.66	.125
			LIVER	SULFAMETHAZINE	119.15	.1
			MUSCLE	SULFAMETHAZINE	93.36	.1

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CLG-CEF1	Ceftiofur Quantification					
	Test	Tissue	Results	Date Started	Date Completed	Conclusion
	DCCD (2274)	Kidney	2.37	08/20/2014	09/05/2014	Residue Detected - Violative
	Test	Tissue	Results	Date Started	Date Completed	Conclusion
	DCCD (2274)	Muscle	0.19	09/10/2014	09/15/2014	Residue Detected - Non-Violative

CLG-MRM1	Analgesic/Anti-Inflammatory Screening				
Test	Tissue	Results	Date Started	Date Completed	Conclusion
Analgesics/Anti-Inflammatory (2980)	Kidney	Not Detected	07/28/2014	07/28/2014	Residue Not Detected
Flunixin (2982)	Kidney	Not Detected	07/28/2014	07/28/2014	Residue Not Detected
Oxyphenylbutazone (2985)	Kidney	Not Detected	07/28/2014	07/28/2014	Residue Not Detected

CLG-MRM1	Beta Agonist Screening				
Test	Tissue	Results	Date Started	Date Completed	Conclusion
Beta Agonists (2560)	Kidney	Not Detected	07/28/2014	07/28/2014	Residue Not Detected
Salbutamol (2563)	Kidney	Not Detected	07/28/2014	07/28/2014	Residue Not Detected
Cimaterol (2564)	Kidney	Not Detected	07/28/2014	07/28/2014	Residue Not Detected
Ractopamine (2565)	Kidney	Not Detected	07/28/2014	07/28/2014	Residue Not Detected

MLG 34	Neomycin Quantification					
	Test	Tissue	Results	Date Started	Date Completed	Conclusion
	Neomycin (2207)	Kidney	17.23	01/10/2013	01/10/2013	Residue Detected - Violative

MLG 34	Oxytetracyline Quantification					
	Test	Tissue	Results	Date Started	Date Completed	Conclusion
	Oxytetracycline (2208)	Kidney	9999	01/14/2013	01/14/2013	Residue Detected - Non-Violative
	Test	Tissue	Results	Date Started	Date Completed	Conclusion
	Oxytetracycline (2208)	Muscle	0.58	01/15/2013	01/16/2013	Residue Detected - Non-Violative

What does USDA (FSIS) Expect When It Issues A Warning Letter For a Violative Drug Residue ?

Warning Letters are issued to achieve voluntary compliance and to establish prior notice. Warning Letters are issued for violations of regulatory significance that may lead to enforcement action if not promptly and adequately corrected. **A Warning Letter is the agency's principal means of achieving prompt voluntary compliance with the Federal Food, Drug, and Cosmetic Act (the Act). Warning Letters are posted on FDA's website.**

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What Happens When [USDA] FSIS Identifies a Violative Residue in Edible Tissue ?

- A warning letter is issued to the producer (source) of the regulatory significant [violative] residue.
- A warning letter is a means, by which, USDA-FSIS hopes to establish prompt, voluntary, compliance under the Federal Food, Drug & Cosmetic Act (under FDA).

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Who should be held accountable for antibiotic residues in meat?

☐ Beef Industry ☐ Dairy Industry ☐ Veal Industry ☐ All producers

A list no responsible livestock producer wants to be on

The FSIS Residue Violation Information System List identifies all producers that have marketed food animals which have tested positive for antibiotic residues at slaughter. The list is updated weekly, ranges from 110 to 140 pages and includes the names, addresses and phone numbers of producers who have marketed animals with antibiotic residues and businesses that have purchased their cattle during the previous 12 months.

Not only does this list present a negative image for the cattle industry, but it is a target for increased scrutiny from industry critics. The reputation of individual producers and of the entire livestock industry is at stake.

Legislation is being considered that would withdraw seven classes of antibiotics from food production unless the animals are sick or unless the drug companies can prove that their use does not harm human health. The effort has the support of the American Medical Association, the American Public Health Association and 350 other groups.

The opinions of groups outside of agriculture also have a significant impact on government policy and consumer purchasing decisions. A good example is the organic section at the grocery store, where sales have steadily risen. Consumer perceptions concerning antibiotic use and misuse in farm animals have helped fuel that growth.

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FDA's Action

- In cases of a residue violation identified by USDA-FSIS, FDA may issue a violation letter to the [residue-source] business whereby they expect a timely response, which is to include, a management plan on how the business intends to prevent further violations.

FDA Has Broad Enforcement Authority In Cases Of Repeated Violations / Non-Compliance

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DRUG RESIDUE, MEAT - USA: (NEW YORK)
Source: 10 XYZ-TV

Federal regulators have cited a dairy farmer for selling cows with **higher-than-permitted residues of antibiotics.**

A US District judge in Buffalo issued an order **barring XXX from selling cattle to be slaughtered for human consumption until he complies with federal limits on antibiotic residues.**

XXX owns a farm in [NY], which sells its dairy cattle to an auction yard in [NY]. A Food and Drug Administration complaint says **"he's sold cows for at least a decade with residues of penicillin and sulfadimethoxine in the animals' edible tissue, posing a public health risk."**

The agency also says XXX **illegally gave the cows higher-than-allowed dosages**. The US Department of Agriculture says it has [cited] XXX **6 times in the past 10 years and that he violated the law by failing to keep adequate records of which cows were medicated.**

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What Role Does NYS Department of Agriculture/Division of Animal Industry Play and What Are We Seeing ?

NYS Department of Agriculture
Division of Animal Industry
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Dear Sir(s):

This letter is to inform you that the United States Department of Agriculture (USDA) detected violative levels of residue(s) in the tissues collected from a dairy cow identified as originating from your premises. The test results and sample collection date are listed on the enclosure. The tissue sample(s) were collected as part of the residue testing programs conducted by the Food Safety and Inspection Service (FSIS). FSIS collects tissue samples from livestock and poultry slaughtered at inspected slaughter establishments. FSIS also collects samples of egg products for residue analysis. Samples are then analyzed at Agency laboratories for various drug, pesticide and other chemical residues. Residue levels in meat, poultry or egg products are violative when they exceed allowable levels for one or more chemical substances in the tissue or tissues or product analyzed.

Violative residues constitute adulteration within the meaning of the Federal Food, Drug, and Cosmetic Act and indicate violations of the Federal Meat, Poultry, and Egg Products Inspection Acts and/or State law. Accordingly, USDA FSIS has notified the Food and Drug Administration (FDA) and the appropriate authorities in your state of its findings.

Should another violation be detected in livestock, poultry, or egg products from any premises under your ownership within a twelve (12) month period after having received a FSIS Violation Notification Letter, your name will be posted on the USDA, Food Safety and Inspection Service website (http://www.fsis.usda.gov/Science/Chemistry) as a repeat violator.

It may be helpful to discuss this notification with your veterinarian.

If you have any questions, please contact the Policy Development Staff at: (800) 233-3935 (select option 6) or email residue@fsis.usda.gov.

Sincerely,

Jim Holterman, D.V.M.

Jim Holterman, D.V.M
Senior Staff Officer- Residue Lead
USDA, FSIS, Policy Development Staff
Enclosure

NYSDAM-DAI: What happened provide some overall guidance

13. WHAT WERE THE FACTORS FOUND DURING THE INSPECTION THAT COULD LEAD TO ILLEGAL DRUG RESIDUES?

(Circle all that apply):

A. Production Management Causes

1. Animal(s) fed colostrum or milk containing drug residue
2. Animal(s) fed medicated feed by mistake
3. Drug administered to animal(s) by mistake
4. Failure to keep proper animal identity and treatment records
5. Inadequate segregation of treated animal(s)
6. Failure to follow labeled/prescribed withdrawal time
7. Feed manufacturing cGMP deviations

B. Extralabel Use

1. Veterinarian's prescribed withdrawal period not observed
2. Withdrawal period verbally recommended by veterinarian not observed
3. Animal treated with higher than the recommended dosage of drug
4. Labeled route of administration not observed
5. No withdrawal period prescribed
6. Drug not approved for species
7. Frequency of treatment different than on label
8. Duration of treatment longer than on label

C. Unable to Determine.

D. Interviewee stated drug used was not the same as residue reported by FSIS.

E. Interviewee told purchaser/hauler animal was medicated - animal later diverted for human food.

F. All label/prescription directions followed and documented, residue still occurred.

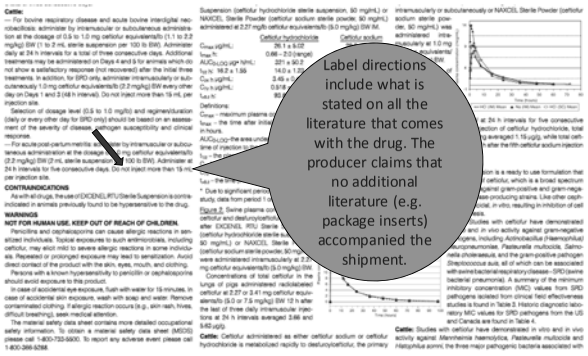
G. Other _____

A Violative Chemical Residue Identified in a Dairy Cow --Case Example--

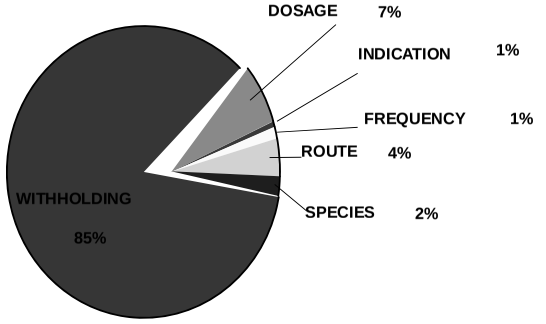
A Case Example

- Drug was prescribed by the herd veterinarian with whom the producer had a valid veterinarian-client-patient relationship (the drug was drop shipped to the farm by a drug company).
- Producer administered 20cc of drug, subcutaneously-in one location, to the cow in question.
- Producer followed his veterinarians instructions: 'administer the drug according to label directions.'
  - Review of vial label directions substantiates what the producer said.

? How could the producer have failed to follow label directions if the drug vial label directions were followed ?

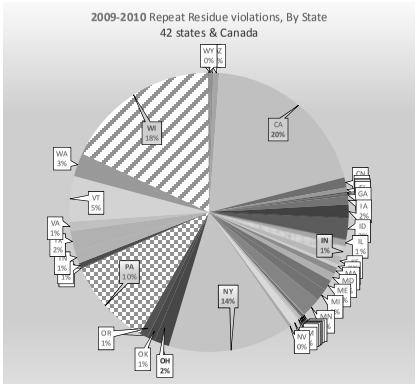


Label directions include what is stated on all the literature that comes with the drug. The producer claims that no additional literature (e.g. package inserts) accompanied the shipment.

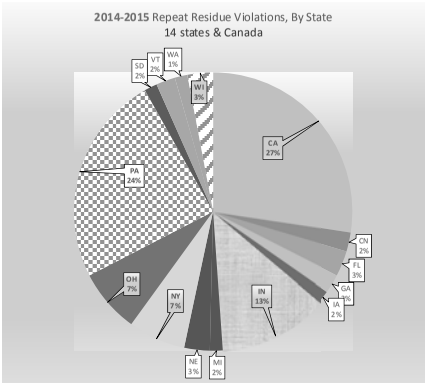


** Data Compiled From DAI Residue Investigations

What's Been Happening With The Number Of Tissue Residue Violations ?

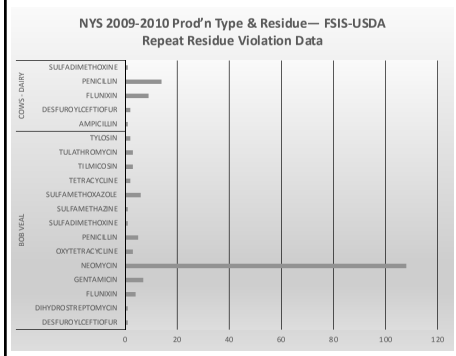


1215 Cases, Nationally

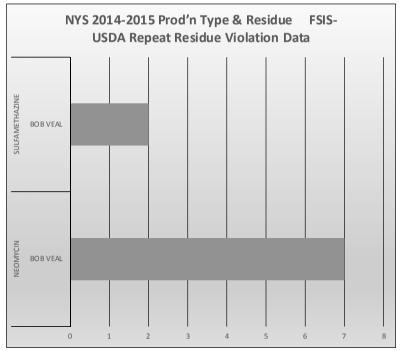


135 Cases, Nationally

NYS Violative Residues Over Time



174 Cases From NYS (all dairy: cows & bob veal)



9 Cases From NYS (all dairy: bob veal)

How Can You Minimize The Chances of A Residue Violation ?

Records, Communication and Good Herd Drug Use Practices

I Just Treated Number 56, Be Sure To Mark It Down and ID her.

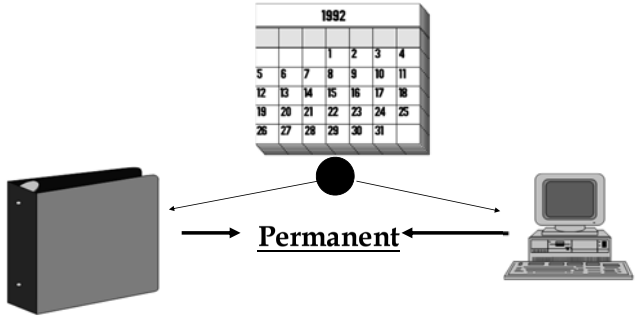
Yeah

Some Time Later

56 was sold before her meat withholding date—I told you to record the information and identify her!

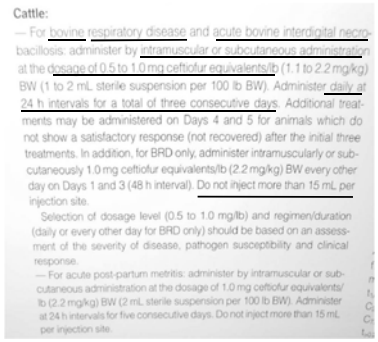
When ?

Record Keeping ; An Indispensable Part Of Any Good Management Routine



Read & Follow The Label !

- Species
- Indication for use
- Route of administration
- Dosage
- How often administered
- Other directions



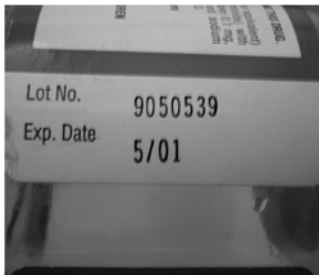
Cattle:

— For bovine respiratory disease and acute bovine interdigital necrobacillosis: administer by intramuscular or subcutaneous administration at the dosage of 0.5 to 1.0 mg ceftiofur equivalents/lb (1.1 to 2.2 mg/kg) BW (1 to 2 mL sterile suspension per 100 lb BW). Administer daily at 24 h intervals for a total of three consecutive days. Additional treatments may be administered on Days 4 and 5 for animals which do not show a satisfactory response (not recovered) after the initial three treatments. In addition, for BRD only, administer intramuscularly or subcutaneously 1.0 mg ceftiofur equivalents/lb (2.2 mg/kg) BW every other day on Days 1 and 3 (48 h interval). Do not inject more than 15 mL per injection site.

Selection of dosage level (0.5 to 1.0 mg/lb) and regimen/duration (daily or every other day for BRD only) should be based on an assessment of the severity of disease, pathogen susceptibility and clinical response.

— For acute post-partum metritis: administer by intramuscular or subcutaneous administration at the dosage of 1.0 mg ceftiofur equivalents/lb (2.2 mg/kg) BW (2 mL sterile suspension per 100 lb BW). Administer at 24 h intervals for five consecutive days. Do not inject more than 15 mL per injection site.

Proper Drug Use Practices Includes Discarding Drugs That Are Outdated, Contaminated Or Otherwise Compromised (refrigeration?)



What Else Can Cause A Residue Violation Even If Label Directions Are Followed ?

- Animal's illness may affect the rate at which a drug is metabolized.
- If an animal is down or positioned in such a way that circulation is impeded.
- A drug is not thoroughly mixed (or 'shaken') so the concentration per cc is higher than it should be.
- Another drug contaminates the container (vacuum takes out residue from a syringe previously used to administer a different drug).
- Medicated milk replacer storage error (medicated vs non medicated).

A Summary Of Actions That May Help You Avoid A Violative Chemical Residue

1. Keep accurate treatment records. All treated animals should be recorded into an information system that lists the date, animal ID, person administering the treatment, drug used, amount used, route of administration and meat or milk withholding times.

2. **Identify all treated cattle.** Examples include chalk, leg bands and segregation to another pen.

3. Have a list on your farm of **who is allowed access to the drug cabinet** and **who is allowed to administer treatments.** All farms, regardless of size, should have **written treatment protocols** developed by the veterinarian who prescribes the medication

4. Only **use the medication as directed by your veterinarian** **according to the label instructions**. If exact label instructions are not followed you may affect meat and milk withholding times.

5. **Never use unapproved medication**….. No 'home brew' drug mixtures.

6. **Take time to sit down with your herd veterinarian(s) and review farm drug treatment protocols—on a regular basis.**

Summary Comments & Afterthoughts

Think Before You Treat---There is no 'Panaceamycin'

➔Animal History, Production Potential, Value As **Quality** Beef Vs Milk Production.
➔Treatment Success, Pre Treatment Condition(s)…long term prognosis
➔ Costs/risks associated with medication, product withhold, inventory and management of medication

Work with your herd veterinarian, develop a plan and review it from time to time….best management practices are a moving target!

ASSESSMENT, SCORING AND DISEASE MANAGEMENT OF DAIRY CALVES

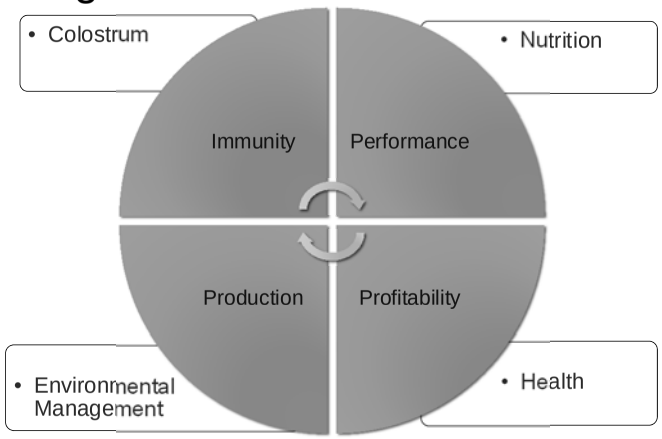
Sheila M. McGuirk, DVM, PhD
SCHOOL OF VETERINARY MEDICINE
University of Wisconsin-Madison
Advancing animal and human health with science and compassion

Basic Care Package

Five C's
- Colostrum
- Calories
- Consistency
- Comfort
- Cleanliness

Health Screening and Management

Making a Difference



Reducing Mortality in the First 24-hours

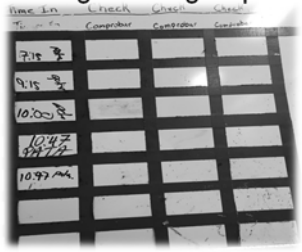
- Most calves that die within 24-hours of birth are alive when born
- With normal presentation, sustained progress, observe but do not assist
- If moved during labor, allow time for labor to resume

Herd Goals for Dairy Calves

- Stillbirth rate for whole herd less than 6%
  - First lactation: less than 8%
  - Second lactation and greater: less than 4%
- Stillbirth rates > 10%, need calving management training
- Not more than 30% of calvings need assistance
- Calves dying in first 24-48 hours: < 2%
- Calves dying 48 hours to weaning: < 5%

Achieving Goals: Have a Calving Plan

- Standard procedures are understood and recorded
- Intervention criteria are established
  - Time
  - Progress
  - Position of Calf
- Good labor area
  - Space
  - Cleanliness
  - Lighting
  - Restraint capability
- Hygiene and lubrication during assistance
- Good records
- Attention to calving ease in sire selection
- Training of calf group



Reducing Mortality in the First 24-hours

- Prevent dystocia
  - Sire calving ease (SCE) <8%
  - Daughter calving ease (DCE < 6%)
- Assist only when necessary
- Particular attention to first calf heifers and cows with twins
- Train, train and retrain
- Monitor equipment, supplies, calving cows and records

Training to Reduce Stillbirths

1. Description of signs associated with labor stages
2. Learn when and how to assist
3. Know how to correct abnormal presentation, position or posture of calf
4. Calving hygiene practices
5. Accurate record keeping
6. Expected communication
7. Newborn calf care

Unassisted Vaginal Delivery is Best for the Calf and the Cow

- Vaginal delivery improves calf vigor and survival
- Outside the pen supervision every 15 minutes
- Assist only when necessary
  - Abnormal position
  - Sustained lack of progress
    - 70 min after amniotic sac appearance*
    - 65 min after feet appearance*
- Use proper assistance protocols
- Call for help before it is too late

*Schuenemann GM et al, JDS 2011

Observation for Normal Behavior

- Head righting in minutes
- Sitting in 5 minutes
- Attempts to stand within 15 minutes
- Standing within 1 hour
- Temp high at birth, declines to 101-102 by 1 hour
- Suckling within 2 hours

Drug-Free Resuscitation

- Postural drainage
- Topline towel rub from tailhead to poll
- Towel stimulation of ears, eyes and nose
- Compress and shake trachea
- Ice-water in ear
- Pinpoint nasal pressure
- Suction nose and throat
- Infrared radiant heat

Ice Water Technique

- 60 cc of ice water in the ear
- 250 to 500 cc over the poll of the head
- Results in vigorous head shaking
- Improved pulmonary gas exchange

Navel Care

- Prevent infection
  - Spontaneous rupture
  - Clean calving environment
  - Immediate removal to well-bedded calf pen
  - Clean colostrum
  - Navel disinfection - spray or dip cord
    - 1,2, and 7% iodine
    - 0.5% chlorhexidine
    - Navel-Guard

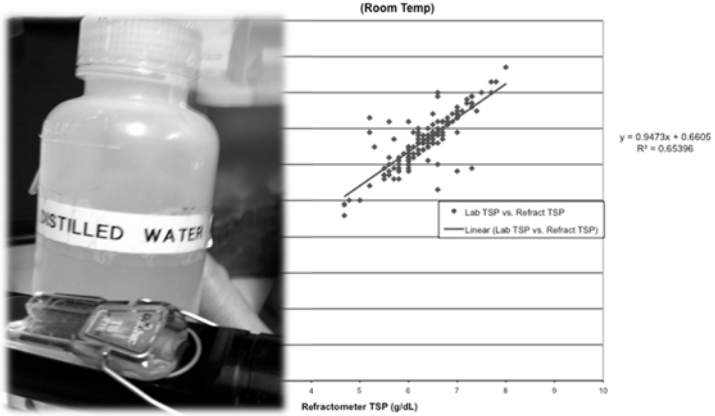
Put Colostrum Testing Into Action

Mark High-Risk Calves

Classify Herd Status

- Failure of Passive Transfer Based on serum total protein (STP)
  - More than 20% below 5.5 gm/dl
  - More than 10% below 5.2 gm/dl

Refractometer Calibration



A systematic review of colostrum protocols may be needed.

- Colostrum Volume
  - Less than 4 quarts given by esophageal feeder
  - Less than 3 quarts suckled
- Colostrum Quality
  - High producing cows
  - Delayed milking
  - Calf suckles
  - Cow leaks
  - Short dry period
- Poor absorption
  - Delayed feeding
  - Bacterial contamination
  - Additives in maternal colostrum
  - Calving assistance

Training to Use the Esophageal Feeder

Selective Use of Esophageal Feeder

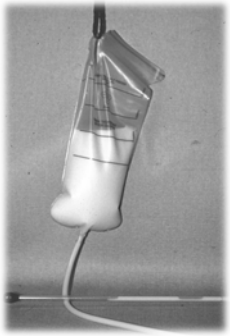
- Standing position for calf if possible
- Calf must be able to maintain sternal recumbency
- Not for use in calf with respiratory effort
- Not for use in calf with abdominal distension
- Equipment is sanitized and in good condition
- Do not force feed milk/milk replacer without veterinarian's recommendation
- Limit forced milk feedings (usually 3 or less)

Equipment Selection

Colostrum

Pass the feeder only once!

Oral Electrolyte Solution

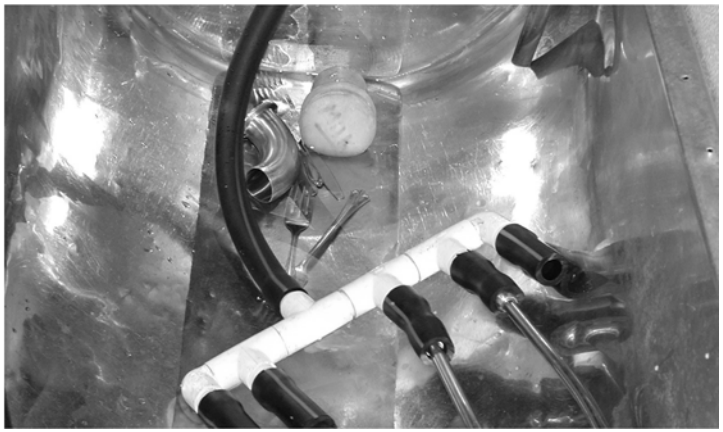


Keep the nose below the ears.

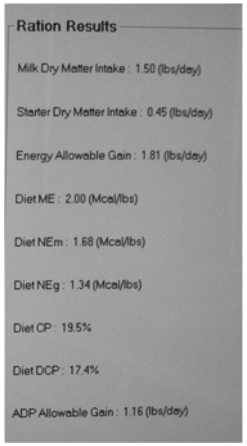
How many esophageal feeders are needed?

The number should equal the maximum number of calves that might need an esophageal feeder in one day – colostrum or oral electrolyte solution.

Sanitizing the Esophageal Feeders



Are We Feeding Enough?



- NRC Simulation Program
- Use actual ration inputs
- Assumptions may be needed for starter intake
- Adjust for calf body weight
- Use environmental temperature
- Have a plan

Average Daily Gain (lb/day)
1.0
1.2
1.6
1.8
2.0
2.0
1.4

Assumptions Needed for NRC Calculator

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

ADG (lb):
Holstein 80 lb birth weight – 2 wks

Temperature	20:20	22:20	24:18	28:20
20° F	1.2	1.2	1.2	1.3
40° F	1.4	1.5	1.5	1.6
60° F	1.4	1.5	1.6	1.9
80° F	1.4	1.5	1.6	1.9

95 lb at 14-days
- 0.5 lb starter intake;
- 10 oz powder per 2 qt water
- 6 qt/day

protein

energy

Protein and energy

ADG (lb):
Holstein 80 lb birth weight – 2 wks

Temperature	20:20	22:20	24:18	28:20
20° F	1.8	2.0	2.0	2.1
40° F	1.8	2.0	2.2	2.4
60° F	1.8	2.0	2.2	2.6
80° F	1.8	2.0	2.2	2.6

95 lb at 14-days
- 0.5 lb starter intake;
- 10 oz powder per 2 qt water
- 8 qt/day

protein

energy

Protein and energy

NRC Ration Results

8-qts 20:20 MR @ 20°

Ration Results

Milk Dry Matter Intake : 2.50 (lbs/day)

Starter Dry Matter Intake : 0.45 (lbs/day)

Energy Allowable Gain : 2.19 (lbs/day)

Diet ME : 2.07 (Mcal/lbs)

Diet NEm : 1.75 (Mcal/lbs)

Diet NEg : 1.40 (Mcal/lbs)

Diet CP : 21.7%

Diet DCP : 19.6%

ADP Allowable Gain : 2.13 (lbs/day)

Crude Protein Balance : -7 (g)

Monitor Feeding Consistency

- Total solids
- Temperature
  - Mixing
  - Feeding
- Delivery – same feed from first to last calf
- Additives
- Timing
- Between feeders
- Water delivery within 20 to 30 minutes of milk/milk replacer feeding

Total Solids

Calculate

- 10 oz powder = 0.625 lb
- 2 qt water = 4.17 lb

$$\frac{0.625}{0.625 + 4.17}$$

- = 13% solids

Total Solids
- < 2% change per day
- Never > 18%

Measure

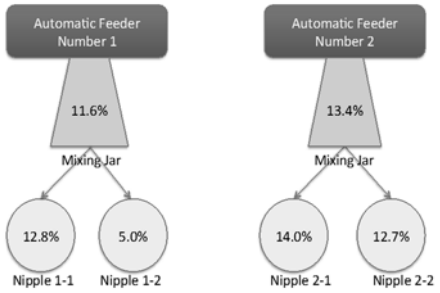
Variability may be more than you expect.

Days	28:20 - weight	22:18 - volume
1	12.2	15.6
2	11.5	17.0
3	12.5	19.3
4	8.8	16.0
5	10.9	14.4

Koepnick and McGuirk, 2010

Milk Delivery Consistency

- What is calculated
- What is in the machine or bucket
- What the calf drinks



The Importance of Water

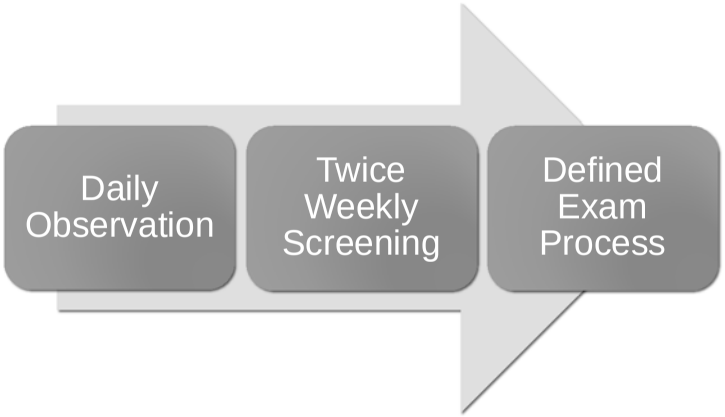
- Fed after every feeding
  - Winter and summer
  - Starting by day 3
- Delivered warm
- Especially with diarrhea
- Absolutely necessary for calves getting electrolytes
- Allows the calf to "correct" feeding errors

Regularly Assess Milk Quality

Sample Type	Goals (cfu/ml) Total Bacterial Count	Total Coliform Count	Total *E. coli* Count
Colostrum	< 100,000	< 10,000	< 1,000
Waste Milk	< 500,000	<200,000	< 1,000
Pasteurized waste milk	< 20,000	< 1,000	< 100
Milk replacer	< 10,000	< 1,000	0

With automatic feeders, collect milk through the nipple.

Managing Calf Health



Early Detection for More Effective Treatment

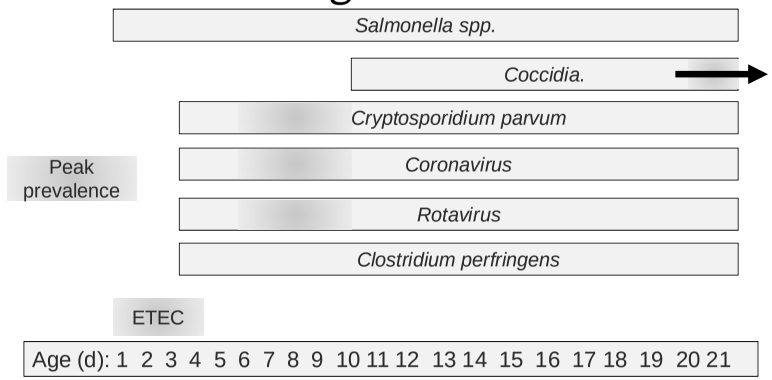
Effective and Efficient Calf Health Screening

- Maximize disease detection
- Facilitate early intervention
- Minimize treatment cost
- Gather data
  - Track incidence/prevalence
  - Treatment response
  - Cost
- Reduce mortality
- Shorten disease duration
- Improve treatment outcomes

Address the Most Important Conditions of Calves

Producer-Attributed Cause of Death	Percent
Scours, diarrhea, or other digestive	56.5
Respiratory	22.5
Unknown reason	7.8
Calving problem	5.3
Other known reason	4.3
Lameness or injury	1.7
Joint or navel problem	1.6
CNS, incoordination, depression	0.3

The common bugs…



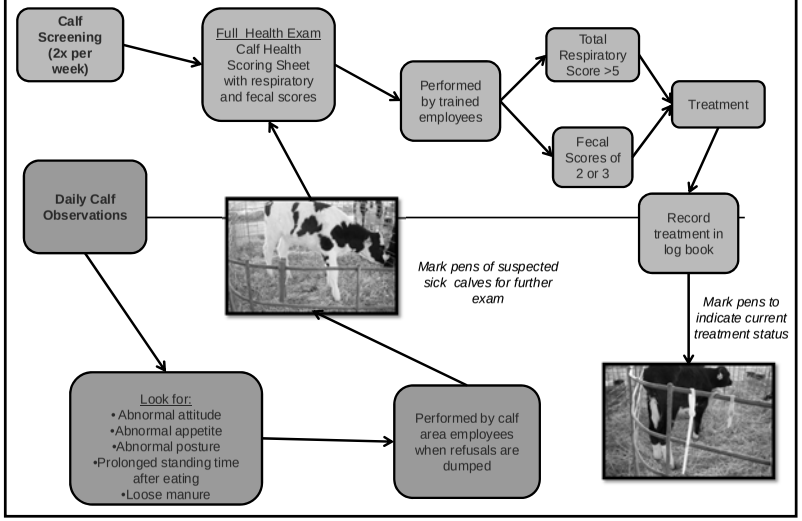
Health Evaluation Must Not Penalize

- Calves
- Screeners
- Examiners
- Treatment Crew

Labor Needs: It Takes a Trained Team

- 1 FTE/100 calves for routine chores
- 0.5/100 calves for health management

It Takes a Defined Process



Daily Observation

- Accomplished during other chores
  - Picking up bottles
  - Dumping milk/water
  - Putting out calf starter
- Calves still standing when most are lying
- Calves slow to get up for feed

Observers have good “calf sense”.

Screeners Find…

- Calves still standing when 90% are lying down or calves still lying when 90% are standing
- Diarrhea
- Bleeding (anywhere)
- Discharge – eyes or nose
- Sunken eyes
- Abnormal posture
  - Arched back
  - Tilted head
  - Star-gazing
- Coughing calves
- Breathing effort/noise

Timing of Health Screening

- Incorporate some aspects into normal chores
  - Collecting milk buckets/bottles
  - Delivering water
  - Picking up refusals

- Last calves standing after feeding
- Last calves to rise at feeding time

Mark Calves/Pens that Need Full Exam

Full Exam by Highly Trained Workers (1)

Temperature	• > 103°F • < 100°F
Head position	• Tilted • Star gazing • Dropped or extended
Discharge	• Eyes • Ears

Full Exam by Highly Trained Workers (2)

Nasal Discharge	• Color • Amount
Cough	• Spontaneous • Induced
Breathing Pattern	• Rapid • Grunting • Abdominal effort/snap

Full Exam by Highly Trained Workers (3)

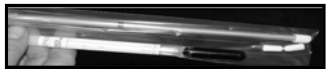
Navel	• Thick • Painful or hot • Discharge or malodorous
Legs	• Lame, won't get up • Swelling • Crooked
Feces	• Loose • Watery • Blood

Screening Tools

Calf Health Scoring App

Group Pen Respiratory Scoring

Diagnostic Testing May Help

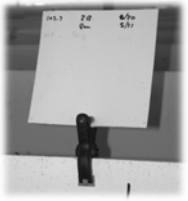


Post-Mortem Exams are Useful

- Training to open dead calves
  - Collect samples
  - Take pictures for the Veterinarian

Treatments Needed

- Written protocols from a veterinarian who is actively involved by participation, training and monitoring results
- Treatment crew that has good skills, cares about animals, has patience, gets results
- Manager who leads by example
- Communication is essential
  - Exam to treatment crew
  - Treatment to manager
  - Manager to records
  - Stall side markers help



Treatment Status

Avoid Calf Vaccination Pitfalls

- Vaccinating sick/stressed calves
- Multiple vaccines at once
- Gram negative bacterial components
  - *Pasteurella* and *Mannheimia*
  - *Salmonella*
- *Mycoplasma bovis*
- Half-dose vaccinations

Where are your weak points?

- Delayed removal from maternity
- Contaminated colostrum
- Esophageal feeder
- Warming area bedding
- Calf pen bedding
- Inadequate nutrition
- Limited water
- Contaminated feed
- Feed refusals dumped in calf housing
- Limited time between successive occupants
- Failure to remove bedding or stall base between calves
- Lack of sanitation protocols for feeding equipment
- Delayed disease detection
- Incomplete/ineffective treatment
- Cold stress
- Over vaccinating

MANAGEMENT OF CALF SCOURS

Franklyn Garry, DVM, MS
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Introduction

There are numerous causes of disease and death in nursing calves. Within the first several days of life, the leading causes of calf disease are metabolic and behavioral problems, which are most commonly the direct or indirect result of dystocia. After the first 2 to 3 days of life, the most common calfhood problems are infectious diseases. Infections of the respiratory and gastrointestinal system account for the overwhelming majority of disease and death in calves more than 48 hours old. Gastrointestinal diseases tend to be most common within the first month of life, while respiratory disease tends to be more important after that time.

There are numerous causes of gastrointestinal infection in calves and it is very important to distinguish between them because they can have very different modes of prevention and treatment. Simple calf scours is the most common type of gastrointestinal infection. Scours is caused by viruses and protozoa that affect the lining cells of the gut but do not invade further into the body. These agents cause disease and death by increasing fluid and electrolyte losses via diarrhea. Affected calves can routinely be saved if treatment includes sufficient fluid and electrolytes to counterbalance the diarrheic losses.

There are also several bacterial agents that can infect the baby calf intestine, most commonly Salmonella, E. coli, and Clostridium species. While these infections can cause diarrhea, they also produce much more severe problems than just fluid loss as they cause severe inflammation, they can invade into and beyond the gut wall, and they can produce toxins that affect multiple body systems. Therefore it is important to try and distinguish between simple calf scours, where the problem for the calf is mostly diarrhea and fluid loss, versus bacterial infection, where the problem is most commonly more severe.

A considerable amount of research effort has been directed toward understanding, treating, and preventing calf scours. Although our best attempts at prevention cannot eliminate calf scours, we have numerous methods of limiting the disease. Importantly, we have very effective means for limiting calf death when the disease does occur. Most of the treatment and prevention methods are readily available to the producer.

Viral and protozoal enteritis = calf scours

The direct cause of calf scours is exposure to and infection by specific infectious agents. Indirect causes include the many factors that increase calf exposure to the microorganisms or decrease calf resistance to infection. The microbes may act individually to cause diarrhea but frequently when a scours outbreak is found in a herd, two or more of these agents can be identified in

affected individuals or in the group of scouring calves. Although each of these agents is unique, and they can cause disease in several different ways, the end effect of the infection in the calf is strikingly similar for all of the major scours-causing agents. The four agents that cause the majority of calf scours are rotavirus, coronavirus, cryptosporidia, and K-99 *E. coli*.

Rotavirus and coronavirus have a very similar mechanism of action in the calf. Both viruses infect the lining cells of the intestinal tract and destroy the cells responsible for digestion and absorption of milk. Damage to the gut can be repaired if the calf survives. The usual cause of death in animals affected by these viruses is tremendous fluid and electrolyte losses that result from the diarrhea and lead to severe dehydration and acidosis.

Cryptosporidia is a protozoan parasite similar to coccidia. Like rota- and coronaviruses, it affects the intestinal lining cells resulting in damage to the cells and subsequent decreased absorption and digestion. Cryptosporidia typically does not kill calves except by causing severe dehydration, electrolyte imbalance, and acidosis.

In calves, the characteristic *E. coli* that causes simple scours is termed K-99. The K-99 designation identifies an antigen that enables the *E. coli* to attach to the gut wall and secrete a toxin that affects the intestinal lining cells. The effects of this toxin are to stimulate hypersecretion of water and electrolytes from the cells. The end effect of this activity is like that of the other scours-causing organisms to produce severe diarrhea plus electrolyte and fluid loss. It is important to realize that K-99 *E. coli* does not invade the intestine or kill calves directly, rather it kills calves via production of dehydration and severe acidosis. The loss of fluid can be so rapid and extreme that calves affected by this strain of *E. coli* can die within 24 hours from the onset of the disease. On the other hand, if calves are supported with sufficient fluid and electrolyte replacement, they are very efficient at clearing this organism from the intestinal tract, thus can effectively cure themselves.

The four microbes described above are the leading causes of calf scours but they are not the only causes of diarrhea. An important distinction needs to be made between calf scours and other types of infections that may produce diarrhea but also other organ problems. The prevention, treatment, and eventual prognosis of these diseases are quite different. In calf scours, the primary problem is diarrhea leading to electrolyte and fluid losses as the major disease effect. The diarrhea seen in calves with some other infections is only one of many problems caused by the infecting organism and in such cases calves usually die because of damage to other tissues besides the gut. Calf scours primarily affects calves within the first three weeks of life. The more aggressive diseases that affect multiple organ systems can occur early in the calf's life but can and frequently do affect calves older than three weeks of age.

Bacterial enteritis and septicemia

Clostridial enteritis is a sporadic disease of neonatal calves with very high mortality and is caused by *Clostridium perfringens*. These bacteria can proliferate rapidly in the intestine of some calves and then secrete a very potent exotoxin. Affected calves usually die rapidly before the onset of diarrhea due to the profound effects of the toxin on the vascular system.

There are numerous different types of the bacteria *Escherichia coli (E. coli)* that cause different effects during their infection and invasion of the body. Many types of *E. coli* are normal inhabitants of the gastrointestinal tract and do not cause disease. Other *E. coli* have characteristics that allow invasion through the gut wall and spread to many different organs. These are known as the invasive *E. coli* and they cause septicemia (microorganisms in the blood). In this instance, the infectious bacteria can spread to any organ in the body, including lungs, brain tissue, kidneys, and joints and can cause severe damage at these infected sites. The *Salmonella* species of bacteria have been associated with calf enteritis but like the septicemic *E. coli*, *Salmonella* has a strong tendency to spread beyond the gut and cause widespread disease. Even when these bacteria do not cause septicemia, they damage the gut and cause severe inflammation, quite different from the problems caused by viral and protozoal simple scours.

Distinguishing between calf scours and bacterial enteritis

A good diagnostic work-up can and should distinguish between these different causes of diarrhea in calves. Again, making this distinction is important because successful treatment and prevention measures will depend on being appropriately directed at the right disease. The following discussion of fluid therapy measures is aimed at calf scours and not at the more severe, but also more sporadic, systemic calf diseases.

As discussed above, the infectious calf scours problems result primarily from excessive loss of water and electrolytes from the intestines. In severe cases, the diarrhea is so fluid that it contains little particulate matter and is mostly water, electrolytes, and mucus. The end result is development of varying degrees of dehydration associated with electrolyte imbalance and acidosis. In mild states of dehydration, the calf will show mild lethargy, tackiness of the mucous membranes, loss of elasticity in the skin, concentrated urine, and beginning retraction of the eye into the orbit. The extremities (legs, tail, ears) are usually cooler than the body due to constriction of peripheral blood vessels to counteract the decreased blood volume. The worse the dehydration and electrolyte loss, the more severely affected will be the calf. With increasing severity, calves will show more severe depression, may be unable to stand, will lose their nursing reflex, and will drop to subnormal body temperature. In even more severe cases, dehydration will lead to a calf that is unable to rise and will become comatose. When fluid and electrolyte losses are severe enough, affected calves will die.

Because the major impact of calf scours on the calf is the loss of fluid from the gut, the signs of disease are fairly predictable, and the appropriate treatment of calves is fairly straightforward. The calf loses fluid and electrolytes in the diarrhea beyond its ability to maintain good body fluid balance from its normal feed intake. The calf becomes progressively more dehydrated, which can be seen by evaluating the ability of the skin to return to normal position when it is pinched. Dehydration is also see as drying out of the tissues in the mouth, and by drying and sinking of the eyes into their sockets.

The loss of electrolytes causes increasingly severe acidosis. This is seen as progressive depression and lethargy of the calf. With worsening acidosis calves become lethargic and weak, have trouble standing, and lose their suckle reflex.

A good calf observer can note that an affected calf develops diarrhea. Then the calf becomes progressively more dehydrated and progressively more depressed as the amount of fluid loss and acidosis become more severe. These problems can all be corrected if the calf gets enough additional fluid and electrolytes to reverse the dehydration and acidosis.

By comparison, a calf with Salmonella or E. coli scours or septicemia can have less diarrhea, or blood in the feces, or severe depression without dehydration, or other evidence of severe inflammation such as increased size of blood vessels in the eyes. In other words, a careful observer can see that the calf does not have simple scours. Such calves may need fluids too, but giving fluids will not correct the problem, because the problem is much more than just fluid loss.

Treatment of scouring calves

With this understanding of the causes and effects of calf scours, we can devise very effective treatment measures. Since the leading causes of disease signs and death in the scouring calf are dehydration, electrolyte loss, and acidosis caused by the outpouring of fluid into the gastrointestinal tract, by far the most important treatment measure is replenishment of these vital fluids and electrolytes.

The loss of fluids that occurs with calf scours is a progressive problem. In the initial or mild stages of the disease, calves are still standing and orally administered fluids will be effectively used. As the disease progresses, however, the dehydration worsens and calves become more lethargic and decrease their own voluntary intake of fluids. The most common mistakes made in the use of commercially available oral electrolyte replacement fluids are waiting too long before administering these formulas or administering them too infrequently to affected calves. Administered early and frequently, these fluids help the calf maintain vigor and normal body temperature and allow it to continue sucking. Administering fluids too late, so that the calf is already depressed and down, or administering too little so that the calf continues to lose more fluid than it is receiving orally, allows the progressive dehydration to continue and the calf's condition to deteriorate.

When dehydration and acidosis are severe enough, normal intestinal function declines and orally administered fluids are not appropriately absorbed. In such cases, oral fluids do little to enhance calf survival. At this stage, the only effective means of preventing death is to administer intravenous fluid therapy. For severe cases with extremely rapid onset of dehydration, intravenous fluid administration may be the only effective treatment. For most cases, however, the progression of the disease is not nearly so rapid and the problem lies only in the missed opportunity to administer oral fluids at an earlier stage of the problem. Since calves with normal hydration can rapidly excrete excess water and electrolytes, it is usually better to administer oral electrolytes when in doubt than to wait until the calf is more significantly dehydrated.

Other treatments besides fluids have been tried. Intestinal protectants such as Kaolin and pectin are favored by some but their efficacy in stopping fluid and electrolyte loss is highly questionable. They may act to absorb toxins and thus help clear them from the intestinal tract but this again is very debatable. The intestinal protectants are at least not harmful. In contrast, numerous treatments have been devised to affect intestinal motility. At one time, it was popular

to use drugs that decreased intestinal motility with the assumption that hypermotility of the intestine was the cause of the diarrhea. We now know that most of the diarrhea-causing organisms decrease intestinal motility and the use of such types of drugs is, in fact, contraindicated.

Although antibiotics have been historically used in the treatment of calves with scours, they have mostly been used inappropriately. These drugs can be given orally or systemically. The overall effect of oral antibiotics, however, is detrimental. A quick review of the organisms that cause calf scours shows that the major causes of calfhood diarrhea are resistant to antibiotics. Rota- and coronavirus are not affected by antibiotics at all, while cryptosporidia, like most coccidia, respond poorly or not at all to antibiotics. The K-99 serotype of *E. coli* that classically causes calf scours is routinely cleared by the calf as long as fluid therapy is provided to keep the calf alive.

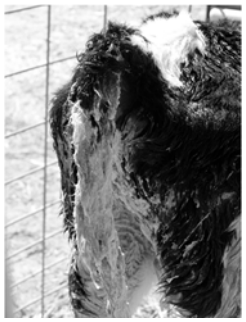
The invasive forms of *E. coli* and *Salmonella* that penetrate the intestine and cause septicemia will generally respond better to antibiotics administered systemically. Since these organisms typically cause a deterioration of normal gut function, it is highly questionable how much orally administered antibiotics are appropriately absorbed to fight the infection. Furthermore, orally administered antibiotics have some deleterious effects on the calf. Oral antibiotics alter the normal intestinal flora and in some cases can predispose to superinfections or infections with fungal organisms. Some of the antibiotics commonly used for scours actually inhibit glucose absorption from the intestine and alter the intestinal lining cells. In these cases, the continued use of oral antibiotics can lead to a prolongation of diarrhea.

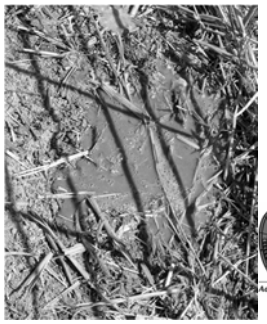
In summary, oral antibiotics are rarely effective in treating scours and sometimes can produce an adverse result. By contrast, when septicemia is suspected, antibiotic use is critical in the treatment of the disease but in such cases the type of antibiotic used should be based on accurate identification of the disease-causing organism and the antibiotic is best administered by injection, not orally.

Recently, the use of natural biologic products to reestablish a normal balance of intestinal microorganisms has been suggested as a useful treatment for calf scours. Products containing either *Lactobacillus* or *Streptococcus faecium* are commercially available. It is debatable how effective they are, but it is likely that they are useful in cases where scours are very prolonged or when oral antibiotics have been used extensively.

Electrolyte fluid administration is by far the most effective treatment for calves with scours. Because affected calves are typically weak and chilled, additional nursing care can be very important. In this regard, provision of warmth, dryness, protection from the elements, and adequate nutritional support are all critical. Fluid therapy is most effective when it is administered aggressively and early in the course of the disease. The most critical factor may be the early recognition of affected calves. Caught early, most calves will respond very favorably to oral fluid therapy. Once the calf becomes more severely dehydrated so that it is weak and unable to rise, or if it has no suckle, intravenous fluid therapy may be the only way to save the calf's life. Other treatments may be beneficial but they are far less important than fluid and electrolyte replacement.

Trouble Shooting Diarrhea in Calves





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Advancing animal and human health with science and compassion

Diarrhea: Agents Involved?

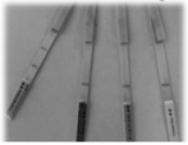
- It is hard to make a diagnosis from diseased calves
- Exposure is usually same for all calves
- Go to the targeted age group
- Sample untreated calves – diarrhea or not

Looking for a shedding pattern

Laboratory Fecal Sample Diagnostics

- Work with your lab for best sample, sample preservation and handling of samples
  - Cultures for *Salmonella*
  - Smears or PCR for *C. parvum*
  - PCR for rota and corona virus
  - Toxin-producing *E. coli*

Calf-Side Fecal Sample Diagnostics



Enterichek® 4 test
Enterichek® Crypto

Evaluation of a commercial rapid test kit for detecting bovine enteric pathogens in feces

Yong-Il Cho, Dong Sun, Vickie Cooper, Grant Dewell, Kent Schwartz, Kyoung-Jin Yoon

Abstract. Recently a commercial antigen-capture enzyme-linked immunosorbent assay kit in the form of a dipstick (Bovine Enterichek®, Biovet Inc.) was made available to bovine practitioners and producers for the rapid detection of *Betacoronavirus 1* (BCV-1), *Rotavirus A* (RV-A), *Escherichia coli* K99, and *Cryptosporidium parvum* in feces from diarrheic calves. The diagnostic performance of Bovine Enterichek was evaluated in comparison with a multiplex real-time polymerase chain reaction assay (mrtPCR). One hundred fecal samples were procured from diagnostic submissions to Iowa State University Veterinary Diagnostic Laboratory and were used for the assessment. The agreement quotient (kappa) in results for each pathogen between Bovine Enterichek and mrtPCR were 0.095 (BCV-1), 0.521 (RV-A), 0.823 (*E. coli* K99), and 0.840 (*C. parvum*). In comparison to mrtPCR, the diagnostic sensitivity of Bovine Enterichek was 60.0%, 42.3%, 71.4%, and

Calf Raiser Fecal Screens Prevalence in 134 Calves

	Day 5	Day 14
Rota	30.6%	43.3%
Corona	2.2%	0.75%
C. parvum	3.0%	74.6%
Salmonella spp.	0%	2.2%

Benchmarks
- ≤20% shedding rota- or corona virus
- ≤20% shedding *Crypto. Parvum*
- No *Salmonella* positive fecals

Exposure in Bedding

- Bedding
  - Maternity Pen
  - Transport vehicle
  - Warming area

  } Shedding before 5 days
  - Calf housing } Shedding after 7 days

- Bacterial types and numbers
- *Salmonella* culture

Bedding Analysis

Location	Coliforms	*Salmonella*	Total cfu/ml)
Maternity	1,000	Negative	576,000
Holding pen	500	Negative	150,825
Truck	6,900,000	Positive	6,921,750
Clean hutch	750	Negative	11,500
5-day hutch	1,500	Negative	577,500
Repeat truck	50,000	Positive	4,075,000
Goals:			
Clean pen	< 1,000	Negative	< 5,000
Occupied pen	< 500,000	Negative	< 2,000,000

Environmental Samples

SAMPLE	*SALMONELLA* SPECIES
Cattle Trailer	Negative
Calf Cart	Negative
Post weaning barn – pen 1 water area	Negative
Post weaning barn – pen 1 bedding	Negative
Post weaning barn – pen 2 water area	*Salmonella Dublin*
Post weaning barn – pen 2 bedding	*Salmonella Dublin*
Post weaning barn – pen 3 water area	Negative
Post weaning barn – pen 3 bedding	Negative
8-Week old calf group – feeding/water area	*Salmonella Newport*
8-Week old calf group – bedding pack	*Salmonella Newport*
9-Week old calf group - feeding/water are	*Salmonella Newport*
9-Week old calf group – bedding pack	*Salmonella Newport*
10-Week old calf group – feeding/water area	*Salmonella Newport*
10-Week old calf group – bedding pack	*Salmonella Newport*
>10-Week old calf group – feeding/water area	*Salmonella Newport*
>10-Week old calf group – bedding pack	*Salmonella Newport*

Fecal pH Monitoring
Mix 1 tsp of feces with 15 ml of deionized water

Fecal pH monitoring

- Calves depend on the colon (rather than the rumen) for digestive fermentation
- Nutrients that escape digestion and absorption in SI undergo large bowel fermentation
  - ↑lactate, VFAs, gas and trimethylamine
- Higher lactate and fecal acidity have been associated with diarrhea (Sato 2009, 2010)

Observations so far
- In first 3 days, average between 5.8 and 6.0
- Alkaline feces (>7) in first 3-days could be ETEC
- Fecal pH in normal calves is higher at 14 days (6.4-6.7)
- Acidification or drop in pH may indicate maldigestion, malabsorption or presence of lactic acid

Diarrhea problems can be limited

Removal from calving pen within 10 minutes

Interim housing is "safe"

Colostrum is clean

Avoid long stays in interim housing

High plane of nutrition

Safe milk/milk replacer

Clean equipment and feeders

Rehydration is key!

Clear definitions and protocols

Feed them

Oral electrolyte solution
- Fecal score 2: 2 qt OES once daily
- Fecal score 3: 2 qt OES twice daily

Score 2

Sick Calves Get Antibiotics

High temp (> 103); Low temp (< 100)
Reduced intake or feed refusal
Arched back, hair standing up
More than a streak of blood
Another body system involved – lungs, navel or joints

School of Veterinary Medicine
UNIVERSITY OF WISCONSIN-MADISON

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Developing a Quality Heifer: Management, Economic and Biological Factors to Consider

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Acknowledgements

Harald Hammon
Katie Andrews
Dan Lopez
Fernando Soberon

Overview of today's talk

- Introduction
- Biology of heifers interspersed with…
- Economics
- Benchmarking
- Future productivity
- Summary

Goal of The Replacement Program

The primary goal of all heifer programs is to raise the highest quality heifer that can maximize profits when the animal enters the lactating herd.

A quality heifer is an animal carrying no limitations – nothing that detracts from her ability to produce milk under the farm's management system.

Optimize profits by obtaining the highest quality heifer at the lowest possible cost usually in the least amount of time.

Herd Replacement Objectives

- Focus on return on investment – over their productive life
- Minimize non-completion (animals that are born and either never milk or finish a lactation)
- Optimize the productivity of the animal (manage them for their genetic potential starting at birth)

Key Areas

- Quality
  - Outstanding growth, few to no treatments, high quality environment, good airflow, low ammonia, minimize organic material contamination, meet all the growth benchmarks for optimum milk yield
- **Costs: 20 to 30% of costs to operate the business**
  - Total costs ($2,000 - $2,400)
  - Feed (53% if total heifer costs; $1.42-$2.05/d)
  - Labor
  - Non-completion/performance (10%)
- Number raised
- Capturing value of excess heifers

Quality of the Replacement

- Meet benchmarks for growth and calving to optimize first and subsequent lactation milk yield
- Calving problems
  - Too heavy (fat)
  - Too light (frame)
- General condition of the animal
  - Mastitis
  - Feet and legs
  - Injury
- Prior treatment's – especially respiratory and timing is important – pre- vs post-weaning
- Replacement Heifer Management Snapshot

Snapshot Evaluation of the Potential Quality of The Replacement

- 1st Calf Heifers "Treated" as Calf/Heifer* ≤30%
  24 hrs. → 3 mos. ____, 4 mos. → fresh ____
- DOAs in first calf heifers ≤7%
  Male DOAs. ____, Female DOAs ____
- 1st Calf avg. peak ≥80% of Mature
  1st Calf lactation total yield ≥80% of Mature
- 1st Calf Culls ≤ 60 Days in Milk ≤5%
- 1st Calf ME's ≥Mature
- 1st Calf "Treated" in Lactation* ≤15%
- 85% retention (any herd) to 2nd lactation ≥85%
- Lower #1 reason for 1st lact. culls(continuous improvement)

The Need and Importance for Monitoring Body Weight Gain and Age at First Calving and Productivity

Growth Benchmarks to Optimize First and Subsequent Lactation Milk Yield

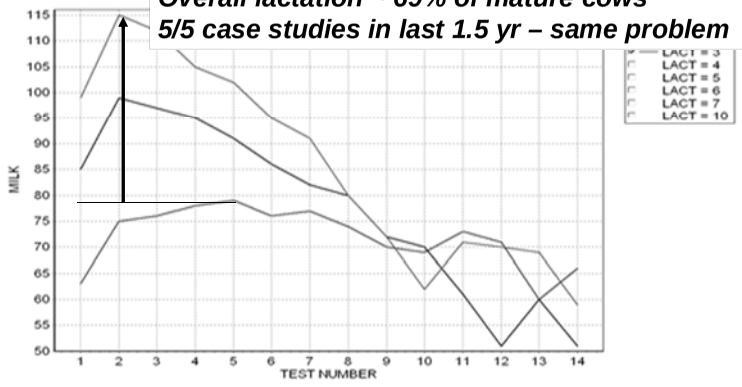
Birth to weaning:	double body weight
Puberty:	45% mature weight
Breeding and Pregnancy:	55-60% mature weight
First lact. post-calving BW:	82 to 85% mature weight

Goal is to achieve 82% of mature size to achieve 80% of mature cow milk yield

Mature weight determined at middle of 3rd and 4th lactation – 80 to 200 days in milk on healthy cows, not cull cows

PLOT MILK BY LACT

Peak ~ 69% mature cows
Overall lactation ~ 69% of mature cows
5/5 case studies in last 1.5 yr – same problem



Discussion Group Heifer Project

Question from group: How do we optimize first lactation milk yield and the quality of the heifer as she arrives at lactation?

Herd	% Mature Peak
1	68
2	85
3	75
4	82
5	79
6	79
7	76
8	77
9	70
10	76
11	75
12	72

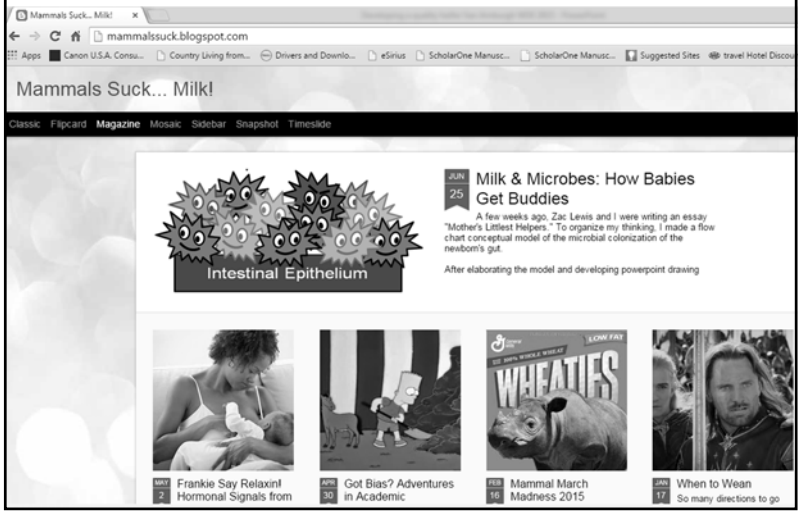
Target weights

		Mature weight, lb		
		900	1,300	1,760
	% mature wt.	Target weight, lb		
pregnancy	55%	495	715	968
1st lact. fresh	82%	765	1,105	1,496
2nd lact. fresh	92%	828	1,196	1,619
3rd lact. fresh	96%	864	1,248	1,690

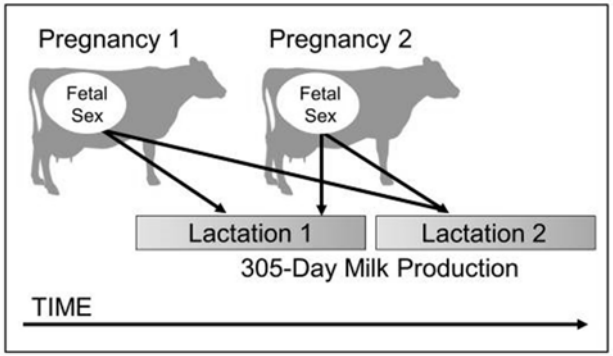
Input AFC – sets breeding age for you and breeding weight is a function of the mature size. Requirements are then calculated to meet the targets.

So When Does The Process of Creating a Quality Heifer Start?

Dr. Katie Hinde, Harvard – Blog "Mammals Suck… Milk!



Holsteins Favor Heifers, Not Bulls: Biased Milk Production Programmed during Pregnancy as a Function of Fetal Sex



Hinde et al. PLosOne 2014 10.1371/journal.pone.0086169

Hinde et al., – Mom's favor heifers

Evaluated the effect of sex of offspring on subsequent milk yield

2.39 million lactations from 1.49 million cattle – U.S. herds

First lactation cattle giving birth to heifers produced 980 lb more milk over the first two lactations

- 490 lb for the first two lactations

Ettema and Ostergaard 2015
- $6 per lactation marginal return for average semen
- $12 per lactation marginal return for sexed semen

Pro-active Calf program goals:

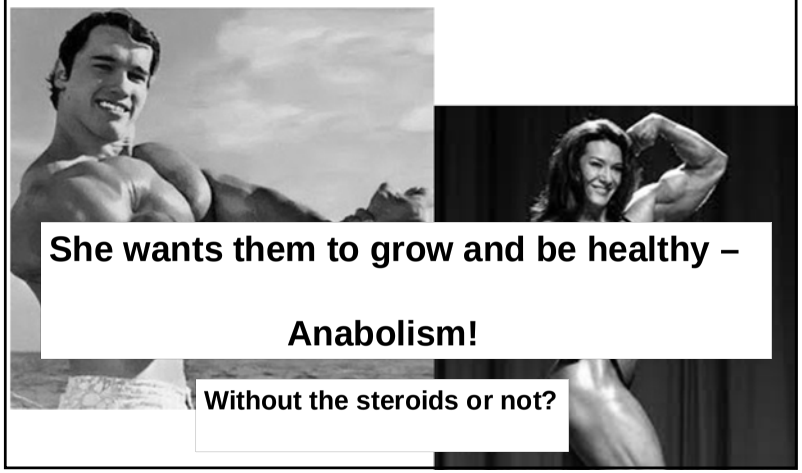
1. Double birth weight by 56 days (minimum goal)

84 lb birth weight ⟶ 168 lb @56 days

Some herds both Holstein and Jersey are achieving 3x birth weight by 60-65 d!

Why do this?
- Capture feed efficiency of early life
- Achieve breeding weight at an earlier age
- Potentially reduce AFC/increase BW@calving
- Increase potential for Internal Herd Growth
- Potentially increase milk yield and herd life

What Does Mom Want for Her Calf?



Relatively new definition related to the topic of programming in neonates:

•Lactocrine hypothesis (Bartol, Wiley and Bagnell, 2009)
- maternal programming extended beyond the uterine environment through ingestion of milk-borne morphological factors - milk in this case can include colostrum

- In neonatal pigs, maternal relaxin from colostrum stimulates development and differentiation of the uterus (15 vs 30 ml colostrum)
- Mediates the expression of estrogen receptors – stimulates on differentiation of stroma and epithelial cells and then proliferation

Importance of Colostrum Supply for the Neonate

- Colostrum provides immunoglobulins for establishing passive immunity in the neonate
- Colostrum contains high amounts of nutrients, but also non-nutrient factors that support gut maturation
- Colostral growth factors such as IGF-1 or hormones like insulin might act through specific receptors in the gut mucosa of the neonate to stimulate cell proliferation, cell differentiation, and protein synthesis
- Colostrum is a tool of the mother to support offspring development at the beginning of extra-uterine life

Colostrum vs milk

Components	Units	Colostrum	Mature Milk
Gross Energy	MJ/L	6	2.8
Immunoglobulin G	g/L	81	<2
Lactoferrin	g/L	1.84	Undetectable
Insulin	µg/L	65	1
Glucagon	µg/L	0.16	0.001
Prolactin	µg/dL	280	15
Growth hormone	µg/dL	1.4	<1
IGF-1	µg/dL	310	<1
Leptin	µg/dL	30	4.4
TGF-α	µg/dL	210	<1
Cortisol	g/ml	1,500-4,400	710
17βEstradiol	g/ml	1,000-2000	10-20

Blum and Hammon, 2000, Bonnet et al., 2002; Blum and Baumrucker, 2008

Source of Colostrum Replacement Important for Feed Efficiency – first 29 days of life

Calves fed colostrum or a serum derived colostrum replacement demonstrated differences in feed efficiency

- **no differences in IgG status**

Variable	Colostrum		Colostrum Replacement	
	N	P	N	P
Total DMI, lb	34.5	33.1	30.1	32.1
Milk replacer DMI, lb	23.5	24.3	21.6	24.1
Starter DMI, lb	10.9	8.7	8.5	8.2
Feed efficiency,(gain:feed)	0.43	0.36	0.22	0.26
	0.40		0.24	

Jones et al. JDS 2004

Effect of Colostrum level on Growth and Feed Efficiency

- Calves fed 4 L (+2L @12 hrs) or 2 L of pooled colostrum within one hour of birth
- Half of calves on each colostrum treatment assigned to "*ad libitum*" feeding regimen
- All calves are housed in a co-mingled pen and fed with an automatic feeder
- Daily intakes of milk replacer and weekly measures of body weight and hip heights
- Weekly blood samples

Soberon, 2011

Effect of High (4+2 L) or Low (2L) Colostrum and Ad-lib (H) Milk Replacer Intake on Feed Efficiency and Feed Intake in Pre and Post-Weaned calves (Soberon Ph.D. diss., 2011)

Treatment	HH	LH	
	Mean	Mean	Std dev
n	34	26	
IgG concentration, mg/dl*	2,746[a]	1,466[c]	98
Birth wt, lb	97	92	2
Weaning wt, lb	172[a]	159[c]	4
ADG pre-weaning, lb	1.74[a]	1.48[c]	0.06

Effect of High (4+2 L) or Low (2 L) and Ad-lib (H) Milk Replacer Intake on Feed Efficiency and Feed Intake in Pre and Post-Weaned calves

Treatment	HH	LH	
	Mean	Mean	SD
ADG birth to 80 d, lb	1.72[a]	1.45[b]	0.07
Hip height gain, birth to 80 d, cm/d	0.214[a]	0.184[c]	0.008
Total milk replacer intake, lb DM[1]*	97.8[a]	90.1[c]	2.4
Grain intake pre-weaning, lb[1]*	4.8[a]	4.6[a]	3.3
ADG/DMI, pre-weaning[2]*	0.60	0.67	0.042
ADG post-weaning[3], lb	2.4[a]	1.76[b]	0.13
DMI post-weaning[3], lb/d	6.4[ab]	5.7[c]	0.23

Effect of Prolonged Colostrum Intake on Glucose Metabolism

- 7 calves fed colostrum versus 7 calves fed milk-based formula 4 hrs on average after birth
  - Comparable in macronutrients
- Basal blood samples were drawn before morning feed and 2 hours after intake on day 1 to day 4
- Glucose absorption into blood using isotopes

Steinhoff-Wagner et al., 2011

Composition of Colostrum and Formula

	Dry Matter g/kg	Ash g/kg FM	OM g/kg FM	Lactose g/kg DM	Crude Protein g/kg DM	Crude Fat g/kg DM	Crude Energy MJ/kg DM	IGF-I µg/l
Colostrum								
Day 1	239	10.7	228.2	200.9	523.2	194.6	22.1	373.4
Day 2	179	9.1	170.0	259.6	395.9	269.1	23.6	192.4
Day 3/4	151	8.1	143.2	341.0	296.8	292.8	23.3	85.6
Formula								
Day 1	240	20.9	219.0	200.9	514.0	173.4	22.5	n.m.
Day 2	179	12.9	165.7	259.8	409.3	246.4	23.8	n.m.
Day 3/4	153	10.5	142.6	338.3	338.3	246.2	23.5	n.m.

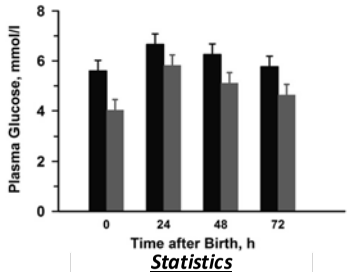
n. m. = not measureable

Steinhoff-Wagner et al., 2011

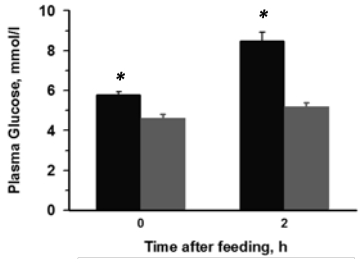
Plasma Glucose: Postnatal Concentrations and Changes after Feed Intake

Colostrum
Formula

Postnatal Concentrations before Feed Intake



Changes on Day 4 after Feed Intake



Statistics

Main Effects:	
Diet	P < 0.001
Time	P < 0.05
Diet × Time	P < 0.7

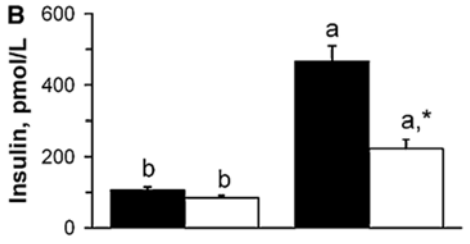
Statistics

Main Effects:	
Diet	P < 0.001
Time	P < 0.001
Diet × Time	P < 0.001

*: Sig. Diet Effet at Time Point

Steinhoff-Wagner et al., 2011

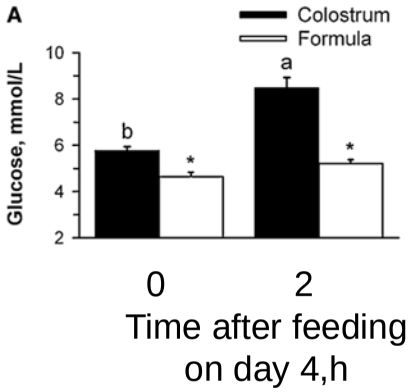
Plasma Insulin Concentration of Calves Fed Colostrum or Colostrum like formula from Birth – Day 4 of Life



Dark bars are colostrum fed calves, white bars are control calves

Steinhoff-Wagner et al., 2011

Plasma Glucose Concentration of Calves Fed Colostrum or Milk Replacer from Birth – Day 4 of Life



Dark bars are colostrum fed calves, white bars are control calves

Steinhoff-Wagner et al., 2010

Colostrum

- Mom is trying to send information to the calf via mammary secretions – some of our management approaches have short circuited this "information flow"
- Colostrum contains factors that impact nutrient absorption, gut development and pre- and post-weaning feed efficiency from 0 to 40% among studies

Take home for colostrum management

Colostrum feeding for 4 days….

First milking colostrum within 6 hr of birth – 4 qt for large breeds

First milking colostrum at 12 hr

Second milking colostrum for day 2

Third and fourth milking colostrum for days 3 and 4

Pro-active Calf program goals:

1. Double birth weight by 56 days (minimum goal)

85 lb birth weight → 170 lb @56 days

2. C

3. C

There are Jersey and Holstein herds achieving 3x birth weight by 60-70 d

Why do this?

Capture feed efficiency of early life
Achieve breeding weight at an earlier age
Increase potential for Internal Herd Growth
Potentially increase milk yield and herd life

Nutrient Requirements of Pre-weaned calves

How much energy/nutrients do these hold?

Energy content of typical feeds

Milk replacer 20% CP:20% fat:

4.75 Mcals ME / kg DM
2.16 Mcals ME/ lb DM

Milk replacer 28% CP:20% fat:

4.88 Mcals ME / kg DM
2.22 Mcals ME / lb DM

Whole milk 26% CP:31% fat:

(Holstein) 5.37 Mcals ME / kg DM
2.44 Mcals ME / lb DM

Accounting for maintenance requirements

- The maintenance requirement of a calf can be described by the following equations:
  - Mcal ME x $BW^{0.75}$ so for a calf weighing 90 lbs the maintenance requirement is:

90 lb/ 2.204 lb/kg = $(40.8 \text{ kg})^{0.75}$ x 0.1 = 1.61 Mcals ME

Scale for heat loss due to body weight and surface area:

- One adjustment is to scale for surface area to account for the additional heat loss and the following equation and example is used: 0.14 x $BW^{0.57}$ ($0.14 \times 40.8^{0.57}$) = 1.21. Thus, to account for the additional heat loss due to body size the requirement for the 90 lb calf is adjusted:

1.61 Mcals ME x 1.21 = 1.95 Mcals

Jersey Requirements and Heat Loss

- Surface area to body weight relationship is greater – means greater heat loss potential
- Actualized maintenance requirements are ~ 20% greater than Holsteins
- Need higher fat diets to meet energy demand at level of intake – described in Bascom et al. work from Virginia Tech

Adjust for conditions outside of thermoneutral temperature

For every degree C below thermoneutral (~68° F ~ 15° C) the energy requirement increases by 0.022 Mcals ME.

So for the same calf at ~32° F (0° C) the adjustment would result in 15 x 0.022 = 0.33 Mcals for a total maintenance requirement of **1.95 + 0.33 = ~2.3 Mcals**

Feed for Maintenance

To estimate feed required for maintenance using a 20:20 milk replacer:

4.75 Mcal/kg /2.204 lb/kg = 2.16 Mcal/lb

2.3 Mcals/2.16 Mcals/lb = ~1.1 lb of milk replacer powder to meet the maintenance requirements of the calf.

Maintenance Requirements for Calves

Temp. °F	68[a]	50	32	14	5
Body weight, lb			Mcal ME/d		
65	1.31	1.45	1.72	2.00	2.14
88	1.62	1.80	2.14	2.48	2.65
110	1.92	2.12	2.53	2.93	3.13
135	2.20	2.43	2.90	3.36	3.59
155	2.47	2.73	3.25	3.77	4.03

[a]Lower critical temp. calves less than 21 d age.

Energy content of Milk and Milk Replacer

Whole milk (26:31): 2.4 Mcals/lb DM, ME basis
Milk replacer (28:20): 2.2 Mcal/lb DM, ME basis

90 lb calf Maintenance requirement

68°F is 1.62 Mcal/d (ME)

0.7 lbs of milk or 0.84 lb replacer to meet requirements

20°F is 2.71 Mcal/d (ME)

1.25 lb of milk or 1.5 lb replacer to meet requirements

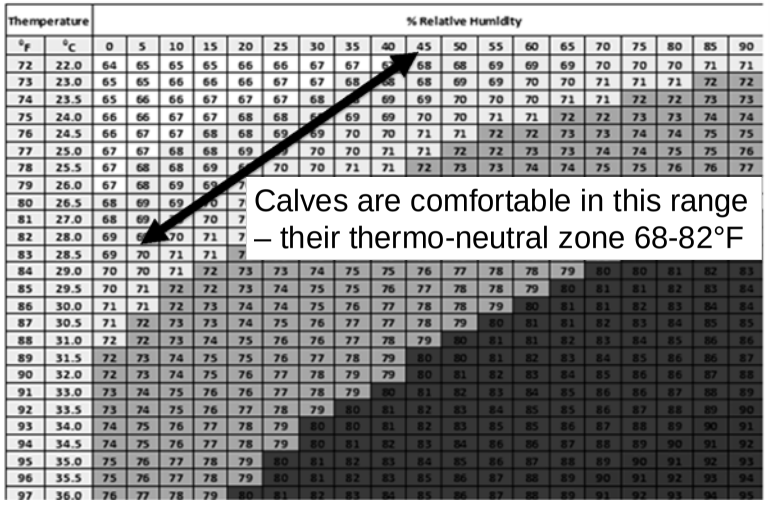
"Summer" vs "Winter" Feeding

April 1 to September 30:

To achieve doubling the birthweight, calves require **at least** 6 qts of milk or 7 qts of milk replacer per day.

October 1 to March 31: To achieve the same goal, calves require **at least** 8 qts of milk or 9 qts of milk replacer – this usually requires 3 x feeding or adding a midday feeding (breakfast, lunch and dinner)

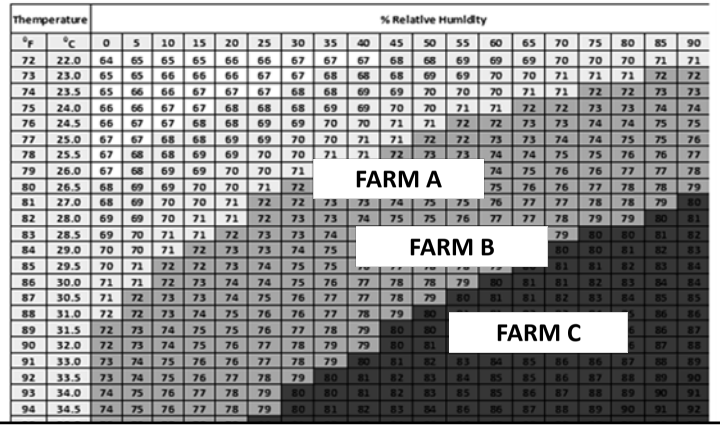
Heat Stress and Performance of Calves



Summary of Feed Cost and Measured Gains During June and July 2014			
Feed Basis (As-Fed)	Farm A	Farm B	Farm C
Housing Type	Barn with mechanical ventilation	Barn with natural ventilation	Hutches, back propped up for increased ventilation
Pounds Milk Replacer fed per calf	1.50	1.82	1.25
Pounds grain fed per calf	0.47	0.86	1.00
Average Daily Gain (ADG)	2.00	1.88	0.67
Feed cost per animal per day	$3.01	$3.72	$2.65
Feed cost per pound of gain[1]	$1.69	$1.97	$3.94
Gross Feed Efficiency (Gain:Feed)	1 : 0.99	1 : 1.43	1 : 3.36

Heat Stress/Management Impact

- Farm B fed more, and still achieved lower ADG
  - Maintenance requirements for Farm B calves were higher than Farm A, Farm C greater yet but lower intake



Updated Nutrient Requirements of a 100 lb Calf Under Thermoneutral Conditions

Rate of gain, lb/d	ME[a], mcal/d	DMI, lb/d	ADP, g/d	CP, g/d	CP, % DM
0.44	2.35	1.12	87	94	18.0
0.88	2.89	1.40	140	150	23.4
1.32	3.48	1.67	193	207	26.6
1.76	4.13	1.98	235	253	27.5
2.20	4.80	2.39	286	307	28.7

Van Amburgh and Drackley, 2005

Effects of Neonatal Nutrition on Productivity

Review of Available Data Sets – Meta Analyses

Mixture of several publications
Journal papers, abstracts, and proceedings
Suckling, whole milk and milk replacer

Hypothesis: increased nutrient intake that results in greater growth rates positively impacts first lactation milk yield

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 (post-weaning protein)	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	1,583[NS]
Morrison et al., 2009 (no diff. calf growth)	0
Moallem et al., 2010 (post-weaning protein)	1,613[s]
Soberon et al., 2012	1,556[s]
Margerison et al., 2013	1,311[s]
Kinzeback et a, 2015	0

Data sets excluded from the analyses

- Foldager and Krohn, 1991- inadequate data for analyses
- Davis-Rincker et al., 2011 – did not measure full lactation –projected 305 d milk
- Conducted meta-analyses with and without Soberon et al. (2012) data to understand weighting effect

Meta Analysis and Regression

- Used Comprehensive Meta Analyses software (www.Meta-Analysis.com - Borenstein M, Hedges L, Higgins J, Rothstein H. Comprehensive Meta-analysis Version 2, Biostat, Englewood NJ. 2005)
- Used available data:
  - study
  - treatment size (number calves)
  - mean milk yield (effect size – positive or negative)
  - standard error/deviation
  - P value
  - effect direction
- Inclusion and exclusion of Soberon et al. (2012) did not change the outcome of the analyses

Outcome of Meta-Analyses

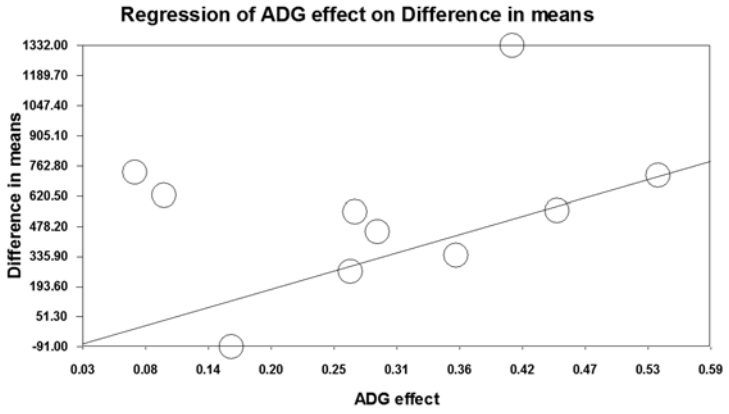
Milk yield effect of early life nutrition – asking the Yes/no question, does feeding a calf improve long-term productivity?

Difference in means, lb	SE, lb	Lower Limit, lb	Upper Limit, lb	Z-value	p-Value
435	117	205	664	3.72	<0.001

Odds ratio of effect

Odds Ratio	Lower Limit	Upper Limit	Z-value	p-Value
2.09	1.48	2.96	4.16	0.001

Meta Regression - Effect of Pre-Weaning ADG on Milk Yield Outcome



Equation: milk yield = -118.5 lb + **1,527 lb***ADG (lb), Z value = 2.42, *P* = 0.001

Example – 100 lb calf

- A traditional U.S. feeding rate of milk replacer would be 1.25 lb/d (20:20) - enough energy for approx. 0.4 lb/d gain under no stress conditions
- Feeding 2.2 lb/d (28:20) – energy for approx. 1.6 lb/d gain under no stress conditions

Difference in ADG = 1.2 lb/d, thus

(1,541 lb* 1.2) = 1,850 lb additional milk expected in the first lactation

Cornell Herd - Effect of Pre-Weaning Daily Gain on Milk Yield

- In this evaluation, 22% of the variation in first lactation milk yield was explained by pre-weaning growth rate up to 42 - 49 days of age

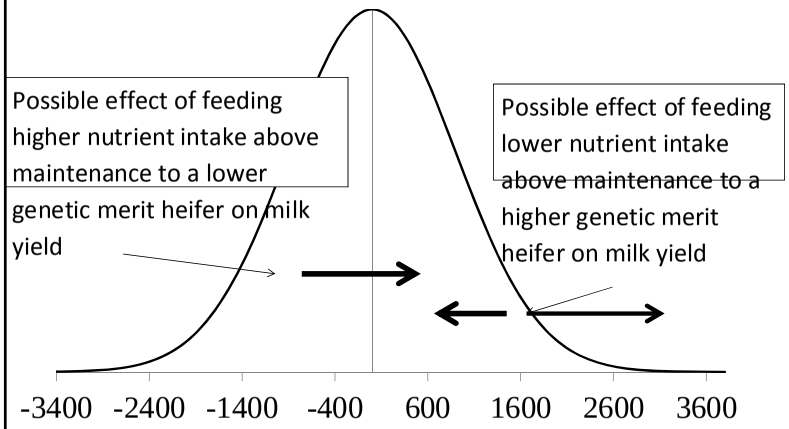
Soberon et al., 2012

What this means

- Genetic selection yields ~ 150 – 250 lb milk per lactation
- Pre-weaning calf nutrition and management can yield 4 to 8 times more milk than genetic selection per lactation
- If we are going to breed and select animals for greater genetic capacity, we have to feed and manage them for that expectation and outcome

Soberon et al., 2012

Effect of early life nutrition on phenotypic milk yield



Soberon and Van Amburgh, 2013

What about "Detractors" and Milk Yield?

- Mean milk response from Cornell herd:
  - 850 lb milk per lb pre-weaning ADG
- Calves treated with antibiotics (respiratory by SOP)
  - 623 lb milk per lb pre- weaning ADG
- Calves not treated with antibiotics
  - 1,407 lb milk per lb pre-weaning ADG
- Calves treated for respiratory issues didn't feel well, consume as much feed and grow as well those that weren't and didn't make as much milk

How Early Should Heifers Calve to Optimize Lifetime Productivity?

Dairy Comp 305 ---------- A REAL Dairy ---------- Page 1

SUM AFC LFMPL LFMLK ME305 LACT FOR AFC=(18-31) BY AFC\TA

AFC	%COW	#COW	Av AFC	Av LFMPL	Av LFMLK	Av ME305	Av LACT
1-7	**3**	**26**	**19**	**21185**	**49389**	**23090**	**3.5**
1-8	**7**	**67**	**20**	**24173**	**60433**	**31994**	**2.4**
1-9	**21**	**207**	**21**	**22320**	**63008**	**27643**	**2.7**
1-10	**21**	**205**	**22**	**22024**	**70268**	**27712**	**2.9**
1-11	**12**	**120**	**23**	**17488**	**51059**	**26357**	**2.4**
2-0	**8**	**83**	**24**	**17266**	**46157**	**26026**	**2.2**
2-1	**4**	**42**	**25**	**13202**	**33566**	**27024**	**1.9**
2-2	**4**	**42**	**26**	**11077**	**21363**	**27133**	**1.4**
2-3	**4**	**39**	**27**	**11273**	**19609**	**28507**	**1.2**
2-4	**3**	**32**	**28**	**13003**	**15868**	**28699**	**1.1**
2-5	**3**	**30**	**29**	**15817**	**22281**	**28268**	**1.2**
2-6	**3**	**28**	**30**	**17731**	**19186**	**28472**	**1.0**
2-7	**2**	**21**	**31**	**17013**	**19652**	**27440**	**1.1**
Total	100	980	23	18767	50307	27575	2.3

Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

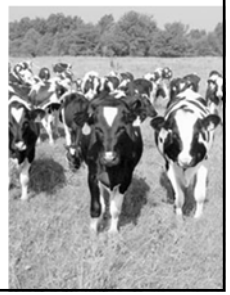
- Lactation records from
  - 2,519,232 first lactation cows
  - 937 herds in the Northeast and California
- Within herd analysis
  - Accounts for management, environment, and genetic differences among farms

Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

- Retrospective assignment to AFC treatment groups
  - Herd avg. AFC was calculated each year
  - Heifers were assigned to one of 5 AFC age groups:
    1) Less than -63 days from herd avg. AFC
    2) -22 to -63 days from herd avg. AFC
    3) -21 to 21 days from herd avg. AFC
    4) 22 to 63 days from herd avg. AFC
    5) Greater than 63 days from herd avg. AFC

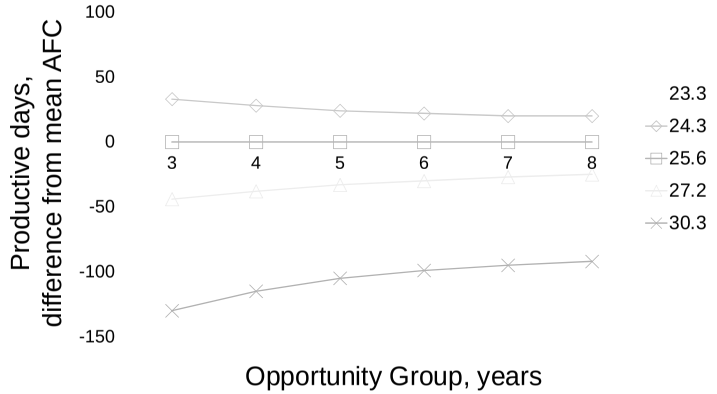
Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

- Retrospective assignment to AFC treatment groups
  - Herd avg. AFC was calculated each year
  - Heifers were assigned to one of 5 AFC age groups:
    1) 23.3 months AFC
    2) 24.3 months AFC
    3) 25.6 months AFC
    4) 27.2 months AFC
    5) 30.3 months AFC



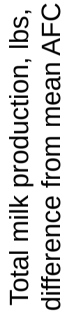
Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

Figure 1. Average number of productive days, difference from study herd mean AFC (25.6 month)



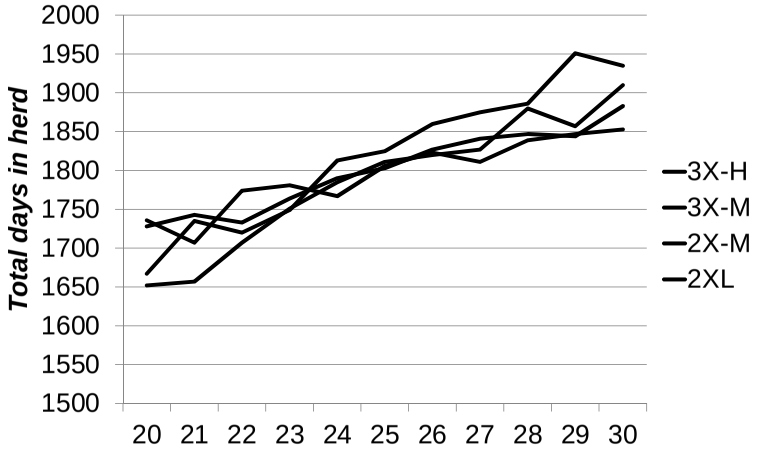
Within Herd Analysis of AFC on Productive Days, Milk Yield, Longevity

Figure 2. Average total milk production, lbs, difference from herd mean AFC (25.6 month)



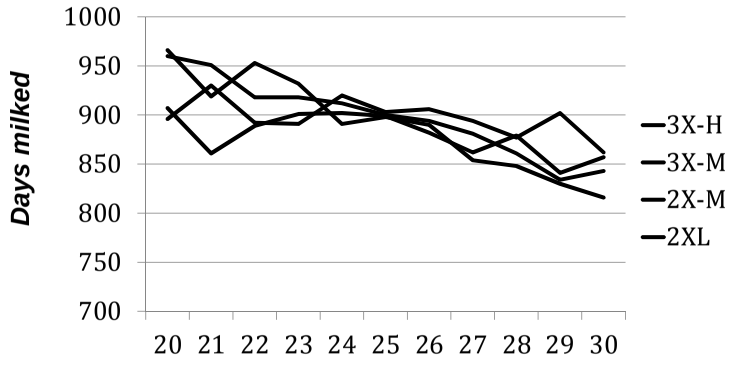
Opportunity Group, years

Exit age (total days) by AFC and 2x or 3x milking stratified by herd milk yield



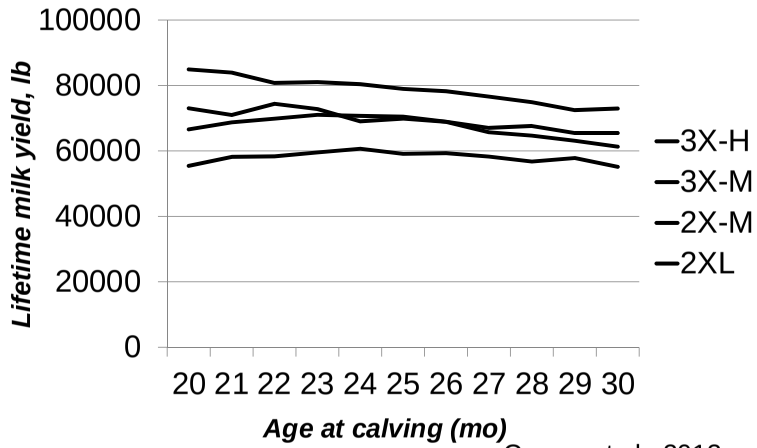
Curran et al., 2013

Herd life (days milked) by AFC and 2x or 3x milking stratified by herd milk yield



Curran et al., 2013

Lifetime milk (lb) by AFC and 2x or 3x milking stratified by herd milk yield



Curran et al., 2013

Analyzing Profitability by Calving Age within Herd

AFC	Cost to 1st Lact.	Breakeven Milk Prod. lbs	Actual Milk Prod., lbs	Cost of 1st Lact.	Milk revenue	Profitability
20	$1,806	8,738	20,796	$2,411	$4,299	**$82**
22	$1,986	9,609	21,368	$2,477	$4,417	**$-49**
24	$2,167	10,484	22,910	$2,656	$4,736	**-$87**
24.8	$2,235	10,813	24,533	$2,844	$5,071	**-$8**
28	$2,528	12,231	23,927	$2,774	$4,946	**-$356**
30	$2,709	13,106	21,844	$2,532	$4,516	**-$725**
35.9	$3,239	15,670	22,250	$2,579	$4,600	**-$1,218**

- Cost per day to lactation 1 is assumed to be $2.995 based on Karszes, 2012
- Net milk price is assumed to be $20.67 based off of the 2013-2014 Federal Milk Marketing Order averages
- 30.14 days per month assumed for calculations
- Cost in lactation 1 is calculated by using standardized cost per cwt of milk produced used from 112 farm averages as published in the 2013 DFBS for large herd farms (300+ Cows), Karszes et al.
  - $11.59/cwt cost to produce milk includes costs for:
    - Purchased and homegrown feed, breeding, veterinary medicine, milk marketing, bedding, milking supplies, livestock professional services and other

Summary

- The cow wants to communicate to the offspring and that starts in-utero
- She continues with colostrum and milk and wants to ensure the calf is always in an anabolic state – maximizing lean tissue gain
- Enhanced lean growth during the neonatal period has long lasting implications
- The effects of nurture is up to 7 times larger than nature – so we need to reinforce selection for genetic capacity with a similar management and nutrition program

Summary

- Productive days and milk is greater for heifers with lower AFC
- Economic analysis indicates that lower AFC is more advantageous
- Lower AFC requires fewer replacements per year to maintain herd size and this inventory reduction has significant financial implications

Thank you for your attention.

Achieving Maximum Growth Potential of Replacement Heifers Through Management and Nutrition

Robert B. Corbett DVM, PAS, Dipl. ACAN
Dairy Health Consultation

Raising replacement heifers is often looked upon as a major cost on the farm without a return on the investment until the animal begins its first lactation. As a result, heifers are often fed the cheapest feed available with minimum inputs on facilities and labor until they approach the time of calving. Efforts to improve management and nutrition of the dairy replacement heifer, in order to decrease the "age at first calving", have been labeled as an "accelerated heifer growth program". All young animals have a certain potential rate of growth that is possible to attain, as long as they receive adequate nutrition to provide the required nutrients that allow them reach their growth potential. The goal in other food animal livestock production systems such as poultry and swine, is to provide these animals with excellent nutrition that optimizes the health as well as the rate of growth of these animals. Dairy calves are the only livestock that I can think of where they are purposely "limit fed". Calves may be allowed to eat all they want, but the protein and energy levels may not be provided in the amounts to allow them to reach their individual growth potential. "Accelerated heifer growth programs" is actually a poor description and often misleads those who hear the term to think that it is an abnormal management procedure and that animals are somehow force-fed or artificially induced to grow at rates that are not normal. A more proper term would be "programs to allow the replacement heifer to reach its normal growth potential". Dr. Jim Drackley from the University of Illinois suggested we call it "biologically normal growth".

However, since the term "Accelerated Heifer Growth" is a more familiar term, I will continue to use it when referring to programs which maximize the normal potential rate of growth. Accelerating heifer growth has been a very controversial subject in recent years. The main controversy revolves around the subject of fat deposition in the udder during periods of rapid weight gain. However, I would like to start by differentiating between accelerated weight gain and accelerated growth rate. In my opinion, these are two completely different topics. Accelerated weight gain occurs when excessive levels of energy are fed to heifers with insufficient amounts of metabolizable protein which results in overconditioning without an increase in frame size. Accelerated growth rate involves formulating a ration that is much higher in metabolizable protein with sufficient amounts of energy provided to allow the utilization of this protein as well as the other energy requirements of the animal without causing excessive deposition of body fat. This results in an increase in frame size without overconditioning the heifer, reaching puberty and breeding size at an earlier age, and reduced age at first calving without compromising size at first calving or first lactation milk production. This process must start soon after birth in order to obtain the maximum frame size possible at calving.

Dairy owners are well aware of the importance of delivering adequate amounts of high quality colostrum to newborn calves as soon as possible after birth. A recent publication states that calves receiving adequate amounts of colostral immunoglobulin have reduced morbidity and mortality, reduced treatment costs, improved growth rates to 180 days, improved feed efficiency, decreased age at first calving, and increased first lactation milk yield (Faber et al., 2005). The calf should receive 10% of its body weight in high quality, first milking, clean colostrum as soon as possible after birth. It is also recommended that a second feeding of first milking colostrum be given at a rate of 5% body weight within 8 hours of the first feeding. High quality colostrum will contain at least 50 grams per liter of IgG immunoglobulin, and have a low bacteria count, preferably below 10,000 per milliliter, and less than 1,000 coliform bacteria per milliliter. However, if proper management and hygiene of colostrum is observed, it should be possible to achieve the same goals for bacteria counts that are established for bulk tank milk shipped to the processing plant which is <10,000 Standard Plate Count and <300 Coliform Count. Colostrum can be given for the first 2-3 feedings if desired. It is also a common practice to feed transition milk (second and third milking colostrum) to the calf for the first week. An entire article can easily be written just on Colostrum Management so no more than this basic description will be covered here.

Most of the accelerated formula milk replacers will contain between 26 and 30% protein and 15 to 20% fat. The protein level is very similar to that of whole milk solids but the fat level is somewhat lower. The purpose of this protein to fat ratio is to promote lean tissue growth rates and minimize the effect of fat on starter grain intakes. Research at the University of Illinois showed that the ratio of lean tissue to body fat was much greater and that the efficiency of gain was much greater in those calves fed the high protein milk replacer. These calves gained weight much faster but also required less dry matter per pound of weight gain. This fact needs to be considered when evaluating the economics of an accelerated calf growth program. This same study fed 3 groups of calves a 26% crude protein, 18% fat milk replacer at a rate of 10 %, 14% or 18% of body weight per day. The corresponding growth rates were 0.79 lbs, 1.55 lbs and 2.25 lbs respectively. I would like to emphasize again that the calves with the greatest growth rates had the highest lean tissue to fat tissue ratio. The higher protein milk replacer promotes more lean tissue gain as well as improves efficiency of gain.

It is important that the protein:energy ratio be calculated properly in order to achieve the maximum rate of growth without excessive fat deposition. The following table summarizes the current information about the requirements for growth of the calf based on the body composition data derived since the 2001 NRC was published.

Table 1. The energy and crude protein requirements of calves from birth to weaning (Van Amburgh and Drackley, 2005).

Rate of Gain, lb/d	Dry matter intake, lb/d	Metabolizable energy, Mcal/d	Crude protein, g/d	Crude protein, %DM
0.45	1.2	2.4	94	18.0
0.90	1.4	2.9	150	23.4
1.32	1.7	3.5	207	26.6
1.76	2.0	4.1	253	27.5
2.20	2.4	4.8	307	28.7

The energy requirements are slightly lower than previous recommendations since they were based on heavier veal type calves fed higher fat diets and depositing more fat per unit of weight gain. The protein requirements are higher than the NRC 2001 due to recent research updating the efficiency of use calculation for protein. This research indicated that the absorbed protein was used with an efficiency of 0.70 instead of 0.80 as suggested by the 2001 NRC. This results in an increase in the protein requirement that is 10-12% higher than the current predictions (Van Amburgh, 2006).

Researchers at Cornell University are recommending that milk replacer should be formulated at 28% protein and 15% fat and fed at a rate of up to 20% of body weight (Van Amburgh and Drackley, 2005). Young calves are more efficient at converting feed to body weight, and this fact should be taken advantage of when the calves are still on milk. Danish research has also shown that calves fed milk free choice gained 0.66 lbs. per day more than those fed 10 lbs. of milk per day. Those that gained weight the fastest also gave more than 1,000 lbs. of milk during their first lactation than those receiving the 10 lbs. of milk per day (Foldager and Krohn, 1994).

The traditional method of feeding calves for the last 60 years has been to provide them with 2 quarts of milk per feeding and two feedings per day. When milk replacer was first developed, the purpose was to provide the dairy owner with a product that could be fed to the calves that would allow the dairyman to sell more of his milk. It is obvious that if the product was to be less expensive than whole milk, then it would have to have a lower nutrient content. Since no one was really aware of how much milk the newborn calf required, or normally consumed, it became a standard practice to feed the calf 2 quarts twice a day. The bottles that were manufactured to feed the calves were two quarts in size, and still the most common bottle used to feed calves is the 2 quart bottle.

The most common milk replacer in use today contains 20% protein and 20% fat. Whole milk from Holsteins averages about 27% protein and 30% fat on a dry matter basis. Milk replacer is commonly mixed at a rate of 1 pound of milk powder to 1 gallon of water. Since milk replacer is 95% dry matter and water weighs 8.34 pounds per gallon, the milk solids content of a 20:20 milk replacer mixed at this rate is 11.34%. Whole milk from Holsteins averages about 12.5% solids. When calculating the total amount of protein and fat that the dairy calf receives from 1 gallon of a 20:20 milk replacer mixed at 1 pound per gallon compared to 1 gallon of whole milk, the 20:20 milk replacer has 0.19 pounds of protein and 0.19 pounds of fat, and the whole milk contains 0.285 pounds of protein

and 0.317 pounds of fat. Whole milk contains 50% more protein and 67% more fat than the 20:20 milk replacer! It is no wonder that when a dairy switches their calves from a 20:20 milk replacer to whole milk that they notice a tremendous improvement in the health and growth of the calf.

The National Research Council (NRC) publishes the Nutrient Requirements for Dairy Cattle. It has also produced a computer program that allows the nutritionist to evaluate feeding programs and see what the potential gain is from protein and from energy. If the standard 2 quarts twice a day of a 20:20 milk replacer is entered into this program, and the environmental temperature is set at 68° F, the calf has the potential to gain about 0.5 pounds per day from protein, and about 0.5 pounds per day from energy. The thermoneutral temperature of the calf is 68° F (20° C). This is the temperature at which the calf does not have to expend any extra energy to either warm itself or cool itself. If the environmental temperature drops to 32° F (0° C), the NRC program calculations result in a weight loss, both from the protein supply as well as the energy supply. We already discussed the fact that whole milk contains 50% more protein and 67% more fat than a 20:20 milk replacer. We should expect much better results from whole milk than we would the milk replacer. At 68° F the program states that the calf should gain approximately 0.75 pounds per day from protein and the same from energy. However, when the calculations are done at 32° F, the result is weight loss, both from the amount of protein and also energy. It is no wonder then, that when the environmental temperature is cold, we see weight loss and a significant increase in respiratory disease in calves that are only fed 2 quarts twice a day.

If a dairy calf was allowed to nurse its mother, it would nurse approximately 10 times per day and would consume an average of 20% of its body weight per day in milk. If we assume that a Holstein calf weighs 85 lbs., 20% of its body weight would be approximately 2 gallons. This is twice as much milk as a calf would normally receive on a traditional program on most dairies, especially those that are bottle fed. The Holstein calf would consume approximately 0.7 pounds of protein per day, compared to 0.285 pounds of protein when receiving only 4 quarts a day of whole milk or 0.19 pounds of protein when receiving 4 quarts of a 20:20 milk replacer. This protein is required by the calf in order to allow it to grow and develop according to its own genetic potential. The amount of fat is also doubled, which permits the calf enough energy to fuel the various systems of the body, as well as their immune system. This energy is also utilized when environmental temperatures are colder, to provide the energy to maintain the body temperature and continue to gain weight.

It is obvious then, that a nutritional program must be developed that will provide this increased amount of protein and energy to the calf, so that the calf will continue to grow and be healthy, regardless of the environmental temperature. In order to do this, the amount of nutrients consumed by the calf per day can be increased by increasing the volume of milk fed per feeding, increasing the number of feedings per day, and increasing the solids content of the milk or milk replacer. When any of these management practices, or combination of these practices are implemented, a noticeable

improvement in the health and condition of the calves will be observed in just a few weeks.

It is obviously less expensive if the dairy utilizes its waste milk to feed the calves. However, it is important that this milk is pasteurized, in order to reduce the bacterial load in the milk and decrease the adverse effects of high bacterial counts on the gastrointestinal tract of the young calf. The calf should receive 15% of its body weight in milk per day during the first week of life. This would amount to 3 quarts twice a day for the average Holstein calf. Starting at the second week of life, this amount should be increased to 4 quarts twice a day or 20% of its body weight. This amount should be maintained until the calf is eating enough of a high quality starter to begin the weaning process. Starter amount and quality will be discussed later.

It is possible to increase the solids content of whole milk with milk replacer or "milk extenders". Milk extenders are formulated specifically to be added to whole milk, and are usually higher in protein than in fat. If either one of these products are used, it is very important to monitor the percent solids of the final product with a Brix Refractometer. The percent solids can be raised to 15% without creating any issues with nutritional diarrhea. Under excellent management conditions, the percent solids can be increased to as high as 18%, if free choice water is available to the calf at all times, without causing issues with osmotic diarrhea. It is important to not increase the percent solids more than 2% per adjustment, if changing your program on calves that are currently on just whole milk or milk replacer which is approximately 12% solids. If starting new calves on a higher percent solids diet following colostrum, it can be done at the very next feeding since colostrum is around 24% solids.

The same type of program should be used if feeding milk replacer. It is difficult to provide the maximum levels of protein and energy required by the calf to reach its potential rate of growth with a 20:20 milk replacer. For this reason, newer formulas have been developed that have much higher levels of protein (26-28%) and approximately the same level of fat (15-20%). The higher protein level allows the calf to grow faster in stature and muscle development without becoming over-conditioned, but at the same time provides the necessary energy for maintaining body temperature, growth, and fueling the immune system. Research has shown that higher fat levels in the milk will suppress the appetite and discourage intake of calf starter. It is also recommended to increase the solids of the milk replacer to 15% or higher in order to better meet the nutritional requirements of the calf. Higher protein diets will improve feed efficiency thus decreasing the amount of solids needed per pound of gain for the calf.
It is also possible to increase nutrient intake by increasing the number of feedings per day. If using bottles to feed the calves, it is very difficult to increase the volume of milk fed per day unless the number of feedings are increased. There are 3 quart bottles available now that are helpful, but still only allow 6 quarts per day to be fed, which is about 75% of the recommended amount if the calves are fed twice a day. This is obviously much better for the calf to receive more feedings per day, but also requires a significant increase in labor costs so many dairy owners are reluctant to increase nutrient intake by increasing the number of feedings per day. This is one of the main reasons why

feeding methods have been developed to allow multiple feedings per day with minimal labor. These would include computerized automatic milk feeders, and free access to acidified milk. The main drawback to these systems is that an increase in the spread of infectious disease, usually respiratory disease, is often noticed. There has been a tremendous amount of work done at the University of Wisconsin in recent years in the proper design and ventilation of group-housed calves which has resulted in a significant decrease in the incidence of respiratory disease in these facilities.

Another false paradigm that needs to be addressed concerning traditional milk feeding systems is that the earlier a calf is weaned, the better. This has become a common management procedure for several reasons. One is that the cost of milk or milk replacer is higher than dry feed for the calf. The second, is that it is a common belief that the calf has more problems with infectious disease while it is on milk. The entire heifer raising operation on a dairy farm is commonly thought to be a significant cost with no return to the farm until the heifer enters the lactation herd. When looking at the costs of raising a heifer, the most common approach is to look at the cost per animal per day. However, what is important is the cost per pound of gain of this animal since size and weight are what determines the age at first breeding as well as the appropriate size at first calving.

Feeding high quality feeds, especially milk products, will be more efficiently utilized and converted into pounds of weight gain, thus reducing the cost per pound of gain. As far as illness is concerned, the most common time for young calves to have problems with diarrhea is between 7-12 days of age. This is because the most common causes of diarrhea (Rota and Corona Virus, and Cryptosporidium) usually manifest themselves at this time. It is also common to see issues with respiratory disease around 30 days of age because many milk feeding protocols call for a reduction in the quantity of milk being fed at this time. This stresses the calf, and with a lower nutrient intake the immune system cannot function properly, thus resulting in a higher incidence of disease. Also, 3-4 weeks is the time when the calf's nutrient supply on a traditional feeding program becomes significantly deficient to the point where their immune system cannot function properly and disease incidence increases, especially respiratory disease. Research from Cornell University has shown that heifer calves that are treated only one time with antibiotics (usually for respiratory disease), and respond to treatment, gave 1085 pounds less milk during their first lactation.

Unfortunately, the main goal of many heifer operations is to wean the calf early. The main goal of any dairy heifer replacement operation should be to raise a high quality, healthy, heifer calf that has had the proper nutrition to be able to maximize its own genetic potential for growth, and to do it economically. These heifers would reach breeding size earlier, and also enter the lactating herd at a younger age but at the desired size and weight, and with the ability to produce much more milk during its productive life. There are numerous research studies that indicate that the higher plane of nutrition during the milk-fed phase will result in an average of 1,700 lbs. more milk during the first lactation. This increase in production also continues into subsequent lactations. Early weaning has a detrimental effect on the health and growth of the calf, as well as its ability to produce milk in the future.

Calf operations that have implemented this program of providing a higher plane of nutrition for the milk-fed calf have seen tremendous improvements in the health of the calf. In the past, it has been a common goal of well-managed dairies to have a death loss of 5-7% while the calves are on milk. Dairies that are feeding the amounts of milk suggested in this article are commonly seeing a death loss of less than 0.5 to 1%. The number of calves that are treated for various illnesses is also greatly reduced. It is not uncommon to see a decrease of at least 80% in the cost of the medicine to treat calves during the milk-fed phase.

Another common paradigm is that the earlier a calf consumes large amounts of calf starter, the better, since calf starter consumption is related to rumen development. Quite to the contrary, this is an indication that the young calf is not receiving enough nutrients through its milk supply to fulfill its requirements for energy and protein and is desperately looking for other sources of nutrients to fulfill these requirements. Since the calf's rumen is not yet developed, it does not have the ability to efficiently utilize the nutrients in a calf starter grain. The energy and protein in milk or milk replacer made from only milk products is rapidly available to the calf and is easily digested. For this reason, it is not advisable to feed any soy protein in milk replacer until calf is at least 3-4 weeks old. Preferably, soy protein would be better left out of milk replacer in general. The goal is to maintain the calf on a consistent level of milk (20% of birth weight) until the calf has developed the ability to consume enough calf starter to start the weaning process. Unfortunately, the most common level of crude protein in commercially available calf starters is 17-18%. It was previously mentioned that the protein level of whole milk in Holsteins is around 27% on average, on a dry matter basis. This is a tremendous drop in protein content from whole milk to a calf starter. Therefore, the calf has to consume enough calf starter prior to weaning to be able to meet its nutrient requirements after weaning. Also, one must assume that the efficiency of rumen fermentation of the young heifer is not as good as older animals, and the ability to utilize the nutrients in calf starter is limited. In general, if an 18% protein calf starter is used, the calf should consume somewhere around 4 pounds of it for 3 days in a row before starting the weaning process. However, if a high quality starter is used than contains around 24-25% protein, approximately 2 pounds should be consumed for 3 days in a row before starting the weaning process.

There is a general concern that if the calf is fed larger volumes of milk, that the desire to consume calf starter will be significantly delayed. Once again, I would like to mention the fact that early consumption of calf starter is a sign of malnutrition. Initially, the calf will definitely consume less calf starter. However, dry matter intake depends on body weight, and calves that are consuming larger volumes of milk have the ability to gain over 2 pounds per day compared to only 0.5 to 0.75 pounds on a traditional program. Since these calves gain so much more per day, the desire to consume more dry matter comes along with the increased body weight. By the time the calf is 4-6 weeks old, the amount of calf starter consumed increases significantly and the calf will more than likely be consuming enough calf starter to start the weaning process between 7 and 10 weeks of age, depending on the size of the calf.

This process of "transitioning" from a total milk or milk plus some dry feed diet, to a 100% dry feed diet is much more complicated than many people think. There are two very important factors that must be considered when designing a successful "Transition Management and Nutrition Program" for the dairy calf. One is the ability of the calf to consume enough high quality starter to supply its nutrient requirements prior to weaning, and the other is adequate rumen development. Both of these factors are often ignored when weaning calves based on age only.

What determines whether or not the calf starter is "high quality"? The calf starter should contain a minimum of 22% protein, but 24-25% is preferred. The source of protein in the calf starter should be soybean meal. Soybean meal has a good amino acid balance, is highly digestible, and degradable in the rumen. This provides a readily available protein source for the rumen bacteria, allowing it to multiply rapidly thus improving their ability to digest and ferment feed that enters the rumen. Bypass protein sources should not be used in calf starters. In the developing rumen, the ability to utilize the protein is limited anyway, and any protein not digested in the rumen becomes bypass protein and passes on into the small intestine for absorption. There needs to be a readily available form of starch in the calf starter. Whole corn is often used in calf starters, but the starch is not rapidly available, and as a result, tends to impede rumen development. The calf starter should be very consistent, especially in the moisture content. Calves are very habitual eaters and do not like changes in the consistency of their feed. This tends to decrease dry matter intake of the starter.

An entire article could be written on the process of rumen development, so we will only cover the basics here. When the calf is born, the rumen is significantly smaller than the abomasum and is not developed as far as the musculature of the rumen is concerned, and rumen papillae are absent. The rumen is essentially sterile at birth, and the first bacteria that enter the rumen are those that are ingested from the environment. The majority of these bacteria are "aerobic", or require oxygen to grow. The rumen of the adult cow has an "anaerobic" environment, which means that the bacteria do not grow in the presence of oxygen. During the development of the rumen, the population of bacteria changes from aerobic to anaerobic.

Bacteria require a liquid environment in order to grow. Unfortunately, there are still dairies that either provide no water, or water access is limited to the calves that are being milk-fed. This inhibits the growth of the bacteria that are important in rumen development, thus delaying it significantly. It is often noticed that calves with limited water access, really struggle after weaning and have a high incidence of respiratory disease. Many people think that since milk is close to 90% water, that it should satisfy the requirement for water. However, regardless of whether or not the calf sucks a bottle or drinks from a bucket, the esophageal groove closes and the milk bypasses the rumen and goes directly into the abomasum. Therefore, the water requirement for the rumen bacteria is not met. However, when drinking water from a bucket, it flows directly into the rumen. A high percentage of calves will drink fresh water when it is offered to them after their milk feeding. Multiple studies have been done to show that there is a

significant increase in starter consumption when calves have free choice water. This also accelerates rumen development, as well as increases the growth rate of the calf.

As mentioned previously, the calf starter must also contain a readily available source of starch. When starch is fermented in the rumen, butyric acid is produced in large amounts. Research has shown that butyric acid has more influence on the development of both rumen size and rumen papillae than any other substance in the rumen. Rumen papillae are necessary for the absorption of volatile fatty acids (VFA's) that are produced in the rumen during the fermentation of feed. These VFA's are an important source of energy to the ruminant. A poorly developed rumen cannot absorb these VFA's efficiently, which results in the buildup of these acids in the rumen and can result in serious issues with rumen acidosis. Corn is the most common source of starch in calf starters. There are several forms of corn that can be used in calf starters. Steam-flaked corn has the most highly available form of starch. The only problem with it is that the flake is fairly thin and tends to break up in the starter, thus resulting in an excessive amount of fines. Rolled corn is not submitted to quite as high of temperatures and the thickness is greater than steam-flaked corn. It has less fines than steam-flaked corn, but can still result in more fines than desired. Bump corn is rolled but only slightly. It is significantly thicker than regular rolled corn but is still easy for the calf to chew up and starch is fairly available. Some starters contain whole corn which is also palatable, but the starch is not very available to the rumen bacteria. Studies have shown that rumen development in calves that are fed whole corn is slower than with other forms of corn. Therefore, it would be better to avoid whole corn in the calf starter if possible. Some calf starters will contain a small amount of flaked barley in them as a source of rapidly available starch, thus providing some starch immediately to the developing rumen bacteria, before the starch from corn is available.

Calf starters are available in three different forms, textured, pelleted, or meal. The textured form is preferred for several reasons. One is that it is more palatable, and results in a higher level of dry matter intake than the other two forms. The other is that because of its form, it tends to do a better job in stimulating the musculature of the rumen wall. There is some concern that if the milk-fed calf does not have some forage to nibble on, the musculature of the rumen wall will not develop properly. However, research has shown that textured starters function in the rumen to develop the muscle layer sufficiently in the absence of forage. The size of the pellet in both textured starters and pelleted starters is important in this process. Unfortunately, many calf starters use small size pellets in them (8 mm), which are less effective in developing the rumen musculature. I prefer to use a 5/16 inch diameter pellet (12 mm). When running a side by side trial, I have seen an average of 15% in increase in dry matter intake of a textured starter when compared to a pelleted starter. Some dairies make their own calf starter. Since they usually do not have the ability to manufacture pellets on the farm, the starter is a mixture of various forms of ground feed or meal. In general, calves do not like this form of feed, and dry matter consumption of this form is less than the pelleted or textured form.

In order to "transition" the calf, the weaning process has to be in synch with rumen development. There are pictures accessible on the internet that show a fairly well

developed rumen at 4 weeks of age. However, these calves were not receiving 20% of their body weight in milk per day and were essentially forced to look elsewhere for the nutrients needed to survive. Once again, early consumption of large amounts of calf starter is a sign that the calf is not receiving enough nutrients in its milk to satisfy its requirements for growth and maintenance. Since the rumen is not well-developed at the time that the calf starts to consume calf starter, a very small portion of it is actually digested and utilized by the calf. Therefore, the calf is not receiving enough nutrients from the limited amount of milk and starter to allow it to reach its genetic potential in growth. Even though the rumen is developed in this case at 4 weeks, the calf is still not growing well, and its immune system is not receiving enough nutrients to function properly.

If the calf receives 20% of its body birth weight per day from the 2nd week of life, and continues to receive this amount, the consumption of calf starter gradually increases as the calf grows and gains weight. Once it reaches the weight where it needs more nutrients, calf starter consumption increases accordingly. It will usually take 3-4 weeks for the calf to increase consumption of calf starter to the point where the goal of 4 pounds of low quality starter (18% protein) or 2 pounds of a high quality starter (24-25% protein) is consumed. This is enough time for the rumen to develop sufficiently to digest or ferment the feeds that enter the rumen. It is best to feed only calf starter for at least 7-14 days after weaning, to further develop the rumen from starch fermentation and the production of butyric acid. Calves should be left in the hutch or individual pens during this time in order to observe the amount of starter consumption.

Traditional weaning programs will have a goal of weaning the calf at a specific age. In order to accomplish this, the amount of milk being fed is reduced at a certain age in order to force the calf to consume more starter. The calf usually only has about one week at this reduced amount of milk before being weaned. The problem with this system is that the rumen does not have sufficient time to develop prior to the calf being weaned. The calf is forced to consume more starter to try and satisfy its appetite and nutrient requirements, but does not have a sufficiently developed rumen to ferment the feed in the rumen efficiently. These calves will often develop rumen acidosis and "matting" of the rumen papillae. Calves can be successfully weaned on this type of program if they have been consuming a significant amount of calf starter for at least 3 weeks prior to weaning. However, if consuming a lot of starter early on like this system requires, they are definitely not receiving enough nutrients through the milk to meet their nutritional requirements for achieving their genetic potential for growth and properly fueling their immune system.

In recent years, there has been an increasing awareness of the importance of increasing the amount of milk to the calf. For this reason, it has become more commonplace to see an increasing number of computerized automated milk feeders. Most of these feeders have flexibility in their programming to allow just about any type of feeding program desired. However, many of these come already programmed with a complicated series of increases and decreases in the amount of milk that the calf is allowed to drink from week to week. One common approach is to gradually increase the amount of milk per day until

it peaks at a certain level and then turn around and immediately start reducing the amount of milk per day in an effort to encourage starter intake. Most are programmed to allow weaning before 8 weeks of age. Again, this approach forces the calf to eat more starter, and the rumen may not be sufficiently developed to efficiently digest or ferment dry feed. One major problem with computerized feeders is that when the calves are group housed, there is no way to observe what the individual intake of starter is per calf. Even though the program has reduced milk intake, some of the calves may not be consuming enough starter prior to weaning to be able to meet its nutritional requirements after weaning. For this reason, it is common to see calves struggle post weaning with poor weight gains and an increase in respiratory disease. In many cases, existing buildings have been retrofitted with computerized feeders without taking into consideration the ventilation of these facilities. Numerous operations have experienced serious issues with respiratory disease and increased death losses when moving into these poorly ventilated barns. Dr. Ken Nordlund at the University of Wisconsin has done a tremendous amount of work in the design of calf barns and ventilation systems, and his guidelines for the design of calf barns have greatly reduced the incidence of respiratory disease.

Some dairies in cooler climates have developed programs for the feeding of acidified milk. In this case, the calves have free access to milk at all times. The low pH of the acidified milk tends to limit the amount of milk they will consume in one feeding, but calves may still consume up to 12 quarts or more of milk per day. These calves will gain weight rapidly; however, the same issue exists at weaning time. They are usually group housed so the amount of milk must be reduced prior to weaning, so some calves may not be consuming enough starter at weaning since individual starter consumption cannot be monitored. The same problems with increased respiratory disease in this system have also been observed in poorly ventilated barns.

A successful “transition program” for the dairy calf must include the presence of a rumen that is sufficiently developed to efficiently ferment dry feed entering the rumen. It must also be designed to provide at all times the necessary nutrients to allow the calf to gain in weight and increase in size according to its own genetic potential. Traditional programs of feeding the calf at a rate of only 10% of its birth weight per day are borderline starvation diets, and in times of cold weather or heat stress, often result in weight loss and increase in infectious disease. A very easy goal to reach is to double the birth weight of the calf by 8 weeks, of age. More intensive programs with increased milk solids can result in the tripling of the birth weight by 10 weeks of age. Designing a transition program with these thoughts in mind will result in a tremendous increase in the rate of gain without excessive fat deposition, a much healthier calf with lower morbidity and mortality rates, a heifer that reaches the appropriate breeding size much earlier, and a first lactation heifer that enters the herd at a younger age and with the ability to produce much more milk. As long as a high plane of nutrition is maintained during the entire growing period of the heifer prior to the first calving, the longevity of these heifers is improved as well as lifetime milk production. Successfully transitioning the dairy heifer calf is an important investment in the future productivity and profitability of the dairy operation.

As the heifers mature, their rations have to be adjusted according to their requirements. The problem comes with the grouping of the heifers. Smaller dairies often have to group heifers together that have a wider range of age. This makes it extremely difficult to formulate a ration that is adequate for the younger animals without over-feeding the older heifers. In order to maximize the growth of the younger animals, the ration should be formulated for them, carefully observing the older animals in the group to ensure that they do not become overconditioned. Smaller dairies may wish to utilize the lactating ration for one group of heifers and the pushout from the lactating cows for another group. Pushout or feed refusals may not be a viable alternative for herds on a strict Johne's control program. Each dairy that is interested in an accelerated heifer growth program needs to consult their respective nutritionist in formulating the appropriate rations based on the ages of heifers within the respective groups. Basically, these rations will be somewhat lower than what is usually formulated for energy and higher for protein. Concerns about overfeeding protein can be satisfied by checking the blood urea nitrogen levels to see if they are elevated. If the rations are properly formulated, the heifers will increase rapidly in frame size without becoming overconditioned.

Once heifers are successfully weaned, they should be left in the hutch for 1-2 weeks to make sure that their starter intake increases up to approximately 8 pounds per day. When moving to the first group pens, the group size should be kept to 6-8 calves per pen if possible. It is not advisable to change the ration at the same time the animals are mixed together. This creates stress from a social change at the same time there is stress from a ration change. Calves should be mixed together for at least a week with only access to calf starter and then changed to a grower ration consisting of 20% high quality alfalfa hay and 80% concentrate in a total mixed ration. If alfalfa hay is not available, then another high quality dry forage can be used. The crude protein of this ration should be 20-22%. Heifers would remain on this ration until they are about 5 months of age.

The next group of heifers would consist of animals that are 5-8 months of age. Fermented forages can now be introduced in the ration with a total crude protein level of around 18%. The potential gain from metabolizable protein should be about 0.5 lbs. higher than the potential gain from metabolizable energy. The body condition should be monitored routinely to make sure that the ration is formulated properly to allow the maximum gain in the frame size and muscle deposition without the heifers becoming over-conditioned.

The next ration change is at 8 months of age and continues until the heifers are diagnosed pregnant. This ration will be around 16% crude protein but the potential gain from metabolizable protein will be about 1.0 lbs. higher than the potential gain from metabolizable energy. As the groups of heifers get older, this potential difference between protein and energy continues to increase in order to maintain the proper growth characteristics in the heifers.

Heifers need to be bred when they reach the appropriate frame size, not according to body weight. I like to use 51 inches at the withers for the height at which to begin breeding. I have found that on a good accelerated heifer growth program, approximately

28% of the heifers will reach this height at 10 months of age. About 60% will be ready at 11 months and the rest by 12 months of age. There will always be a few that are delayed in reaching their breeding height. These heifers must be critically evaluated and possibly culled. Instead of waiting until breeding age to evaluate heifers for possible culling, I like to do the evaluation at approximately 400 lbs. It is very easy to pick out heifers that are obviously stunted and/or in poor health when compared to their herdmates of similar age. Unless these heifers are obviously sick, they can be sold for current heifer market prices without a loss. If kept in the herd, they often calve, produce poorly, and are then culled at beef price. The cull price is close to what would have been received if sold at 400 lbs. only without all the feed costs that were incurred in feeding the heifer to adulthood.

The single most common problem with breeding heifers on an accelerated heifer program is waiting too long to initiate breeding once the heifers have reached the appropriate breeding size. As heifers get older, the rate at which their frame size increases tends to slow down. If heifers are still several months away from calving when this process occurs, they tend to gain body condition. Heifers that were bred late or took longer to conceive could become overconditioned when compared to heifers that conceived close to the time they reached the appropriate breeding size. If this occurs, the late bred heifers would have to be put on a lower quality ration to prevent overconditioning. It has also been my experience that heifers calving in for the first time at 30 months of age or older do not milk well and do not return the money invested in them up to calving. These heifers are obviously problem breeders and often are extremely difficult to get bred back after calving.

Once heifers have been confirmed pregnant, the metabolizable energy levels must be cut back while maintaining the level of metabolizable protein or heifers may become over-conditioned. The ration is formulated at a negative 1-2 Mcal below the suggested requirement for energy, but the metabolizable protein is maintained at about 150-200 grams above suggested requirement. In order to accomplish this, the crude protein level of the pregnant heifer ration will usually be around 15-15.5%. Since the growth curve has been shifted significantly to the left, the rate of growth slows down earlier in the gestational period when compared to a traditional program of calving at 24-28 months of age. It has been suggested that the ideal height for heifers at calving is 54.9 inches at the withers and weighing 1350 to 1400 lbs. pre-calving. Heifers raised on this program, which will allow them to reach their natural potential growth rate, will meet or exceed these goals set for a traditional program, will not have any increase in calving difficulties, and will produce more milk during their first and subsequent lactations.

If at all possible, it is advantageous to keep the springer heifers separated from the second lactation and older cows in the close-up dry cow pen. Heifers do not compete well with older cows and often will not consume adequate amounts of dry matter for optimum health. Care should also be taken to provide adequate bunk space for heifers and to adjust the ration on a daily basis according to the number of heifers in the close-up pen. Recent research from British Columbia has shown that heifers and cows that have reduced dry matter intakes 3 weeks prior to calving are the same animals that experience

the greatest incidence of metabolic disease after calving (Huzzey, J.M. et al,. 2006). Close-up dry cow pens and fresh cow pens should be kept at 80% capacity in order to minimize competition at the feed bunk and maximize dry matter intake. The area in which the heifers give birth, whether it is the close-up pen or a specific maternity area, needs to provide the heifer with adequate space so she can lie down and give birth without being disturbed. I have seen situations where the percent of calves born dead was cut in half simply by doubling the size of the close-up pen where the heifers were giving birth.

The number one concern pertaining to accelerated heifer growth programs is deposition of fat in the mammary gland, resulting in decreased first lactation milk yield. However, these results were received by accelerating the weight gain on prepubertal heifers, without much attention paid to the protein requirements needed to increase frame size. There have also been several studies examining the mammary gland which have proven that there is no decrease in milk producing tissue in fresh heifers that have been on accelerated growth programs with increased protein levels in the ration. The reduction in mammary parenchyma DNA that has previously been reported in heifers reaching puberty, is simply due to the fact that heifers on a higher plane of nutrition reach puberty at a younger age (Van Amburgh, 2005). I have followed animals now for 5 lactations that were raised on an accelerated program and have seen no adverse effects on their reproductive efficiency or production. In fact, data collected from these herds suggest that their longevity in the herd may actually be improved.

Now that more is known about how to properly formulate rations to accelerate the growth in replacement heifers, it is possible to have heifers calving in at 20 months of age and still obtain the same frame size as 24 month old heifers raised on a conventional ration. These heifers do not show a decrease in first lactation milk yield and do not show any increase in calving difficulties.

The following chart is a printout from Dairy Comp 305 of a 1,500 cow herd following this program that shows no difference in the average week 4 milk, week 12 milk, and 305 ME in first calf heifers from 18 months to 24 months of age at first calving:

By FRAGE	%COW	#COW	Av W4MK	AvW12MK	Av305ME
1-6	1	4	69.8	76.2	29872
1-7	15	70	62.6	72.2	27618
1-8	32	151	66.8	73.9	28172
1-9	24	114	67.2	74.0	28178
1-10	17	82	69.6	74.8	28468
1-11	9	44	70.8	77.0	28958
2-0	3	13	68.8	74.8	27602
Total	100	478	67.3	74.2	28215

Following is a table that illustrates the total number of heifer replacements needed per 100 cows in order to maintain herd size, taking into consideration the age at first calving and the herd's cull rate:

Age at First Calving*

Cull Rate	22 Mo	23 Mo	24 Mo	25 Mo	26 Mo	27 Mo	28 Mo	29 Mo	30 Mo
20%	38	42	46	48	52	56	61	63	67
22%	42	46	50	54	58	63	67	69	73
24%	46	50	54	58	63	67	71	75	81
26%	48	54	58	63	69	73	77	81	87
28%	52	58	63	69	73	79	83	87	94
30%	56	63	67	73	79	83	89	94	100
32%	61	67	71	77	83	89	96	100	106
34%	63	69	75	81	87	94	100	106	112
36%	67	73	81	87	94	100	106	112	121
38%	71	77	85	92	98	106	112	118	127
40%	75	81	89	96	104	110	118	125	133

*Based on 12% heifer losses: deaths 0-12 months=5%; pre-breeding culls=3%; deaths 13 months to calving=1%; and post-calving losses 3%.

If we assume that an average culling rate in today's large dairies is around 36% and that the current age at first calving is 26 months, the dairy would have to have 94 heifers per 100 cows on the farm from birth to calving in order to maintain herd size. If this is a 1,000 cow dairy, then 940 heifers would be needed. If the age at first calving was reduced to 22 months, then only 670 heifers would be needed to maintain herd size. That is a difference of 270 heifers needed on the farm. Approximately half of these heifers needed on the farm to maintain herd size would calve in one year. Half of 270 would be 135. If these heifers had to be purchased at $1,800 per head, this would equal $243,000 per year on increased costs.

Let's look at this same situation another way. A 1,000 cow dairy with a 36% cull rate would need 360 replacement heifers per year. Assuming that 50% of the cows have heifer calves that would yield 500 heifers per year. Since it takes approximately 2 yrs for the heifers to calve, about 250 of these heifers would calve per year. This still leaves a deficit of 110 heifers per year even with an age at first calving of 24 months. However, if we also assume that there is at least a 12% death loss from birth to post-calving, there would be 30 heifers less calving per year. That would leave only 220 heifers or a deficit of 140 heifers per year that would have to be purchased in order to maintain herd size. At a cost of $1,800 per heifer, the cost of purchasing additional replacements would be $252,000 dollars per year.

It is evident that extending the age to first calving is extremely costly to the dairyman. It has been estimated that 15-20% of the total costs on the dairy farm are associated with heifer rearing (Karzes 1994). It has also been stated that the single most important variable influencing costs associated with heifer replacements is the age at first calving (Cady 1996). After summarizing much of the available literature on accelerated heifer growth, VanAmburgh from Cornell stated, "The economics are very strong that early calving, even at lighter post-calving body weight, improves farm profitability."

The increasing costs of heifer replacements, coupled with the fact that cull rates on large dairies are often exceeding 35%, emphasizes the importance of establishing a good heifer replacement program that will result in decreased death losses as well as decreasing the age at first calving.

In summary, some of the nutritional considerations for establishing an accelerated heifer growth program are as follows:

1. Rations should be formulated that increase growth rate by increasing frame size without excessive body condition. In general, rations will have higher levels of metabolizable protein in comparison to traditionally raised calves.
2. In the past, most heifer nutritional requirements published have tended to overestimate the energy and underestimate the protein needed to accomplish accelerated growth without causing excess fat deposition.
3. Rations should be formulated to maximize rumen microbial growth, which improves feed efficiency as well as optimizing amino acid balance.
4. Maximize dry matter intake through better management procedures such as adequate feed bunk space, providing fresh feed and water at all times, utilizing good quality forages in heifer rations, and providing a clean dry and comfortable environment.
5. Monitor the body condition scores as heifers mature to ensure that the rations are properly formulated to maximize frame size without the heifers becoming overconditioned.
6. The herd nutritionist and dairy owner must work together to establish a program that works in correlation with the existing facilities and managerial ability, that will allow the replacement heifers to reach their potential growth rate.

I have been feeding calves on my clients' dairies for more than 16 years on this type of program with great success. The average death loss from birth to weaning is less than 1%, the cost of medicines used has decreased by approximately 80%, and the heifer calves are averaging around 260 lbs. at 10 weeks of age. This type of program enhances the animal's immune system as well as growth rate. The heifers have a larger frame size but are not over-conditioned, with a higher lean tissue to fat tissue ratio than calves raised on a traditional whole milk or milk replacer program. Continuing the heifers on a high plane of nutrition with proper protein:energy ratios will help them obtain their genetic potential for growth and future milk production, and allow them to enter the herd at an earlier age and at the same size or larger than traditional heifer programs. These heifers will have an increase in milk production and herd longevity because of increased performance.

Accelerated heifer growth programs can be a valuable asset in increasing the overall profitability of the dairy operation if the time is taken to design the program to fit into the management scheme and the rations are formulated properly to maximize frame size without overconditioning the heifers.

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