VTDairy–Home of the Dairy Extension Program at Virginia Tech

New trends in calf feeding and housing – The good and not-so-good!

Bob James

Virginia Tech Invent the Future · Virginia Cooperative Extension · VSU Virginia State

Colostrum Management

- Quality, quantity, quick and clean
- >85% of 1st milking colostrum over 50 g/liter
- Using Brix Refractometer
  - Not temperature sensitive
  - More durable than colostrometer
  - Readings > 22 indicate good quality colostrum
  - RID values > 50mg IgG/mL
- 4 liters - 1st 12 hours

Clean colostrum

It's a race between bacteria in the environment or the initial feeding and the antibodies in colostrum.

One reason why it's important

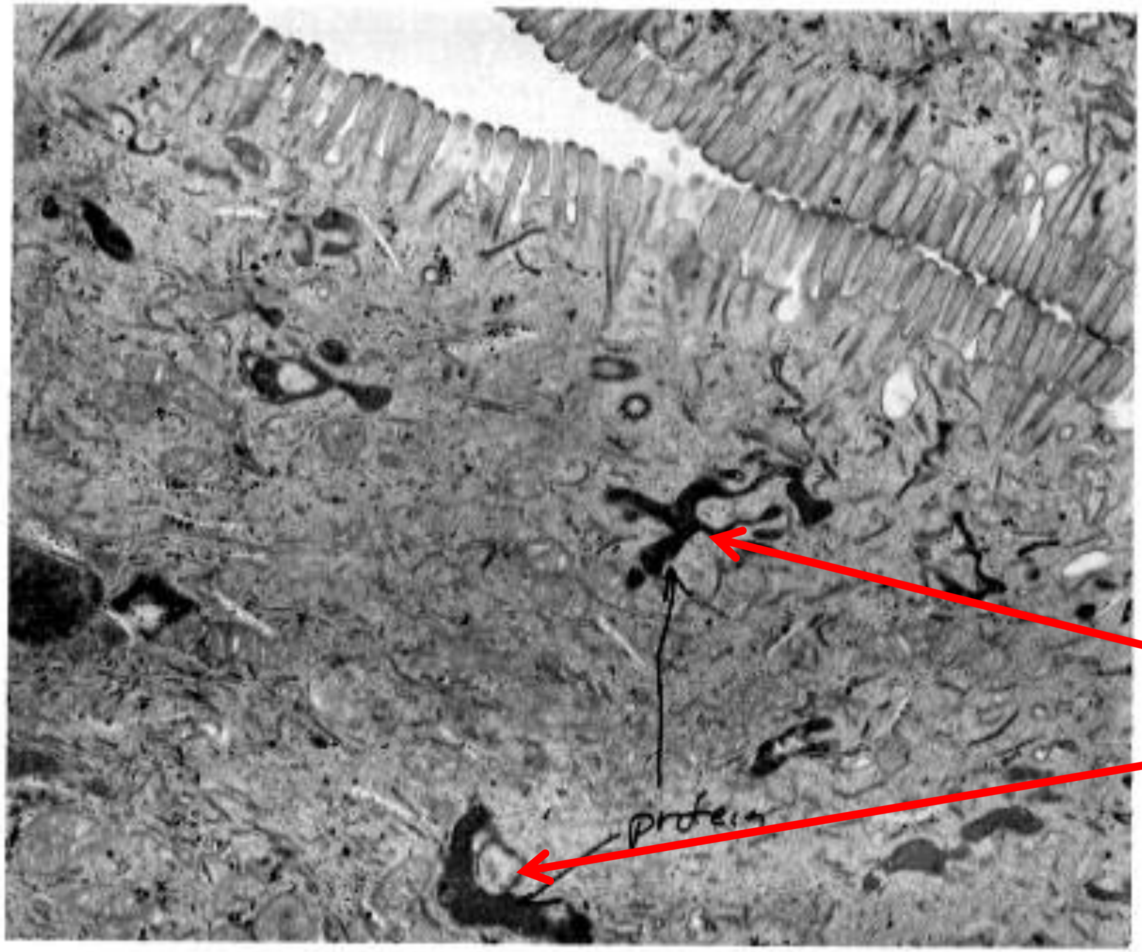


FIG. 4. Ileal epithelial cells from a calf which had received colostrum prior to *E. coli* were unaltered cytologically. Dark aggregations of colostral proteins were in the apical tubular system of the cells (approximately 14,000×).

Early consumption of colostrum before exposure to ???

Colostrum protein

One reason why it's important!

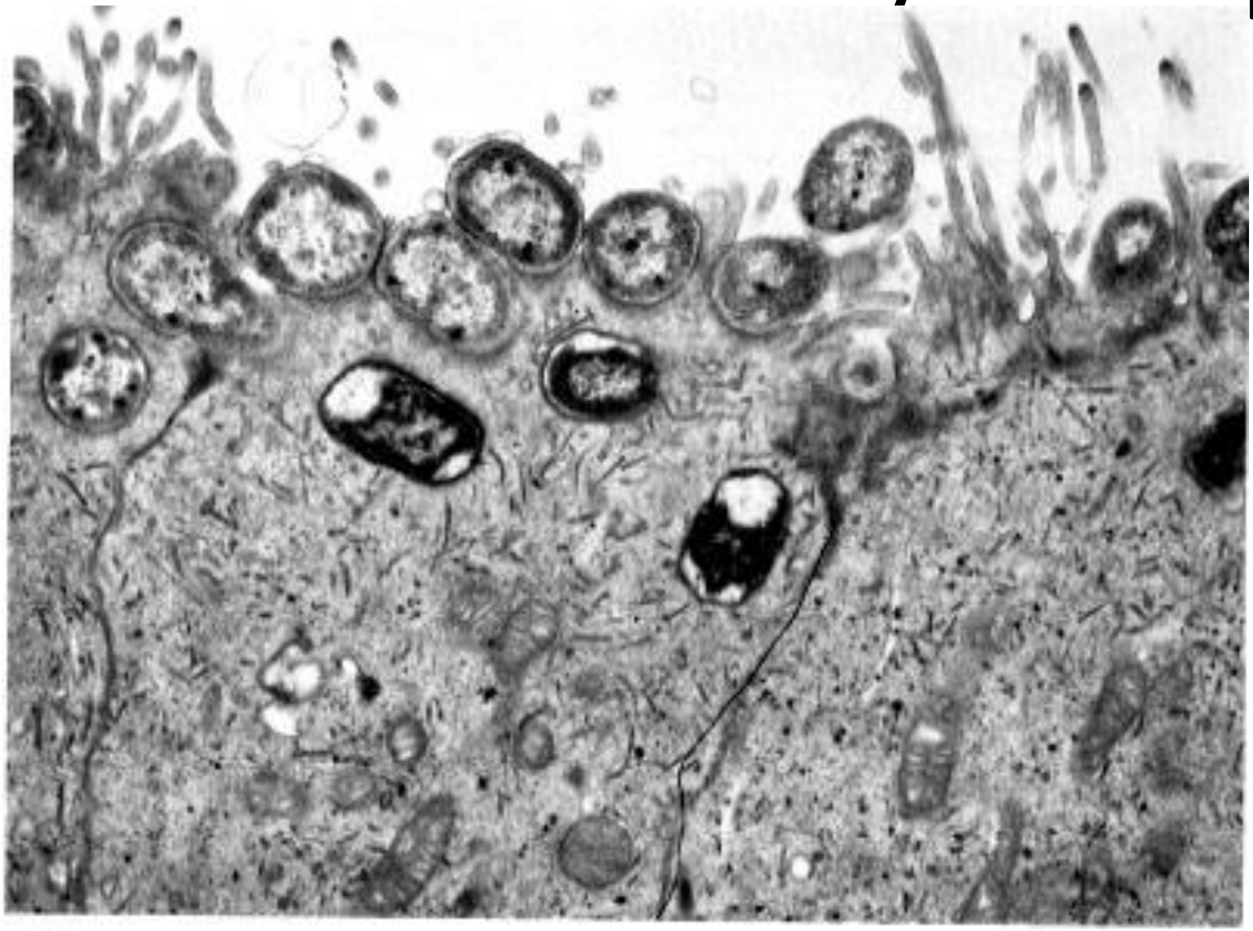


FIG. 2. Apical ends of several ileal epithelial cells from an *E. coli* exposed calf which had received no colostrum. The microvilli were largely absent at the sites of *E. coli* attachment. *E. coli* were also within the apical cytoplasm (approximately 16,000×).

Early exposure to E. coli without colostrum intake

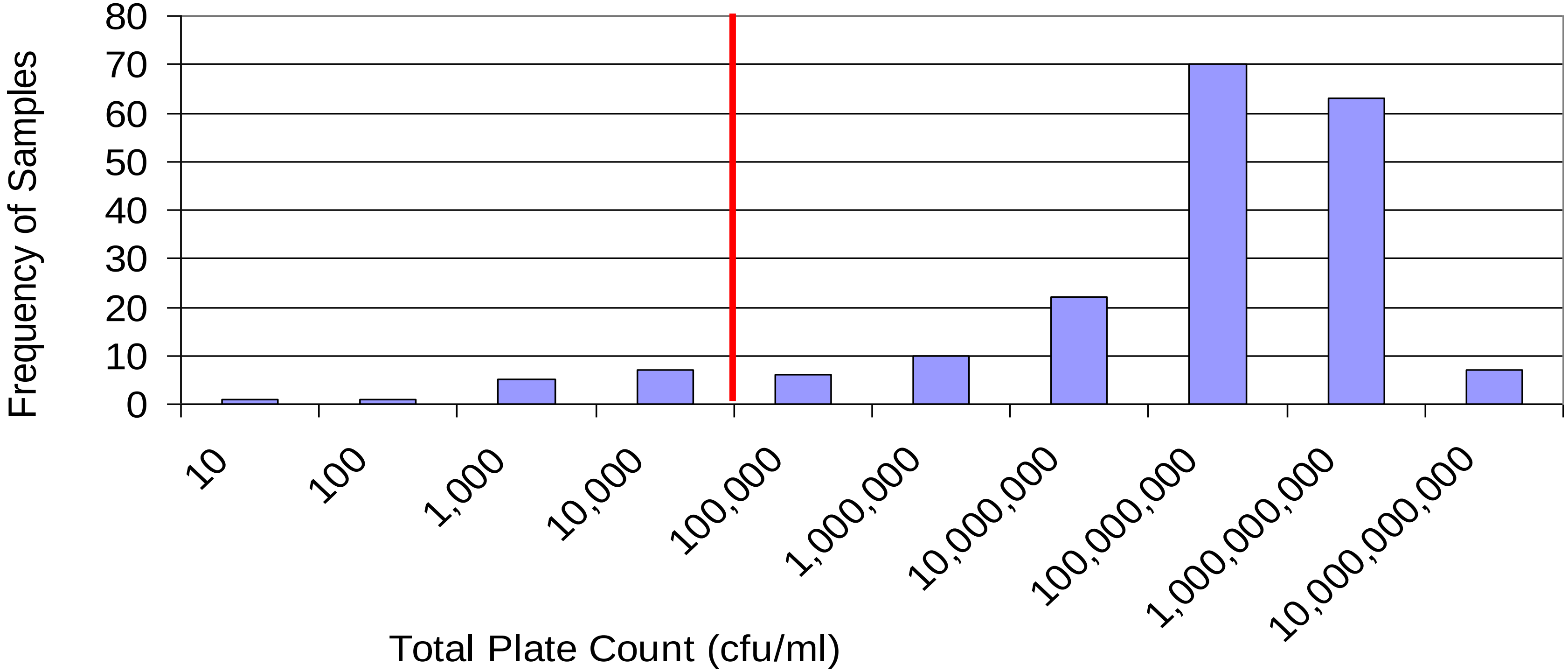
Total Bacteria Counts in Minnesota Colostrum

(Swan et al. 2007. JDSci. 90)

Median TPC = 615 million cfu/ml (73 to 104 billion)

93% of samples > 100,000 cfu/ml TPC

"We are feeding 'fat-laden' manure" Rob Trembley, 2006



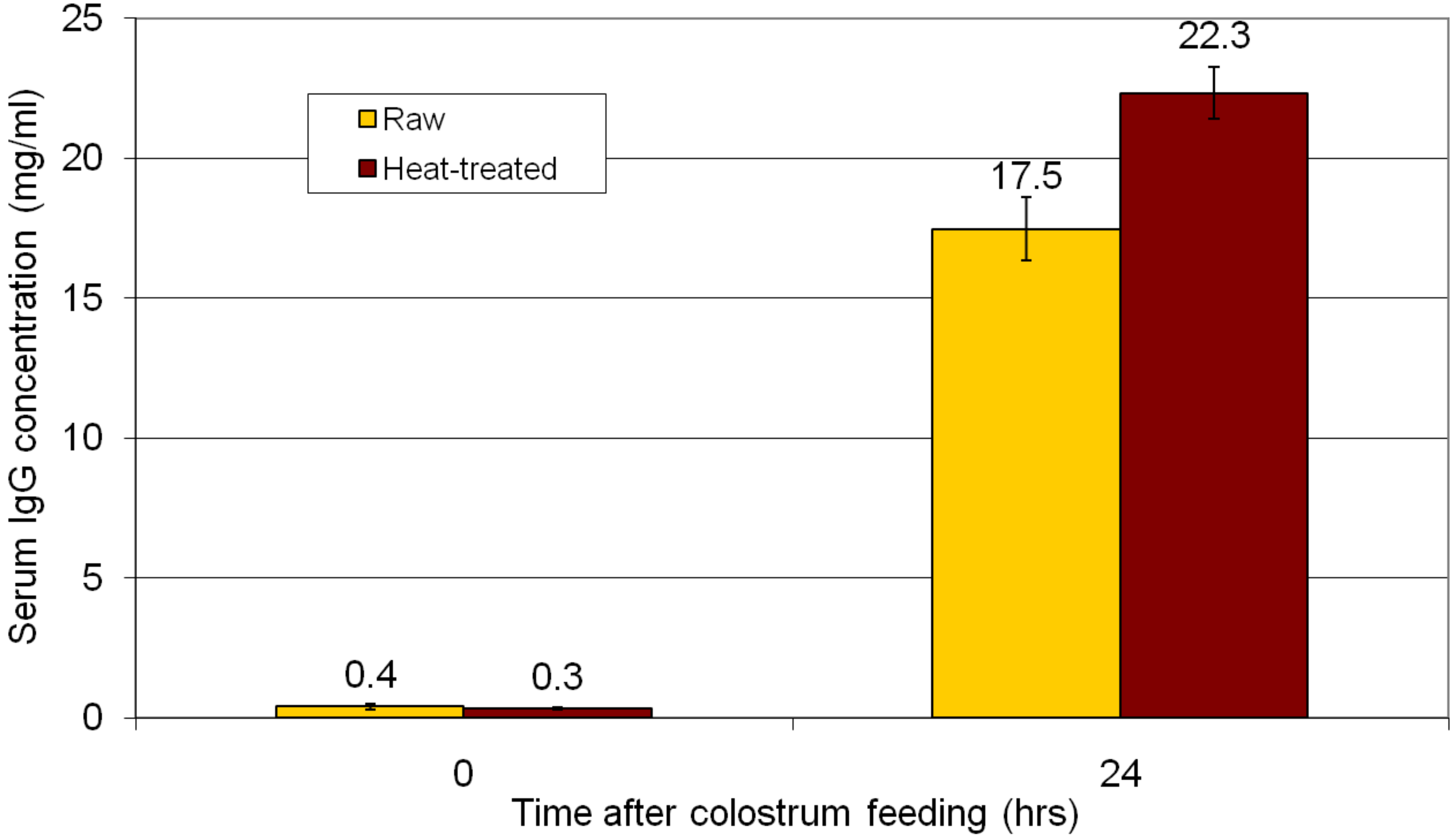
From - S. Godden

Pasteurization of colostrum

- **Batch** pasteurize: 60 ºC x 60 min
  - No viscosity changes
  - No change in colostrum IgG (mg/ml)
  - Significantly reduce or eliminate *M. paratuberculosis, Salmonella, Mycoplasma bovis, E. coli, Listeria*

(McMartin et al. JDSci. 2006. 89:2110
Godden et al., JDSci. 2006. 89:3476)

Serum IgG levels were significantly higher in calves fed heat-treated colostrum



Godden et. al, 2006

Recent UMN Field Study

M. Donahue, S. Godden et al. 2012

- 1,000 calves / 6 herds
  - ½ fed raw and ½ fed heat-treated colostrum
- Colostrum total plate count and serum IgG – **negative effect**
- Colostrum IgG concentration – **positive effect**
- Heat treatment – **positive** – independent of Total plate count
- Colostrum Total Coliform Count and risk of scours – positive.

Characteristics of calf and colostrum

Godden et al. 2012

Variable	Fresh (n=518)	Heat-treated (n=553)
Calving ease (1-5)	1.4	1.4
Age at 1st feeding (min)	47.5	50.0
IgG in Colostrum (mg/ml)	63.9	61.1
TPC in colostrum (cfu/ml)	515,000	2,100
TCC in colostrum (cfu/ml)	51,500	90

Disconnect between critical control points! - evaluation plan!

- Location
  - Calving area
  - Fresh cow milking
  - Calf housing
- People – who is responsible?
  - Fresh cow milking?
  - Colostrum handling?
  - Calf feeding

Disconnect cont'd

- Quality
  - Colostrum handling –
    - Feed immediately or cool as soon as possible
    - Rapid cooling – frozen Coke bottles in bucket.
      - 6 hours at room temp = 6,000,000 cfu/ml
    - Clean containers
      - Luke warm water rinse
      - Hot soapy water
      - Sanitizer
      - SPC / sq. in. < 1,000

Two recent herd visits

- Dairy 1
  - >25,000,000 /ml   SPC, >15,000 coliform /ml,   E. coli - TNTC
  - 8 calves < 7 days -   serum protein – 3.9 – 4.6 g/dl.
- Dairy 2
  - >25,000,000/ml, >15,000 coliform, E. coli TNTC -
  - 9 calves < 7 days – serum protein 3.9 – 5.2 g/dl

Economic comparison of conventional vs. biologically normal systems

AABP - 2010

- Michael Overton – DVM

  University of Georgia

Economic analysis

Initial calf value = $200

Net Results		
Outputs	Conventional	Biologically Normal
Calf investment cost at calving	225	223
Average age @ 1st service	14.0	11.3
Average age @ 1st calving	24.7	22.0
Average daily gain (lb)	1.52	1.98
Total rearing cost/heifer	$1,706	$1,687
Ave. cost/day	$2.27	$2.52
Additional milk value		$170
Net cost/heifer	$1706	$1537

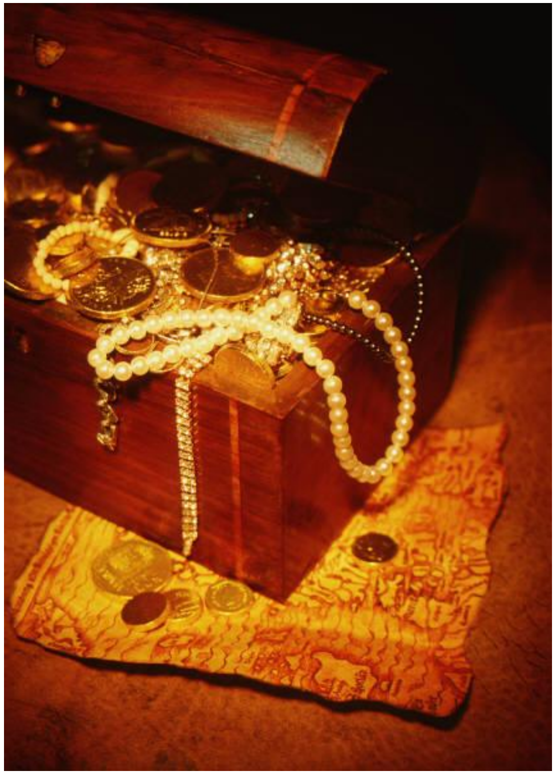
Economic analyses

- Based on assumptions used in this model
  - Net results (Biologically normal vs. traditional)
  - Feed cost $74.29
  - Labor cost $(14.66)
  - Health/vet med $(14.65)
  - Interest cost $(15.50)
  - Reproductive culls $(7.45)
  - Other costs $(20.36)
  - Total "dead calf" costs $(21.49)
  - Net result $(19.81)

Total value of biologically normal = $190

Waste Milk – Treasure?

- Treasure
  - High nutrient value – on a powder basis – 29% fat and 27% protein
  - Low cost - $.25/gallon on CA dairies
  - What is the true cost?



or Trouble

- Antibiotic residues
- Bacterial growth
  - Mycoplasma
  - Mycobacterium – JOHNE'S
  - Staph…
  - Coliforms
  - Salmonella
  - Endotoxins?
- Dirt and flies

Goals of pasteurization

- Standard plate count - <20,000 cfu/ml
- Alkaline phosphatase activity - < 500 mU/ml
  - Enzyme naturally present in milk which is destroyed when adequate temperature/time have been achieved.

Pasteurization time and temperature combination

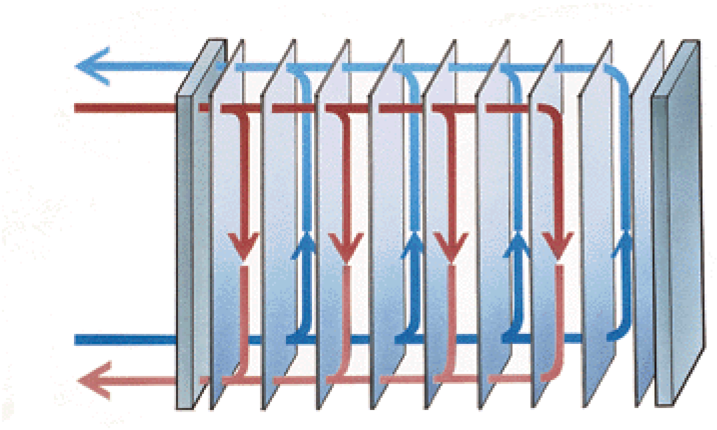
Type	Time	Temp C^o	Temp F^o
Batch	30 min.	63	145
HTST	15 sec.	72	161

Concerns with batch pasteurizers

- Batch
  - Time to heat and cool milk - hours
  - Dead spots if poorly agitated.
  - Head space above the liquid must be heated properly.
  - Sanitation is not easily automated
  - More suited to smaller operations with <100 calves

HTST units

- Speed of processing
- Ease of automation
  - Sanitation
- Diversion valve to recycle milk if insufficient temperature
- Rapid heating and cooling
- Sufficient hot water
- Clogged plates - tubes



Critical areas for quality management

- East coast studies
  - Studied 3 dairies from February to August 2005 – 600 – >2,000 cows.
  - Visit every other week for 7 months
- West coast studies – 9 dairies, one calf ranch
  - June 2005
  - January 2006
- Milk sampled prior to and post pasteurization and every 20 minutes until feeding was completed
  - Aerobic plate count, Alkaline phosphatase
  - Fat%, Protein%, Total Solids, SCC

Wisconsin study

(Jorgensen, Hoffman et al, 2005)

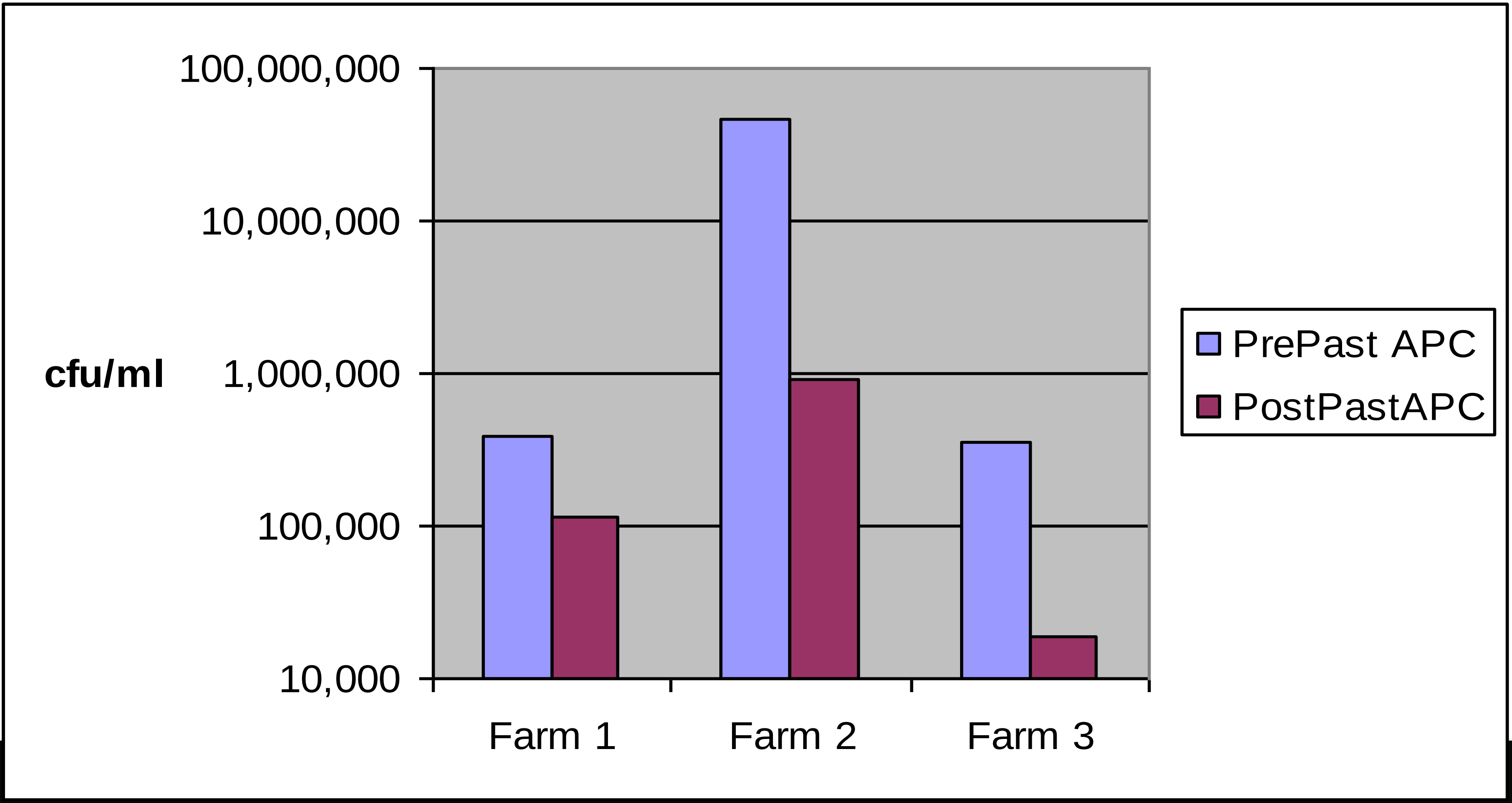
- 62 milk samples from 32 farms or calf ranches evaluated – pre and post pasteurization
- Measured:
  - Nutrient composition
  - Somatic cell count
  - Alkaline phosphatase
  - Antibiotic residues
  - Standard plate counts
  - Identification of principal microorganisms

Quality of incoming milk

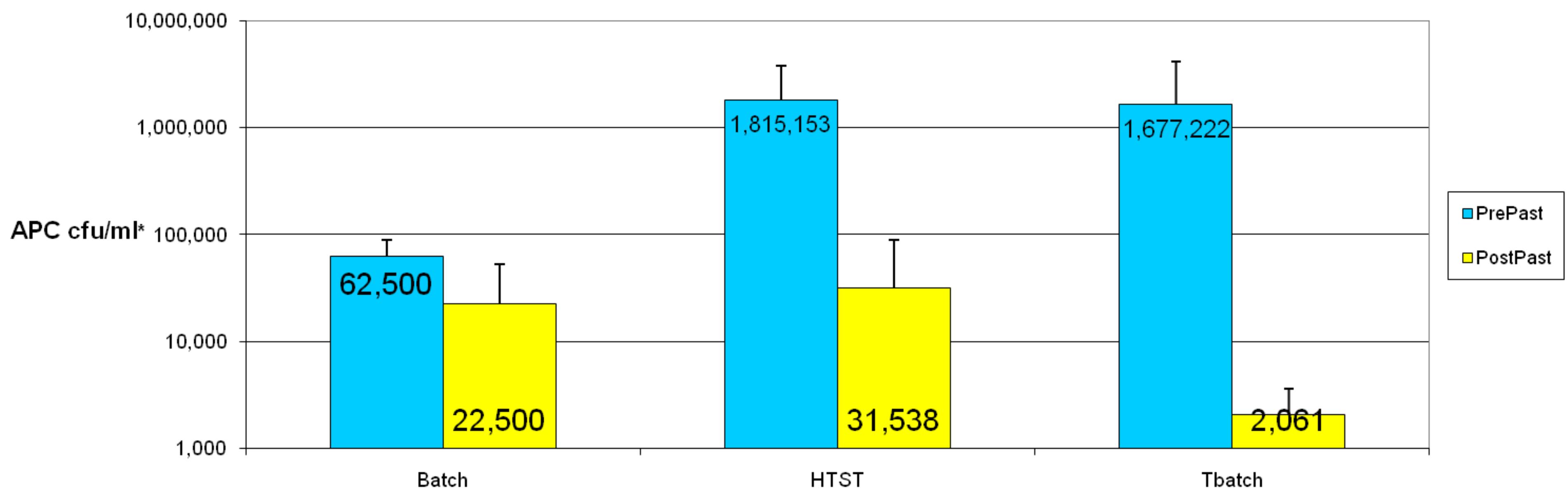
Location	PrePasteurization - Aerobic plate count		Fat %		Protein %	
	Low	High	Low	High	Low	High
East	300,000	1×10^8	1.5%	4.5%	2.7%	3.8%
West	26,000	5.9×10^6	1.2%	12.1%	2.7%	4.7%
WI	6,000	7.2×10^7	2.8%	4.7%	2.9%	5.1%

Pre vs. Post Pasteurization Aerobic Plate Counts

Sample from 3 East Coast dairies obtained over 7 month period.



Pre vs. Post Pasteurization Aerobic Plate Counts – Western
Sorted by Pasteurizer Type

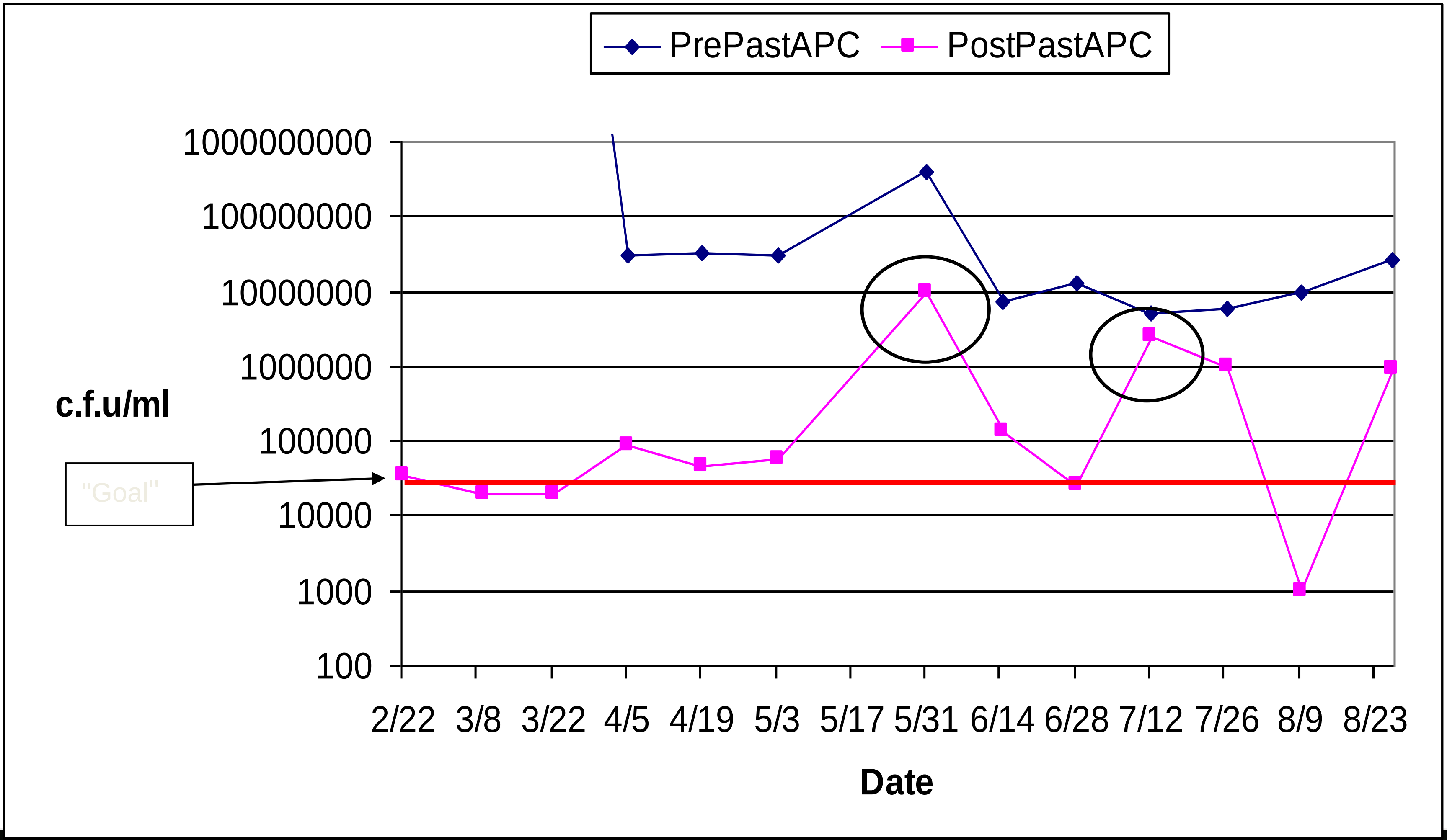


Only two herds had batch pasteurizers

Quality of post pasteurized milk

- East herds - pasteurized milk ave. Aerobic plate count - 105,000 cfu/ml
- West Herds – pasteurized milk ave. Aerobic plate count - 19,400 cfu/ml

Farm #1 – refrigerated milk – 50°F – 5.6X10^8



Factors influencing microbial growth in waste milk

- Exposure of milk to flies, manure, dirt
- Cleanliness of storage tanks and length of time milk is held prior to pasteurization.
- Temperature of milk during storage
- Cleanliness of pasteurization equipment
- Cleanliness of bottles, tanks, buckets receiving pasteurized milk.
- Microbial content of milk from the cow

How successful are pasteurizers under the best conditions?

- Batch and HTST pasteurizers reduce
  - APC by 98 – 99%
  - 2,000,000 X .99 = 20,000 = o.k.
- UV systems achieve 3 – 5 log decrease in APC.
  - Test conducted under lab settings.

How successful were pasteurizers?

- “Failure rate – Alkaline phosphatase >500 mU???
- Wisconsin study – 13%
- Eastern operations – 18%, 15%, 0%
- Western operations – 4 herds tested positive for AP.

Efficacy of on-farm pasteurized waste milk systems on 31 WI operations

- Antibiotic residues
  - 65% β-Lactam positive
  - 68% non-β-Lactam positive
- Questionable pasteurization (13%)

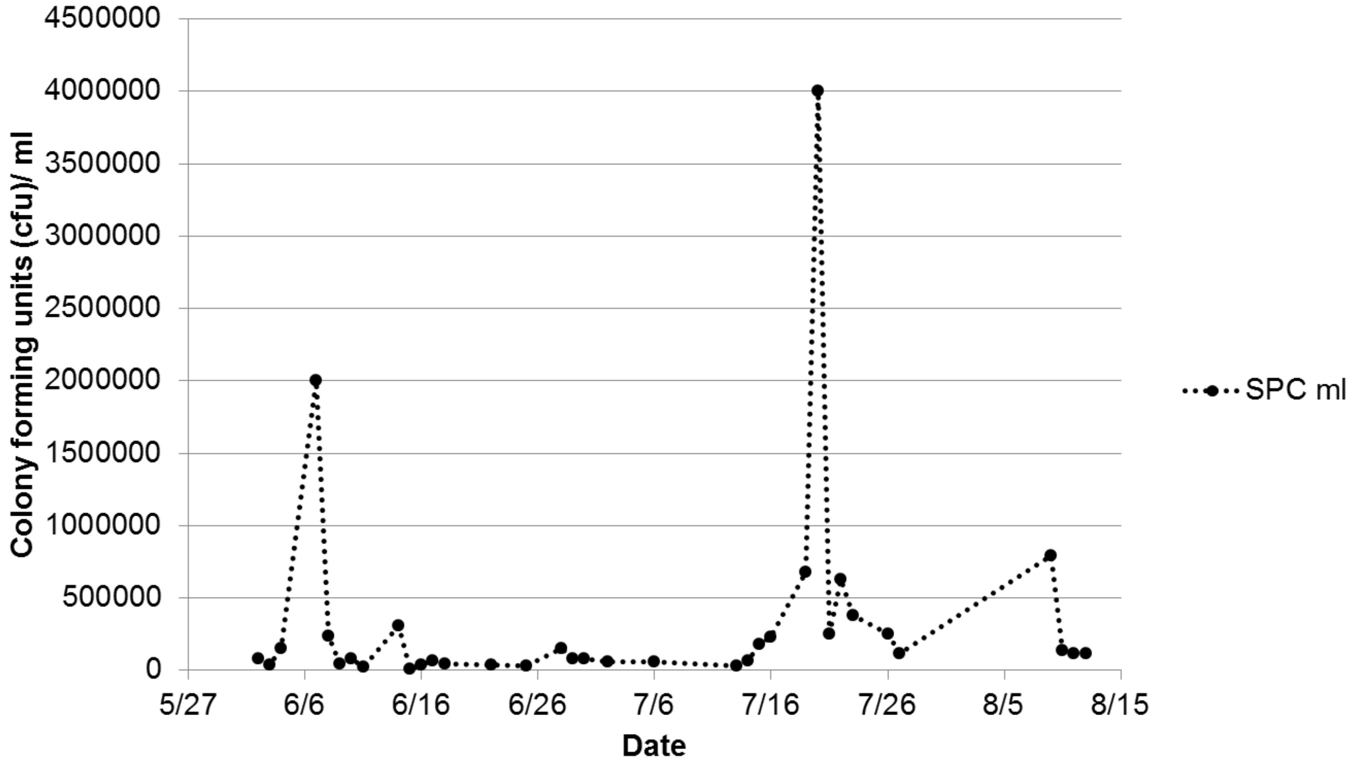
cfu/ml	PrePast	PostPast
APC	8,822,000	35,000
E. Coli	10,000	134
Salmonella spp.	243	<10

Jorgensen et al., 2005

Nutritional value of waste milk

Location	Fat %		Protein %	
	Low	High	Low	High
East	1.5%	4.5%	2.7%	3.8%
West	1.2%	12.1%	2.7%	4.7%
Wisconsin	2.8%	4.7%	2.9%	5.1%

Intensive study on one dairy - June – August 2010



Mean SPC: 332,171 ± 733,487 cfu/ mL

Least squares means of pasteurized waste milk (PWM) and balancer (Bal) components

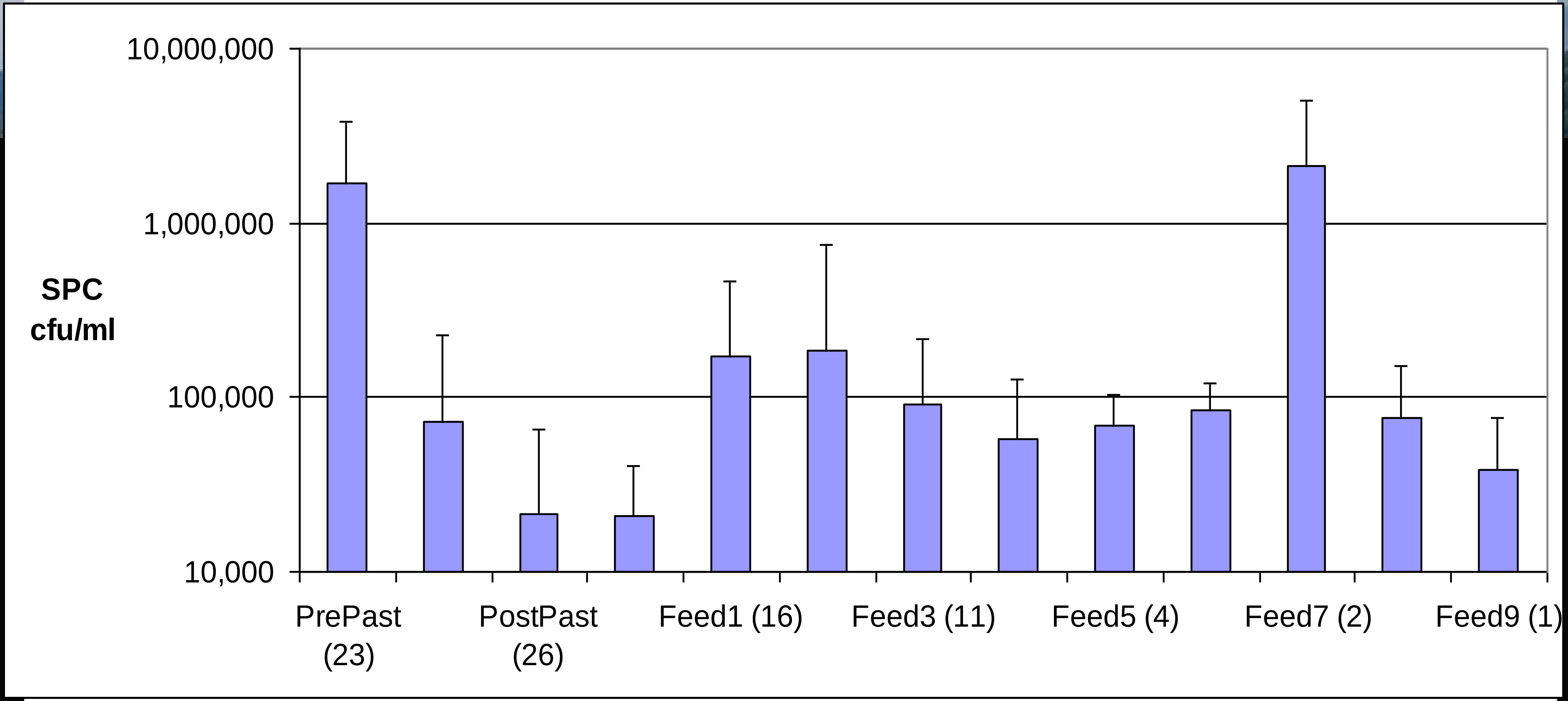
Milk parameter, (%, on liquid basis)	Least squares means	SD	Minimum	Maximum
PWM solids (%)	11.64	1.066	9.02	13.18
PWM protein (%)	3.12	0.303	2.27	3.56
PWM fat (%)	3.51	0.585	1.94	4.66
Bal solids (%)	13.64	1.238	10.22	15.09
Bal protein (%)	3.87	0.445	2.90	5.09
Bal fat (%)	2.89	0.386	2.16	3.65

Reasons for variation in nutritional value

- Addition of flush water to the receiving tank prior to sanitizing the milking system.
- Poor agitation
  - sampling of waste milk
- Interval between pasteurization and feeding
  - Buckets
  - Bottles
- Fresh cow vs. treated cow inventory in the sick pen.

Post pasteurization quality control

Sample obtained prior to an every 20 minutes



Aerobic plate count on 10 western operations

Pasteurizer cleaning

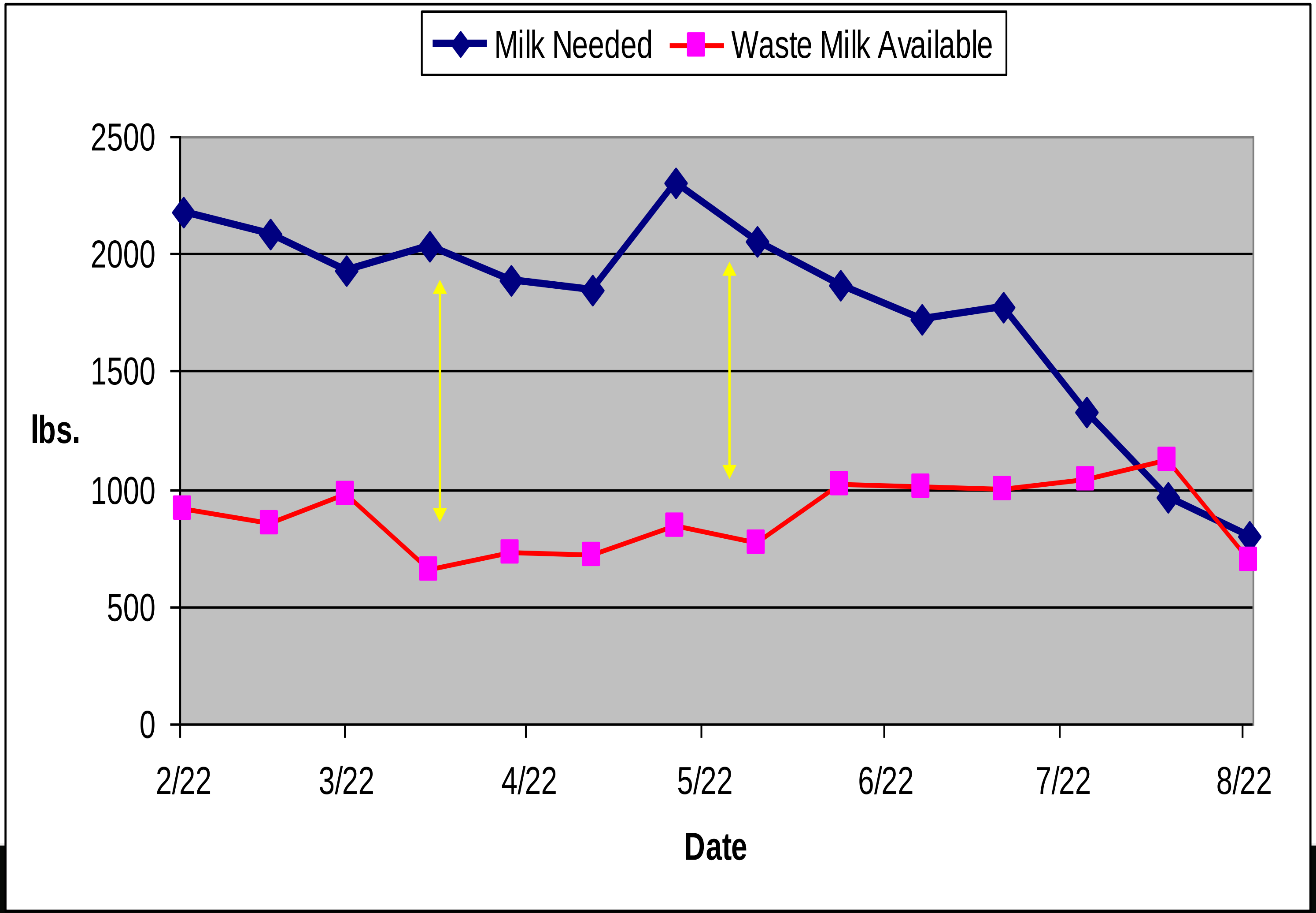
- Rinse – ***warm*** water
- Caustic detergent
- Sanitize with acid cleaner

- Never allow HTST unit to run dry. Commercial machines have automatic flow sensors to prevent "cooking" of milk between plates.
- Cleaning "batch" pasteurizers?

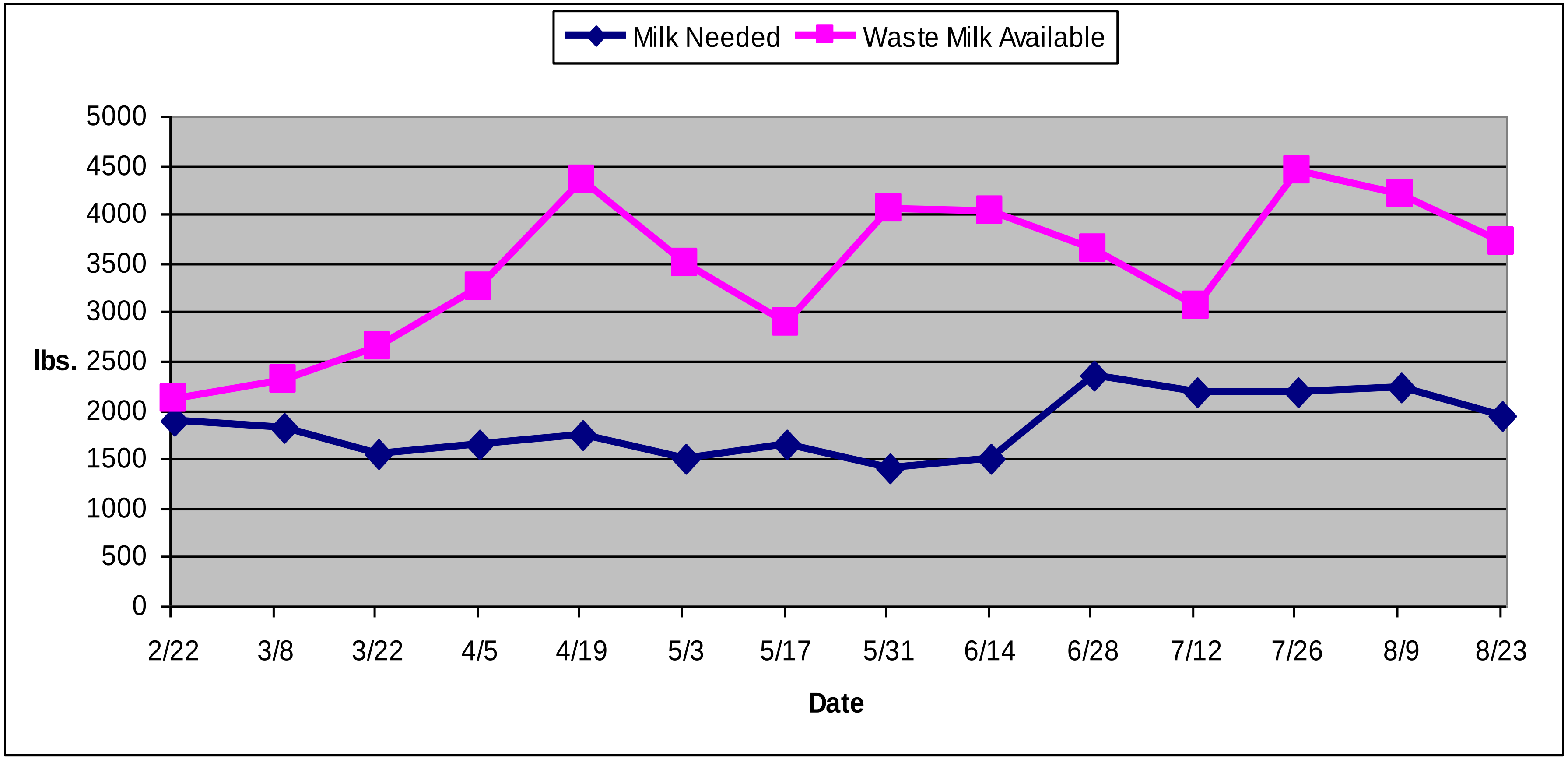
Microbial quality during feeding

- Cleanliness of receiving tank and hoses
- Cleanliness of bottles and buckets
- Farm a – 8 of 14 post pasteurization samples exceeded 100,000 cfu/ml
- Farm b – 4 of 14 samples exceeded 200,000 cfu/ml
  - Staph - >20,000 cfu/ml
  - Coliforms - >1,000 cfu/ml

Comparison of milk needed and milk available – Farm a

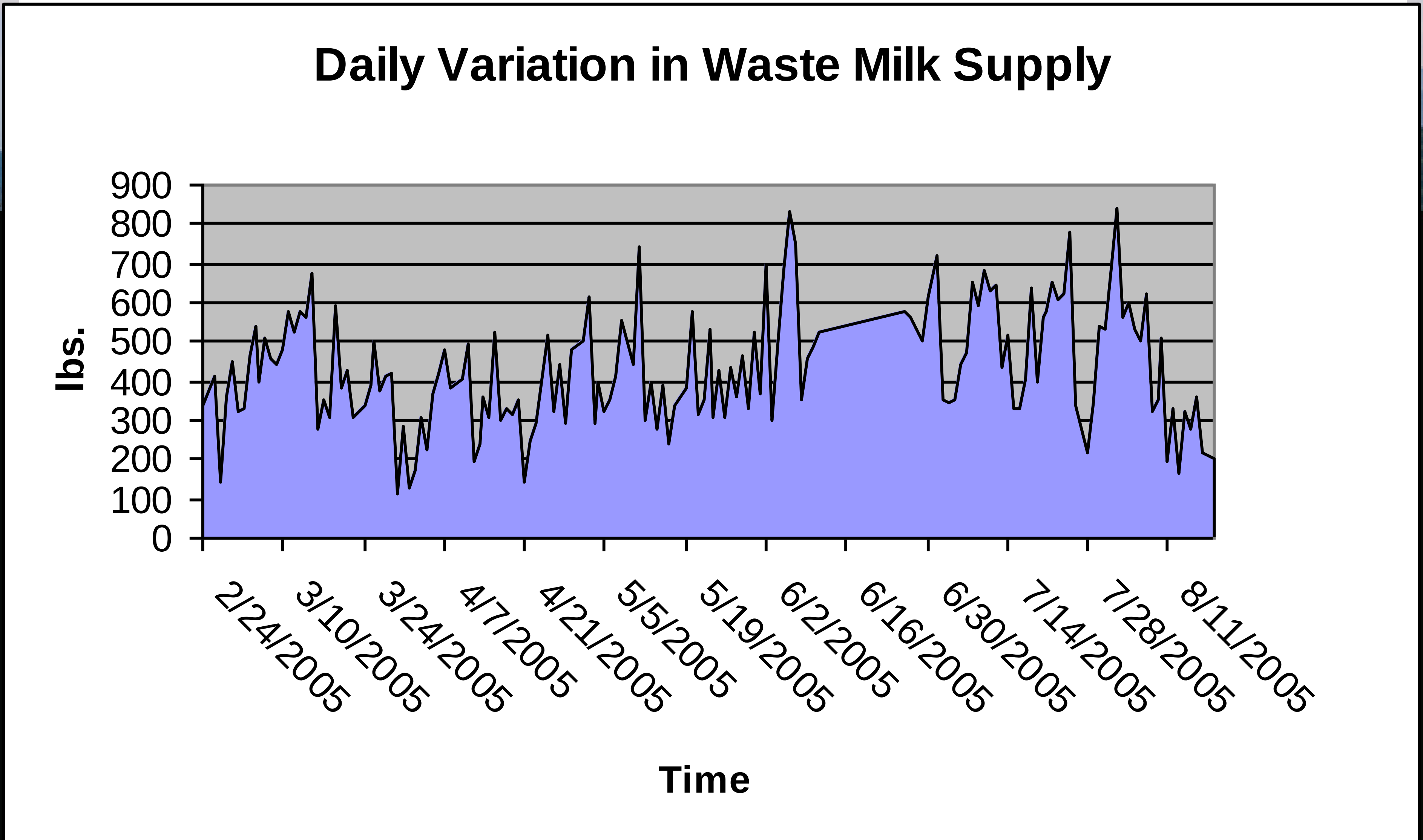


Supply of waste milk relative to needs – Farm b



Excess waste milk - cost due to excessive discarded milk?

Farm a



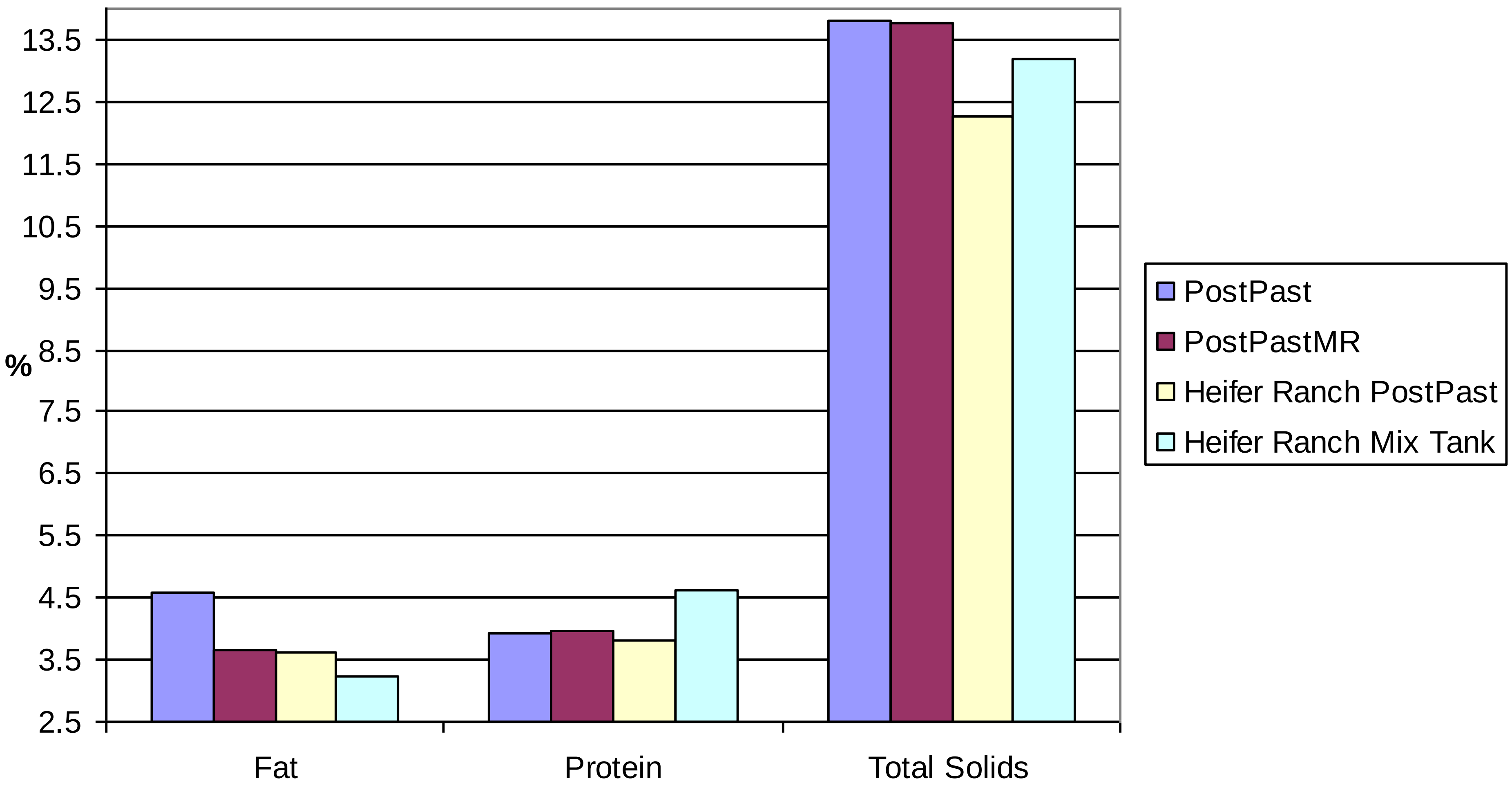
Daily Variation in Waste Milk Supply
900
800
700
600
500
400
300
200
100
0
lbs.
2/24/2005
3/10/2005
3/24/2005
4/7/2005
4/21/2005
5/5/2005
5/19/2005
6/2/2005
6/16/2005
6/30/2005
7/14/2005
7/28/2005
8/11/2005
Time

Options to meet shortfall in waste milk supply

Compromise between nutrition of calf and expense

1. Additional saleable milk from bulk tank
2. Supplement waste milk by adding solids from milk replacer, whey protein and/or fat supplements
3. Switch calves to milk replacer.

Supplementing waste milk



Supplementing waste milk

- Must know solids content when mixing?
- Adjust to solids content of 15 to 17%?
  - Milk replacer
  - WPC
  - Fat/mineral/vitamins

Switch calves to milk replacer

- Start on pasteurized waste milk or milk replacer
- Switch to opposite > 3weeks of age or vice versa.

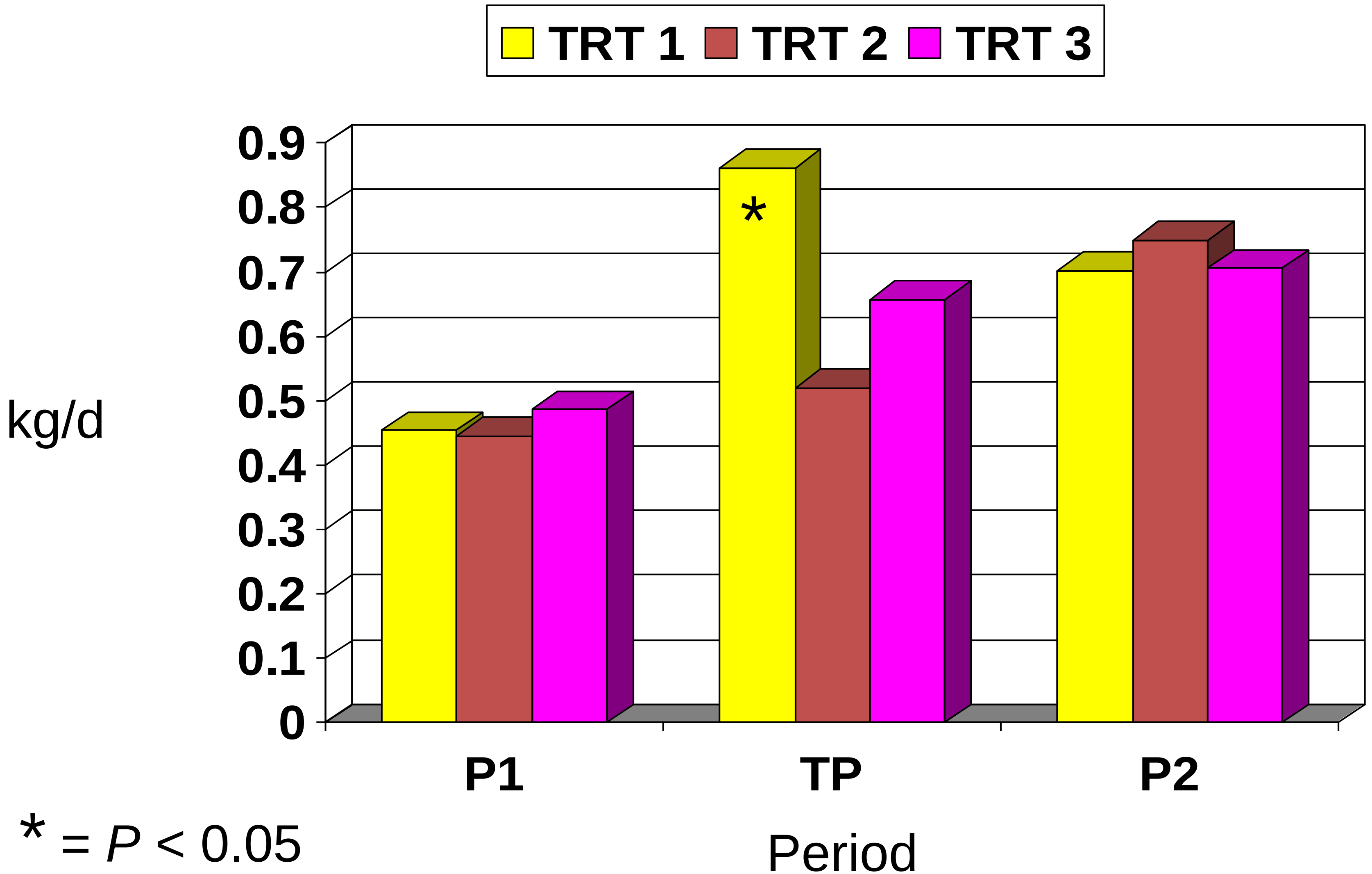
Alternate strategy to extend waste milk

Scott et al., 2006

- 62 calves (45 heifers, 17 bulls)
  - Holsteins, Jerseys and Crosses
- Born 3/21 – 10/10 2005
- Feeding rates (lb. milk solids) – determined at birth
  - 2.5 lb. – Holstein
  - 2.0 lb. – Cross
  - 1.5 lb. - Jersey

whole milk or milk replacer – equal!!!

Average daily gain



* = $P < 0.05$

Economics of pasteurized waste milk feeding systems

- What is the cost of waste milk?
  - Free? There is a cost to the milking operation.
  - Best herds produce enough for 30% of calf needs?
  - California – waste milk sold to calf ranches - $2.90/cwt.

Important considerations

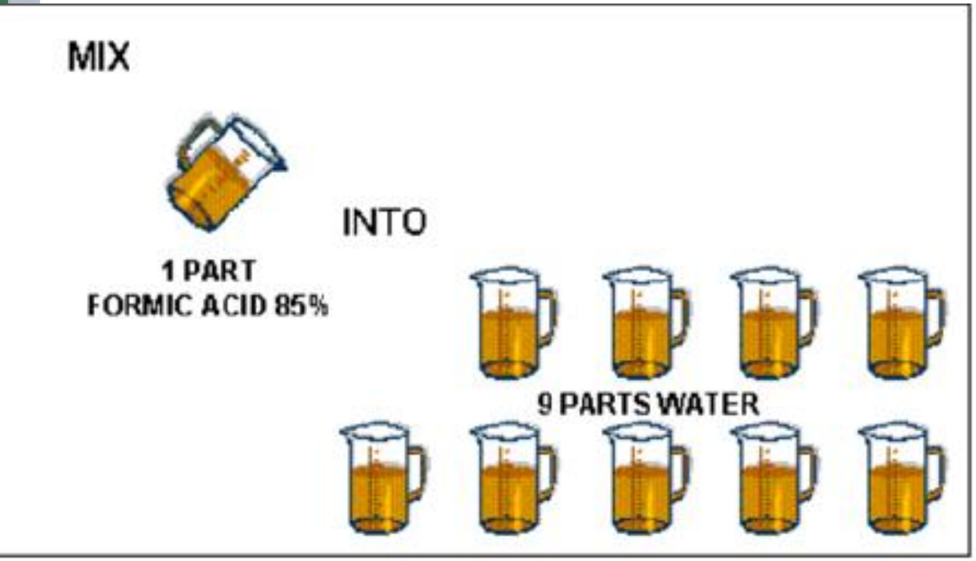
- Cost for milk replacer of similar nutrient content as waste milk.
- Accurate estimates of costs in various categories
- Net benefit varies greatly depending on input and milk replacer costs.

Pasteurizer Conclusions

- Pre Past storage is key
  - Cooled, agitated
- Post Past handling important
  - Automatic tank washers
- Timing is important
  - Milking, storage, pasteurization, feeding
- More waste milk per calf on west coast
- Hot water supply/protocols for employees

Group Housing

Free choice acidified milk

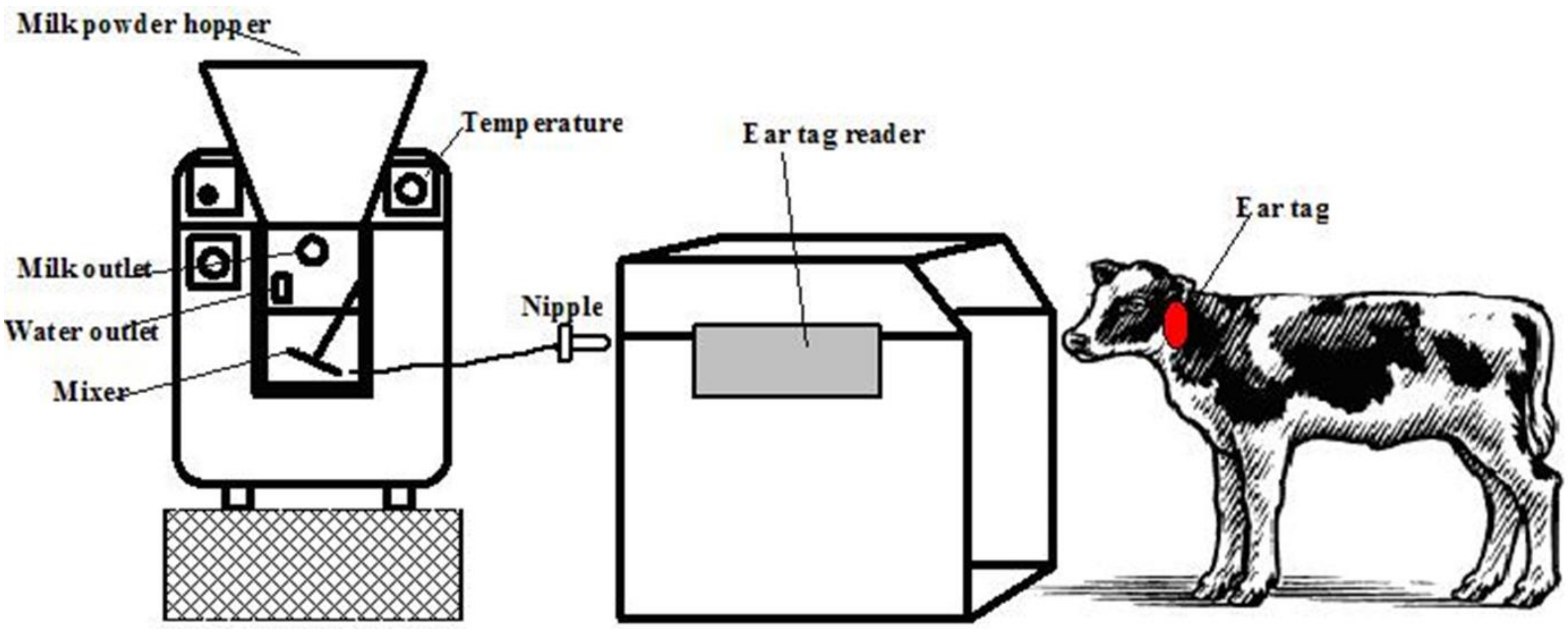


http://www.omafra.gov.on.ca/english/livestock/dairy/facts/mimick.htm

Dangerous compound at 85% level – care in handling

Higher intake – 8 – 12 quarts / calf / day

Principles of calf autofeeders



Biotic industries, Bell Buckle, TN

Computer controlled feeders

“Basic” System

Biotic Industries
Bell Buckle, TN

"Sophisticated"

Forster Technik, Germany
Delaval, GEA, Lely

Behavior of calves when managed in groups

- Early life social adaptation
  - Calves raised in pairs and less post weaning "slump" problems – Chua et al (2001)
- Cross sucking
  - Calves raised on nipple buckets had lower incidence than those raised on open buckets – Jensen (2002)
  - Less problem with autofeeders as compared to mob feeders

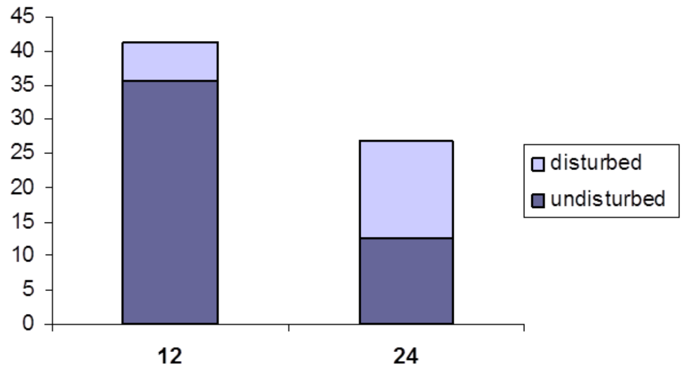
Age at introduction to group

- Day 6 compared to Day 14?
  - More restless 1st day after introduction - Rasmussen et al, 2006)
  - Needed more guidance to feeder (Jensen, 2008)
- 50% less risk of respiratory disease if wait to 14 d (Svensson and Liberg, 2006)

Photo – Jensen - 2009

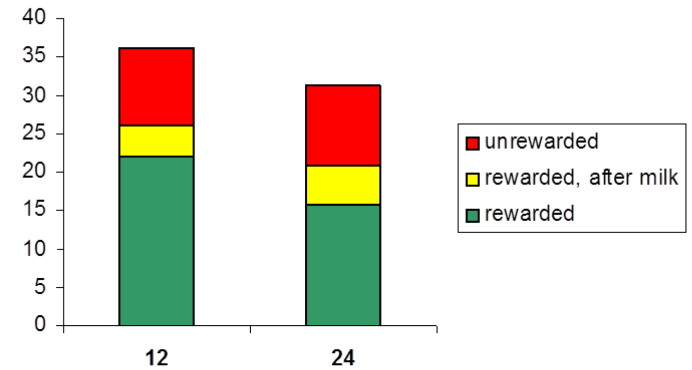
Important concepts of group feeding.

Calves per feed station



More calves / feeder =
More competition

Calves per feed station



More calves = increased
Rate of intake

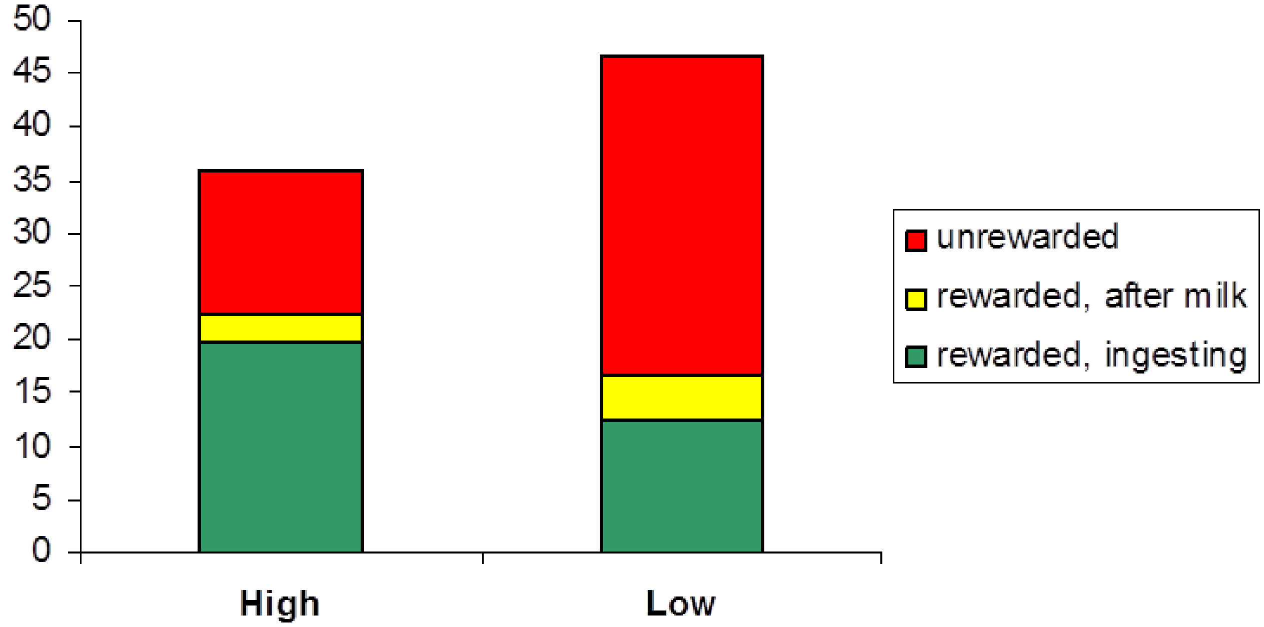
Jensen, 2004

Calves per feeder?

- Manufacturers recommend 20 – 25 per station
- Most herds we surveyed had less than 20/feeder
- Difference in two systems.

Milk allowance per calf

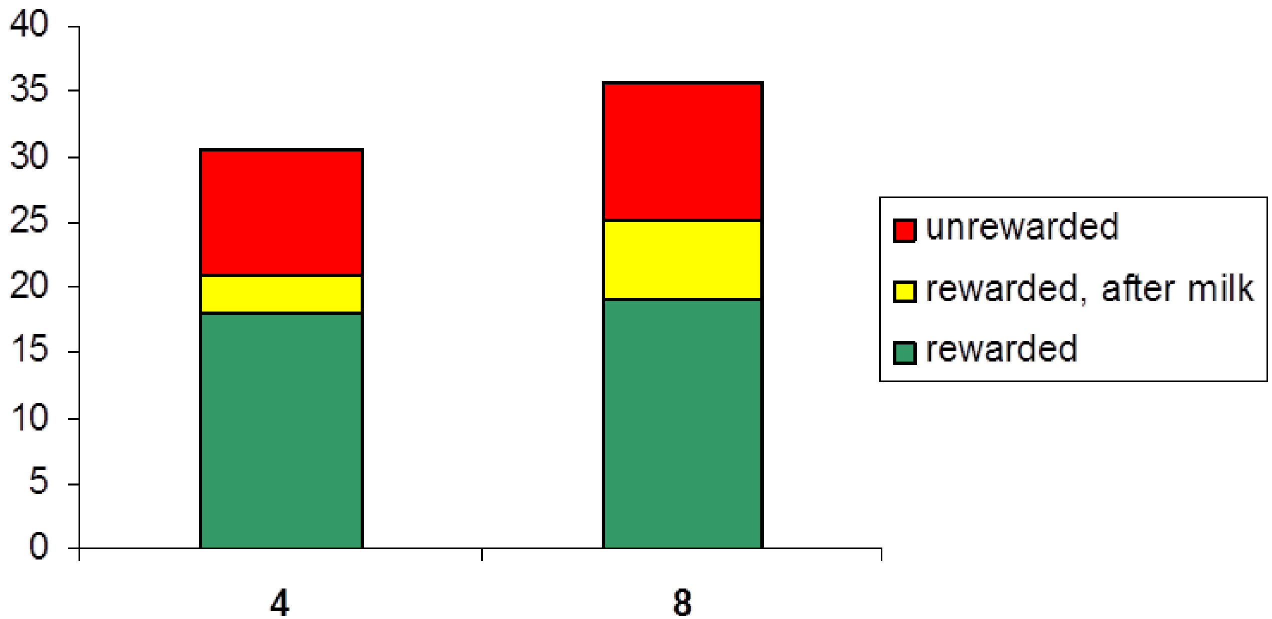
Min. / calf / 24 h



Lower milk allowance = more time in feeder
More unrewarded visits.

Milk portions per day.

Min. / calf / 24 h



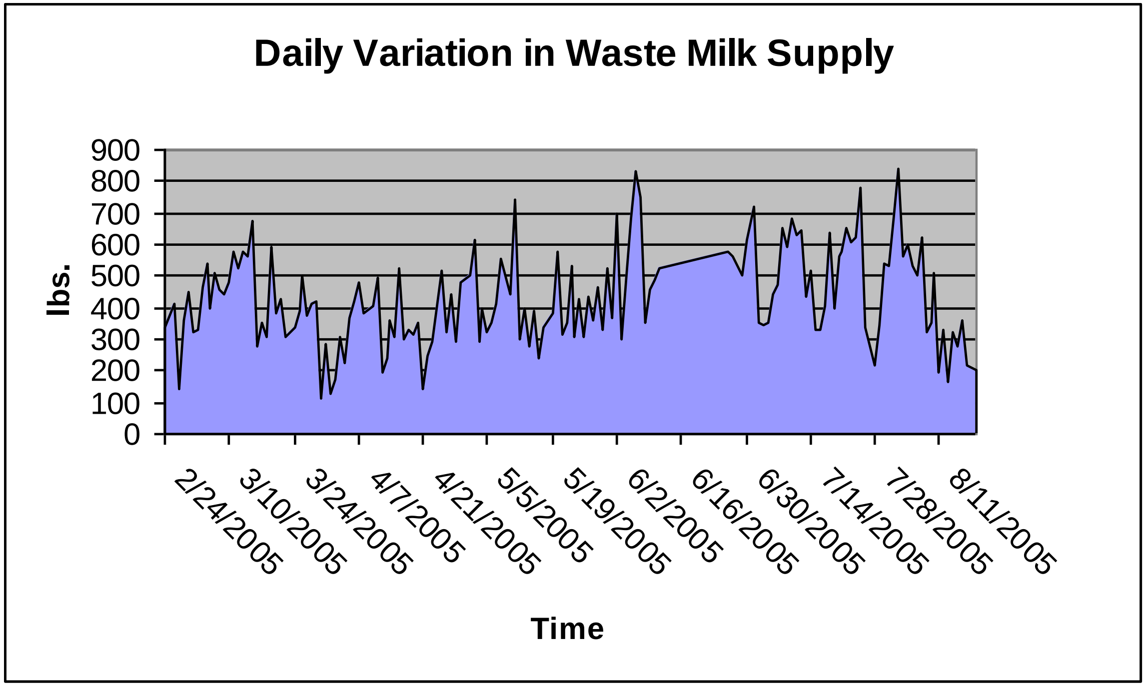
- More portions/ day = more occupation after feeding
- Limits cross sucking
- Depends on stocking rate and total fed.

(Jensen, 2004)

Feeding waste milk and milk replacer

- Challenges
  - Managing the pasteurizer – timing
    - Milking fresh and hospital cows
    - Pasteurize
    - Cool
    - Deliver to the autofeeder
    - Monitor pasteurizer function

Managing variation in waste milk supply



Virginia Tech Research

Machado and James, 2012

- 10 dairies in VA and NC identified with feeders.
  - Survey of management
  - Measure: Temperature, SPC, Brix refractometer to estimate solids.
  - 6 farms visited monthly between June and September

Management practices

- Age when started on autofeeder – 2 – 14 days
- Training calves to feeder
- Milk replacer used – 20:20 – 28:20
- All milk
- Milk replacers with some milk proteins replaced with modified soy flour, soy protein concentrate….

Dairy	Herd size	Management strategy	Feeder type	# calves/ feeder	Milk replacer
1	280	Technology	Sophisticated	20	25:20
2	400	Technology	Basic	16-21	24:18
3	3,100	Additional method	Basic	20	20:20
4	900	Additional method	Basic	15-19	22:18
5	220	Labor	Sophisticated	12-35	20:20
6	250	Labor	Basic	11-20	28:20
7	190	Labor	Basic	25	28:20
8	500	Feeding rates	Sophisticated	25	20:20
9	1,300	Feeding rates	Basic	17	22:20
10	125	n/a	Basic	20	20:20

Management strategies

- Technological advancement: purchased feeders more than 2 years ago and have made technological advancements in other areas on the dairy
- Additional method: fed calves individually but used the autofeeders as alternative method of feeding an abundant number of calves which exceeded current individual housing facilities

Management strategies

- Refocused labor: intention to reassign labor management from time demand of preparing and feeding milk to the care, sanitation, and well-being of calves

- Feeding rates: represented producers who purchased automated feeders to manipulate feeding rates -- gradually increase milk intake until peak, at a higher rate than conventional feeding, followed by soft weaning

Data collection

- **Duplicate milk replacer samples at the time of the survey**
  - **Sanitation of the autofeeder (SPC)**
  - **Temperature of the milk replacer liquid**
  - **Refractometer to estimate solids?????**

Brix refractometer can monitor changes within feed type

Mean standard plate count (10^5), temperature (°C), and refractometer (Brix) reading by machine type

Machine type	Variable	N	Mean	SD	Minimum	Maximum
Basic	SPC	89	69.25	73.71	0.00	500.00
	Brix	35	12.00	2.10	7.00	18.00
	Temperature	31	38.8	6.72	87	118
Sophisticated	SPC	44	13.39	22.03	0.00	88.00
	Brix	15	10.37	1.68	7.00	13.00
	Temperature	14	38.5	6.76	81	107

**note: Brix refractometer reads 2% less than total solids??

Category	Variable	N	Mean	SD	Minimum	Maximum
Technology	SPC	18	25.94	17.04	0.00	67.00
	Brix	5	10.10	2.84	7.00	12.50
	Temperature	4	37.2	4.77	93	103
Additional calves	SPC	18	63.17	45.42	8.00	181.00
	Brix	8	10.31	1.22	9.00	13.00
	Temperature	7	39.2	5.62	95	110
Refocused labor	SPC	12	8.33	16.96	0.00	54.00
	Brix	5	12.00	1.97	9.50	14.00
	Temperature	3	39.0	2.80	99	104
Feeding rates	SPC	77	48.66	44.30	0.00	187.00
	Brix	30	11.88	2.09	7.00	18.00
	Temperature	29	39.3	6.64	87	118

- There is no goal for SPC for milk replacer.
  - Bacteria should be less than 20,000 cfu/ml in pasteurized waste milk
- These averages were all well over 100,000 cfu/ml
- Calf liquid diets should be fed at a range of 100-105°C
- Averages were within feeding guidelines >> the minimum (81°F) and maximums (118C) indicated a lack of accuracy in several systems
  - These temperature extremes could cause cold stress or decrease milk intake.   MR doesn’t dissolve well at lower temperatures.

Summary

- Of the autofeeders studied, Biotic (basic) more than Förester-Technik (sophisticated) machines, appear to require greater attention and maintenance

- Producers with the assumption that calves can be fed and left alone were not satisfied with the autofeeder – additional method

Credits –

- Kayla Machado
- Cooperating dairies

Land O Lakes Animal Milk

Summary

- The data from this study indicates the need to conduct further studies evaluating autofeeder sanitation, consistency, and calf performance
- Future research could help develop benchmarks to encourage improved sanitation and consistency of milk delivered to calves on autofeeders

A final word

- Calf autofeeders are the most exciting thing to happen in calf nutrition – amount and feeding frequency / calf behavior
- Must haves:
  - Excellent colostrum program
  - Excellent housing – dry and well ventilated

A final word

- Critical
  - Initial health status
  - Stocking density
  - All in and all out vs. continually adding calves.
    - Compromise
- People skills must be different
  - Routines
    - Machine monitoring
    - Calf monitoring