Building the Foundation

2006 Dairy and Veal Healthy Calf Conference

Organized by: Nutritious Ontario Veal Delicious

OVA President Welcome

Each year dairy and veal producers record calf mortality rates of 10 percent up to 15 percent which translates into a financial impact of over $50 million of lost potential revenue for farmers across the industries. Due to these overwhelming statistics, the Ontario Veal Association has developed the Building the Foundation: Dairy and Veal Healthy Calf Conference. By learning together and building relationships we can strengthen the connection between our integrated industries. For both the dairy and veal industries strong, vibrant, healthy calves are extremely important. This year's conference brings together an exceptional line up of speakers that both dairy and veal producers can learn practical, hands on tips for raising strong healthy calves.

On behalf of the Ontario Veal Association, I welcome you to the second biennial Healthy Calf Conference.

Judy Dirksen

For more information on the Ontario Veal Association or to become a member contact the OVA office at 519-824-2942

Agenda:

9:00am **Registration, Morning Refreshments and Tradeshow**

9:30am **Welcome**

9:40am **Acidified Milk Program Update**
Dr. Neil Anderson, OMAFRA

10:00am **Increase your awareness of calf disease challenges**
Dr. Sam Leadley**,** Attica Veterinary Associates, New York

11:05am **Calf immunity – what is happening on-farm**
Dr. Ken Leslie, University of Guelph

11:35am **Nutritional management for healthy calves**
Mr. Bill Woodley, Shur-Gain

12:15pm **Ontario veal luncheon**

1:45pm **Hints and tips for raising quality calves: a producer perspective**
Ms. Jeanne Wormuth, CY Farms, NY

2:45pm **Protecting your herd from disease challenges**
Dr. Rob Bell, Pfizer Animal Health

3:15pm **Top ten take home tips for calf management**
Dr. Tom Fuhrmann, DairyWorks™, AZ

4:15pm **Adjourn**

Building the Foundation

2006 Dairy and Veal **Healthy Calf** Conference

GreenField Ethanol Inc. is proud to be a sponsor for the second, biennial Dairy and Veal Healthy Calf Conference held Tuesday December 5th, 2006 at the Woodstock's Oxford Auditorium.

GreenField Ethanol is building two new fuel ethanol plants in Ontario and wants to increase the awareness of their co-products, such as Dried Corn Distillers w/s and Wet Distillers Grains for the expanding veal programs in Ontario. Our D.D.G.'s w/s and our W.D.G. are a very important ingredients in diets in the ruminants program for Dairy & Beef and give our livestock producers a positive alternative to the traditional corn, soybean meal and supplements. With the ever-increasing demand for corn for industrial and food use, it is apparent that co-products will become a larger factor for use in all our various livestock programs.

GreenField Ethanol Inc. is continuing to provide the highest quality of D.D.G.'s w/s as possible. We installed a special cooling unit in our current Chatham Ethanol plant to insure the flow ability of our D.D.G.'s w/s into our feed mill storage bins and our on farm bin storage systems. It's very important for GreenField to ensure the quality and consistency for our D.D.G.'s w/s. and Wet Distillers Grains products.

GreenField Ethanol Inc. is proud to be a sponsor for this innovative conference.

THANK YOU TO OUR SPONSORS!

The Ontario Veal Association would like to thank each of our sponsors for supporting this year's Building the Foundation: Dairy and Veal Healthy Calf Conference. Your support is greatly appreciated.

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Acidified Milk Program Update

Dr. Neil Anderson

Dr. Neil Anderson works with the Ontario Ministry of Agriculture, Food and Rural Affairs' Animal Health and Welfare Group where his major initiatives include disease surveillance and prevention, dairy cattle behaviour, and prevention of diseases associated with dairy cattle housing and the environment. He searches for ways to give cows and calves a better life and shares those methods with others. His recent projects focus on free-access feeding of dairy calves with acidified milk.

Acidified Milk Program Update

One of the prime stressors of neonatal calves is hunger. Research indicates that calves are being underfed during this critical period of life. Dr. Neil Anderson will be providing an update on his research into free-access feeding with acidified milk which could help alleviate this challenge. In this presentation you will learn more on how free-access feeding with acidified milk can benefit calves.

Mimicking Nature's Way for Milk-Fed Dairy Calves: Free-Access Feeding with Acidified Milk

Neil Anderson

November 2006

TAKE-HOME MESSAGES

1. Hunger is a major stressor and a fundamental health issue for neonatal calves.
2. Freedom from hunger is a right of calves. It also is our duty to calves.
3. Hunger can be prevented by simple changes to conventional and automatic feeding practices.
4. Free-access feeding with acidified milk is a unique way to prevent hunger in calves.

INTRODUCTION

Something old is new again – free-access feeding. It's old because it's nature's way. What's new is the way we can fulfill our ancient contract of assuring freedom from hunger for calves in exchange for milk surplus to the calves' needs. Hunger is a major stress in the early days of life of a newborn calf. It may be the main predisposing cause for sickness in the first 7-21 days. Conventional feeding strategies often leave calves hungry because our methods do not meet the standards of an average cow mother. Since June 2005, in Ontario, several hundred calves have enjoyed freedom from hunger and good health because of free-access feeding with acidified colostrum, milk or milk replacer. Moreover, the free-access feeding scheme has given joy to those caring for calves.

Figure 1. A 'calf-maid' feeder in use on a dairy farm in Finland. Grober Animal Nutrition imported a similar feeder in the spring of 2006. An Ontario producer has been using it for several months.

CONTENTS

1. NATURE'S WAY and CONVENTIONAL FEEDING SYSTEMS

Nature's way of feeding calves includes free access, nursing until satiated, frequent meals per day and suckling. Conventional rearing systems usually limit access, restrict milk intake per meal, encourage rapid feeding or gorging, restrict meals per day or provide milk in pails (non-suckling).

Restricted-access systems include housing intermittently with an accommodating nurse cow, an automatic computerized feeding system programmed in a conventional manner or bottle, pail or mob feeders with feeding 2 or 3 times per day. The origins of limit feeding in frequency and quantity of milk may have been from research showing this practice stimulates greater intake of grain at a younger age and a desire by producers to limit costs (milk vs. grain) in calf rearing.

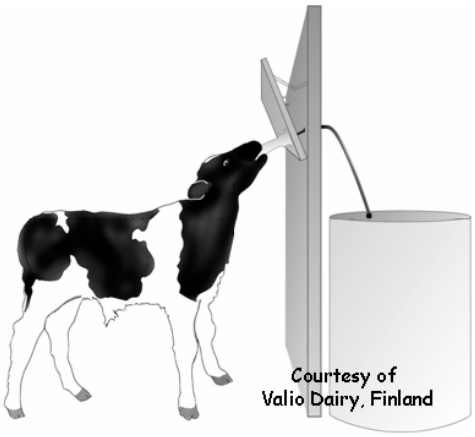
Figure 2. Suckling is nature's way of feeding calves.

Free-access milk-feeding systems include continuous housing with an accommodating nurse cow or unrestricted access to a container of milk. An automatic feeding system programmed for unrestricted access may still restrict access because of the calf-to-nipple ratio. The origins of free-access feeding may have been from producers or their advisors noticing improved health, greater feed conversion, rate of gain and growth in calves fed in ways that mimic nature. No doubt they also are looking for methods to decrease labour.

2. CHOICES and BENEFITS

Choices in feeding systems, housing and management affect health, growth and behaviour of calves and profit of a farm. Ontario producers commonly rear milk-fed dairy calves in individual pens and restrict milk feeding to 2 or 3 meals per day. In Finland, 30% of larger dairy farms and 90% of veal operations choose group housing and free-access feeding.

Finnish farmers have practical experience with free-access feeding since 1996. They use formic acid to acidify milk to preserve it for 1 to 3 days. They claim less labour, inexpensive equipment and efficient use of surplus colostrum, transition cow milk or milk from cows under treatment. They also report calves stay healthy, have few bouts of diarrhea and rarely suck on navels or ears. For Finnish farmers, free-choice feeding is an easier feeding method for substitute workers. It allows calves to eat to appetite and satisfies the calves' biological need to suckle. Of course, calves have very good growth with weight gains near 1 kg/day. Closer to home, a New York State study showed a reduction in labour per calf per day, from 10 minutes for calves in individual pens to 1 minute for calves reared and fed in group housing. The basic components of a Finnish free-access feeding system include a reservoir to contain the milk or milk replacer, a nipple, a plastic tube and a check valve (**Figure 3**). Acidification with formic acid preserves milk for storage at room temperature and allows them to mix batches at 1- to 3-day intervals to save labour. In addition, the milk is fed cool to avoid gorge feeding.



In June 2005, an Ontario dairy goat producer was the first to use the free-access acidified-milk system for rearing kids. A dairy producer with cattle soon followed. Several producers set up pilot projects. They discovered practical methods of implementation and useful information about what does and does not work. A few producers tried and quit the feeding system. About 100 producers in Ontario, Saskatchewan, Alberta, Nova Scotia, New Brunswick and New York State adopted the system in the past 16 months.

3. HUNGER – QUANTITY, FREQUENCY, QUALITY

Hunger is a state of discomfort, queasiness or weakness caused by a lack of food. Hungry calves are in need of food. Calves display hunger by vocalizations or suckling behaviour while searching for a teat. Intersuckling on other calves may be a sign of hunger but it is often perceived as unwanted behaviour.

Modern calf raisers often use socialistic feeding strategies. They feed all calves the same volume, regardless of the calf's body weight. Consequently, the heaviest calves often suffer from hunger. In comparison, calves suckling their dams consume milk to their needs.

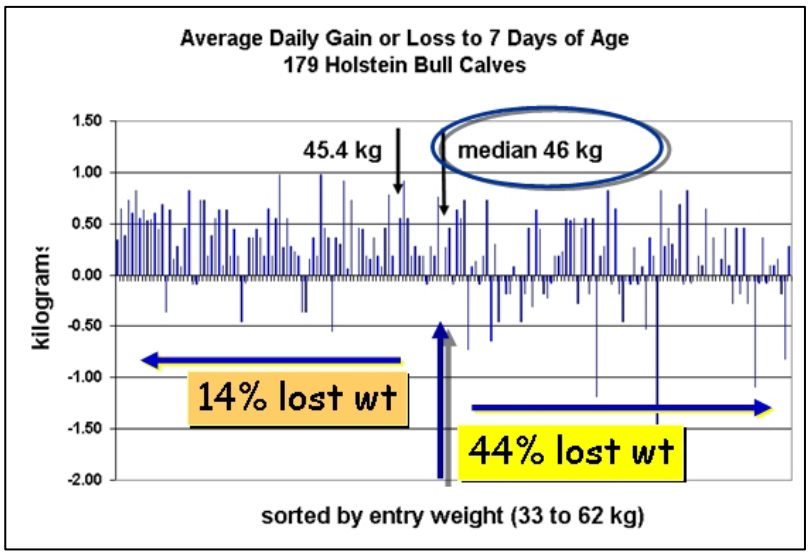


Figure 4 is a graph that shows the average daily gain or loss at 7 days of age for 179 Holstein bull calves fed 4 liters of milk per day. The calves are sorted by birth weight from left to right (33 to 62 kg). Fully 44% of calves greater than the median weight of 46 kg did not gain or lost weight in their first week of life on the restricted-milk feeding scheme.

Conventional feeding strategies often provide less milk than calves would consume with free access to a nurse cow. Despite their greater total daily consumption of milk, suckling calves appear to have fewer problems with scours.

Figure 5. A comparison of conventional calf feeding to suckling or free-access systems shows that we fail to meet the standards of an average cow mother. Our conventional feeding practices usually fall short in quantity and frequency of feeding and missed potential for weight gain. The comparison supports the argument that hunger is a prime issue for calves 1-21 days of age.

	Nature's Way	Conventional Feeding
% Body Wt	20 - 25	8 - 15
Liters	8 - 10	4 - 6
Gain g/day	1000	200 - 500
meals	7x	2x - 3x
nursing minutes	48	6-8
interval hrs	4	10 - 14

In addition to quantity and frequency, we may fail to deliver milk of sufficient quality to our calves. With milk replacer, the most common error is in mixing an inadequate weight of powder per liter of water. With whole milk, some choose to dilute it with water. However, bacterial quality may be just as important an issue.

Figure 6. Waste milk, colostrum and prepared milk replacer can be found stored in pails at room temperature on some farms. This milk incubates bacteria and becomes a cesspool for calf feeding. The same can be true for large volumes of milk stored in refrigerators. Without stirring, only milk at the periphery of the pails is adequately chilled while milk towards the center remains warm and incubates bacteria.

4. MYTHS CONTRIBUTE to HUNGER

Myths are collective opinions or beliefs that are often based on false premises. Several myths about calf feeding, when put into practice, contribute to hunger of calves. The first is 'too much milk causes scours or too much milk is bad for calves.' It's the reason milk is restricted or diluted with water. Gorge feeding large volumes of milk may be the real issue. Experience has shown that calves thrive on more milk than offered with conventional feeding. However, a greater volume per day must be consumed in several small meals to avoid hazards of gorge feeding.

'Too much milk powder causes scours' is on the same theme. This may have been true years ago when soy was a major component of milk replacers. Soy ingredients cause an allergic reaction in the intestinal tract and diarrhea in young calves. However, most modern milk replacers are made with all-milk components. They are the best choice for your young calves. The too-much-powder myth led to producers using insufficient amounts of milk replacer powder per liter. With most quality milk replacers, about 125 - 150 grams of powder per liter will yield a solids content close to that of whole milk.

The last myth has to do with willingly withholding milk from calves – the '10% of body weight per day' myth. Someone devised this feeding strategy to stimulate calves to eat grain. For sure, they will eat grain when starved of milk. However, grain intake for calves fed milk at 10% of body weight is no greater in the first 14 days of their life than calves that have free access to milk. Further, the young calf needs and uses milk as a food source and not grain in its early days. Experience with free-access feeding shows the dogma to be unfounded and detrimental to calves.

5. FREE-ACCESS MILK FEEDING

Free-access feeding systems allow calves easy and unconstrained freedom to consume milk. The system allows calves to suckle milk when and as often as they choose. In an individual pen, a calf could suckle without interference from other calves. In group pens, it is essential to have several nipples available to limit the number and frequency of displacements of calves from nipples. Unlike most computer or automatic feeding systems, several calves in a group can suckle at the same time. Access to nipples and milk is not controlled, restricted or hampered by external influences.

The system requires unrestricted access to quality milk and at temperatures suitable for calves to drink. Reservoirs of colostrum, milk or milk replacer require preservation. Acidification is one easy way. Another is souring with specific bacteria. In Finland, at least one field trial used REDI-SET™ dairy culture to acidify milk.

The least expensive equipment includes an electric drill and paint mixer attachment to mix the milk and preservative, a container to hold a reservoir of milk and teats on the container or attached to a feeder bar on a wall. The system may be gravity fed with teats at the bottom of the container or line-fed with teats attached to a plastic line with a one-way valve.

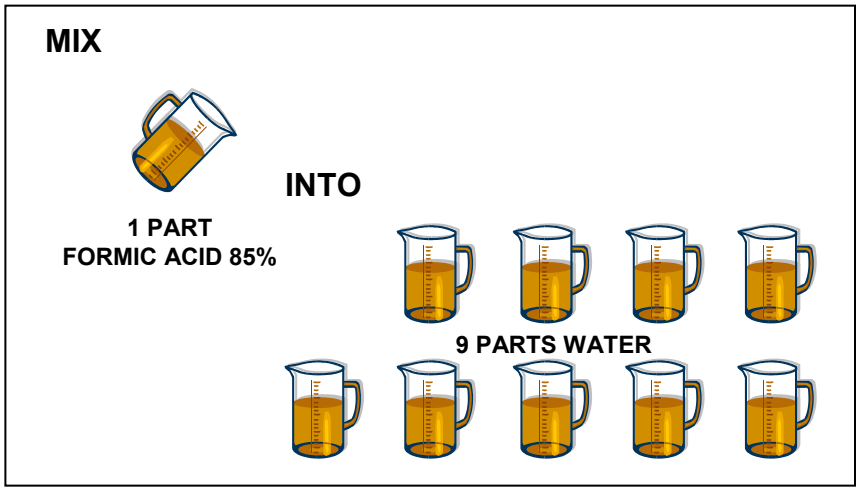
Figure 7. A line-fed system may have teats attached to the reservoir or remotely from the container. The size of container depends upon the number of calves given free access to the milk and the frequency of filling. It could be a 20-liter pail for a single calf or 100-200 liters or more for several calves.

Free-access feeding systems can be automated with mixers on timers or recirculation pumps to deliver milk from one reservoir to several groups of calves and back to the reservoir. Free-access feeding is also possible with some computerized feeding systems that have a milk reservoir. Free-access systems are suitable for individual or group-housed calves. In general, acidified milk may be prepared at 1-3-day intervals and the equipment cleaned twice per week. The use of a preservative (acidification to pH 4.0 - 4.5) and feeding at a cool (20°C in winter) temperature (to limit intake per meal) are essential to the success of free-access feeding systems.

6. HOW to ACIDIFY COLOSTRUM, MILK or MILK REPLACER

a) Prepare dilute acid

- Mix 1 part concentrated Formic Acid 85% into 9 parts water.
- For example, put 9 L water into a container; then add 1 L of Formic Acid 85%. (**Figure 8**) Mix.
- Label clearly – Dilute Formic Acid. Caution – Irritating to skin, eyes and lungs. Keep out of reach of children. Mixing Directions: While stirring vigorously, add 30 mL to 1 liter of whole milk or milk replacer. Mix 40 - 45 mL to 1-liter colostrum. Check pH 4.0 - 4.5.



b) Cool the colostrum, milk or milk replacer before adding dilute acid

- to avoid clot formation.
- Warm milk may be acidified. It separates quicker and requires vigorous and frequent stirring. Use an electric drill and paint stirring attachment for vigorous stirring.

c) Mix dilute acid into colostrum, milk, or milk replacer

- Mix 30 mL dilute acid into 1 liter (1000 mL) milk or milk replacer. Add 40 to 45 mL dilute acid to 1 liter colostrum. Check pH 4.0 to 4.5.
- Mix 150 mL dilute acid into 5 liters milk.
- Mix 300 mL into 10 liters
- Mix 450 mL into 15 liters
- Mix 600 mL into 20 liters

d) Stir vigorously while adding acid. Stir again within an hour and, then, 3 times through the day. (Figure 9) Use a paint mixer and brisk speed on a cordless drill.

e) Check to assure within the range of pH 4.0 to 4.5 when mixing is complete. (Figure 10)

f) Feed at ambient temperature in the summer. Feed at 20°C in winter. Do not warm the milk.

g) Store in closed containers for 1 to 3 days. Prevent entry of flies/cats into milk.

h) Clean nipples, valves, lines, and container with warm water and dish washing detergent.

i) Provide free-choice water and calf starter.

j) Mount nipples 24 to 28 inches above floor level for calves.

7. PURPOSE of ACID

Acidification to pH 4.0 - 4.5 is **to *preserve* the milk/milk replacer**. Once preserved from growth of bacteria and molds, the milk can be stored at room temperature for several days. Proper preservation permits free-access feeding of milk to calves without the need for refrigeration of the milk. Acidification decreases a calf's exposure to bacteria because it decreases the bacterial load in milk or milk replacer. It may be useful for storing surplus colostrum or waste milk when refrigeration is not available. There may be merit in acidifying surplus colostrum prior to storage in freezers.

Acidification does not inactivate or kill all bacteria found in milk. However, acidification at a target pH of 4.0 - 4.5 and contact time of 8-12 hours will produce milk that meets or exceeds quality targets for feeding calves.

8. WHY ACIDIFY to pH 4.0-4.5?

Standard textbooks of laboratory procedures show that many bacteria and molds will not grow at pH less than 4.5, but they survive and reproduce readily at pH levels greater than 4.5. To test the theory that acidification (pH 4.0 - 4.5) preserves milk, we conducted standardized Plate Loop Count bacterial cultures on control and acidified bulk-tank-milk samples stored at room temperature. Bacteria multiplied quickly in the control sample and colonies became too numerous to count, whereas the acidified sample showed no bacterial growth after several hours of contact with formic acid and pH of 4.2. However, upon repetition of the experiment, we found some bacteria survive acidification.

The effects of acidification on *Mycobacterium avium parTB* (Johne's) are unknown. We are hopeful that a University of Guelph researcher will soon answer the question.

	Optimum	Range	Inactivated / lost activity
Bacillus cereus		4.3 - 9.3	< 4.3 and > 9.3
Clostridium perfringens	6.0 - 7.0	5.5 - 9.0	< 5 and > 8.3
Clostridium botulinum		4.6 - 9.0	< 4.6 and > 9
E coli (STEC)	6.0 - 7.0	4.4 - 9.0	< 4.4
E coli O157:H7	6.0 - 7.0	4.4 - 9.0	< 4.4
Lactobacillus acidophilus	5.8 - 6.6	4.0-4.6-6.8	< 4.4*
Listeria monocytogenes	7.0	4.4 - 9.4	< 4.4
Mycobacterium avium paraTB (Johne's)	6.0 -7.0	5.0 - 7.0	< 5 no growth
Pseudomonas aeruginosa	6.6 - 7.0	5.6 - 8.0	< 5.6
Salmonella	7.0 - 7.5	3.8 - 9.5	< 4.4*
Staph aureus	7.0 - 7.5	4.2 - 9.3	< 4.2
Strep pneumoniae	7.8	6.5 - 8.3	< 4.5
Vibrio cholerae	7.6	5.0 - 9.6	< 4.5

Figure 11. The table lists several bacteria of interest on dairy farms, the optimum and range of pH for their growth, and the pH at which they are inactivated or lose their activity under laboratory conditions. The recommendation to acidify milk to pH 4.0 - 4.5 is logical when one considers the information in the table.

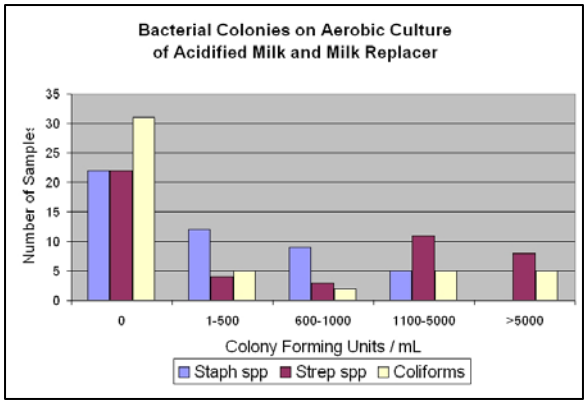
9. ABOUT pH and CONTACT TIME

Acidification creates unfavourable conditions for growth or survival of many bacteria. The effect does not happen immediately. It takes time. The contact time varies with the bacterium and the pH.

In the summer of 2006, we conducted experiments using whole milk from a few cows. We found no growth of coliforms after a contact time of 1 hour at pH 4.1 in whole milk acidified with formic acid. We found no growth of Staphylococcus aureus after a contact time of 4-6 hours at pH 4.1 in whole milk acidified with formic acid.

Next, in 2006, we collected acidified milk from containers on 24 farms (Figures 12 and 13). We found 81% of 46 milk samples were in the target pH range of 4.0 - 4.5. On bacterial culture, the majority of samples had no growth or less than 1000 colony-forming units per millilitre (cfu/mL) of milk. Thirty-one of 48 samples had no coliform growth. We found environmental Staphylococcus and Streptococcus in less than half the samples and at levels of 1-5,000 cfu/mL.

Figure 12. In our study of acidified milk from 24 farms, laboratory staff reported results as no growth and in ranges of less than 500 colony-forming units per mL (cfu/mL) of milk, 600-1000, 1100-5000 and greater than 5000. The graph shows the number of samples that fall within those ranges for three bacterial species – Staphylococcus, Streptococcus and coliforms. The majority of samples had no growth or less than 1000 cfu/mL of milk. Thirty-one of 48 samples had no coliform growth.



There is scant information to predict the precise contact time needed to inactivate specific bacteria common in milk, waste milk, colostrum or milk replacer. However, with limited experience, 6-12 hours seems appropriate. In practical application, acidify milk in the afternoon and feed it the next morning.

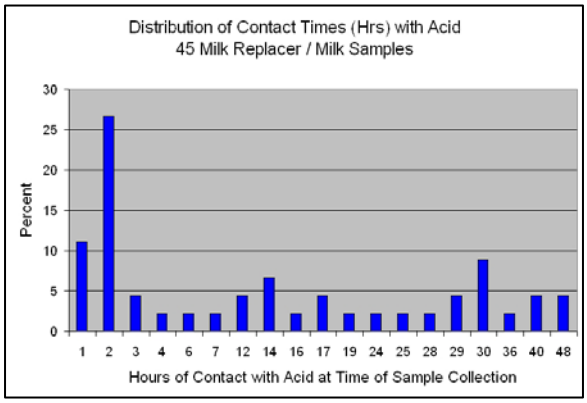


Figure 13. In our on-farm study, the hours of contact time with acid at the time of milk sample collection ranged from 1 to 48 hours for the bacterial cultures shown in Figure 12. The contact times reflect the frequency of mixing acidified milk. Although pH is important for inactivating bacteria, adequate contact time also is essential.

10. SHELF LIFE of ACIDIFIED MILK

Shelf life will vary with pH and ambient temperature. Finnish farmers and advisors recommend preparation of batches every 1-3 days. A survey of 24 Ontario producers found they commonly mixed batches at 1-2-day intervals. One producer mixed at 3-4 day intervals. Nonetheless, no one has determined the storage life of acidified milk under farm conditions.

11. DOES ACIDIFICATION ALTER MILK?

The most obvious change to colostrum, milk or milk replacer (milk) is separation that happens within 10-30 minutes after acidification to pH 4.0 - 4.5. It is like gelation seen in making yogurt.

Figure 14. The photographs show the separation (gelation) that occurs with milk acidified to pH 4.2. Similar separation occurs with colostrum, milk or waste milk. The separation is more rapid with warm or hot (≥30°C) milk. We used an all-milk replacer, 22% protein and 17% fat and mixed at 150 g/L. All samples looked like the control sample after a vigorous stir. It is essential to stir acidified milk 2-4 times per day to keep the constituents in solution.

Those feeding acidified milk must stir the mixture about 30 minutes after preparation. Subsequently, the milk will separate again after several hours. Therefore, it is necessary to stir vigorously 2-3 times per day thereafter. Published research reports show no harmful effects of acidification to colostrum or fat, protein or lactose in milk. At a recent on-farm demonstration, a volunteer stated that the acidified milk tasted different and that the control sample would be his first choice. Nonetheless, calves drink the acidified milk readily. Any slight change in taste may be beneficial to limit intake in free-access feeding systems.

In the 6-8 hours immediately following acidification, milk will separate again and require stirring. However, when stirred vigorously 8 hours after acidification, I found milk stayed in a uniform mix for 12 to 18 hours. A practical approach would be the use of an automatic mixer set on a timer. An alternative for hand stirring the milk would be to prepare the acidified milk in the morning and serve it in the evening following a good stir.

Figure 15. The photograph shows the control sample and the Formic Acid and Agri Acid samples at 7:30 a.m., 15.5 hours after a vigorous stir at 4:00 p.m. the previous day. Although not shown, the AcidPak samples looked similar.

12. STIRRING is ESSENTIAL and IT CAN BE AUTOMATED

Timely stirring of acidified milk assures calves receive a consistent mix when they suckle. Since acidified milk gels and separates, timely stirring is essential. Vigorous stirring at high rpm for a short duration will achieve excellent mixing.

Figure 16. An electric drill and a paint stirrer attachment do a very good job of mixing. Several producers made mixers to insert into their electric drills. It is essential to select a mixer for the size of the container and volume of milk. For example, the smallest commercially available paint mixer is not adequate for mixing milk in 20-L pails or 100-L barrels.

One producer uses a 12-volt diaphragm pump that circulates milk through a line feeding nipples at individual calf pens. The pump is on the return side of the line because this location prevents milk leakage at the nipples. Milk exits from the bottom of the barrel and enters the top.

During the summer months, a producer fed free-access milk to his calves in hutches. The acidified milk is in a pail hanging on a hook suspended from the top of the hutch. The calf feeder simply gives the pails a vigorous shake a few times a day. The calves also shake the pails while nursing.

A pond pump stirs milk replacer at one farm I visited. The pumps are available at garden centres, come in various sizes, and have a pre-filter to prevent clogging of the pumping mechanism.

Figure 17. At a Milverton-area farm, a dose of old-fashioned ingenuity from a young farmer assures an even mix throughout the day. His storage and mixing system consists of a barrel, a 1/3-HP motor to drive a mixer and two timers to control frequency and duration of mixing. The motor mounts to a lid. A cart makes easy work of moving the barrel for washing and filling. Cables attach to the lid in three locations and they support the mixer above the barrel when moving the barrel away.

13. COOL MILK is BEST and PROTECT FROM SUNLIGHT

Cool (20°C) milk limits intake. In effect, it prevents gorge feeding. Researchers compared health, feed conversion and rate of gain in calves fed cool and warm milk. The calves fed cool milk had the best performance in all three categories. Calves fed cool milk have fewer days with scours than calves fed warm milk. Calves housed in barns with moderate temperatures have similar performance when fed either cool or warm liquid diets.

Calves will drink cold (<10°C) milk but they shiver after feeding. Calves shiver to regenerate body heat lost when they drink cold milk. Cold milk is a poor choice for calves housed in cold barns. Research showed calves housed at temperatures <5°C and fed milk at 10-15°C had less weight gain (12%) and less feed efficiency (13%) than calves fed milk at 35-38°C.

Closer to home, a producer on a pilot project fed his calves and goat kids milk warmed with hot water circulating through a coil at the bottom of the barrel. The young animals developed scours within 24 hours. However, diarrhea stopped within a day after removing the heater from the milk. At an outdoor farm show, we exposed our milk container to direct sunlight. While looking for reasons for sudden onset diarrhea in our calves, we found the milk was hot to touch. We made a cool batch of milk, shaded it from the sun and scours stopped. These practical experiences indicate that hot, acidified milk leads to diarrhea. The reason is unknown. Therefore, I recommend feeding at temperatures close to 20°C in winter. During the summer, feed at ambient temperatures and protect the containers from direct sunlight.

14. KEEPING MILK COOL (20°C) in COLD BARNS

During the winter of 2005-6, some producers let milk chill to ambient temperatures that often hovered between 3-10°C. Their calves drank the cold milk (slowly) and shivered from the chill, yet they thrived in the system. Others experimented with various heat sources to keep milk from freezing yet cool in their cold calf barns. Those who built and heated an insulated enclosure for the milk container seemed most pleased with their system. They kept milk cool by placing containers inside insulated boxes and adding supplemental heat to warm the miniature room. One producer used discarded chest-type food freezers. They have insulation and a good fitting lid. He located the freezers adjacent to calf pens to keep lines short. In a pen for 1-3-day old calves, he mounted nipples directly on the outer wall of a small apartment-sized freezer. Heat lamps or small thermostatically controlled electric heaters keep the air and milk within the chest at an appropriate temperature.

Figure 18. Free-access feeding is possible in cold calf housing. The challenges are to protect milk and milk lines from freezing, and maintain milk at 20°C. The photograph shows a chest freezer with short lines to nipples. The insulated freezer retained heat generated by a thermostatically controlled heater. The chest contains milk in short barrels.

To date and to my knowledge, no one in Ontario has found a satisfactory submersible heater for use in milk. Stock tank heaters prevent freezing but do not heat to 20°C. Pail heaters are too hot and cook milk on the element.

A producer in Northern Ontario built a large milk container and placed it within a warm water bath. Producers have tried circulating hot water from hot water tanks through coiled copper tubing in the milk. Early attempts with this device failed because the water was too hot.

Another producer has a heated milk preparation and storage room with four pens, 2 on either side. His milk containers are inside the warm room. Milk lines exit through the insulated wall to nipples mounted on the other (calf pen) side.

Our attempts at temperature control with industrial band heaters for steel barrels were not successful. We melted plastic containers. A waterbed heater has been working for an Eastern Ontario producer.

Figure 19. The photograph shows an aquarium heater used to warm water within a 3-inch plastic pipe submersed in milk. This heater maintains the temperature of freshly prepared milk replacer. Aquarium heaters are available in numerous sizes. A "pond pump" (not shown) used in garden applications, keeps the milk mixed in this barrel.

A few producers are considering the use of old bulk milk tanks. They plan to maintain milk temperature by circulating warm water through the copper lines normally used for cooling.

Figure 20. The photograph shows a 'calf-maid' feeder manufactured in Finland by FinnLacto OY. It has an automatic mixer and temperature control. The robust tires make an easy task of moving 200-300 L of milk.

15. FREQUENT SUCKLING BENEFITS CALVES

Prevention of abomasal ulcers or abomasitis in suckling calves presents challenges to veterinarians and their clients. The commonly proposed etiologies for abomasal ulcers include mechanical abrasion from coarse ingesta, infection with *Clostridium perfringens* Type A, trace mineral deficiencies and stress. Because of sudden deaths or unrewarding treatments, it is important to control or prevent ulcers. Feeding frequency could be a preventive measure.

Researchers at the University of Illinois set out to find practical treatments. They speculated that long periods of low pH in the abomasum could increase the chance of injury to the abomasal mucosa. Further, they wondered if feeding frequency had an effect on abomasal luminal pH and the risk of ulceration. The researchers discovered changes in abomasal pH with different schedules for feeding milk replacer. From their findings, they advise increasing feeding frequency to prevent abomasal ulcers in suckling calves.

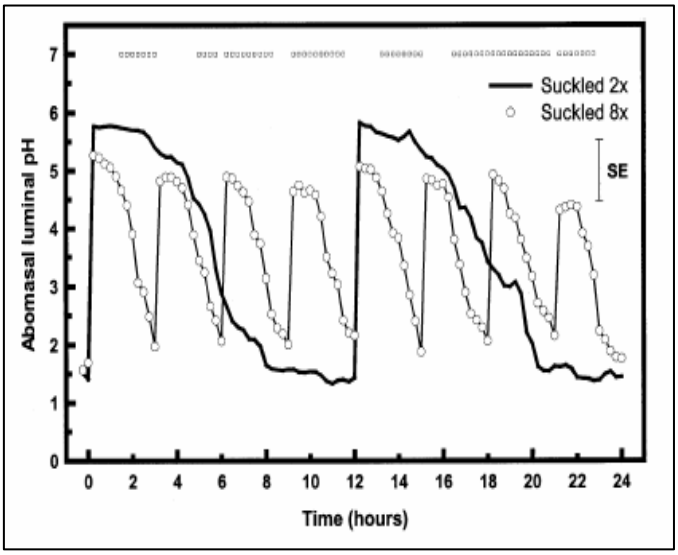


Figure 21. The graph shows the least squares mean abomasal luminal pH in dairy calves (n=6) that suckled milk replacer at 3-h intervals (8x; O_O) and 12-h intervals (2x;__). Open symbols at the top of the graph represent values that were significantly (P <0.05) different at the same time. Bar represents the overall standard error (SE) for least squares means. (Ahmed AF, 2002)

The graph shows that frequent suckling succeeded in reducing the number of hours per day that the abomasal lining was exposed to low pH. However, it also shows abomasal pH was less than 5.5 for the entire day. A quick look back to the table

in **Figure 9** shows that *Clostridium perfringens* prefers a pH of 5.5 - 9.0 for optimum growth. Frequent suckling seemed to assure that the optimum pH for that growth was not achieved. Further to the argument, free-access feeding of acidified milk could be of benefit because the milk entering the abomasum is at a pH less than 4.5.

16. SUCKLING ACTIVITY with FREE-ACCESS to MILK

In the summer of 2005, we recorded on video tape the feeding activity for 8 calves on free-access feeding. The calves were in groups of 4 with 3 nipples per 4 calves. On average, our study calves ate 7 meals with a range of 4-14. None chose less than 4 meals per day. The calves suckled for an average of 48 minutes per day with a range of 35-70. None chose 5-10 minutes. An average suckling bout was 7 minutes with 75% of suckling bouts greater than 5 minutes. The calves clustered most meals between 4:00-7:00 hours and 17:00-22:00 hours with a smaller cluster between noon and 15:00 hours.

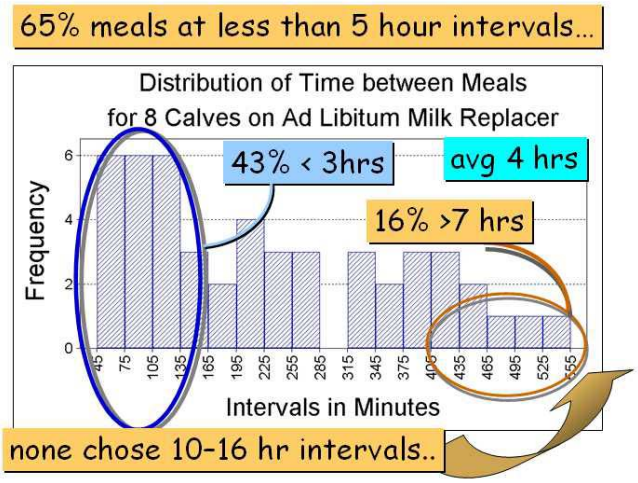


Figure 22. For 8 calves on free-access feeding, the average interval between meals was 4 hours with 65% of meals at less than 5-hour intervals. Fully 43% of meals were at less than 3-hour intervals and 16% at greater than 7 hours. None chose to suckle at 10-16 hour intervals.

17. NIPPLE to CALF RATIO

Since calves have the herd instinct to eat and rest as groups, it is advisable to provide ample nipples for feeding. Finlanders recommend at least 1 nipple for 3 calves. An abundance of nipples assures that older or stronger calves will not displace smaller or timid calves from nursing opportunities. Older calves teach young calves by example. The youngest calves explore what the older calves are doing and quickly learn from them. Free-access feeding implies a nipple and milk are available when wanted and, in general, there should be no waiting for milk. Research from British Columbia showed reduced time on teats, reduced daily milk intake and increased competitive displacements from teats with reduced access to teats (4 teats : 3 calves vs. 1 teat : 3 calves).

18. MILK INTAKE and WEIGHT GAIN

From textbook references, calves can drink 20-25% of their body weight daily. On free-access feeding, in the first week of life, Holstein calves will drink 6-8 liters of milk each day. Prior to weaning at 5-6 weeks, calves may drink 12-15 liters of milk per day. Researchers in British Columbia (BC) documented an average intake of 11 liters per day during a 27-day feeding period from 5-32 days of age. On average, their calves gained 1.1 kg per day. In another BC experiment, researchers found teat-fed (free-access) calves drank 8.8 liters per day in the first two weeks of life. In general, when given the opportunity, calves will consume about 20% of their body weight in milk. This is double the common recommendation or practice on most farms.

19. REARING COSTS

Since calves consume more milk, there will be greater costs associated with milk or milk replacer. However, reports show the investment in milk or milk replacer is offset by better health and fewer treatment costs, thus giving the advantage to the free-choice fed calves compared to calves on restricted feeding. There may be less time treating sick calves and more or equal time in feeding-related activities.

20. BENEFIT from EARLY WEIGHT GAIN

Since there is no research on the subject with free-access feeding of acidified milk, we could learn from research about accelerated milk replacer programs. Recently, researchers suggest a benefit to the immune system from enhanced feeding of young calves. Weight gain during the first 4-6 weeks of age has no harmful effect on future milk production. Calves will be taller at weaning than those on restricted feeding. In addition, calves will show estrus about 2 weeks earlier and subsequently breed earlier. Calves raised on 'accelerated' milk replacer programs have been shown to produce more milk during their first lactation.

21. CROSS-SUCKLING in GROUPS

With Holstein calves, inter-suckling has not been an issue. It is a very rare event in groups with free-access feeding. The reason may be an abundance of teats, so several calves can feed at the same time, and the ability to feed (suckle) until satiated. The exception has been Jersey calves at weaning as shown at one farm on a pilot project. They started cross-suckling behaviour (especially for urine) after abrupt weaning. At least one research report suggests hunger is the reason for the behaviour. Calves should have free-access to salt, grain or starter pellets, hay and water during the milk-feeding stage.

Figure 23. Jersey calves shown in this photograph did not cross-suckle while on the free-access feeder. However, some did when weaned abruptly or gradually. Producers report cross-suckling is not an issue with Holstein calves before or after weaning.

22. FREE-ACCESS WATER and GRAIN

Calves must have free-access to clean water and a starter ration of grain or pellets at all times while on the acidified milk feeding program. This advice is the same as for other feeding systems. Although seldom practiced, it may be beneficial to provide these young calves with access to a salt lick. The intake of pellets will increase noticeably during the fourth week of age. Calves on free-access feeding do not consume as much starter as calves on restricted feeding. However, post weaning, the free-access calves quickly consume quantities of starter similar to calves on restricted feeding. Recent research indicates that offering hay is not harmful to rumen development contrary to commonly held beliefs from earlier research studies.

23. ABRUPT or GRADUAL WEANING

Abrupt and gradual weaning are possible. Gradual weaning over a 7-day period is the preferred method. Producers report some separation anxiety from the teat. However, calves appear to suffer no greater setback at weaning than calves weaned from conventional feeding systems. To wean gradually, make the milk replacer with more water and less powder or dilute whole milk with water. Water alone could be the only liquid available by teat at the time of weaning.

24. HEALTH CHALLENGES with GROUP REARING

Respiratory disease and diarrhea are the greatest health issues for neonatal calves. Some say pneumonia is more common with group rearing. Housing in individual pens or hutches became popular as a way to separate calves and diminish the risk of diseases. Recent research from Sweden looked at the effect of group size on health and growth rate of Swedish dairy calves housed in pens with automatic milk-feeders (Svensson and Liberg, Prev. Vet. Med. 73, 2006). The authors stated that "calves in pens for 12-18 calves had a higher incidence of respiratory illness (Odds Ratio: 1.4) and grew 0.022 cm/day less than calves

housed in groups of 6-9 animals (equivalent to approximately 40 g/day). We detected no differences between calves kept in the small-sized versus the large-sized groups in terms of risk of diarrhea."

At least three Ontario producers tried unsuccessfully to rear calves in large groups housed in barns with ventilation challenges. Their calves began to cough, so they wisely switched back to hutch rearing. Ventilation can be a challenge in controlled-environment calf barns. At one farm, tearing from eyes and coughs stopped when the owners dropped relative humidity from 65% to 50% and set the temperature at 10-11°C. Testimonial evidence from 24 Ontario producers indicates diarrhea is less frequent with free-access feeding of acidified milk than with their previous feeding systems.

25. GROUP SIZE – LIMIT to 8 or FEWER CALVES

Our recommendation is 8 or fewer calves per pen. It is based on the Swedish research and experience at pilot project farms in Ontario.

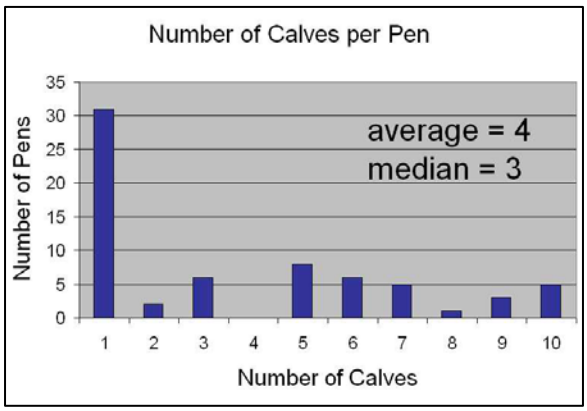


Figure 24. A sample of 24 Ontario farms using free-access feeding showed they had an average of 4 calves per pen. The number of calves per pen ranged from 1 to 10. Fully 31 pens/hutches were for individual calf housing. Five pens had 10 calves in a group, 8 pens had 5 calves in each group. The number of pens for individual calves skewed the average. In general, it was most common for group size to be 5-8 calves. Pen area per calf varied from 12-75 square feet, with an average of 29 and median of 25.

26. ACIDIFIED MILK and SCOURS

In Finland, advisors recommend feeding acidified milk for farms experiencing diarrhea problems in their calves. They claim acidified milk prevents diarrhea. Calves can eat as much as 9 to 12 liters a day with free-choice feeding. At these feeding levels, the consistency of feces is loose but the situation is different from a serious diarrhea caused by bacteria. Diarrhea has not been reported as a problem on the pilot-project farms. Indeed, the owners report scours as a rare event with free-access feeding. However, diarrhea was a problem on 3 pilot-project farms where producers fed hot acidified milk. The calves responded without treatment after the producers fed cool milk. Since acidification decreases the bacterial population in milk, acidified milk should provide a reduced hazard to calves.

In a previous section about frequent suckling, I argue that milk acidified to pH 4.0 - 4.5 should have a benefit for calves, especially when one considers *Clostridium perfringens* Type A. This bacterial agent is being diagnosed with increasing frequency in calves with abomasitis and sudden death. Since its optimum range for growth is pH 5.5 - 9.0, milk entering the abomasum at pH 4.5 should produce an inhospitable environment for Clostridial growth and sporulation in the abomasum. For sure, research would be helpful to prove or disprove this theory. At best, frequent feedings or feeding acidified milk should be considered as a prevention strategy because other means of prevention have been unrewarding.

Viruses are notoriously resistant to acids. I have not found information related to acidification of milk and survival of Enzootic Bovine Leucosis virus or Bovine Virus Diarrhea virus.

27. FREE-ACCESS for GOAT KIDS

Free-access feeding of acidified goat's milk, cow's milk and milk replacer to goat kids has been very successful on several Ontario farms.

My first experience with the feeding system was with goat kids at a large dairy. Death loss in the kids was 32% and most deaths were related to scours that started at 7-10 days of age. Challenges with colostrum quality (late harvest), undernourishment (thin body condition), engorgement stress (pot bellies after feeding) and diarrhea were identified and addressed with a feeding protocol designed to mimic normal feeding behaviour. An ad libitum feeding system allowed kids to suckle small quantities at each

feeding episode. The intention also was to improve consumption of colostrum and transition milk in the first few days of life and to overcome the stress of hunger. The scheme included harvesting colostrum immediately after freshening of the doe, feeding the newborns warm fresh colostrum at birth, chilling the remaining colostrum and then acidifying it, and feeding acidified colostrum for the next few days after birth of the kids. In addition, subsequent feedings included acidified milk and/or milk replacer for the first 3 weeks of life.

Figure 25. Newborn goat kids suckling acidified milk with free access. From implementation of the new feeding scheme, at one farm, to the end of kidding season, death loss dropped from 32% to 3% in 2005. In the 2006-kidding season, owners fed acidified colostrum, milk and milk replacer for the first 3 weeks of age. Their records for 2006 showed death losses of less than 6% for all causes in the neonatal kids.

28. FEEDING PROTOCOLS from BIRTH to WEANING

Many advisors recommend feeding 4 L of colostrum to calves either by suckle bottle or by stomach tube. Producers often remark that the calves fed 4 L will not drink for several hours or a day following this large meal. Free-access feeding provides an opportunity to feed newborn calves several smaller meals during the first few hours when the gut is open to antibody absorption. The following protocol has been working successfully on pilot-project farms. The protocol takes full advantage of the benefits of colostrum and fresh cow milk. It may not be applicable to those on Johne's control programs.

Feeding newborn calves – birth to 2 to 4 days

- Within 1 hour of calving,
  - harvest colostrum from the fresh cow.
  - feed the newborn calf at least 2 liters of fresh colostrum.
  - use a nipple bottle.
  - cool (<10°C) the remaining colostrum.
  - acidify the remaining colostrum with dilute formic acid.
  - store the acidified colostrum in containers with lids.
- 2 to 4 hours after the calf's birth – feed acidified colostrum by nipple.
- Move the calf to its individual or group housing pen;
  - provide free-choice access to acidified colostrum.
  - be sure the calf is suckling the acidified colostrum.
  - feed acidified colostrum and fresh-cow milk for 2 to 4 days.
  - provide free-choice water and grain.

Feeding post-colostrum to weaning - whole milk or milk replacer

- House calves in groups;
  - put 2- to 4-day-old calves (off colostrum) into group pens.
  - prepare the 'milk' with dilute formic acid as per instructions.
  - mix enough 'milk' for 1 to 3 days.
  - calculate 8 to 12 liters per calf per day for pens of calves of mixed ages (1 to 6 weeks).
  - stir the 'milk' for 10 to 15 seconds at least 3 times per day.
  - be sure each calf is nursing the nipple.
  - use containers with lids to keep flies and cats out.
  - clean the equipment with warm water and dish washing detergent.
  - provide clean, fresh water free choice.
  - provide fresh calf starter – grain – free choice.
  - remove weaned calves from the group at 5 to 7 weeks of age.

- Provide 1 teat per 3 calves, minimum recommendation.
- Restrict group size to 8 calves maximum.
- Soft feces should be considered normal for calves fed free-choice liquid diets.
- Abrupt weaning may be necessary. Gradual weaning is the preferred method.

Figure 26. Calves exhibit group feeding behaviour similar to cows at a feed bunk. There should be enough teats available to enable several calves in a pen to suckle at the same time. In groups of 6 - 8 calves, 4 nipples should be adequate.

29. SUMMARY

Conventional milk-feeding systems have worked well on Ontario farms. However, cow numbers and calf numbers are increasing as our dairy farms increase in size. There is considerable labour devoted to feeding of individual calves and the labour issue has producers looking at alternative feeding systems. Hutch rearing has proven itself for calf health but is falling into disfavor by those feeding calves during miserable weather. Mob feeders, free-access feeding and automatic (computerized) feeders are choices to consider for feeding calves as groups. The main challenge becomes the prevention and control of respiratory disease in group housing systems. Confinement housing, with controlled heat and ventilation, includes additional expense in rearing and challenges with respiratory disease. Group rearing in green-house type shelters with wind screens could be adapted to group feeding systems. Calves thrive in cool temperatures but the equipment for feeding must be protected from freezing. That is where we need some innovations to make free-access or automated feeding an alternative on larger farms.

For more information, please refer to the **INFO**Sheet, *Free-Access Feeding of Dairy Calves and Kids Using Colostrum, Whole Milk or Milk Replacer Acidified with Formic Acid*

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31. ACKNOWLEDGEMENTS

Dr. Laura Kulkas and her colleagues at Valio Dairy, Jouni Pitkäranta and several Finnish dairy-farm families showed me calf rearing in Finland, February 2005. Heikki Kemppi at Valio continues to provide answers to questions based on 10 years experience with feeding acidified milk to calves.

Jenny Montgomery and Tyler O'Neill, OMAFRA 2005 summer-experience students, collected data about calf behaviour when suckling free-access acidified milk.

Several owners and managers of dairy cattle and goat farms implemented pilot projects to further our understanding of free-access feeding. They have been excellent on-farm researchers and teachers.

Jennifer Garner, OMAFRA 2006 summer-experience student, collected milk samples and survey data at 24 farms. Dr. Anna Bashiri, Mastitis Research Laboratory, Department of Population Medicine, Ontario Veterinary College, University of Guelph, provided laboratory services. Twenty-four Ontario dairy producers welcomed us to their farms to study their free-access feeding systems.

Mr. Grant Gould, Grober Animal Nutrition and Mr. Steve Wilson, Halchemix Canada, contributed valuable information from their free-access feeding projects across Canada.

32. CONTACT INFORMATION

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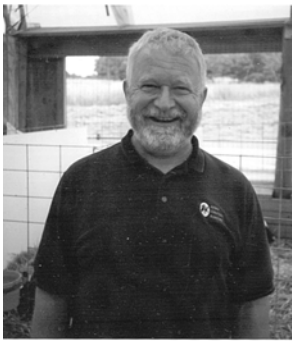
Increase your awareness of calf disease challenges



Dr. Sam Leadley

Dr. Sam Leadley is the calf/heifer management specialist for the Attica Veterinary Associates in Attica, New York, a practice devoted solely to dairy cattle. He consults with dairy farmers and heifer growers with the economic goal of raising healthier, faster-growing animals through better management practices. Dr. Leadley also writes “Calving Ease”, a free monthly newsletter that is distributed internationally, and the “Calf Connection” column in the Northeast Dairy Business magazine.

Increase your awareness of calf disease challenges

Success on both dairy and veal farms is directly related to calf health. Dr. Sam Leadley will delve into what the most common calf diseases are as well as the symptoms and treatment options for these challenges. From his experience, Dr. Leadley will also provide strategies for disease prevention and different treatment options for overcoming these challenges in the herd.

Preventing Calf Diseases

Sam Leadley
Attica Veterinary Associates, P.C.

Minimize Manure Meals

- In the birth canal
- On the ground
- From the dam

Feed Colostrum

- Clean
- Quickly
- Quality
- Quantity

Feed Enough

- Meet maintenance needs
- Meet growth goal needs

Minimize Pathogens

- Feeds are clean and wholesome
- Housing is dry and clean
- Air is fresh

Avoid Stacking Stresses

- Feed changes
- Dehorning
- Wet dirty bedding
- Inconsistent handling

Questions?

Washing Milk Containers

1. **RINSE**
   USE LUKEWARM WATER. Do not rinse with hot water. Rinse off dirt and milk residue.

2. **WASH**
   USE HOT WATER. Add soap and bleach. Brush all surfaces. Scrub off remaining milk residue. Keep water above 120° (49° C) at all times.

3. **RINSE**
   Use warm water. Add acid. Rinse containers. Do not rinse off the acid. Leave it on the bottles and pails while they dry.

4. **DRY**
   Allow the bottles and pails to drain and dry. Do not stack pails inside each other. Do not sit pails upside down on a concrete floor.

Nettoyage Des Chaudières À Lait Pour Les Jeunes Veaux

1. LE RINÇAGE
Il est important d'utiliser de L'EAU À LA TEMPÉRATURE DE LA PIÈCE. Ne jamais rincer une chaudière sale avec de l'eau chaude. Rincer les résidus de lait et la saleté.

2. LE LAVAGE
Il est important d'utiliser de L'EAU TRÈS CHAUDE. Ajouter du savon et du désinfectant. Brosser la surface et assurez-vous d'enlever toute saleté. La température de l'eau doit être plus élevée que 49º C.

3. LE RINÇAGE
Utiliser de l'eau tiède. Ajouter de l'acide. Ne pas enlever l'acide. Laisser sécher les chaudières et les instruments pendant qu'ils sèchent.

4. LE SECHAGE
Laisser les bouteilles et les chaudières sécher à l'air libre. Ne pas empiler les chaudières. Ne pas mettre les chaudières à l'envers sur une surface de ciment.

Traduction près Andree Bourgeois Le 17 dècembre 2003

Feeding Pre-weaned Calves: Colostrum

How do your procedures measure up? Do they provide the opportunity for your calves to grow into their genetic potential?

Let's consider procedures for feeding colostrum. Compare your routines with the standards in this checklist. When making this evaluation I like to use these scores:
1=never, 2=seldom, 3=often, 4=usually, and 5=almost always.

_____ 1. All feeding equipment that comes in contact with colostrum is scrubbed after every use.

_____ 2. When periodically cultured for bacteria, colostrum as fed to calves is not contaminated with environmental bacteria thus reducing septicemia and scours. Very highly contaminated colostrum may substantially reduce the rate of antibody transfer as well.

_____ 3. Colostrum contaminated with mastitis and blood is discarded.

_____ 4. Colostrum quality (antibody concentration) is estimated and the best quality available fed to heifer calves. While only a very rough guide to quality, a Colostrometer® may be used to exclude the lowest quality colostrum. Feeding more of poor quality colostrum is not an effective substitute for a good quality product.

_____ 5. Colostrum is fed to heifer calves no more than four hours after birth and to at least one-half of the heifer calves within one hour after birth. One-half of a heifer's ability to absorb antibodies is gone within six hours; three-quarters of this capability is gone within twelve hours after birth.

_____ 6. Plenty of good quality colostrum is fed. Average and large calves are fed four quarts within the first six hours. Smaller calves are fed proportionately less but still more than two quarts.

_____ 7. When only low quality colostrum (low antibody concentration) is available, an effective colostrum supplement is also fed to boost its antibody content.

_____ 8. When possible, fresh or refrigerated colostrum is fed rather than frozen colostrum. Thus, the calf gets a full dose of maternal immune cells as well as the maternal antibodies.

Estimated Gains Feeding Tank Milk

[12.5% dry matter, protein level 3.0 test (24% d.m.) and fat level 3.7 test (29.6 d.m.)]

To read values, read across from the selected volume fed daily. Select the lower of the two values on that line as the most likely estimate of projected daily gain. These values are shown in **bold** type.

41 Kg calf @ 16°C	Tank milk	3.0%protein 3.7%fat
	Predicted gain (Kg/day)	Predicted gain (Kg/day)
Volume fed daily	Energy Limited Gain	Protein Limited Gain
4 litres (0.5 Kg. d.m.)	0.4	**0.4**
5 litres (0.6 Kg. d.m)	Above 0.5	**0.5**
6 litres (0.7 Kg. d.m.)	Above 0.7	**0.6**
7 litres (0.9 Kg. d.m.)	Above 0.8	**0.7**
8 litres (1.0 Kg. d.m.)	Above 0.9	**0.8**

41 Kg calf @ 4°C	Tank milk	3.0%protein 3.7%fat
	Predicted gain (Kg/day)	Predicted gain (Kg/day)
Volume fed daily	Energy Limited Gain	Protein Limited Gain
4 litres (0.5 Kg. d.m.)	**0.1**	0.4
5 litres (0.6 Kg. d.m)	**0.4**	0.5
6 litres (0.7 Kg. d.m.)	**0.6**	0.6
7 litres (0.9 Kg. d.m.)	Above 0.8	**0.7**
8 litres (1.0 Kg. d.m.)	Above 0.9	**0.8**

41 Kg calf @ -10°C	Tank milk	3.0%protein 3.7%fat
	Predicted gain (Kg/day)	Predicted gain (Kg/day)
Volume fed daily	Energy Limited Gain	Protein Limited Gain
4 litres (0.5 Kg. d.m.)	**Weight Loss**	Weight Loss
5 litres (0.6 Kg. d.m)	**0.1**	0.5
6 litres (0.7 Kg. d.m.)	**0.3**	0.6
7 litres (0.9 Kg. d.m.)	**0.5**	0.7
8 litres (1.0 Kg. d.m.)	**0.7**	0.8

Estimated Gains Feeding Pasteurized Waste Milk

[14% dry matter, protein level 3.54 test (25.3% d.m.) and fat level 4.42 test (31.5 d.m.)]

To read values, read across from the selected volume fed daily. Select the lower of the two values on that line as the most likely estimate of projected daily gain. These values are shown in **bold** type.

41 Kg calf @ 16°C	Pasteurized Waste milk	3.54%protein 4.42%fat
	Predicted gain (Kg/day)	Predicted gain (Kg/day)
Volume fed daily	Energy Limited Gain	Protein Limited Gain
4 litres (0.5 Kg. d.m.)	Above 0.4	**0.4**
5 litres (0.6 Kg. d.m)	Above 0.5	**Above 0.5**
6 litres (0.7 Kg. d.m.)	Above 0.7	**Above 0.7**
7 litres (0.9 Kg. d.m.)	Above 0.8	**Above 0.8**
8 litres (1.0 Kg. d.m.)	Above 0.9	**Above 0.9**

41 Kg calf @ 4°C	Pasteurized Waste milk	3.54%protein 4.42%fat
	Predicted gain (Kg/day)	Predicted gain (Kg/day)
Volume fed daily	Energy Limited Gain	Protein Limited Gain
4 litres (0.5 Kg. d.m.)	**0.3**	0.4
5 litres (0.6 Kg. d.m)	**0.5**	Above 0.5
6 litres (0.7 Kg. d.m.)	Above .07	**Above 0.7**
7 litres (0.9 Kg. d.m.)	Above 0.8	**Above 0.8**
8 litres (1.0 Kg. d.m.)	Above 0.9	**Above 0.9**

41 Kg calf @ -10°C	Pasteurized Waste milk	3.54%protein 4.42%fat
	Predicted gain (Kg/day)	Predicted gain (Kg/day)
Volume fed daily	Energy Limited Gain	Protein Limited Gain
4 litres (0.5 Kg. d.m.)	**Weight Loss**	Weight Loss
5 litres (0.6 Kg. d.m)	**0.3**	Above 0.5
6 litres (0.7 Kg. d.m.)	**0.5**	Above 0.7
7 litres (0.9 Kg. d.m.)	**0.7**	Above 0.8
8 litres (1.0 Kg. d.m.)	**0.9**	Above 0.9

Cold Weather Calf Care ~ Checklist

Are you using effective cold weather calf care procedures? Do they provide the opportunity for your employees to provide quality calf care?

Let's consider your cold weather calf care procedures. Compare your actions with the standards in this checklist. When making this evaluation I like to use these scores:
1=never, 2=seldom, 3=often, 4=usually, and 5=almost always.

_____ 1. I feed all calves at least 4 quart of high quality, clean colostrum no later than 6 hours after birth. (At www.atticacows.com at Calf Facts, see "Feeding Preweaned Calves: Colostrum.")

_____ 2. For calves consuming primarily a liquid ration, I feed enough milk/milk replacer appropriate to the environmental temperature to provide enough energy for both maintenance and at least one pound per day growth. (At www.atticacows.com , see Jan'01 Calving Ease "Cold Weather and Energy for Calves.")

_____ 3. For calves on a combination liquid and calf starter ration, I feed free-choice calf starter grain. (At www.atticacows.com , at Calf Facts, see "Feeding Preweaned Calves: Starter Grain.)

_____ 4. I provide free-choice water to all calves in both non-freezing and freezing weather. (At www.atticacows.com , at Calf Facts, see "Feeding Preweaned Calves: Water.)

_____ 5. During cold weather, I dry calf hair coats at birth enough to fluff in order to reduce evaporation heat losses.

_____ 6. During cold weather in calf barns, I provide adequate air exchange (15 cfm/min/calf) without creating drafts on individual calves. (At www.ansci.cornell.edu/prodairy/ choose in order, "Dairy Facilities," "Papers," "Articles," and "Calf & Heifer Facilities" to get to Curt Gooch's paper, "Existing Facilities for Replacement Heifers."

_____ 7. In all housing in cold weather, I keep an adequate layer of dry bedding underneath calves to insulate them from a cold base. Much of the insulation value of bedding is lost when it is wet. Wet bedding can have three times the heat loss as dry bedding.

_____ 8. In all housing in cold weather, I control convection losses either by adequate soft bedding to allow "nesting" or by the use of calf blankets.

Calf immunity – what is happening on-farm

Dr. Ken Leslie

Dr. Ken Leslie was raised on a central Ontario dairy farm, graduated from the University of Guelph in 1974. After accepting a clinical faculty position at the Ontario Veterinary College, he completed his MSc. graduate training in dairy cattle reproductive management. Dr. Leslie is currently a Professor in the Department of Population Medicine, with the Ruminant Health Management Clinic. He has responsibilities for service, teaching, research and extension of dairy health management programs. His special interests are udder health, replacement heifers and transition cows.

Calf immunity – what is happening on-farm

Passive immunity from cows to calves plays an important role in the challenges calves face while they grow. Dr. Ken Leslie will provide insight into how much immunity, a.k.a. immunoglobulin, is actually being passed through colostrum from the cow to the calf. A brief overview of how management practices effect immunoglobulin levels and the success of passive transfer in calves under seven days old will also be presented.

This project is funded in part through contributions by Canada and the Province of Ontario under the Canada-Ontario Research and Development (CORD) Program, an initiative of the federal-provincial-territorial Agricultural Policy Framework designed to position Canada's agri-food sector as a world leader. The Agricultural Adaptation Council administers the CORD Program on behalf of the province

Canada

Agricultural Adaptation Council

Ontario

Passive Immunity in Ontario Dairy Calves and Influence of Calf Management Practices

Dr. Lise Trotz-Williams, Dr. Ken Leslie, and Dr. Andrew Peregrine
Ontario Veterinary College, University of Guelph

Abstract:

Adequate passive transfer of maternal immunity is important for optimal health and performance in newborn dairy calves. In the summer of 2003 and the winter of 2004, blood samples were collected from 961 dairy calves 0 to 8 days of age on 11 farms in southern Ontario. This was followed by a second study in 2004, in which samples were taken from 422 calves up to 8 days old on 119 dairy farms throughout southern Ontario. For each sample collected, serum refractometry was used to evaluate total protein as a measure of passive transfer of maternal immunity. During each study, producers were asked to provide information on calf management practices used on the farm, including details of colostrum feeding. Data were analyzed to assess the levels of maternal immunity present in the calves, and to investigate whether these were associated with any calf management or colostrum feeding practices used on the farms. Serum protein readings ranged from 3.5 to 9.8 g/dL. Controlling for any effects of variation between farms, no statistically significant difference was found between serum protein levels, or prevalence of failure of passive transfer, between heifer and bull calves. Several calf management practices were significantly associated with higher serum protein readings. Information from these studies provides valuable insight into maternal immunity in newborn dairy calves in southern Ontario.

Background:

There is a recognized association between calf morbidity and mortality, and low levels of maternal immunoglobulin transfer to neonatal calves (Pare et al., 1993; Donovan et al., 1998). In addition, calves with lower levels of passive immunity have been found to show reduced daily gains in the first few months of life (Robison et al., 1988). Poor performance and increased morbidity and mortality among dairy calves result in increased production costs and reduced profitability for the dairy industry as well as for veal operations. Therefore, it is important to ensure that dairy calves receive adequate colostrum within the first hours of life to facilitate optimal passive transfer of maternal immunoglobulin from dam to calf.

To date, there is a lack of published information on levels of maternal immunity in dairy calves produced in Ontario. Such information is, however, important in determining whether additional measures need to be taken by the industry to ensure adequate transfer of passive immunity to calves entering the veal and dairy industries. It is hypothesized that improvement in this area would markedly reduce economic losses to the veal industry. Therefore, data collected on southern Ontario dairy farms as part of 2 large dairy calf health studies conducted in 2003 and 2004.

The data from these two studies were analyzed with the following objectives:

1) To determine the levels of total serum protein in calves up to and including 8 days of age on southern Ontario dairy farms as a measure of passive transfer of maternal immunity from colostrum.
2) To investigate whether colostrum feeding and other management practices on southern Ontario dairy farms are associated with levels of total serum protein and/or failure of passive transfer in calves up to and including 8 days old.

Methodology:

***Data collection*:**
Data to be analyzed for this work consisted of farm management information and calf total serum protein measurements collected as part of 2 studies conducted in 2003 to 2004. In the first project, the Calf-Level 2003-2004 Study, the primary purpose of the work was to investigate the influence of management practices on the risk of *Cryptosporidium parvum* shedding in dairy calves. For this project, weekly visits were made to 11 dairy farms in south-western Ontario in the summer of 2003 and winter 2004. On each visit, a jugular blood sample was taken from each calf born since the previous visit (up to and including to 8 days of age). This blood sample was used for assessment of passive transfer of maternal immunity by serum refractometry. Producers were asked to complete a questionnaire on calf management methods for each calf. Information collected in this way included methods used to collect, store and feed colostrum given to the calves.

The second study was carried out on 119 dairy farms throughout southern Ontario, with the objective of investigating the influence of farm management practices on the prevalence of *Cryptosporidium* in Ontario dairy herds. Herds of various sizes, and representing several management styles, were included in the study. In addition to fecal samples collected to be tested for *Cryptosporidium*, blood samples were taken from no more than 5 calves on each farm, that were up to and including 8 days old. In addition, a questionnaire was administered on each farm to gather information on the farm-level management practices. As in the first study, this questionnaire included questions on colostrum storage and feeding methods used on the farms. However, information collected in this work referred to herd-level practices, rather than management methods to which individual calves had been exposed.

In both studies, sera were separated from blood samples within 24 hours and serum refractometry was performed in order to determine total protein content as a measure of passive transfer of maternal immunity. Data were entered into EpiData and Microsoft Access databases and were then exported into Stata 8.0 for statistical analysis.

Statistical analysis: Descriptive analyses were carried out in order to determine the distribution of total serum protein levels among the calves and the number of farms using each management practice to be investigated for associations with serum total protein levels. Regression techniques were then employed to investigate the data collected in the Calf-Level Study, for associations between colostrum feeding practices (as independent variables) and serum total protein measurements.

Results:

From the 2003-2004 calf-level study, individual calf data were available for 961 dairy calves from less than 1 to 8 days of age from 11 south-western Ontario farms. In addition to these data, calf-level total protein readings and herd-level management information from the 2004 study were analyzed for 422 calves up to 8 days old on 119 dairy farms throughout southern Ontario. The results from these studies are presented separately in this report.

Data from Calf-Level 2003-2004 Study:

Of the 961 calves in this study, 355 (36.9%) were born in the winter and 606 (63.1%) in the summer. Information on sex was recorded for 932 of the 961 calves: 355 (38.1%) were male (bull) calves, 575 (61.7%) were females (heifers) and 2 calves (0.2%) were freemartins. Twenty-eight (2.9%) of the 961 calves were less than 1 day of age at sampling. The distribution of the ages of the calves is shown in Figure 1.

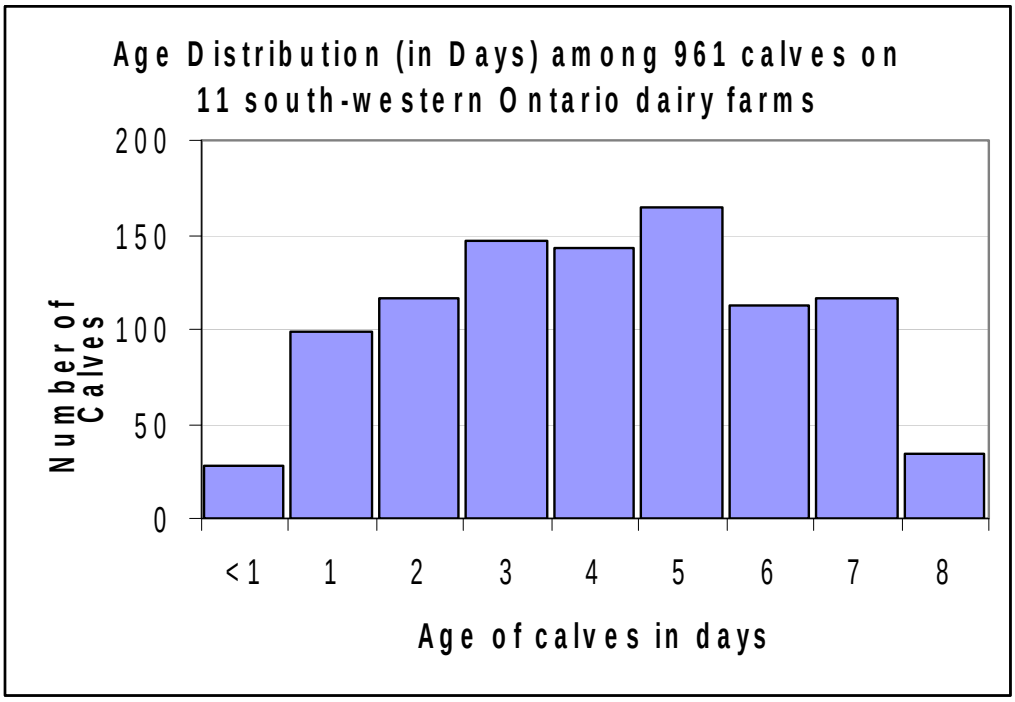


Figure 1

Serum total protein measurements for the calves ranged from 3.5 to 8.6 g/dL, and are summarized in Figure 2. Using a cut-off value for failure of passive transfer (FPT) of 5.2 g/dL, 87 (9.1%) of the 961 calves in this study showed FPT, with serum total protein levels of <5.2 g/dL.

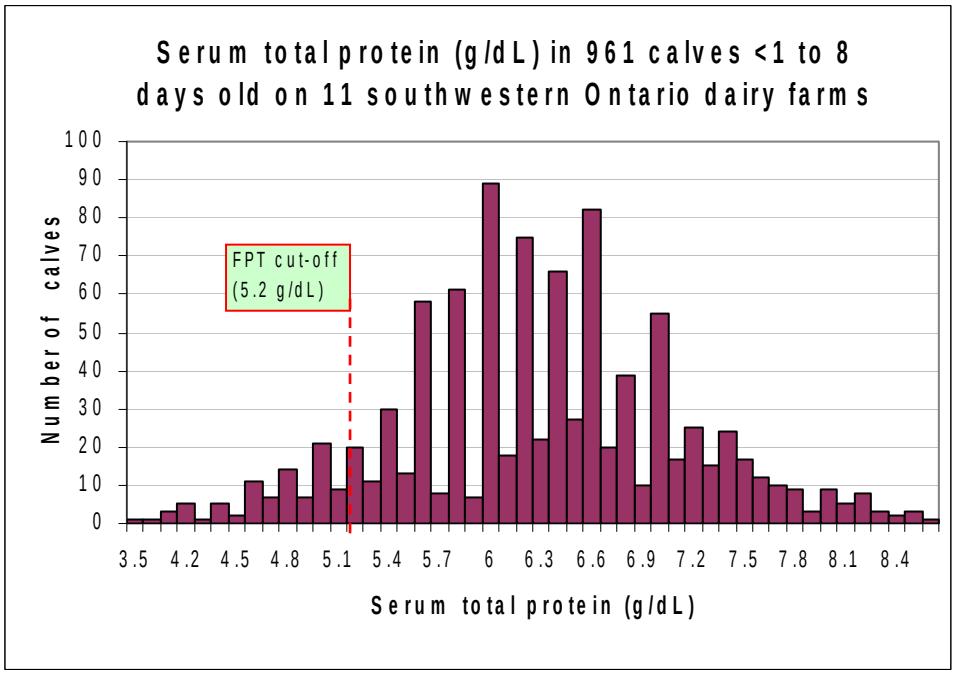


Figure 2

Controlling for differences in proportions of male and female calves between farms, there was no statistically significant difference between the total protein levels of bull and heifer calves ($p>0.05$). Serum protein levels indicated FPT in 65 (11.3%) of 575 heifer calves as opposed to 15 (4.2%) of 355 bull calves; however, when controlling for the farm effect, this difference was not statistically significant ($p=0.60$). The distribution of total protein levels in bull and heifer calves is shown in Fig.3.

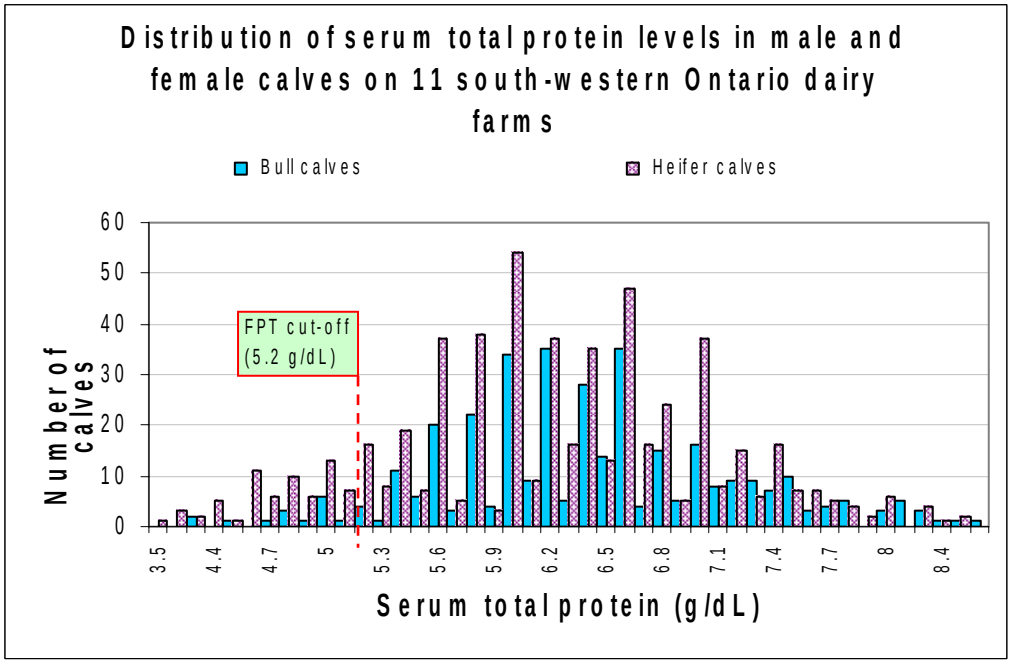


Figure 3

Colostrum feeding practices

Calf management (including colostrum feeding) methods to which calves in this study were exposed are summarized in Table 1. Where information on management methods were missing, calves were excluded from counts, therefore total counts for some variables may be less than 961 calves.

As shown in the table, although approximately equal proportions (between 20 and 30%) of the calves in this study were born in each of the 4 six-hour periods of the day or night, less than 50% of the calves were allowed to remain with their mothers for more than an hour after birth. The calf's mother was reported as the most common source of colostrum given to the calves, with 59.5% of calves receiving colostrum from their mothers. Pooled colostrum was given to 45.3% of the calves in the study. Most (75.7%) of the calves received fresh colostrum, whereas 54.2% were given colostrum that had been frozen. Most (89%) of the calves were bottle-fed colostrum, however, 31.6% were tube-fed. In fact, 202 calves received colostrum both by bottle and by tube (not shown in table). The amount of colostrum given in each interval of time within the first 24 hours of birth varied from 0 to 6 litres for the first 6 hours, 0 to 4 litres for the next 6 hours, and 0 to 9 litres for the last 12 hours (12 to 24 hours after birth). In each period, the most commonly stated quantity of colostrum given was 2 litres (not shown in table).

Table 1: Summary of responses to questionnaire administered to 119 southern Ontario dairy farms.

Calf management question	Response options	Number of calves	Percentage of calves
At approximately what time was this calf born?	- 6 pm to 12 midnight	198	20.5%
	- 12 midnight to 6 am	238	24.6%
	- 6am to 12 noon	286	29.6%
	- 12 noon to 6 pm	244	25.3%
How long was the calf left with the mother?	- < 1 hour	512	51.8%
	- 1 to 3 hrs	392	39.6%
	- >3 -12 hrs	73	7.4%
	- >12 -24 hrs	11	1.1%
	- > 24 hours	1	0.1%
How many liters of colostrum were fed to this calf in the first 6 hours after birth?	Open question	Range: 0 to 4 L Median :2.0 L	N/A
How many liters of colostrum were fed to this calf from 6 to 12 hours after birth?	Open question	Range: 0 to 6 L Median :2.0 L	N/A
How many liters of colostrum were fed to this calf from 12 to 24 hours after birth?	Open question	Range: 0 to 9 L Median :2.0 L	N/A
What type(s) of colostrum was fed to this calf?:			
- commercial	No	957	96.9%
	Yes	31	3.1%
- colostrum from mother	No	400	40.5%
	Yes	588	59.5%
- colostrum from another cow	No	931	94.4%
	Yes	55	5.6%
- pooled colostrum from cows	No	539	54.7%

in herd	Yes	447	45.3%
- frozen	No	396	45.8%
	Yes	468	54.2%
- fresh	No	218	24.3%
	Yes	680	75.7%
How was the colostrum fed to this calf? *Indicate more than one if applicable)*			
- mothers suckle calves	No	944	95.8%
	Yes	41	4.2%
- tube (esophageal feeder)	No	674	68.4%
	Yes	312	31.6%
- bucket	No	984	99.8%
	Yes	2	0.2%
- bottle	No	108	11.0%
	Yes	878	89.0%

Data from 2004 Herd-Level study:

Total protein refractometry readings were available for 422 calves. Information on sex of the calves was available for 251 calves from 65 farms. Of these 251 animals, 122 (48.6%) were bull calves and 129 (51.4%) were heifers. The ages of 417 calves were known: these ranged from a few hours (<1 day) to 8 days old. Twelve calves (3 males and 9 females) were less than 1 day old at the time of testing. Figure 4 shows the distribution of ages of calves in this study.

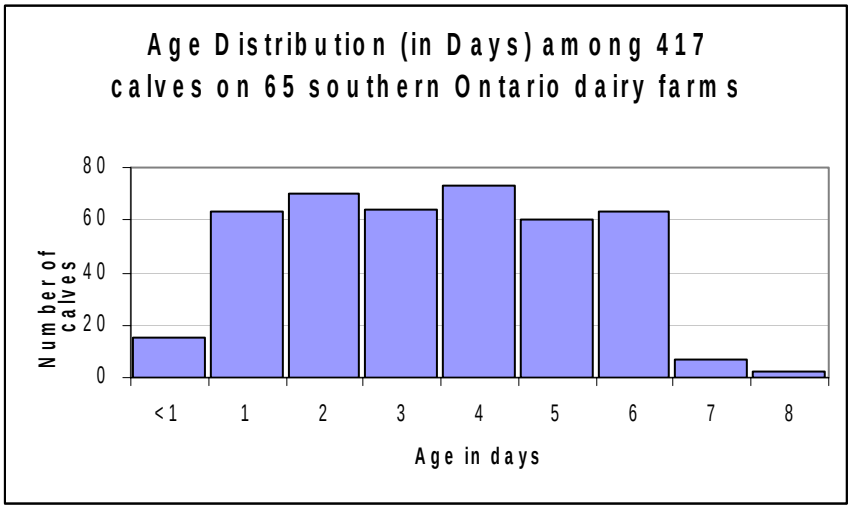


Figure 4

Serum total protein measurements for the calves ranged from 3.2 to 9.8 g/dL, and are summarized in Figure 5. Serum total protein readings of <5.2 g/dL indicated FPT in 158 (37.4%) of the 422 calves.

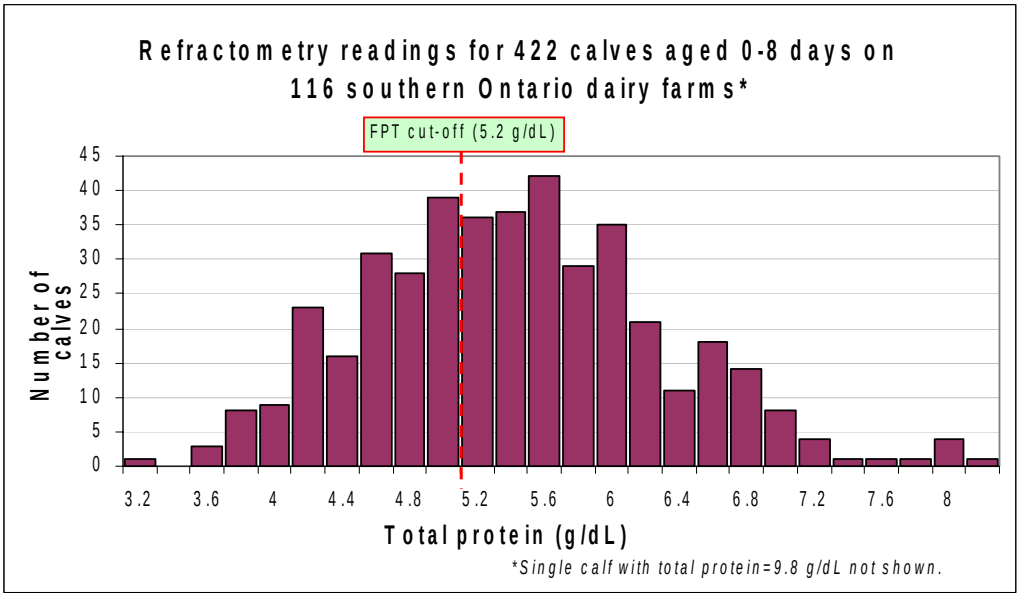


Figure 5

As in the calf-level study data, controlling for the effect of variation between farms, no significant difference in serum total protein levels or FPT was found between the 2 sexes of calves. Figure 6 shows the distribution of serum protein readings in bull and heifer calves in this study. Of the 251 animals for which information on sex was recorded, 50 (41.0%) of 122 bull calves and 51 (39.5%) of 129 showed readings indicative of FPT (p=0.82).

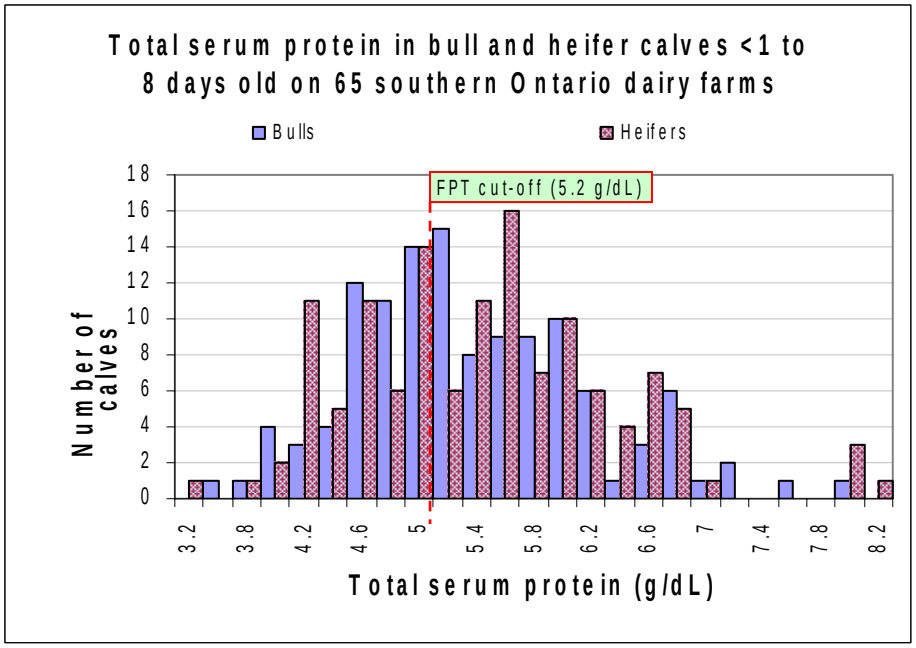


Figure 6

Colostrum Feeding Practices

Table 2 summarizes the calf management and colostrum feeding practices used on the dairy farms participating in the study. Where information on management methods were missing, calves or farms were excluded from counts, therefore total counts for some variables may be less than 422 calves or 119 farms.

Table 2: Summary of responses to questionnaire administered to 119 Ontario dairy farms

Calf management question	Response options	Number of farms	Percentage of farms	Number of calves exposed	Percentage of calves exposed
What is the gender of the primary caregiver for the calves?	-Male	88	73.9%	314	73.5%
	-Female	23	19.4%	85	19.9%
	-Both	8	6.7%	28	6.6%
Do you usually make an effort to remove newborn calves from their mothers as soon as possible after birth?	- Always	42	35.3%	127	29.7%
	- Occasionally	24	20.2%	96	22.5%
	- Never	53	44.5%	204	47.8%
How long are the majority of calves usually left with their mothers?	- < 1 hour	23	19.3%	89	20.9%
	- 1 to 3 hrs	34	28.6%	124	29.0%
	- 3 -12 hrs	39	32.8%	144	33.7%
	- 12 -24 hrs	16	13.4%	51	11.9%
	- > 24 hours	7	5.9%	19	4.5%
How many liters of colostrum are usually fed in the first 6 hours after birth?	Open question	Range: 0 to 6 L Median :2.5 L	N/A	Range: 0 to 6 L Median :2.5 L	N/A
How many liters of colostrum are usually fed from 6 to 12 hours after birth?	Open question	Range: 0 to 6 L Median :2.0 L	N/A	Range: 0 to 6 L Median :2.0 L	N/A
How many liters of colostrum are usually fed from 12 to 24 hours after birth?	Open question	Range: 0 to 7 L Median :2.0 L	N/A	Range: 0 to 7 L Median :2.0 L	N/A
What percentage of calves receive at least these quantities of colostrum within the first 24 hours after birth?	- < 50%	0	0%	0	0%
	- 50 to 75%	3	2.5%	10	2.3%
	- >75 to <90%	11	9.2%	40	9.4%
	- > 90%	105	88.3%	377	88.3%
What percentage of calves receives each of the following types of colostrum?:					
- commercial	Open question	0% : 109 farms 1-25%: 3 farms 50-100%: 5 farms	93.2% 2.6% 4.2%	0% : 386 calves 1-25%: 6 calves 50-100%: 21 calves	93.5% 1.4% 5.1%
- colostrum from mother	Open question	0%: 2 farms 15-50%: 5 farms 75-100%: 112 farms	1.7% 4.2% 94.1%	0%: 9 calves 15-50%: 16 calves 75-100%: 402 calves	2.1% 3.7% 94.2%
- colostrum from another cow	Open question	0% : 59 farms 1-25%: 51 farms 50-100%: 7 farms	50.4% 43.6% 6.0%	0% : 213 calves 1-25%: 183 calves 50-100%: 22 calves	51.0% 43.7% 5.3%
- pooled colostrum from cows in herd	Open question	0% : 111 farms 5-15%: 5 farms 100%: 1 farm	94.9% 4.3% 0.8%	0% : 392 calves 5-15%: 21 calves 100%: 5 calves	93.8% 5.0% 1.2%

- frozen	Open question	0% : 73 farms 1-50%: 44 farms 75-100%: 2 farms	61.3% 37.0% 1.7%	0% : 255 calves 1-50%: 165 calves 75-100%: 7 calves	59.7% 38.6% 1.7%
- fermented	Open question	0%: 118 50%: 1	99.2% 0.8%	0%: 424 calves 50%: 3 calves	99.3% 0.7%
- fresh	Open question	50-75%:8 farms 80-100%: 111 farms	6.7% 93.3%	50-75%: 29 calves 80-100%: 398 calves	6.8% 93.2%
What percentage of calves receives colostrum by each of the following routes?:					
- mothers suckle calves	Open question	0%: 90 farms 1-50%: 22 farms 70-100%: 7 farms	75.6% 18.5% 5.9%	0% : 322 calves 1-50%: 89 calves 70-100%: 16 calves	75.5% 20.8% 3.7%
- tube (esophageal feeder)	Open question	0%: 34 farms 1-50%: 70 farms 60-100%: 15 farms	28.6% 58.8% 12.6%	0%: 121 calves 1-50%: 250 calves 60-100%: 56 calves	28.3% 58.6% 13.1%
- bucket	Open question	0%: 104 farms 1-50%: 4 farms 90-100%: 11 farms	87.4% 3.4% 9.2%	0% : 373 calves 1-50%: 14 calves 90-100%: 40 calves	87.4% 3.3% 9.3%
- bottle	Open question	0%: 22 10-75%: 13 farms 80-100%: 84 farms	18.5% 10.9% 70.6%	0% : 80 calves 10-75%: 43 calves 80-100%: 304 calves	18.7% 10.1% 71.2%

Influence of calf management methods on total serum protein

Statistical analysis of data from the 2003-2004 study showed that total protein levels were significantly higher in calves from 2 to 6 days of age. Because of the significant association between the age of the calves at sampling and the serum total protein levels, all analyses exploring relationships between calf management methods and protein levels included age, to control for this effect.

Some calf management practices (use of commercial colostrum, use of colostrum from another cow, mothers suckling calves and feeding of colostrum by bucket) were excluded from these analyses because of a lack of variation among the calves in the study. For these variables, either more than 90% of the calves had been exposed to the factor, or more than 90% of calves had not been exposed.

Of the remaining calf management factors, 9 were found to be significantly associated with calf serum protein readings. These are described in Table 3.

Table 3: Calf management practices statistically associated with calf serum total protein levels.

Management method	P value	Nature of association
Time of calf's birth	<0.01	Calves born 6 am to 12 noon had the **highest** serum total protein levels. Levels in calves born 6 pm to 12 midnight were lower, whereas levels were **lowest** in calves born 12 midnight to 6 am and those born 12 noon to 6 pm.
Time calf allowed to remain with dam	<0.001	Calves allowed to remain with their dams for 1 hour or more after birth had significantly **higher** total protein readings than calves that were separated from their dams within 1 hour of birth
Quantity of colostrum given to calf within 6 hours of birth	<0.001	Calves reported to have been given more colostrum within the first 6 hours of birth were found to have significantly **lower** serum protein levels than those given less.
Feeding of colostrum from mother	<0.001	Calves fed colostrum taken from their mothers had significantly **higher** levels of serum total protein than calves that had not been fed colostrum from their mothers.
Feeding of pooled colostrum	<0.001	Calves fed pooled colostrum had significantly **lower** total protein readings than those that had not been fed pooled colostrum
Feeding of fresh colostrum	<0.001	Calves fed fresh colostrum had significantly **lower** levels of total serum protein than those that had not been fed fresh colostrum
Feeding of frozen colostrum	<0.001	Calves fed frozen colostrum showed significantly **higher** serum protein levels than calves that had not been fed frozen colostrum
Feeding of colostrum by esophageal tube	<0.001	Calves fed colostrum by tube had significantly **lower** serum protein readings than those that had not been fed colostrum by tube.
Feeding of colostrum by bottle	<0.001	Calves fed colostrum by bottle had significantly **higher** levels of serum total protein than those that had not been bottle-fed.

In addition to the associations described above, calves born in the summer months were found to have significantly higher levels of serum total protein than those born in the winter, controlling for the effect of age on serum protein readings.

Discussion and Conclusions:

Although the data analyzed in this project were obtained from studies that did not have the assessment of passive transfer as a primary objective, the studies involved the collection of samples and data from a large number of calves on dairy farms of a variety of sizes and representing a wide spectrum of management practices. These farms included those considered normal with respect to calf health issues, as well as some with high levels of neonatal calf diarrhea. Therefore, much of the information gained from investigation of these data is likely to be representative of the true status of dairy calves on farms throughout southern Ontario. This is especially true of the range of serum total protein readings reported for the calves in the 2 studies and the lack of a significant association between serum total protein and sex of the calves.

The results reported here also provide useful data on the methods used for the storage and feeding of colostrum (Tables 1 and 2). Farms in these studies represented a wide spectrum of herd size and management practices, and data obtained from those farms are therefore also likely to give a representative view of calf management practices used by southern Ontario dairy producers.

On the other hand, reported associations between management practices and serum protein levels should be interpreted with caution. This aspect of the investigation used data collected from only

11 farms in southwestern Ontario, and results may not be representative of true associations existing on dairy farms throughout the region. Furthermore, many of the responses to the questions asked during data collection were not mutually excusive; in other words, calves may have been exposed to more than one method of feeding or colostrum storage, and may have been given colostrum from more than one source. As is true for all investigations of this type, the reporting of similar results from other studies would give weight to these findings. Nevertheless, the possibility remains that these findings are indeed reflective of true associations that exist on southern Ontario dairy farms.

Conclusions:

- Overall, serum refractometry results from 1383 calves up to and including 8 days of age on southern Ontario dairy farms indicated that 245 (17.7%) of these calves fell below the cut-off point (5.2 g/dL) for failure of passive transfer (FPT).
- No significant association between either passive immunity levels (as measured by either globulin or total protein) or FPT, and sex of the calves was evident in either of the 2 studies.
- Several management factors appeared to be significantly associated with calf serum total protein readings.

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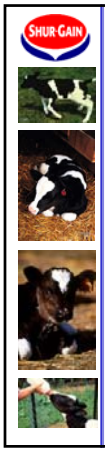
Nutritional management for healthy calves

Bill Woodley

Mr. Bill Woodley has worked for Shur-Gain since 1979 after he graduated from the University of Guelph. He has worked as a Territory Manager in the Oxford/Brant county areas as well as in eastern-central Ontario based out of Peterborough. Bill has had a supervisory role for the last 18 years and his current position is Shur-Gain Ruminant Technical Services Manager. In his current role, Bill provides technical support for Ontario and New York Shur-Gain, provides training for Shur-Gain's Dairy Nutrition Advisor Program, develops new products and programs for the company and provides technical liaison support for Maple Leaf Agresearch and the Shur-Gain Division.

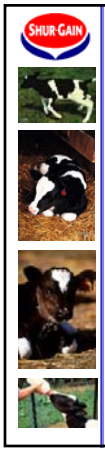
Nutritional management for healthy calves

From birth to weaning, how farmers feed their calves make a difference in the calves' health and success as they grow. Feeding the calf in cold weather and how the different seasons impact the calf's nutritional and energy requirements will be the focus of Mr. Bill Woodley's presentation. Practical nutritional advice and ideas that could be used on your farm will be presented.



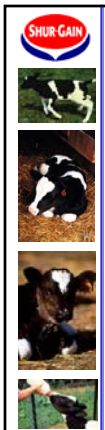
Nutrition of the Pre-Weaned Calf

Bill Woodley
Shur-Gain Ruminant Technical Manager

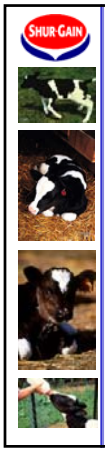


Lets jump to the conclusion….

- Feed ***more*** high quality milk or milk replacer solution
  - Traditional = 4 litres/day
- Improve transition from milk/replacer to dry grain diet when weaning at less than 8 weeks
  - Encourage high grain intake

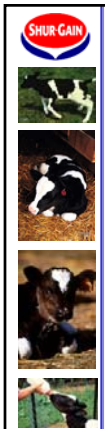


What's Natural? What's Normal?



Milk Feeding: What's Normal?

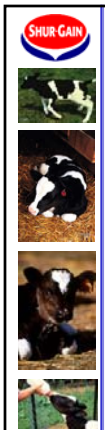
- Many producers have traditional fed limited milk to calves ~ 4 litres/day
  - In cold weather conditions = "starvation" diet
  - Based on the original premise *(1950's)* of moving calves from expensive milk feeding to less expensive dry feed



Milk Feeding: What's Normal?

Appelman and Owen, 1975 review (1940's to 1975)

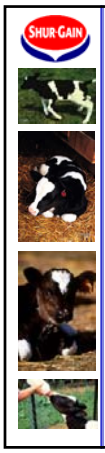
- *"For reasons of economy and to induce early consumption of dry feed, whole milk equivalent of 8 to 10% of body weight has been used. This amount is sufficient to support a modest rate of gain (.3 to .4 kg per day) to 3 wk of age... Although more milk in early weaning programs will produce faster initial gains, the effect will usually have dissipated by 12 to 16 wk of age..."*



Feeding Higher Levels of Milk Weeks 2-6

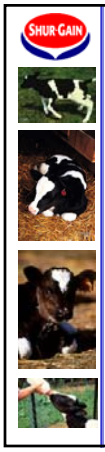
Khouri & Pickering 1968

Whole Milk % of B.W.	12%	15%	18%	ad lib
ADG kgs/day	0.41	0.50	0.62	0.94
Feed to Gain Ratio	1.58	1.48	1.34	1.23



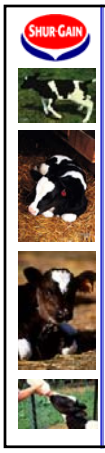
Milk Feeding: What's Normal?

- Biologically Normal Growth Rate
  - *Feeding higher milk/replacer solution levels than traditional levels will encourage higher growth rate (Drackley)*



What's Normal?

- Calf left with dam *(Albright & Arave, 1997)*
  - Will suckle 7-10 x's/day
  - Consume significantly more milk (>10 litres/day)
  - Gained weight at several times the rate of "conventionally" reared calves

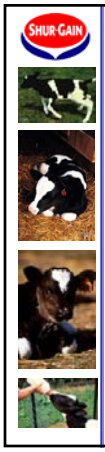


What's Normal?

- Calves fed ad-lib milk from "teat" versus 4 litres *(Appleby et al., 2001)*
  - Average consumption **>10 kgs** of milk/day
    - Spread over **10 meals**
  - Weight gain improvement
    - 1st 2 week period = **2.4 x's faster**
    - 2nd 2 week period = **1.4 x's faster**
  - **Interesting observation**:
    - **nipple fed calves** spend approximately **45 min/day** drinking versus a few minutes for bucket fed calves

What's Normal?

- Effects of ad lib milk intake on dairy calves *(Jasper & Weary, 2002)*
  - Control calves: fed 2x's/day with bucket at 10% of BW ~ 4 kgs of whole milk
  - Test calves: fed milk ad lib from nipple
  - Test calves were gradually weaned b/n day 37 & day 42 (5-6 weeks of age) by diluting the milk with water
  - Measurements taken until day 63 (9 weeks)

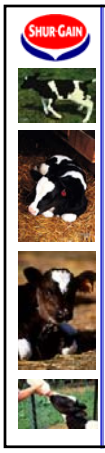


Ad Libitum Milk

(Japser & Weary, 2002)

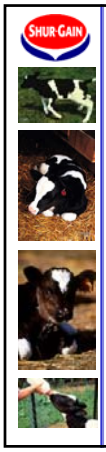
	Ad Libitum Calves Versus Control Calves
Milk consumption	**89%** more milk than control calves
Calf starter intake	**16%** of the calf starter intake of control calves
Dry hay intake	**17%** of the dry hay intake of the control calves
Weight gain before weaning	**63%** more weight gain than control (10.5 kg gain diff.)
Weight gain after weaning	no treatment differences between groups
Final weight at day 63	**89.07** kgs for test versus **81.07** kgs for control
Incidence of diarrhea	no differences between groups ~ **low**

Note: calf starter intake during the 2 weeks after weaning averaged 1.9 kgs for both groups



MLF Agreseach Calf Feeding Demonstration Trial

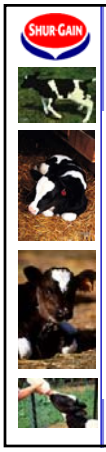
- **Test Calves**: ad lib whole milk feeding with bucket
- **Previous protocol**: 6.4 litres of milk, 2 feedings /day



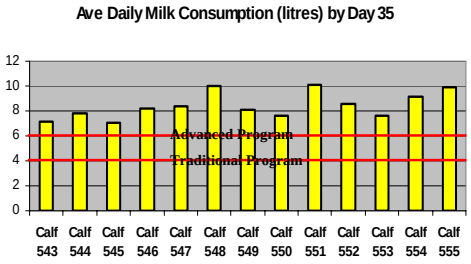
MLF Agreseach Calf Feeding Demonstration

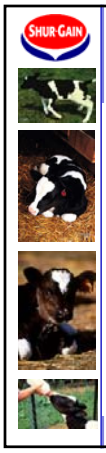
Weaning Strategy

- At the end of the 5th week (day 35), weighed consumption was "cut" in ½ for one week
- After one week, the ½ level was "cut" in ½
- 2 week weaning strategy
  - To encourage rumen development
  - Provide a transition from high volumes of liquid feed

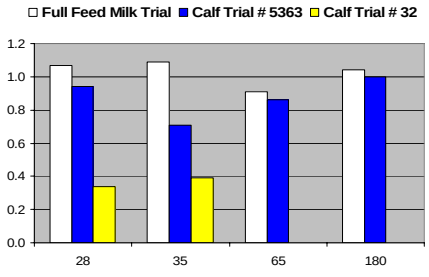


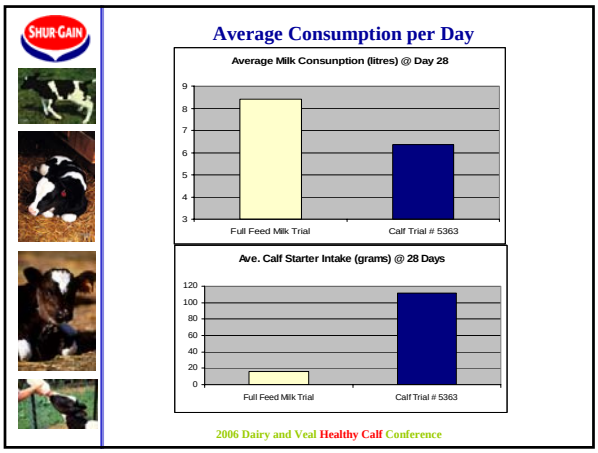
Full Feed Milk Trial

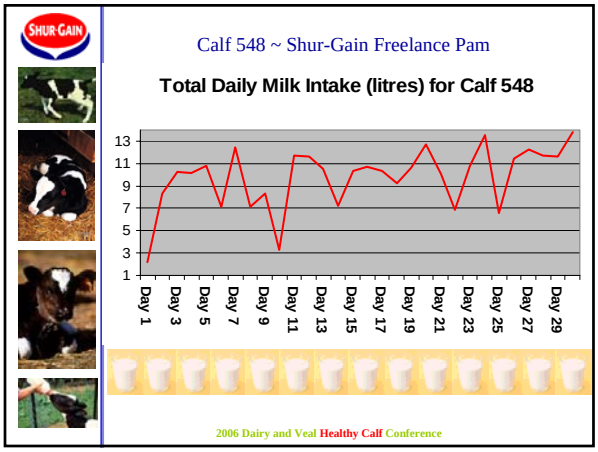


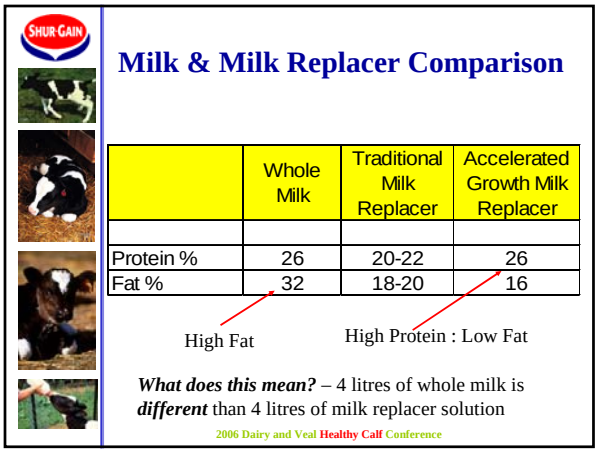


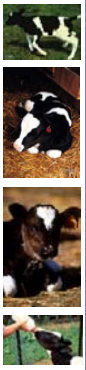
ADG Comparison b/n Previous Trials




Average Consumption per Day
Average Milk Consunption (litres) @ Day 28
9
8
7
6
5
4
3
Full Feed Milk Trial
Calf Trial # 5363
Ave. Calf Starter Intake (grams) @ 28 Days
120
100
80
60
40
20
0
Full Feed Milk Trial
Calf Trial # 5363
2006 Dairy and Veal Healthy Calf Conference


Calf 548 ~ Shur-Gain Freelance Pam
Total Daily Milk Intake (litres) for Calf 548
13
11
9
7
5
3
1
Day 1
Day 3
Day 5
Day 7
Day 9
Day 11
Day 13
Day 15
Day 17
Day 19
Day 21
Day 23
Day 25
Day 27
Day 29
2006 Dairy and Veal Healthy Calf Conference


Milk & Milk Replacer Comparison
Whole Milk
Traditional Milk Replacer
Accelerated Growth Milk Replacer
Protein %
26
20-22
26
Fat %
32
18-20
16
High Fat
High Protein : Low Fat
What does this mean? – 4 litres of whole milk is different than 4 litres of milk replacer solution
2006 Dairy and Veal Healthy Calf Conference

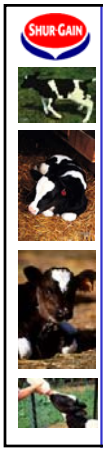


Predicted Milk Replacer CP % to support ADG

The amount of **protein** required by the young growing calf is driven by the rate of growth (ADG) - specifically lean tissue growth versus fat deposition.

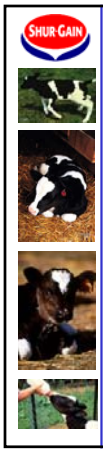
Drackley

Rate of Gain (kg/day)	ME (kcal/day)	ADP (grams/day)	Required DMI (kgs/day)	CP Required (% of DM)
				milk replacer
0.00	1748	28	0.38	8.30%
0.23	2296	82	0.50	18.10%
0.45	3008	136	0.66	22.90%
0.68	**3798**	**189**	**0.83**	**25.30%**
0.90	**4643**	**243**	**1.02**	**26.60%**
1.13	5532	297	1.21	27.20%



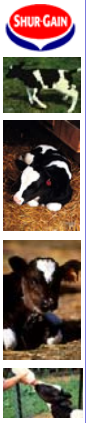
Milk Levels & Calf Starter Intake

- Higher rates of milk or milk replacer feeding, calf starter intake clearly is decreased (e.g., Hodgson, 1971; Huber et al., 1984).
- Higher fat content of the liquid diet also clearly suppress intake of calf starter (Kuehn et al., 1994).



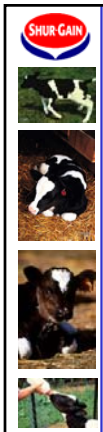
Milk Levels & Calf Starter Intake

- **Lower starter intake** slows the rate of rumen development, which in turn may contribute to calves **"stalling out"** when weaned from milk
- the greatest stimulus for increases of dry feed intake even in early weaning systems is removal of the liquid portion of the diet (Appleman and Owen, 1975), which causes feed intake to nearly double in the first day (Luchini et al., 1993).



Encouraging Calf Starter Intake

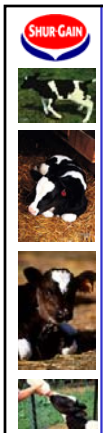
- Lower fat content solution (milk or milk replacer)
- Water access and intake
- Feeding Management



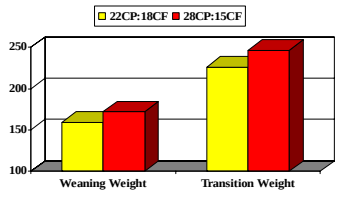
Encouraging Calf Starter Intake

Item	Control	High Protein High Fat	High Protein Low Fat
	20% CP:20%CF	25% CP:20% CF	25% CP:15% CF
Feeding Rate	454 grams/day	675 grams/day	675 grams/day
ADG kgs	0.52	0.65	0.70
Total Weight Gain, kgs	28.99	36.35	**39.26**
Feed Efficiency, kg/kg	0.50	0.54	0.55
Total Starter Intake kgs	42.00	41.80	**47.10**

Study by Merricks Animal Nutrition Inc.,



Fat Content



Tikofsky et al demonstrated that feeding "*isocaloric*" levels of a **22:18** milk replacer and a **28:15** milk replacer resulted in improved weight gain at weaning and at 84 days with the lower fat milk replacer **(28:15).**

Water Pail & Feed Pail Placement

Water & Feed	Separated	Adjacent	% Change
Gains (kg/hd/day	0.84	0.72	14.30
Calf Starter (kg/calf/day)	2.28	2.01	11.80
Water Intake (L/calf/day)	8.20	6.20	24.40

Note: Post-weaning calves

Typical water intake for Holstein calves at 10-26 Celsius

Age (months)	*Litres per day*
1	*5.0-7.5*
2	*5.5-9.0*
3	*8.0-10.0*
4	*11.5-13.5*

Intake of Water Stimulates Dry Feed Intake

Effect of free choice water on calf performance	Water	
	Free Choice	None
Daily gain (grams)	309	180
Calf starter intake (kg)	11.8	8.18
Scour days per calf	4.5	5.4

Kertz, A.F. 1984 J.D.S. 67: 2964-2969

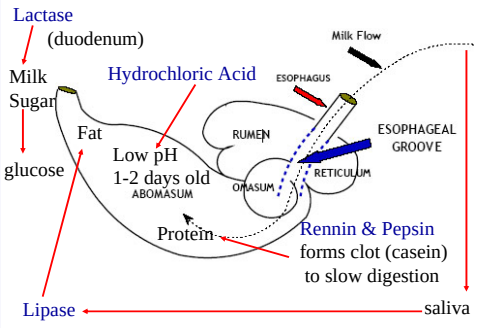
Pre-Weaned Calves

Why is water important?

- Most of the water that enters rumen is from f/c water intake
  - Rumen environment needs water to develop microbe (bug) population
  - Calves need water for metabolic functions
    - even slight dehydration effects metabolic functions and will reduce feed intake
- Milk tends to "by-pass" rumen through esophageal groove
- Recommendation: *don't mix water and milk during 1st 6 weeks*

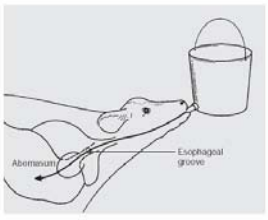
Calf Digestive System

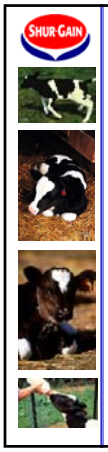
Digestive Tract of the Calf



Esophageal Grove

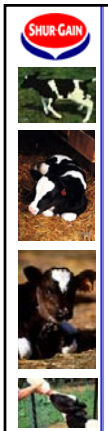
Figure 2. Muscular folds of the reticulorumen form the esophageal groove and direct milk to the abomasum.





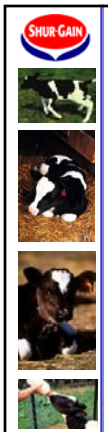
Esophageal Groove

- Esophageal groove "shunts" milk and milk replacer solution to the abomasum for digestion
  - Works best when calves suck from teat (dam or artificial)
    - Saliva production higher with "sucking" = increased lipase > ability to digest fat
  - Works from bucket feeding but…
    - Depending on volume, availability



Rumen Development

- Newborn calf starts life with the basic ruminant "hardware"
  - Reticulum
  - Rumen
  - Omasum
  - Abomasum
- Plus the presence of esophageal groove



Rumen Development

- Reticulum, rumen and omasum:
  - undeveloped & non-functional
- Ruminants require
  - functionally developed rumen to properly consume and digest forages and dry feeds

Rumen Development

- **Goal**: to successfully **transition** the calf from essentially a monogastric to a ruminant.
- Considerations:
  - Size of rumen
  - Musculature
  - Development of rumen papillae

Rumen Development

- Dietary factors influencing papillae growth & development
  - may not effect rumen muscularization or rumen volume
- Example:
  - Ruminal size has been shown to increase proportionately with body size regardless of diet (Vazquez-Anon et al., 1993)

Rumen Development

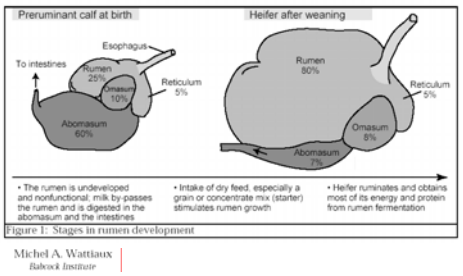
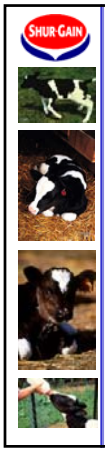


Figure 1: Stages in rumen development

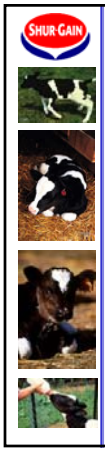
Michel A. Wattiaux
Babcock Institute



Milk, Hay and Grain Rumen @ 4 Weeks

Milk and Hay Rumen @ 4 Weeks

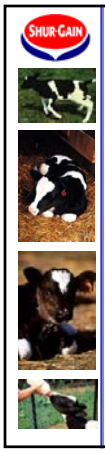
Penn State



Milk, Hay and Grain Rumen @ 12 Weeks

Milk and Hay Rumen @ 12 Weeks

Penn State



Papillae Development

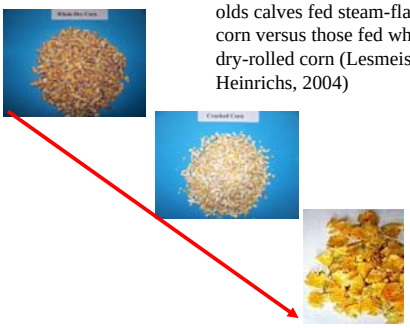
- Influenced by:
  - Rumen microbial end products call VFA's
  - Butyric > propionic > acetic
- Solid feed + rumen microbes = VFA

Rumen Development

- **Grains** cause shift in microbial population = lower rumen pH
  - Increasing **butyric** and propionic acid
- **Forages** cause shift in microbial population = higher rumen pH
  - Increasing **acetic** acid
- Grains > Forages > Milk

Grain Type

Papillae **length** and rumen wall **thickness** > in 4 week olds calves fed steam-flaked corn versus those fed whole or dry-rolled corn (Lesmeister & Heinrichs, 2004)



Rumen Development

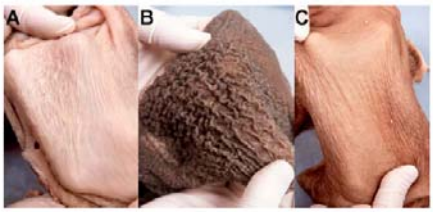
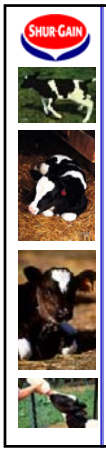


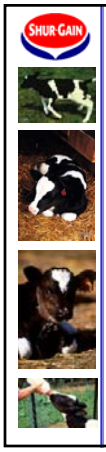
Figure 2. Comparison of rumen papillae development at 6 weeks in calves fed milk only (A), milk and grain (B), or milk and dry hay (C).

Judd Heinrich, Penn State



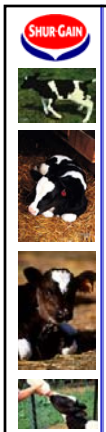
Rumen Development

- **Conclusion:**
  - Grain intake & type is critical for rumen papillae development
  - Adequate papillae development is critical for calves to adapt to higher grain intake post-weaning
  - **3-4 week** time-line for papillae development



Recommendation

- Develop "gradual" weaning strategy when feeding **higher levels** of milk
  - Determine potential weaning date
    - Example : end of week 5 or week 6
  - Reduce milk volume by ½ for 1st week
    - Feed once/day
  - Reduce "reduced" milk volume by ½ for 2nd week
  - Wean when calves consume 1.0 kg of calf starter for 3 consecutive days
  - Feed free-choice water

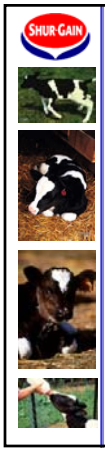


Health Benefits of Higher Milk

- Suggestion:
  - improved health through enhanced function of the immune system (Drackely)

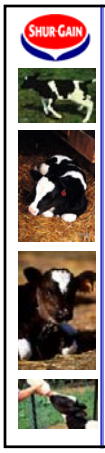
Health Benefits of Higher Milk

- Williams et al. (1981) compared calves fed two amounts of milk replacer solids (0.6 kg/d and either 0.3 or 0.4 kg/d) with either ad lib or restricted access to calf starter
  - Calves fed the higher amount of milk replacer had lower mortality (7.8%) than calves fed the lower amounts of milk replacer (12.6%).
- other studies have noted improvements in immune functions in response to better nutritional status in early life
  - (Griebel et al., 1987; Pollock et al.,1993, 1994; Nonnecke et al., 2000).



Winter Feeding

- Primary problem
  - Energy intake versus energy expenditure
  - dehydration



Temperature Effects

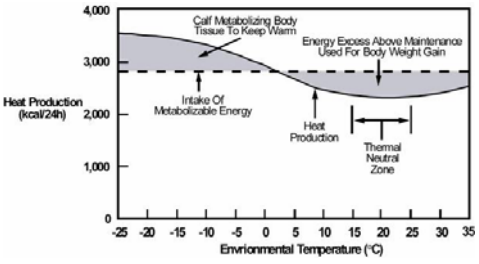
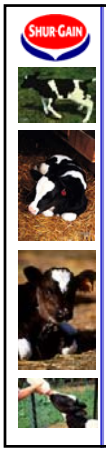
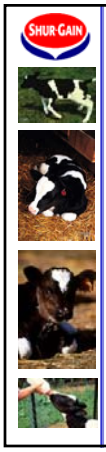


Figure 2. Effect of environmental temperature on heat production of a 45.5 kg calf and the amount of metabolizable energy available for gain in body weight after meeting the maintenance requirements. (Adapted from Gebremedhin et al., 1981) OMAFRA



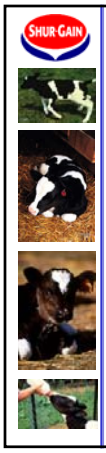
Winter Strategy

- Feed more milk/milk replacer solution (6 litres +)
- Feed higher fat milk replacer (6 litres +)
- Feed milk (6 litres +)
- Feed water (warm)



Conclusion….

- Feed ***more*** high quality milk or milk replacer solution
  - Traditional = 4 litres/day
- Improve transition from milk/replacer to dry grain diet when weaning at less than 8 weeks
  - Encourage high grain intake



Hints and tips for raising quality calves: a producer perspective

Jeanne C. Wormuth

Jeanne Wormuth is the Farm Manager of the CY Heifer Farm, LLC—a custom dairy heifer raising operation that raises 4,000 calves yearly—in Elba, New York. She has been with the facility since 1998 and was instrumental in developing the business from blueprints to its current size. Jeanne is a graduate of SUNY Cobleskill with an AAS degree in Agricultural Science and she also holds a BSc in Animal Science from Cornell University.

Hints and tips for raising quality calves: a producer perspective

Have you ever wondered how your management practices compare to those of other farmers? This is just one of the questions you will be able to answer after Ms. Jeanne Wormuth's presentation. Using her years of experience in dairy calf raising, Jeanne will provide a practical overview of the management practices she uses as well as the trials and tribulations she has undergone as a farmer.

Hints and Tips for Raising Quality Calves

Jeanne Wormuth

CY Heifer Farm, LLC

CY Heifer Farm

Overview

- Heifer Facility started by Agway in Dec. 1998
- 4000 head contract heifer raising facility.
- Purchased by CY Farms, October 2003

CY Farms

Customers & Contracts

- Contract raise for 8 customers
- Warranties in the contract – Attached to Total Protein Scores
- General Guidelines given to the Source Farm to follow
- Costs vary by level of service
- Lots of Communication creates trust

Trucking

Trucking animals

- Truck animals in and out – Mon. – Fri.
- Winter – use straw and calf coats
- Summer – Sawdust and electrolytes for a long ride and hot days
- Wash and disinfect the trailer daily
- Your truck and driver are your daily contact on the farm!!

Calf Admissions




Admission Procedure

- Foot bath
- Measurements and record ID information
- Physical – Temperature, Listen to lungs & heart – record information
- Give nasalgen & vitamins
- Clip horn buds
- Dock tails – BVD testing done

Data Collection

- Source Farms fill out basic information: Dam, Sire, Birthdate, calving ease
- Give our ID, Total Protein Scores

Feeding Schedule

1st – Week
.83lbs powder
2.125 L of water
2nd – Week
1.0 lbs powder
2.55 L of water
3rd – Week
1.16 lbs powder
2.975 L water
4th & 5th – Week
1.32 lbs powder
3.4 L water

Feeding Schedule for Seasons

- Spring, Summer and Fall Schedule is what I just listed.
- Winter schedule – increase amount fed.
- 1st week - .84 to 2.1 L
- 2nd week – 1.16 to 2.975 L
- 3rd week – 1.32 to 3.4 L
- 4th week – 1.49 to 3.825 L
- 5th week – 1.32 to 3.4 L (AM only)

Accelerated Feeding Program

- Excel 26:18
- 5 weeks on milk
- 6th week weaned
- Free-choice grain and water
- Keep a chart of grain intake
- Hold back a calf that is not eating

Feeding

- Feeding at 12 hour intervals
- Followed by luke warm water 30 minutes later
- Change grain every morning
- Add additional grain at night if needed

Treatment Protocols

- If calf leaves milk – Check temperature, Hydration & Navel
- Temperature >103.5 – Use antibiotic
- Poor Hydration – Scours – Electrolytes
- Watery Scours – Add Lactated Ringers
- Record everything
- Necropsy and lab tests

Recording Medication

- Two Calf Teams
- Repeat Shots in the AM only
- Write mini notes
- Daily Sheets
- Record on Calf Paper
- Calf history in entered into Dairy Comp 305

Calf Housing

Moving & Cleaning

Preparing a new barn

- After cleaning out the barn
- Pressure wash all the pens and disinfect
- Clorox the floors
- Wash pails
- Restock kitchen
- New paper work for incoming calves

Bedding

- Summer:
  Sawdust & Paper
- Winter:
  Base of Straw & topped with sawdust & paper

Employees

Work Schedule – Calves AM

Mon.	Tues.	Wed.	Thurs.	Fri.
Feed	Feed	Feed	Feed	Feed
Treat	Treat	Treat	Treat	Treat
Move & Delice	Vacc. – Clost.	Weigh & Move WB	Stock Kitchens	Vacc. - MLV
Weigh	Bed			Bed
	Burn Garbage			Burn Garbage

Work Schedule – Calves PM

Mon.	Tues.	Wed.	Thurs.	Fri.
Admit New Calves	Wash Pails	Admit New Calves	Wash Pails	Admit New Calves
Wash Pens	Admit New Calves	Wash Pens	Admit New Calves	Wash Pens
	Clean Barn			
Dump Water	Dump Water	Dump Water	Dump Water	Dump Water
Feed & Treat	Feed & Treat	Feed & Treat	Feed & Treat	Feed & Treat

Training

New Partnership

- With Grober to create Provitello
- Built a barn to hold 960 animals
- Collaborating for success
- Start up in Dec. 2005

Protecting your herd from disease challenges

Dr. Rob Bell

Dr. Rob Bell was born and raised on a dairy farm in Southwestern Ontario. After graduating from the Ontario Veterinary College in 1978 Bell entered into a private veterinary practice in St. Mary's where he practiced for 25 years specializing in bovine preventative medicine and farm economics. In 2001, Bell completed an MBA from Guelph and joined Pfizer Animal Health as a consultant. He became a full-time employee of the company in 2003 and currently is a Bovine Area Sales Manager for Ontario and Atlantic Canada's bovine technical services.

Protecting your herd from disease challenges

How effective is your vaccination strategy? Dr. Rob Bell will guide us through herd and calf vaccination protocols and why following the protocols are important. Dr. Bell will also address the impact that following protocols can have on animal health and disease prevention.

Dairy Calf Disease Control – The Role for Immunization

Ontario Veal Association
December 2006
Robert Bell DVM, MBA

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Disease Triangle

Animal Immunity
Immune Status
Nutrition
Stress

Pathogen
Virulence
Numbers
Concurrent Disease

Environment
Changes Important
Ventilation
Weather

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Newborn Immunity

- Bovine placenta prevents immune transfer to the fetus
- 41% of dairy calves - failed passive transfer (NAHMS, 1993)
  - Difficult delivery calves have poorer colostrum absorption
- 31% of dairy heifer mortality <21 days of age could be prevented by improved colostrum management (Wells, 1996)
- NAHMS '92
  - 8.4% pre-weaning mortality
  - 2.2% post-weaning mortality
- NAHMS '96
  - 11% pre-weaning mortality
  - No change in post-weaning mortality
  - BRD ~32% (NAHMS 2005)
  - Enteric ~21%
  - Calving Problems ~18%

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Newborn Reserves

- Newborn calf 3% lipid stores versus infant 16%
- Much of this is unavailable, what is available would be used up in 18 hours if the calf did not eat!

Colostrum

- High in Antibody
- Active Cells (CMI) destroyed by freezing, pasteurization
  - 60 C for 120 minutes (Godden 2005)
- Can be enhanced by dry cow vaccination
  - Scours Vaccine
  - IBR, BVD, BRSV, PI3 (Erskine 2006)
- Dry period affects volume, not quality
  - 40 day dry period ~ 15 lb colostrum
  - 60 day dry period ~ 20 lb colostrum (Cornell 2006)
- Colostrum from older cows not necessarily the best - volume, mastitis, leaking, other disease
  - ↓ quality when >8.5 kg 1st milking or >6 hr after calving (Godden 2004)

Colostrum

- 3 Q's - Quantity, Quality, Quickness
  - 4 liters within the 1st 4 hours, 2 liters within next 8 hours
  - 93% passive transfer in calves – 4 litres within 4 hours
- Cleanliness <100,000 CFU/ml (McQuirk, 2004)
- One Cow's colostrum to one Calf
- 5 C's of Calf Feeding
  - Colostrum, Cleanliness, Comfort, Calories, Consistency

Environmental Stress

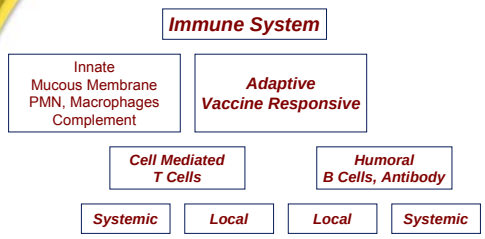
- Calves thermo-neutral zone 15 – 26˚ C
  - Larger surface area than cows so less tolerant to changes
- Humidity is important
  - 26˚ C, 50% RH → 29.5˚ C, 80% RH
  - THI changes from mild to severe as rate of evaporation ↓
- Heat Stress
  - 32˚ C water requirements ↑ dramatically
  - Water highest quantity nutrient in calves
  - 10 – 15˚ C water preferable to aid cooling
  - Convection cooling with fans - 100 cfm/45 kg BW

(Grober Newsletter, July 2004)

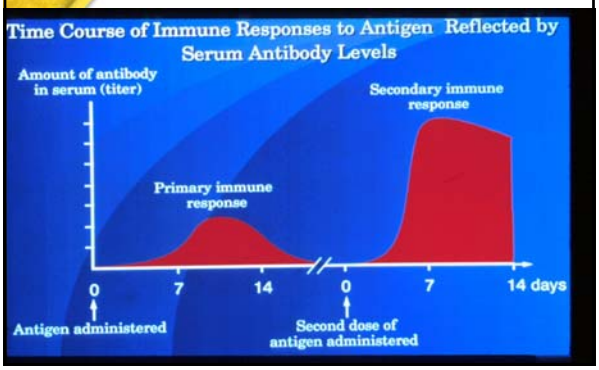
Disease Monitoring

- If calf morbidity is > 10% of calves < 1week of age
  - Total protein test - 70% > 5.5 gm/dl
    - If not – colostrum problem
  - Sanitation – housing and feeding equipment
- Respiratory Disease pre-weaning morbidity > 10%
  - Check environment
    - "knee" test
    - Ventilation – do not like drafts or damp conditions
  - Sanitation – Hutch and Feeding equipment
  - Nutrition
    - >12% of body weight per day
    - Access to calf starter
    - Access to free choice water for at least 30 min after feeding

Immune Response from Vaccines



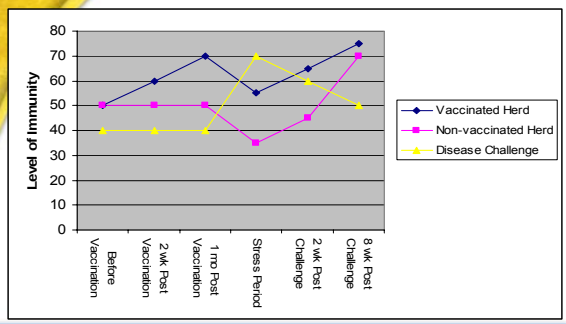
Humoral Immune Response



MLV vs. Killed Vaccines *(Schultz)*

• All 3 types immunity	• Only humoral response
• Longer Duration	• Short lived systemic immunity
• Broader strain protection	• Strain specific unless MLV 1st
• Immunity to all viral phases	• Immunity to one viral phase
• Multiple doses not needed	• Require multiple doses 2-4 wk
• CMI not blocked by colostral immunity	• Humoral response blocked by colostral immunity
• Rarely cause hypersensitivity	• Often cause hypersensitivity
• Rx often associated with concurrent disease	• Cannot cause disease

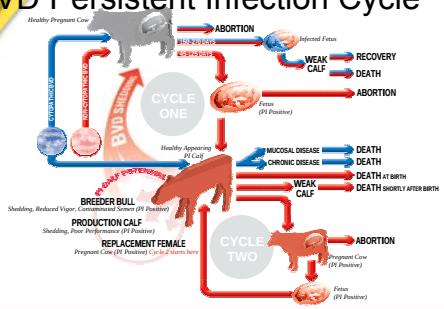
Disease Outbreak



BVD Overview (Bolin et al, 2004)

- BVD is group of related viruses
  - Noncytopathic (80%) vs. Cytopathic (20%)
  - Type 1 (38%) vs. Type 2 (62%)
    - Type 1 – PI, Congenital Defects, Weak Calves
    - Type 2 – Abortion, Bleeder Syndrome
  - 967 strains identified by AHL 6 year period (AHL 2004)
- Primarily subclinical disease
- Primarily reproductive disease or immune suppression, often undiagnosed
- Wide variation in virulence
- Current vaccines are effective in clinical disease control
- Require Reproductive Protection

BVD Persistent Infection Cycle



Health Impacts of a BVD PI Calf (Grooms 2004)

- Endemic Herds –
  - 7% ↑ fetal loss
  - Immune Suppression
    - ↑ Rota, Corona Scours, Mycoplasma bovis
    - ↑ pre-wean mortality by 10% (Cortese, 2004)
    - ↓ adjusted weaning weights by 43 kg (Campbell, 2004)
- PI shed more virus than acute infection

IBR

Dairy Calf BRD

- BRD incidence rate is 15-25%, most before 3 mo.
- Higher incidence/earlier detection when vet diagnosed
- Outbreaks associated with stress – cattle movement, weather
- Direct costs $25/heifer, Indirect costs up to $140/ heifer* when long term impact on productivity is accounted for
  - 10 days delayed 1st calving for every day of treatment (Leadley, 2006)
  - 1.5% of calves culled for chronic respiratory disease < 14 mo old (Donovan et al 1998)
  - 20% ↑ in culling before 1st calving (Warnick et al 1997)

*(Hurd et al, Preventative Veterinary Medicine, 24 (1995) 117-128)

Bovine Respiratory Disease

STRESS

IBR, BVD, PI_3, BRSV
Mycoplasma

M. haemolytica

P. multocida

BRD

BRSV

- BRSV is most significant dairy calf pathogen
  - resides Intracellular, short term colostral protection
- Primary source of BRSV is adult cattle
  - Shared air space ↑ likely hood of BRD outbreaks
- Most difficult viral agent to build long term immunity against

(Hurd et al, Preventative Veterinary Medicine, 24 (1995) 117-128)

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BRSV: Control through Immunization*

- Cows received 2 doses of MLV BRSV pre-calving
- BRSV & IBR colostral antibody (Ab) levels no different
- Calves from vaccinates had significantly higher BRSV Ab titers at 10 and 22 days of age
- Calves vaccinated with Bovi-Shield and One Shot at 10 days of age
  - ↑ CMI at 22 days of age
  - No effect if dam had been vaccinated pre-calving
- Pre-vaccinated calves had significantly higher blastogenic responses to BRSV and IBR at weaning
  - long lived T cell responses

-Ellis et al, JAVMA, Vol 208, No.3 February 1, 1996

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BRSV: 2 versus 1 dose when severe challenge*

- Study on BRSV sero-negative calves (rare in dairy herds)
- Based upon Cumulative Clinical Score (CCS)
  - 2 doses MLV was the only group that that did not have a significant increase in CCS over time
  - If severe challenge recommend a booster dose of MLV 3-5 weeks after primary immunization
- All vaccinated calves had reduced BRSV viral shedding following challenge

* West et al, Vaccine 18 (2000) 907-919

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Humoral Immunity vs Cellular Immunity and the Bovine Viruses

- IBR:
  - Due to "slippery" nature of intercellular bridging, CMI critical to successful response
- BVDV:
  - Multiple studies suggest that a balanced immune response (Humoral & CMI) critical to effective reproductive control
- PI_3
  - Non-specific responses, CMI play roles, but immunity incomplete and re-exposure results in re-infection
- BRSV
  - "F" protein invokes both Humoral and CMI with CMI critical to "clearing" infections

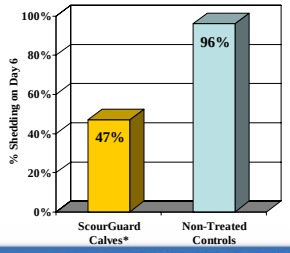
Rationale for Scour Immunization

Causes of Calf Diarrhea

- Enterotoxigenic E. coli (< 4 days of age)
- Rotavirus (4 - 21 days)
- Coronavirus (4 – 21 days)
- Crytosporidium parvum (5 – 28 days)
- Salmonella (broader range of age afflication)
- Nutritional
- Much Rarer
  - Clostridial perfringens Type C – sudden death
  - Enteropathogenic E. coli
  - Parvovirus
  - BVD

Less viral shed = less challenge = less risk to your herd

- Under challenge the amount of rotavirus shed by both groups peaked on day 6.
- Less than ½ of the calves receiving ScourGuard-bolstered colostrum were shedding.
- Almost all non-treated controls were shedding on day six.



*significantly different, P≤0.05

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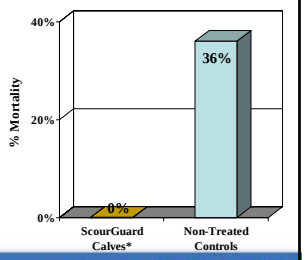
Stronger protection Better results

- Death loss was measured 14 days following challenge.
- See results at right for the ScourGuard difference.



*significantly different, P≤0.05

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Oral Scour Vaccines

- More expensive than vaccinating the cow
- <12 hours after birth
- 20 minutes before colostrum
- Will ↓ severity and mortality rates

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Goals of a Strategic Immunization Protocol

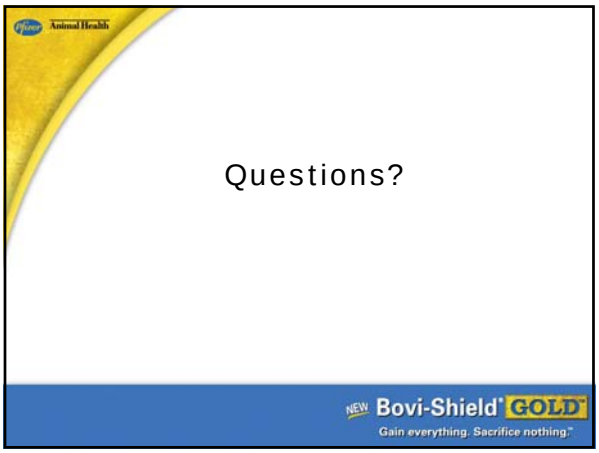
1. Immunize healthy, minimally stressed animals
2. Immunize prior to disease exposure
3. Maximize Immune Response
   - CMI and Humoral at the Systemic and Local Levels
4. Select the correct vaccine
   - Proven to protect for the desired disease entity
   - Safe
5. Ensure duration of immunity provides protection until re-vaccination
6. Use vaccines in conjunction with other management strategies to eliminate disease

Example Dairy Hiefer Immunization Protocol

- MLV in calves as early as 1 wk in high risk herds
  - Intranasal IBR can used < 1 wk of age
- MLV + M. haemolytica 1-2 wk before weaning
- 2 doses MLV FP pre-breeding
  - Bovi-Shield GOLD FP can be boostered pre-calving
- 2 doses Scour Vaccine pre-calving

Economics of Immunization Programs

- ~50:1 ROI on MLV based upon reduced BRD in calves
- ~42:1 ROI on MLV FP in the milking herd based upon improved reproductive performance
- ~11:1 ROI on Scour vaccines based upon reduced morbidity and mortality


Animal Health
Questions?
NEW Bovi-Shield GOLD
Gain everything. Sacrifice nothing.™

Strategic Dairy Immunization Protocols

Prepared by Robert Bell, Pfizer Animal Health

Goals of a Strategic Immunization Program:

1. Strategic immunization programs must be developed to meet individual herd needs, risks and goals.
2. Strategic immunization programs should be developed in conjunction with other disease prevention management practices i.e. maximize natural immunity, optimal environmental conditions and pathogen reduction principles.
3. Immunization must occur before disease challenge.
4. Immunize healthy, minimally stressed animals.
5. Utilize vaccines with proven protection for the identified disease threats.

Implementation of a Strategic Immunization Protocol

1. Follow label directions regarding storage and administration of the vaccine as well as disposal of unused vaccine portions and used needles.
2. Consider duration of immunity of all vaccine components when developing strategic re-vaccination protocols. For example, for reproduction protection the 9-way killed vaccines are probably only effective for 5 to 6 months and the J-5 bacterins for E. coli mastitis are only effective for approximately 4 months.
3. Do not administer more than 2 gram negative vaccines at any one time. Vaccine administration must be separated by at least 1 week to minimize vaccine reactions.
4. Other products, for example injectable vitamin E/Se, can cause reactions in cattle and their administration in conjunction with vaccines should be under veterinary guidance.
5. Avoid vaccinating cattle when ambient temperature is greater than 26º C /80º F. Vaccinate first thing in the morning after cattle have had an opportunity to cool down overnight.
6. Only use local vaccines in calves under 1 week of age (i.e. TSV2, oral scour prevention vaccines)
7. Avoid giving killed vaccines in calves under 5 months of age as maternal antibodies from colostrum reduce the effectiveness of the vaccine.
8. Modified live vaccines (MLV) have been proven to be effective in calves over 1 week of age. However, avoid the use of injectable MLV in dairy calves from 20 to 30 days of age as their white blood cell count may be depressed during this period.

Strategic Immunization for Specific Disease Syndromes:

1. Newborn Calf Immunity –
    a. Newborn immunity is primarily based upon the three ‘Q’s of colostrum management - **quality, quantity, quickness** i.e. 4 litres of high quality colostrum within 4 hours of birth, with an additional 2 litres within the next 6 hours. Holstein calves require ~120 gram of IgG and colostrum quality varies between ~30–70 grams per litre. It is also imperative that colostrum has low bacterial counts so harvesting technique, cleanliness of feeding and storage equipment and proper

refrigeration of fresh colostrum is important. Colostrum can also be frozen for up to 6 months and should be frozen in 1 or 2 litre aliquots.

b. Colostrum replacement products can be used to augment natural colostrum, but one should strive to use natural colostrum whenever possible.
c. Oral scour vaccines should be administered 30 minutes before colostrum intake and, while generally more costly than immunizing the dam pre-calving, have been proven to reduce morbidity.
d. Intranasal MLV IBR vaccines can provide local immunity for respiratory disease protection in the newborn calf.

2. Respiratory Disease in Young Calves –
    a. Most respiratory disease in dairy calves occurs before 3 months of age and is often associated with the stress of group housing after weaning.
    b. BRSV has been identified as a primary pathogen and is shed by older cattle. Consequently, housing calves away from adult cattle in a clean, dry, properly ventilated environment is a critical disease prevention management technique.
    c. In herds experiencing post-weaning respiratory outbreaks, the implementation of a 4 or 5-way MLV at least 2 weeks before weaning has aided in the prevention of these respiratory outbreaks.

3. Reproductive Disease Protection in the Breeding Herd –
    a. The primary reason for vaccinating the breeding herd is to ensure disease protection of the unborn fetus, particularly for IBR, BVD and leptospira bacteria.
    b. Some MLV's have demonstrated superior reproductive disease protection.
    c. While one dose of an approved 4 or 5-way MLV vaccine has been shown to be protective for reproductive disease, if leptospiral pathogens are a risk, two doses of this bacterin must be administered no more than 3 months apart and should boostered on a semi-annual basis.
    d. A strategic immunization protocol should be designed to provide maximized disease protection during high risk periods, i.e. the first 125 days of pregnancy. Therefore, the use of an approved reproductive protective MLV should be administered to open cows at least 3 weeks before breeding or, in properly pre-immunized pregnant cattle with an approved MLV, during the low stress dry cow period.
    e. The primary leptospira serovar in cattle is Lepto hardjo bovis (LHB) and the current 5-way lepto vaccines are not effective in providing reproductive disease protection. LHB can cause abortion, but primarily causes early embryonic death and an increased incidence of stillbirths or weak calves. Spirovac has been shown to prevent the reproductive affects of LHB provided the carrier state has been eliminated through prudent antimicrobial therapy. The recommended

protocol is to administer LA 200 (20 mg/kg) in conjunction with the primary dose of Spirovac at dry off, followed by a booster dose of Spirovac 3 – 6 weeks later and an annual booster dose either during the dry period or pre-breeding.

4. Scour Prevention Immunization of the Breeding Herd –
    a. Approved scour vaccines have been shown to augment colostrum antibody levels. However, to be effective calves must receive adequate volumes of quality colostrum. Challenge studies have proven lowered morbidity due to reduced shedding of pathogens and enhanced immune function and lowered mortality when a proper scour immunization program has been implemented in the pregnant dam.
    b. First time vaccinates should receive a primary and secondary booster of an approved Scour vaccine
    c. Properly pre-immunized cattle should receive an annual booster within 3 weeks of calving.

The development and implementation of a strategic immunization protocol is complex and requires a thorough review of the individual herd's risk factors. As a result, it is recommended that you develop a strategic immunization protocol in conjunction with your veterinarian.

Top ten take home tips for calf management

Dr. Tom Fuhrmann

Born and raised on a Wisconsin dairy, Dr. Tom Fuhrmann is a dairy cattle veterinarian with over 25 years experience working exclusively with dairy herds. Through Dairy*Works*^{TM}, a company he started due to his growing veterinary consulting practice, Tom teaches, trains, consults, and troubleshoots production management issues for dairy producers and their employees. He has worked with some of the largest and highest producing dairies in the U.S. and around the world providing practical knowledge on cow and calf management as well as milking and reproduction management.

Top ten take home tips for calf management

Ensuring a healthy herd requires a farmer to be aware of a variety of management options. Dr. Tom Fuhrmann will be focusing in on the multiple factors that ensure a healthy, productive herd while providing practical approaches to successful calf management and take home management tips that you can use on your farm.

This presentation is funded in part through contributions by Canada and the Province of Ontario under the Canada-Ontario Research and Development (CORD) Program, an initiative of the federal-provincial-territorial Agricultural Policy Framework designed to position Canada's agri-food sector as a world leader. The Agricultural Adaptation Council administers the CORD Program on behalf of the province.

Canada

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Ontario

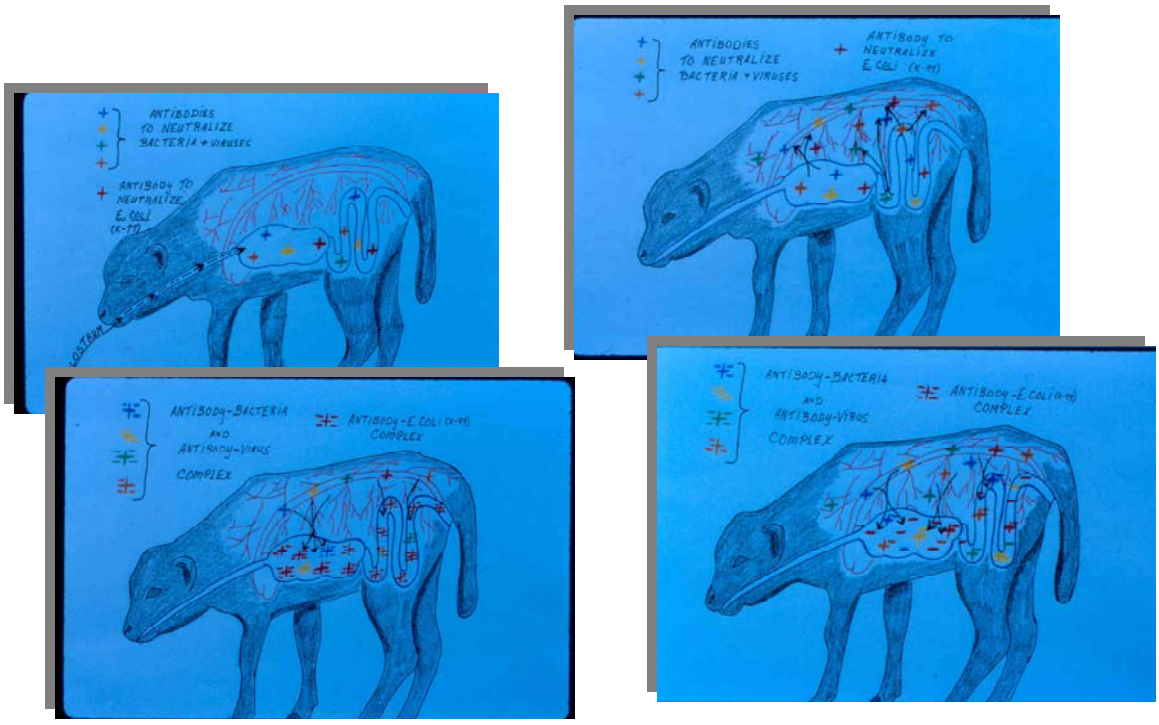
Top Ten Take Home Tips for Calf Managers

Thomas Fuhrmann, DVM
DairyWorks

There is no other segment of agribusiness enterprises that is so sophisticated, yet so simple as calf management. A review of the scientific literature over the past 10 years yields literally hundreds of articles regarding management, colostrum, disease and feeding of the baby calf. Yet thousands of calves born every day go on to live healthy, productive lives on well managed dairy farms, veal operations and calf ranches. This paper attempts to put science into perspective by offering calf managers: "I can be a successful calf manager if……."

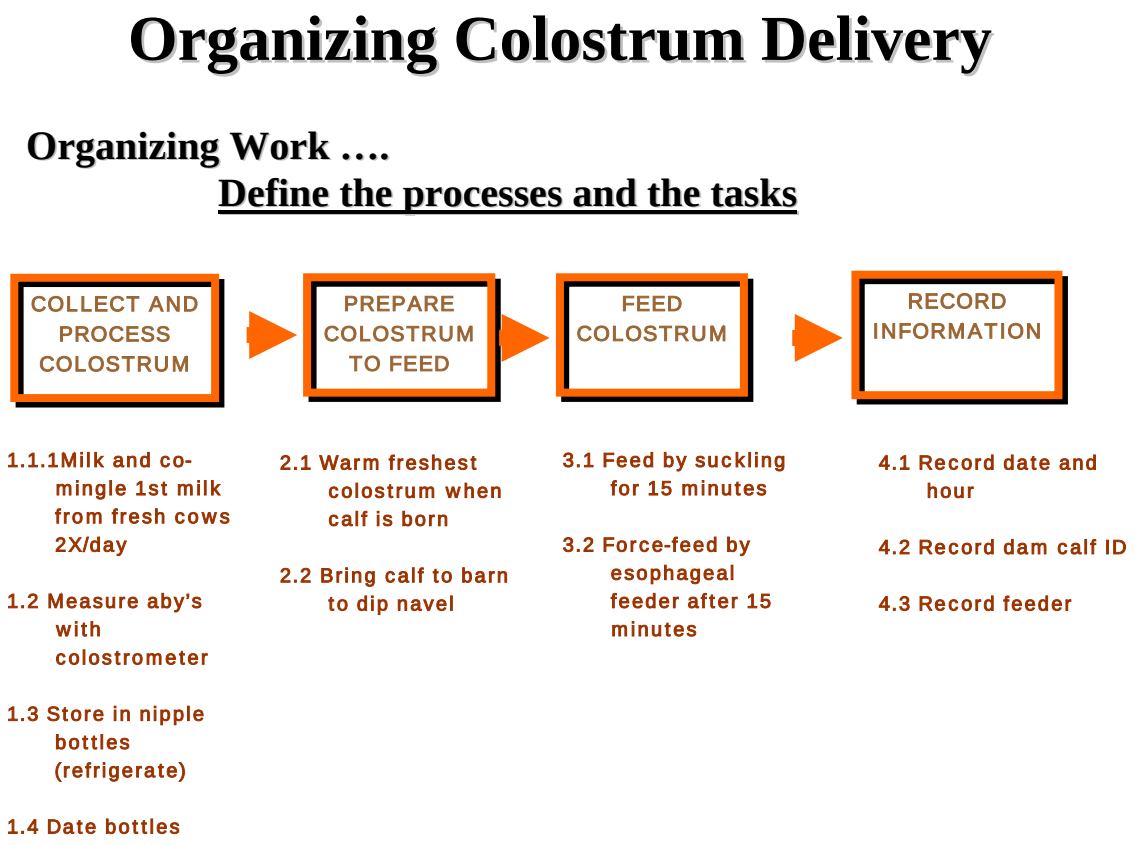
1. "I can be a successful calf manager if I understand and implement practical methods to feed colostrum to newborns". The movement of antibodies from colostrum across the intestinal wall, into the blood stream, and back again into the intestines is depicted below. Colostral antibodies are protein molecules that cross the intestines into the blood for only a few hours after birth. After approximately 6 hours the gut "shuts down" and antibodies no longer move into the blood. Those that remain in the intestines are digested as food and are probably not available to kill bacteria.

Figure 1. Movement of colostral antibodies into and back out of the blood stream



So you must devise a system (how to do work on your facility with your workers) that guarantees someone feeds 4 quarts (liters) of colostrum to all newborns within 6 hours after birth.

Figure 2: Example of a Colostrum Delivery System defining "processes" and "tasks"



TAKE HOME MESSAGES:

1. Collect all colostrum, put it into gallon containers and store it in a refrigerator.

2. Feed one gallon of the freshest colostrum with an esophageal feeder within 6 hours after the calf is born.
3. Write out, organize, train and monitor responsible persons to do this work day and night.

2. "I can be a successful calf manager if I feed all the colostrum harvested even if it tests poor (using a colostrometer) or even if it is from heifers". Colostrum is rich in nutrients even when it is poor in antibody content. The following table compares the composition of colostrum with that of milk. Never discard this rich source of nutrients for baby calves!

Figure 3: Comparison of colostrum and milk components

COLOSTRUM

"secretion from udder for first 24 hours"

Measurement	Milking 1	Milking 2	Milking 3	Milk
Specific gravity	1.056	1.040	1.035	1.032
% solids	23.9	17.9	14.1	12.9
% protein	14.0	8.4	5.1	3.1
% casein	4.8	4.3	3.8	2.5
g/L IgG	48	25	15	0.6
% fat	6.7	5.4	3.9	3.5
% lactose	2.7	3.9	4.4	5.0

Foley & Otterby

JDS 61:1033

The following calculations demonstrate that feeding one gallon of low antibody colostrum within 6 hours of life is adequate to provide protective antibodies to newborn calves.

Calculate minimal amount of colostrum to feed:

- **Calf body weight…….. 40 kg (85 lbs)**
- **Plasma volume (9% of body weight)...…….3.6 liters**
- **Minimum plasma concentration……...…….10 g/l**
- **Efficiency of absorption…….……..35%**
- **IgG intake (3.6 X 10/0.35)……..……..103 gm**
- **Minimal amount to feed……..2.1 liter or 2.5 qts**

TAKE HOME MESSAGES:

1. You don't need to use a colostrometer to measure antibody content of colostrum if you feed one gallon of colostrum within 6 hours after birth.
2. Always save extra (the oldest) colostrum for the second and/or third feeding for young calves.
3. Process and refrigerate colostrum immediately to minimize bacterial growth and contamination. See point 4 below.

3. "I can be a successful calf manager when I know that I can not use second milking colostrum as a substitute for colostrum when I don't have enough colostrum to feed." As identified in Figure 3 above, second milking colostrum does not contain the antibody content or the protein value of colostrum. Colostral substitutes were developed precisely for the purpose of substituting antibodies when natural colostrum from dams is not available. While a variety of colostral substitutes are available and their effectiveness varies, their objective is to provide adequate antibodies. But they probably do not supply other components of colostrum – essential nutrients, growth factors, hormones, protease inhibitors, leukocytes and other essential compounds. You must rely on scientific evaluation of the various colostral substitutes to know which to use; on-farm testing is not precise enough to determine differences between products.

TAKE HOME MESSAGES:

1 Organize your colostrum delivery program (point 1 above) so that you Always have sufficient colostrum available to feed newborns.
2. Have commercial colostral substitutes available to use in the event there is a deficit of natural colostrum.
3. Don't routinely use colostral substitutes when natural colostrum is available.

4. "I can be a successful calf manager if I properly evaluate whether it is necessary to pasteurize colostrum and waste milk for my calves before I feed it." There are two possible reasons to pasteurize colostrum or raw milk fed to calves: to reduce the number of bacteria that contaminate collected colostrum, or to kill contagious pathogens that are in the cow's udder, are found in colostrum and can spread disease to baby calves.

The list of contagious pathogens infecting calves includes Staphylococcus aureus, Corynebacterium paratuberculosis (Johnes Disease), Mycoplasma species and possibly Brucellosis and Tuberculosis. If these organisms are in your herd, converse with your veterinarian regarding the strategy to pasteurize colostrum to control the spread of disease to calves.

Evidence exists to support pasteurizing colostrum or raw milk to reduce the number of bacteria that contaminate collected colostrum. A study conducted in Minnesota found that feeding one gallon of either raw or pasteurized colostrum to calves resulted in a higher level of total proteins in those calves feed the pasteurized colostrum compared to

those fed raw colostrum. However the concentration of bacteria in pre-pasteurized colostrum was not reported nor was disease or death incidence in calves. In another study, a survey of 55 colostrum samples from Pennsylvania dairy farms found an average SPC >997,000 cfu/ml with 38% of the samples exceeding the goal of <100,000 cfu/ml.

A report of "On Farm Pasteurizer Management" that summarized surveys and field evaluations from Wisconsin, North Carolina and California identified management issues regarding the use of on-farm waste milk pasteurization. Some of these include: 1) post-pasteurized milk is not sterile; 2) failure of adequate pasteurization (use of alkaline phosphatase activity) occurred in as high as 18% of samples; 3) post pasteurization contamination occurs when pasteurized milk is feed after two hours after pasteurization or from poorly cleaned pasteurizers and/or feeding utensils; 4) employee time and management effort is required to clean, maintain and monitor pasteurization equipment.

Personal experience suggests that pasteurizing colostrum and raw hospital milk when well-managed colostrum delivery and hygiene programs are in place is not necessary to reduce bacterial contamination. An evaluation of the effects of pasteurizing colostrum and hospital milk that I performed on a 4,000 cow dairy identified no difference in health or death loss in calves before and after feeding pasteurized colostrum and hospital milk.

When considering pasteurizing colostrum or raw milk for your enterprise, consider that: 1) you will have to pool colostrum for several fresh cows and heifers and you will have to utilize batch pasteurizing technology rather than "high temperature short duration" pasteurizing technology for colostrum; 2) High temperature short time pasteurizing equipment is commercially available to pasteurize raw milk but it most be installed properly, maintained and cleaned after every use; 3) Post pasteurization contamination occurs when pasteurized milk is feed from contaminated equipment or after two hours after pasteurization; 4) Good results in calf health without pasteurization may not be "better enough" to justify pasteurization.

TAKE HOME MESSAGES:

1. Talk to your veterinarian regarding the presence of contagious pathogens in your herd and the role of feeding colostrum in spreading them.

2. Pasteurizing colostrum is difficult, time consuming and requires special pasteurizing equipment. Pasteurizing raw milk can be efficient with current commercially available equipment, but pasteurized milk should be fed within two hours after pasteurizing. Do not assume your pasteurized colostrum or milk is sterile; some bacteria will survive pasteurization and post-pasteurized contamination is probable.

3. Concentrate your management efforts on fresh cow milking hygiene and colostrum handling……thousands of calves born daily do well when fed unpasteurized, low bacterial content colostrum and raw milk.

5. "I can be a successful calf manager when I determine that calves are getting adequate colostrum." Analysis of total protein in serum from 1 – 3 day old calves is a direct monitor of the effectiveness of your colostrum delivery system. While commercial calf-side tests are available to determine antibody delivery to the calf, these are more costly albeit more accurate. Monitoring the performance of the persons assigned to feed colostrum is essential and just "good management".

TAKE HOME MESSAGES:

1. Establish your colostrum delivery program (point 1 above); train day and night persons in that system and devise reports to determine who and when colostrum was fed.

2. Sample EVERY calf daily (at 2 – 3 days after birth), use a refractometer and record the results of the total protein analysis.

3. Report results (feedback) to maternity personnel weekly, monthly. Positive results give managers confidence that programs are correct and also motivate workers to continue to implement the programs properly.

6. "I can be a successful calf manager when I recognize that hygiene, next to colostrum feeding, is the second most important principle of calf management." The list of common pathogens causing illness and death in calves includes: E. coli, Salmonella, cryptosporidium, Reo and Corona viruses. All these originate in the environment and generally do not cause disease unless they exist at abnormally high levels or infect an immuno-compromised calf. Keep your calving area clean. Keep individual calf hutches and feeding utensils clean and reduce the number of potential organisms that affect calves.

TAKE HOME MESSAGES:

1. Keep newborns clean, dry and comfortable.

2. Dip the navel of newborns immediately with a 7% iodine solution (closes the freeway bacteria use to gain entrance to the liver kidneys and intestines).

3. Maintain all milk feeding equipment clean and sanitary.

7. "I can be a successful calf manager if I understand how to use vaccines in my calf management program." Calves (all cattle) have two components to their immune system: humeral (or blood carrying) antibodies and cellular antibodies. Vaccines work by stimulating the calf to produce additional antibodies from either or both of these two systems. As discussed earlier (point 1) it is possible to "give" the newborn temporary protection with colostral antibodies. But these will gradually diminish and must be replaced when the calf's immune system produces its own antibodies from both the humeral and cellular immune systems.

Vaccinating baby calves that have had colostrum is best done at weeks or months after birth. As the calf ages, its immune system matures and it can produce more antibodies in response to vaccines. In colostral deprived calves, vaccinate with appropriate vaccines at a very early age. In either case, use vaccines appropriate for the organisms prevalent in your enterprise; depend on veterinary advice to choose whether to use killed or modified live vaccines.

TAKE HOME MESSAGES:

1. Vaccines are not a substitute for colostral antibodies; the calf's immune system can not respond quickly enough to afford the protection that colostrum provides.

2. The baby calf's immune system can respond to vaccines given at an early age; select which vaccines and when they should be administered with the assistance of your veterinarian.

3. Colostrum fed dairy calves are "different critters" than colostral deprived calf ranch calves; vaccinate each differently.

4. Modified-live vaccines have a place in calf management programs.

8. "I can be a successful calf manager if, when treating diarrhea, I do not take calves off milk or milk replacer." Baby calves (like all babies) require nutrients in small amounts regularly to meet maintenance and growth requirements. Depriving the sick calf that wants to eat of the nutrients needed does more harm than good. A field trial conducted at the University of Wisconsin demonstrated that calves fed milk along with therapy for diarrhea responded as well or better when compared to a group of calves when feed was withheld for 24 hours during diarrhea therapy.

TAKE HOME MESSAGES:

1. Involve your veterinarian to design the appropriate treatment program for your scouring calves.

2. Continue to feed milk or milk replacer to calves that will drink during scours treatment.

3. Use an additional "feeding" of oral electrolytes in the middle of the day to scouring calves.

9. "I can be a successful calf manager if I recognize that calves grow best when fed milk or milk replacer and good quality grain mix until weaning." Milk and milk replacer (except in veal operations) provides nutrients to satisfy maintenance requirements only. Additional growth requirements are met through grain consumption. Pennsylvania State University trials identified that rumen development was maximized on diets that contained both milk and grain. Energy deficits are common in under nourished calves and these are more susceptible to disease.

TAKE HOME MESSAGES:

1. Provide water and grain free choice to baby calves ALL THE TIME. Manage so that the youngest calves receive fresh grain daily; feed grain so that calves have access to it immediately when they finish consuming milk.

2. Wean calves when they consume greater than 2.5 lbs. of grain daily.

10. "I can be a successful calf manager if I understand that the transition of weaning and grouping calves from individual hutches is a stressful period for them." Reduce stress, maximize calf comfort and train calves to consume grain from feed mangers during this transition. Recent trials in Ohio confirmed other scientific data that calf starter protein content in excess of 18% is not necessary to feed calves to maximize growth.

TAKE HOME MESSAGES:

1. Keep calves in hutches for a minimum of 5 days after weaning them from milk before moving them to group pens. Move only calves that consume more than 3 lbs of grain.

2. Move calves to small group pens (10 – 15 calves per pen) for a minimum of two weeks. Regroup calves by size when putting them in the group pens for the first time.

3. Feed grain in elevated metal troughs for the first 2 days after moving to group pens; then feed half the grain in the troughs and the other half in the feed manger for another week. Feed the same 18% calf starter used in the hutches to calves in these group pens for a minimum of two weeks after the move to group pens.