A Growth Mindset on the Ranch Encompasses More Than the Health of the Calves

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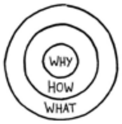
Calf and heifer raisers, like any other business, need to be in a perpetual state of growth to maintain viability and vitality. Growth keeps us on top of the curve and able to be agile to adapt to changing markets and industry standards. Recent trends and events have challenged us to think bigger in a global economy and incorporate our staff to be leaders in biosecurity.

What/how/why

In the 1960s, Wisconsin was home to over 100,000 dairies. In 2019, we are likely to have fewer than 8,500 yet our cow numbers are growing as well as our overall production. Farm growth exacerbates what used to be minor efficiency and health issues in the small herd to full on disasters in a larger economy of scale. These now large gaps and problems was the impetus for groups like the Professional Dairy Heifer Growers Association in 1996, now known as the Dairy Calf and Heifer Association (DCHA), to develop best practices to maximize efficiency and avoid potential meltdown situations.

The DCHA was founded to share a unified focus on health, management, and economics of raising dairy calves. They have developed Gold Standards and are committed to disseminating best practices and innovative ideas to their membership and the industry. Part of this talk comes from the DCHA's 2018 membership survey, which encourages the organization and its membership to continually have a growth mindset. The take home message is that we always need to be thinking about process improvement. Innovative ideas in 1996 are not going to get us to the top in 2020. Developing the next step or an idea leap is not an easy task, let along convincing industry-wide adoption of ideas outside of the status quo.



One way to develop innovative ideas is to stop thinking about what and how we are doing something and focus on why we are doing it as described by Simon Sinek in his Ted Talk "How great leaders inspire action." See figure to the right. Simon uses Apple computers as an example. The "what," or result, is that Apple makes computers. The "how," or process, is that Apple makes sleek and easy to use electronics. Most importantly, the "why," or purpose for Apple is to challenge the status quo by doing things differently. Adapting this to the DCHA, the "what," or result are Gold Standards and meetings. The DCHA's "how," or process is to facilitate collaboration and communication between growers, industry, and academia. DCHA's "why," or purpose is to be a driver and ignitor of innovation for calf health and industry profitability.

Simon Sineck suggests starting with the "Why," not the "What."

The challenge for the calf grower now is to get their organization to focus more on why they are in business and not what specifically they are doing. This thought pattern is not solely for management in the operation. Getting the entire team to understand why they are doing their job and not just fulfilling tasks is not easy. Management may have a different Why/How/What plan than an employee that has a specific job task. Keeping the "Why" in the forefront of your operation will truly differentiate your brand when many fail.

Product driven or market driven?

Figuring out the "Why," or purpose of what we do is not as simple as raising a calf to breeding. Hiring a professional heifer raiser was a game changing re-invention of the model for raising young stock in the 199 0s. However, from the 2018 membership survey we still need DCHA members to improve their ability to recruit and retain clients. "How do we convince people to not raise heifers and let a professional do it?" If we are convinced that our product is of high quality, but we still do not have enough business we need to make sure we are in the right market.

When a leader with reputation for brilliance meets an industry with a reputation for lousy economics, the reputation of the industry will survive – because in terms of long-term financial results, the pond you jump into is 10 times as important as how well you swim.

-Warren Buffett-

We have to be in a good pond. No matter how hard we work if we are in a bad pond, success will be limited. The only way around this in a lousy market is to reinvent the model and do things differently. If the market is lousy because it is not developed, consider moving away from being product driven to market driven. Moving from being in the business for raising calves from weaning to breeding to being in the business of maximizing dairy profitability.

Growth and fixed mindsets

Being in the right market or reinventing the model for the market is key for growth, which is absolutely necessary for sustainability in your market.

Growth is not just revenue, it is a mindset opposite of a fixed mindset. We have these lists hanging in our board room at the diagnostic laboratory. The idea came from similar lists hanging in the board rooms of the Johnsonville Sausage Company in Wisconsin.

Growth Mindsets	Fixed Mindsets
Make fact-based decisions	Jump to conclusions
See problems as opportunities	Accept constraints
Take the initiative to make things better	Blame others
Have a sense of urgency	Wait for others to make a change
Focus on results	Focus on activities
Challenge experts	Rely on experts
Set aggressive goals	Set "safe" goals
Find ways to implement solutions	Create roadblocks
Celebrate small victories	Dwell on setbacks
Make time for priorities	Are too busy to take action
Fail fast and frequently	

Here is what growth is **not:**

1. Striving for revenue growth. Growth is not about profit, rather focuses on continuous improvement and learning from failure to stay on top of the industry curve. Profitability will follow and will be maintained by growth.
2. A business strategy. Growth mindset is a frame of mind within a person. Businesses do not think; therefore, they do not have a growth mindset.
3. Unbounded. The term "Anyone can do anything, so long they put their mind to it" is not practical. Limitless actions are distracting from what we are hired to do in some occasion and can cause demotivation, confusion, and lack of engagement.
4. Binary. Growth is not an all-in or all-out state of mind. Each skill has its own spectrum. For example, dairy owners may focus a growth mindset on efficient milk production but not on heifer raising.
5. Positive, can-do attitude no matter what. We have finite resources and capacities. People are not able to bend the laws of space and time to get things done well.

Investing in employees to be market driven with a growth mindset

Having an effective and engaged team is the direct return on investment in an operation that is purpose and market driven with a growth mindset. Investing time and training to instill the "Why" your operation and the particular area of an employee will likely engage them and their co-workers.

Increasing Your Operation's Positive Impact on the Environment

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Introduction

Agriculture is under increasing pressure to reduce nutrient and sediment loss to both surface and groundwater. While farmers have faced this type of pressure for decades, the fact is that non-point sources of pollution (nutrient and sediment losses coming from many different sources) are under increasing pressure because of the regulations put on Point sources of pollution. The call for increasing regulations and oversight of agriculture is happening throughout the country and farmers everywhere are making changes to their farming systems to reduce the potential for negative environmental impacts.

Point sources have discharge through a pipe to surface water (manufacturing, municipalities, etc.), and have been regulated since the early 197 0s. They have received significant federal, state and local financial aid to improve their treatment systems. However, over the past decade the allowable level of phosphorus discharge from a point source has decreased. In Wisconsin there were revisions to the state water quality codes that established a target criteria of 0.75 mg/liter for phosphorus in streams. This revised criteria has forced some point sources to invest significant funding in their treatment systems, and other point sources to begin working with agriculture to achieve the necessary nutrient reductions through improvements in farming practices.

This paper is not going to outline the rules and regulations farmers face in meeting the new water quality goals because they vary greatly from state to state. The goal of this paper is to highlight:

- When is the greatest risk of loss?
- Clearly identify the challenges facing agriculture.
- What should a farmer target to increase the positive impacts on the environment?
- What are the challenges facing agriculture?

High risk periods

Farmers living in the northern regions of the country have to deal with frozen ground and snowfall. This period of time changes the way your fields act and changes the potential for water to runoff a field. Data from the Discovery Farms Program (www.uwdiscoveryfarms.org) shows that over 50% of the surface runoff measured in Minnesota and Wisconsin occurred during frozen soil and snow melt conditions. To farmers this is reasonable because during this time period rain and melting snow cannot infiltrate the soil. However, what you need to consider is that during this time period the amount of land contributing surface water increases significantly. Woodlands, wetlands and non-farmland change from having high rates of infiltration to no infiltration. That increases the amount of runoff and the potential for sediment and nutrient loss.

Farmers living in regions of the country that do not have frozen ground or snow cover have a different challenge. Normally these regions of the country have periods of time where rainfall is more prevalent. Time periods of significant rainfall produce saturated soil conditions and the risk of runoff is similar between saturated and frozen soils. Soils normally contain open spaces where water can enter and be held. However, when a soil is saturated there is no space in these soils to hold water and additional precipitation runs off the land. While this time period can vary from year to year and based on location, it is common for all areas of the country to have time periods where precipitation is prevalent.

For farmers living in the Midwest the data from the Discovery Farms Program shows that the risk for runoff is highest in March (caused by snowmelt) and June (caused by rainfall). When water is running off a field (whether that field is farmed or not farmed) there is an increased risk of nutrient and sediment loss. There are a number of factors that influence the risk of sediment and nutrient loss from all types of cropland and non-cropland, but the fact is that once water concentrates on the surface and begins moving it can carry sediment and dissolved nutrients to surface water. Farmers living in other regions of the county should evaluate rainfall patterns and identify the time periods that pose the greatest risk of runoff.

Identifying the challenges that limit the positive impacts from agriculture

A key for farmers to be successful in protecting the environment is they need to clearly define the water quality issues facing farmers in their specific area. Many agencies and organizations start with practices they want to promote, like cover crops, low disturbance manure injection (LDMI), no-till or reduced tillage. This process begins by providing a series of solutions instead of engaging farmers in clearly identifying the issues. There are cases where farmers are implementing regulated practices to reduce the risk of a water quality challenge that doesn't exist in their area.

Farmers and their crop advisors need to be engaged around the table to discuss what they know or believe to be water quality challenges in their area that are impacted by agriculture. Information needs to be shared on how agriculture is negatively impacting water quality and farmers need to review the information/data and decide whether or not they agree with the assessment. It is difficult to get farmers to implement solutions to a problem that may not exist on their farms. Helping farmers understand the role their farms play in protecting water quality can greatly improve the level of interest in adopting new conservation farming systems.

The key to clearly defining the issues is creating a "safe environment" where farmers feel comfortable talking about the issues. Presenting credible information on agricultures impact on water quality at a "farmers only" (or at the least with no agency personnel who have regulatory authority) meeting where people can be open and honest. Someone who is respected and trusted must lead the discussion and present data on the issues. These types of meetings cannot focus on "solutions (– if everyone did no-till; if everyone grazed; if everyone planted cover crops; etc.), but must be focused on water quality and how agriculture contributes excessive nutrients or sediment. The moderator must acknowledge agricultures role, while also providing information on other sources (construction sites, golf courses, septic systems, etc.). The key is not assigning blame, just trying to clearly define agricultures role and sources. Farmers need to accept their role in improving water quality and to do this they need to see other sources of the problem accept their role. If industry or municipalities are contributing they also need to accept their role and work with others to reduce their negative impacts. If industry, municipalities and other non-point sources are unwilling to accept their role in protecting water quality, then farmers may be less encouraged to take a leadership role.

Once the local challenges have been defined and farmers agree that they have a role in reducing losses (while this sounds simple, it is important to the long-term success of the project), then discussions on finding solutions to local challenges can begin. Anyone who works with or knows farmers understands that this is the stage where they shine. Farmers are natural problem solvers. They make a living identifying what is wrong and finding a solution, most of the time as quickly as possible and with as little money as possible. Farmers love problem solving and that's why to gain buy-in and long-term success you have to get them to understand and agree that there is a problem. It can't be a problem someone else believes is caused by farming, or a problem other people thinks they have. Farmers have to view the issue as something they can correct and you have to provide farmers and/or crop advisors the metrics to provide feedback that show whether the practices are working or not working.

Practices that farmers can adopt to increase positive impacts on water quality

Let's assume that we have identified the high-risk periods for your farm and clearly identified and prioritized practices that reduce the positive impacts of your farm on water quality. What's next? Identify practices that reduce the risk of loss and decide how to determine if these practices are effective. Let's start with challenges that have been identified throughout the country, excessive sediment and phosphorus loss to surface water.

1. The first step in reducing phosphorus and sediment loss to surface water is to control soil loss. There are a lot of resources that can show the impact of excess soil loss (soil erosion) and most farmers are aware of the need to control soil loss. To be in compliance with federal programs farmers need to control soil erosion to a level (tolerable soil loss – T) that permits current crop production to be maintained economically and indefinitely. However, maintaining soil loss to T is not an environmental measurement. To maintain water quality and reduce sediment delivery to stream and lakes, farms must achieve soil loss levels significantly below tolerable. To achieve acceptable levels of soil loss farmers must match their tillage system to their landscape. Some tillage systems (minimum or full tillage) may work well on some fields and not offer adequate protection on other fields.
2. Farmers also need to evaluate where water concentrates and flows off the fields. Conservation practices like grass waterways, check dams and no-till are required on fields with high potential for soil erosion. The key is that farmers need to understand the risk of soil loss on all of their cropland and implement practices that reduce the risk of soil erosion. That may mean having several types of tillage equipment depending on your cropland and crop rotation.
3. Cover crops are grasses, legumes, small grains or other crops grown between regular grain crop production periods for the purpose of protecting and improving the soil. The most common cover crops are fall-seeded cereals, such as rye, barley or wheat, and fall-seeded annual ryegrass. Late summer-seeded spring oats or spring barley is sometimes used if winterkill is preferred to avoid spring termination by tillage or herbicide. One of the two major reasons for growing winter cover crops is to reduce soil erosion. In many portions of the country a significant amount of the tillable acres has sufficient slope to be at risk for erosion if not adequately protected. Eroding soil particles not only fill in wetlands and streams, but they also carry particulate bound phosphorus to surface water.

   Based on the data collected by the Yahara Pride Farms (www.yaharapridefarms.org) the first farmer-led watershed program in Wisconsin, the use of cover crops is most effective when targeted to specific fields and farming systems. Cover crops have a high potential to reduce phosphorus loss on fields being harvested as corn silage with manure incorporated in the late summer or fall. Research has shown that fields with winter cover incorporated in the spring have 55 percent less water runoff and 50 percent less soil loss annually than do fields with no winter cover. More recent studies show soil losses from corn or soybeans no-tilled into a vigorous growth of rye or wheat to be 90-95 percent less than soil losses from corn and soybeans conventionally tilled.

4. Another major concern is manure application. Manure is an excellent source of organic nutrients and it should be treated as a high value fertilizer. The application of manure at the proper rate, time and method can greatly reduce the risk of manure moving from a field to surface and/or groundwater. Applying manure on frozen, snow covered and/or saturated soil greatly increases the potential for manure to move out of the root zone.

   Manure is either incorporated into the soil using a number of different tillage implements (chisel plow, disk, or field cultivator) or it is applied to the soil's surface and not incorporated. Surface applications of manure have been shown to increase nitrogen and phosphorus runoff to rivers and streams, while injection/incorporation places manure below the surface where it doesn't interact with runoff water during storms. However, on steep slopes injection/incorporation of manure can make the soil more susceptible to erosion.

   Traditional incorporation methods move a great deal of soil and increase the potential for soil erosion. Field evaluations conducted by the Yahara Pride Certification Program during the spring of 2013 and 2014 identified reducing soil erosion as a high priority. Since much of the tillage was conducted to incorporate manure, a system of incorporating manure with minimal soil disturbance needed to be implemented in the watershed. Minimum disturbance equipment also works well with no-till farming systems and allows farmers to experiment with new methods of preserving nitrogen, phosphorus and potassium to save on fertilizer costs. In addition to the economic benefits, improved manure utilization benefits the environment by ensuring efficient nutrient use and improving soil and water quality. Yahara Pride Farms was one of the first groups in Wisconsin to experiment with low disturbance manure injection (LDMI). LDMI is a farming system that incorporates manure into the soil with minimal soil disturbance. There are a number of companies that make equipment to incorporate manure with low soil disturbance. These systems often use a single large fluted coulter to cut crop residue and open a channel in the soil surface for manure placement. Significantly less soil disturbance occurs with this process than with either chisel or chisel/disk manure incorporation systems. The farmers in the Yahara Watershed have been experimenting with LDMI since 2013 and data gathered through their program estimates that LDMI reduces the risk of phosphorus by about 1 pound per acre.

5. Strip-tillage`is a conservation system that offers an alternative to no-till, full-till and minimum tillage. It combines the soil drying and warming benefits of conventional tillage with the soil-protecting advantages of no-till by disturbing only the portion of the soil that is to contain the seed row (similar to zone tillage). Each row that has been strip-tilled is usually about eight to ten inches wide. The system still allows for some soil water contact that could cause erosion, however, the amount of potential erosion on a strip-tilled field would be lower than compared to the amount of erosion on an intensively tilled field. Compared to intensive tillage, strip tillage saves considerable time, fuel and money. Another benefit is that strip-tillage conserves more soil moisture compared to intensive tillage systems. However, compared to no-till, strip-tillage may in some cases reduce soil moisture and increase the potential for soil loss.
6. The final method to reduce the risk of phosphorus loss to surface water is to headland stack manure during snowmelt and high-risk runoff periods. Based on data collected at the Discovery Farms and Pioneer Farms, winter runoff events that occur as a combination of increased temperatures and rainfall, along with frozen soils and deep snow cover, produces a high potential for surface runoff from fields. Livestock producers who make manure applications to cropland during this high-risk period need to understand that spreading manure during snowmelt does have an extremely high risk of runoff.

   Studies from farms cooperating in the Discovery Farm Program indicate that manure applied to snow covered and/or frozen soils during conditions of snowmelt or rain on frozen soils can contribute the majority of the annual nutrient losses. One inappropriately timed manure application can generate large losses of phosphorus to surface waters.

Challenges facing farmers and agriculture

This paper covers practices that can reduce the risk of sediment and phosphorus loss to surface water. The risk of these losses depends on the landscape you are farming and the distance to surface water, so all farms should evaluate their risk of loss and modify the farming systems accordingly.

What makes this difficult is that often what is recommended to reduce the risk of loss for one contaminate could increase the risk of loss for another. For example, to reduce the risk of phosphorus loss through runoff we recommend some type of tillage. However, tillage increases the risk of soil loss and soil particles carry sediment bound phosphorus. On the other hand, switching to a 100% no-till system for livestock operations means that manure is surface applied and the soil surface carries extremely high levels of phosphorus. These high phosphorus levels increase the amount of dissolved phosphorus (phosphorus not bound to soil particles) and can increase the total phosphorus loss from a field.

Another challenge facing agriculture is the increased focus on nitrogen movement to ground and surface water. Farmers in Wisconsin will be hearing a lot more on nitrogen loss and the state is in the early stage of developing regulations on nitrogen management. Nitrogen management is a much more complicated system than phosphorus. Nitrogen comes in a number of forms and can be lost to surface and groundwater in different forms. The other challenge is that nitrogen is not bound to soil particles so it can move rapidly through the soil and into groundwater. Finding the proper balance in a farming system that reduces soil loss, phosphorus loss and nitrogen loss is going to be a challenge.

The last challenge that farmers need to put on the radar is pathogen loss. While in the very early stages it is clear that pathogen movement into groundwater should be a major concern for all livestock producers. Over the past several years new types of testing has been developed to identify pathogens and track them back to animal types and in some cases individual animals. Farmers and their advisors need to be aware of these types of studies and begin working together to reduce the risk of pathogen movement into surface and groundwater.

Calf Scours on a Timeline — Not All Cases are Infectious

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PATHOGENS AND PATHOGENESIS

Not all causes of calf scours are infectious pathogens

We usually think of the major causes of calf scours to be infectious microbes. These microbes include bacteria, viruses, and protozoal parasites. However, we do not want to discount variability in total solids in the milk or milk replacer on a day-to-day basis. Changes in total solids of +/- 2% could be a primary factor in gastrointestinal disorders in calves and in combination with pathogen, could be difficult to treat and lead to increased calf mortality. Total solids can be tested at your veterinary diagnostic laboratory or on farm with a Brix refractometer. Remember that use of the Brix requires standard curves for each milk replacer product. Osmolality of milk replacer products can also be an issue when the solutes per volume is too high, which decreases digestibility and may cause an osmotic draw into the gut instead of digestion into the portal circulation. Finally, mycotoxins (or toxins in general) can be associated with calf diarrhea.

Two basic mechanisms of pathogenesis

Of the infectious and contagious microbes, there are two main mechanisms of how they cause diarrhea: malabsorption and secretion. Pathogens that cause malabsorptive diarrhea do so by damaging enterocytes and intestinal villi to drastically reduce the surface area available to absorb nutrients through passive and active transport mechanisms. Secretory diarrhea is caused by specific virulence factors, such as shiga toxin, that result in enterocytes secreting electrolytes and bicarbonate into the lumen of the bowel. This causes an osmotic draw of water from the extracellular space into the gut and results in watery diarrhea.

Some pathogens have a main mechanism of malabsorption or secretion but may have components of both. For example, some viruses blunt the intestinal villi cells and stimulate secretory cells to undergo hyperplasia. Another example is *Cryptosporidium parvum*, which is thought to primarily cause a malabsorptive diarrhea. However, the parasite also causes some electrolyte secretion and stimulation of the enteric nervous system to increase peristalsis to rapidly decrease GI transit time.

Days 1–3 of life

Diagnosis of calf diarrhea in the first few days of life is challenging and at the diagnostic laboratory we estimate that up to 50% of these cases go undiagnosed. Calves that start to show clinical signs of scours in the first three days of life should be tested for enterotoxingenic *E. coli* (ETEC). ETEC has fimbrial attachements and is also referred to as K99 (F5) and/or F41 *E. coli*. ETECs cause secretory diarrhea from enterotoxins and when they die, can cause septicemia due to endotoxin release. Attaching and effacing and Shiga toxin producing *E. coli* are also reported to cause calf scours but they are considered uncommon. They are, however, very important in human medicine. Important to remember is that not all *E. coli*'s are created equal and it is important to submit testing for ETECs, not *E. coli* in general via fecal culture. The risk period of ETEC calf scours is finite and is likely not a causative agent past 10 days of age.

Days 4–10 of life

When calves start scouring at four to ten days of age, definitive diagnosis becomes more challenging because of the plethora of pathogens that cause disease. Specifically, *Salmonella enterica* has over 2200 known serotypes that are pathogenic! *Salmonella* sp. have endotoxin (like any Gram-negative bacteria) and produce shiga-like enterotoxins that cause secretory diarrhea. Salmonellosis can result in persistently infected carrier animals similar to the "Typhoid Mary" story. This is common with the host-adapted Dublin strain and is reported with Typhimurium as well. In addition to carrier animals that shed sporadically, *Salmonella* organisms are able to survive in harsh environmental conditions, which perpetuate disease on the farm when the environment returns to favorable growth conditions.

From five days to two weeks of age is when we see our most common pathogen of calf scours, rotavirus. Rotavirus causes a malabsorption diarrhea with a small component of secretory from a NSP4 toxin that targets the small intestine. Rotavirus is stable in the environment for up to nine months in fecal material. Significant attention being given to rotavirus type B as a calf pathogen that could cause disease early in the first week of life.

From five days to four weeks of age is when we see coronavirus infections in calves. We diagnose enteric coronaviruses in calf scour cases as well as respiratory coronaviruses in our enzootic calf pneumonia cases. We are not quite sure what to make of the respiratory coronaviruses because they are found commonly in clinically normal calves, which makes us think they are a co-infection issue and likely not a primary pathogen. Enteric coronaviruses cause more severe disease and pathology than rotavirus because they completely destroy the intestinal villi (malabsorptive) and often lead to secretory diarrhea as well. Coronavirus also results in pathology of the small and large colon. Damage can be so severe that secondary bacterial infections can from opportunistic bacteria. Infected calves shed significant amounts of the virus into the environment making the virus very contagious. Up to 70% of normal cows shed coronavirus in their feces, which makes contamination of the calf environment common on any dairy.

From one week to one month of age is when we diagnose cryptosporidiosis in calves. The most common species is *parvum*, but *bovis* and *hominus* also can be found. Cryptosporidiosis is mainly a malabsorptive diarrhea and recent research suggests that bicarbonate and chloride secretion is important in pathogenesis. *Cryptosporidium* causes intestinal villous blunting that requires 4-14 days to regenerate, depending on how much of the villi are denuded. The parasite can survive for months in wet and cold environments, so it overwinters quite well. Desiccation and ultraviolet light is key to kill the parasite in calf environments because it is resistant to several disinfectants. Bleach and other ammonium compounds are often needed for indoor cleaning and sanitation.

Clostridium perfringens A is an opportunistic pathogen that causes disease in the 10-14 days of age range. It is normal flora in the gastrointestinal tract and requires the right conditions to overgrow and cause disease. When this happens, it is typically severe and acute. Nutritional issues and flora upset with oral antibiotics are often associated with *perfringens* A disease. *Clostridium perfringens* B and C also are associated with calf septicemia and disease in the first week of life.

Giardia's role in calf scours is unclear. Some experts believe that is a primary pathogen in as young as five to seven days of age. Others think that it is more of co-infection and happens later in life, from two weeks and older. The pre-patent period is seven days, so finding the organism earlier than one week of age suggests pass-through and a heavily contaminated environment. Either way, it causes dysfunction of the epithelial cell layer of the villi and a malabsorption diarrhea.

Coccidiosis is another parasite that is quite common and could affect calves in the range of 10-14 days of age but due to the 21-day, pre-patent period, finding coccidia in a fecal float earlier than three weeks of age is debated. Coccidia severity is dependent on the year with moisture variability and 95% of cases are subclinical. Calves can develop disease for several months, so it should be on the weaned calf diarrhea differential diagnosis list as well. There are 13 species of *Eimeria* that cause calf scours and they attack the crypt cells to cause a malabsorptive diarrhea. *Eimeria* is hearty in the environment and is shed in high numbers from subclinical and clinical calves so environmental management is important to decrease future infections.

Diagnostic options

Diagnosis of diarrhea in calves has evolved in the past 10 years to heavily rely on molecular diagnostic techniques. Bacterial culture is still important for serotyping and antimicrobial sensitivity. Acid fast staining is still reliable for parasitic infections. Electron microscopy for viral and parasitic infections may be available at specific diagnostic laboratories. Fecal flotation is important for parasites but is limited to the pre-patent period and shedding patterns. Lateral flow immune assay based on colloidal gold have applicability in the field but can be expensive.

Effective diagnosis of calf scours problems on the farm starts with early identification of sick calves. When calves start showing signs of illness is important because different pathogens are typically found in specific age groups of calves. Age of affected calves also will help identify risk factors of infection and disease propagation in order to implement changes in management. The University of Wisconsin has devised applications for the iPad (currently working on Android applications) to assist in record keeping and identification of sick calves.

At the Wisconsin Veterinary Diagnostic Laboratory, we have a niche market in diagnosis and management of calf diarrhea problems. We rely on PCR assays grouped into panels based on the age of the calf because we can get semi-quantitative results with a real-time assay, have high sensitivity, and are able to do high volume testing with reliable results. Testing options are grouped based on the prevalence of each pathogen depending on the age of the calf.

Fecal samples should be collected as soon as possible when a calf develops diarrhea. If this collection is delayed several days, wait for the next calf to start scouring and collect a sample from that calf. This will give the veterinarian the highest probability of finding the causative agent.

Feces should be collected in a leak proof specimen container. Specimen cups with screw-on or snap lids are acceptable, and we prefer several grams of feces. Do not fill the container to the brim. Also, do not submit samples in OB sleeves or gloves. They are difficult to extract the specimen from and have a high chance of contamination.

Calves that start scouring less than seven days of age are tested with the scour panel C. This includes ETEC, *Salmonella*, rotavirus, coronavirus, and *Cryptosporidium*. Calves older than seven days of age should be tested with scour panel B because ETEC is no longer considered a pathogen of interest. As calves get to 21 days of age or older, we add a fecal flotation to look for *Eimeria* and *Giardia*. Remember that CT values are inversely proportional to "strength of positivity." Low CT values are strongly positive, high CT values are weak positives, up to 40 cycles. Not all diagnostic labs test up to 40 cycles, some only go to 35.

Our diagnostic protocols for *Salmonella* are farm dependent. If *Salmonella* is a known player on a farm culture may be appropriate because it is cheaper and directly allows serotyping and testing for MIC values. Not all laboratories serotype, or may only serotype to a serogroup, because serotyping can be a time consuming and difficult process. *Salmonella* culture requires enrichment for appropriate sensitivity. At WVDL, we are able to culture the enrichment for PCR and automatically do with CT below 36 for serotyping and MIC testing.

Sending samples to the WVDL is simple and cheap with our UPS shipping program. In Wisconsin, it is $7 overnight ground and for the rest of the USA we can get your samples for $10 for 2 day air and $14 for next day air. We can also send you all the sampling supplies you will need with return shipping labels to make the testing process as painless as possible. For fecal samples, we will send sample containers free of charge (just shipping).

Summary/Conclusion

Thinking about calf scours as a function of calf age will aid the veterinarian to identify and manage calf scour problems on the farm. Diagnostic options are grouped based on the prevalent pathogens as calves age. Contact your veterinary diagnostic laboratory before you sample to ensure your testing strategy is the most effective and cost-efficient.

NOTES

Dry Period Heat Stress: Effects on Dam and Daughter

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Heat stress leads to dramatic reductions in milk yield during lactation. This is due in part to the impact of heat on dry matter intake, but also cows also adjust their metabolism to increase heat loss under heat stress, which leads to further declines in the efficiency of milk production. But dry cows also experience negative impacts from heat stress, despite the immediate lack of mammary function. Indeed, when seasonal patterns of milk yield are evaluated, it becomes readily apparent that not all of the negative effects of heat stress occur during lactation. When monthly means of yield are plotted against ambient high temperatures, the lowest months for milk yield lag the annual peaks in temperature by two months, suggesting that cows experiencing heat stress in the dry period are programmed for lower yield.

We have conducted a series of studies to determine the mechanisms responsible for these effects, specifically on the mammary function, metabolism and immune function. Using a serial mammary biopsy approach, where samples were collected during the dry period and early lactation from heat stressed and cooled dry cows, a dramatic reduction in mammary epithelial cell proliferation was identified in the dry period, as well as a more rapid loss of cells early in the dry period with cooling relative to heat stress. No effect on cell loss was observed from the mid-dry period or in lactation. Those observations indicate that cows under heat stress have a delay in mammary cell turnover early in the dry period, and that reduces cell proliferation later as parturition approaches. Thus, the capacity for milk yield is reduced for the net lactation.

With regard to metabolic impacts of heat stress in the dry period, the most easily observed is the reduced dry matter intake relative to cooled dry cows. This does not, however, lead to shifts in glucoregulation as circulating glucose, insulin and non-esterified fatty acids all remain similar in heat stressed dry cows, and even challenges with insulin and glucose tolerance tests show no difference in response with heat stress in the dry period. Following parturition, cows previously heat stressed while dry have reduced NEFA mobilization and increased responses to insulin versus cows that were cooled, but these are consistent with the lesser milk yield observed in those animals relative to cooled herdmates.

Disease incidence is highest in mature cows at either end of the dry period, so any management intervention in the transition period should be evaluated for effects on immune status to avoid exacerbating immunodeficiency and potentially increasing disease. We have observed both direct and indirect effects of heat stress on immune status. Under heat stress during the dry period, proliferation of lymphocytes was reduced relative to cows exposed to cooling. In addition, antibody production in response to vaccination with an innocuous antigen was less in cows that were heat stressed versus those that were cooled, a potentially important consideration for dry period vaccination protocols. Whereas those are examples of direct impacts of heat stress, there are also postpartum effects of previous heat stress in the dry period. Neutrophil action, as assessed by the ability to engulf and kill pathogens, was improved with dry period cooling relative to heat stress, despite the fact that all cows were cooled in lactation. Thus, the effects on innate immune status are residual to the dry period treatment rather than a direct impact of heat stress.

The observations from our controlled studies are consistent with seasonal aspects of production and health; that is, cows that are dry during hot weather have increased disease, lower milk yields, and are reproductively challenged when compared to those dry in cooler months. We studied cows on a large commercial dairy in Florida, where management and nutrition were very consistent and at a high level. Compared with those that were dry in December through February in Florida, cows dry in June through August produced 1,100 pounds less milk in the next lactation, with all other factors being similar. In addition, respiratory disease, mastitis, and retained fetal membranes were all increased in cows that were dry in the hotter months. And reproductive performance was lower in cows dry in the hottest months, despite the fact that they were being bred in cooler weather. These observations suggest that under commercial conditions, the same effects we observe in our controlled studies are apparent.

In addition to the effects of heat stress on the cow in late pregnancy, the developing fetus also experiences that heat stress and we have identified a number of negative impacts on that calf early in life and as they enter the production string. Calves from heat stressed dams are born 4-6 days earlier than herdmates from cooled dams, and at a reduced bodyweight. That birthweight reduction persists through weaning and is accompanied by shorter withers height, suggesting that in utero heat stress alters metabolism to increase peripheral accumulation of fat and reduced lean mass accretion.

But early life growth challenges are not the only negative effects of in utero heat stress. Calves from heat stressed dams do not have as effective immunoglobulin transfer from colostrum, and thus are at a reduced immune status when compared to calves from cooled dams. This is not due to differences in colostrum quality, but rather is a shift in gut closure which is accelerated in heat stressed calves thereby limiting total time for immunoglobulin transfer. Because it is apparent from birth and is an effect on the calf, effective management is limited to heat stress abatement of the dam rather than any intervention after birth.

We have now gathered records from multiple studies across multiple years to examine the effect of in utero heat stress on growth, survival and productivity through the first lactation. With regard to growth, we found that bodyweight deficits persist through 1 year of age after a calf experiences heat stress in utero. Survival in the herd, especially before puberty, is also reduced in in utero heat stressed calves, likely as a result of immune depression early in life; that also means that fewer of those calves eventually enter the milking herd. And when those calves that had heat stress in utero enter the milking herd, they make 10 pounds of milk/day less than their herdmates that were born to cooled dams, despite no apparent genetic differences or management variation. We have now extended that observation to show that they never achieve parity with their cooled herdmates in the second or third lactation, and pass that reduced productive potential on to their offspring. Thus, in utero heat stress programs the developing heifer to be less productive for her life and to pass that lower performance on.

Finally, it is of interest to consider the economic implications of dry period cooling to determine the decision point for implementation. We examined this by estimating the potential duration of heat stress exposure annually in the top 23 milk production states in the United States and used that along with the cow population to estimate the potential loss on an annual basis for that state. We then ran a sensitivity analysis across a range of yield increases, milk prices and barn construction costs to determine the point where returns would exceed investment. Not surprisingly in states with hot humid environments, such as Florida and Texas, payoff occurred rapidly, but even in “cooler” locations in the Midwest and northeast, a significant case can be made for improving dry period cooling. It is important to point out that these estimates were based solely on the effects on milk yield in the next lactation and did not include any reductions in disease or on the calf developing in utero. Therefore, the estimates are quite conservative when considering all of the potential effects of dry period cooling.

In summary, dry period heat stress has dramatic negative impacts on the cow and her calf. Cows that experience heat stress in late gestation make less milk and are at greater risk of disease relative to cows that are cooled. The calves from heat stressed dams are challenged early in life and make less milk at maturity. The economic impacts of late gestation heat stress are clear and providing heat stress abatement to dry cows should be profitable in almost every situation. Further details of these effects can be found in the references below.

References available upon request.

Nutritional Regulation of Gut Function: From Colostrum to Weaning

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Take Home Messages

- The prevalence of morbidity and mortality of dairy calves has reached alarming levels and most health problems are related to gastrointestinal health.
- Feeding sufficient amounts of colostrum in the first 24 hours of life is vital for calves and feeding colostrum or transition milk in the first week of life may improve gastrointestinal health and growth performance.
- An elevated plane of milk nutrition during pre-weaning results in increased average daily gain and the potential for more milk production in the future.
- Weaning represents a massive change in the structure and microbiology of the gastrointestinal tract. As such, weaning later and step-down weaning protocols are necessary when feeding an elevated plane of milk pre-weaning.
- The post-weaning phase is often forgotten in calf research and is the next frontier of calf biological discoveries.

Abstract

Raising healthy and productive calves is crucial for the long-term success of the dairy industry. The pre-weaning and weaning periods of life are considered the most challenging times in dairy production and are associated with the highest morbidity and mortality rates among the herd. The most recent survey conducted by the USDA – between 2014 and 2015 – reported that both pre-weaning mortality and morbidity rates for calves have decreased to 5% and 33.8%, respectively, from previous USDA studies assessing calf health. Although it is reassuring to see these numbers decrease there is always room for improvement. As shown in these U.S. Department of Agriculture (USDA) surveys, the majority of calf health problems are related to digestive issues, which could be mitigated through a sound nutritional and management program. Because the newborn calf is born with a naïve immune system, colostrum is the main source of nutrients and immunity – in the form of immunoglobulins (Ig) – after birth. Recent research showcases that pasteurization of colostrum, extending colostrum feeding and introducing transition milk during the first day of life prior to transitioning to milk or milk replacer can have a positive impact on the health and gastrointestinal function of calves. During the first month of life, calves are traditionally fed a limited amount of milk or milk replacer (often ~10% of birth body weight, BW) in dairy production. This is a striking contrast to how calves would consume milk if they were allowed to stay with their dam and suckle ad libitum or had unlimited access to an automated feeder, where they could consume ~20% of birth BW in either situation. Calves raised on a "full potential" feeding program display many benefits, including greater total weight gain during the pre-weaning period, fewer signs of hunger, and increased milk production. The dairy calf undergoes intensive biological adaptations of the gastrointestinal tract during the weaning transition and these adaptations are even more abrupt when elevated levels of milk are fed. A smooth transition from liquid feed to solid feed by weaning later in life and applying a proper step-down feeding protocol is highly recommended as it allows calves to intake and digest sufficient solid feed for their growth and minimize distress at weaning. Future research investigating how pre-weaning plane of nutrition and weaning interact to affect calf health and performance is necessary to improve our future dairy herd.

First week of life

One of the most critical management factors in reducing calf morbidity and mortality is feeding a sufficient amount of high-quality colostrum shortly after birth and ensuring that the newborn calf absorbs adequate Ig (mainly IgG). Urie et al. (2018) demonstrated the positive association between serum IgG in the calf and reduced disease and death. Previous studies have shown that 10 g/L serum IgG is a reliable indication of adequate passive transfer of immunity (Gulliksen et al., 2008; Godden et al., 2009) and in order to achieve that calves must be fed a high-quality colostrum quickly after birth, before "gut closure" occurs. The idea of "gut closure" was defined by Lecce and Morgan (1962) as "the cessation of absorption of macromolecules from gut to blood in neonates," which occurs in calves around 24 hours after birth Stott et al. (1979). In 2007, the USDA National Animal Health Monitoring Systems reported that 19.2% of US dairy calves did not receive adequate IgG in colostrum due to their serum IgG being ≤ 10 g/L (USDA NAHMS, 2007). The quality of colostrum is typically expressed in terms of IgG content; first-milking colostrum is generally considered of high quality when it contains at least 50 g/L of IgG with a low level of bacterial contaminants (<100,000 CFU/ml and <10,000 CFU/ml coliform count) and is entirely free of infectious agents, such as Mycoplasma species and Salmonella species. Some of the initial recommendations state that the newborn calf should receive a minimum mass of 100 g of IgG in the first 2 hours of life (Quigley et al., 2001), however many industry representatives are currently recommending increasing that amount by over 50% (>150 g of

IgG in the first 2 hours of life). Also, on the calf side, Urie et al. (2018) determined that serum IgG concentration has a dose-dependent effect on morbidity and mortality in calves, which means increasing serum IgG concentrations above 10 g/L may enhance calf health and survival as well.

Colostrum management does not stop at Ig; Other nutritive and immune components, as well as contamination, also need to be considered. Colostrum (and transition milk) contains several types of Ig, growth factors, hormones, cytokines, enzymes, polyamines and nucleotides, antimicrobial components, and white blood cells that all contribute to the calf's ability to fight infection (Hammon and Blum, 2002; Langel et al., 2015) and promote the growth`and development of the newborn calf. Certain bioactive compounds, such as insulin-like growth factor 1 (IGF-1), can stimulate intestinal epithelial cell proliferation (Baumrucker et al., 1994), while others, such as lactoferrin, lysozyme and lactoperoxidase, may help to maintain a healthy gastrointestinal tract (Pakkanen and Aalto, 1997). The utility of colostrum as a substrate for microbial species has recently been demonstrated by Fischer et al. (2018a,b), albeit for differing reasons. Fischer et al. (2018a) showed that delaying colostrum feeding to 12 hours after birth, compared to 0 or 6 hours, led to decreased populations of *Bifidobacterium* spp. and *Lactobacillus* spp. in the colon of 51-hour-old calves. Fischer et al. (2018b) took a different approach and showed heat-treating colostrum increased *Bifidobacterium* populations due to increased colostral oligosaccharides being released from the heat treatment. Also, it is well known that bacteria in colostrum may interfere with passive absorption of colostral Ig into the circulation of newborn calves (Johnson, et al., 2007), which necessitates the reduction of pathogen and bacterial colonization in the neonate via pasteurization. Malmuthuge et al. (2015) also concluded that feeding heat-treated colostrum soon after birth can increase the colonization of healthy bacteria (*Bifidobacterium*) and decrease the colonization of *Escherichia coli* (*E. coli*) in the ileum of calves during the first 12 hours of life.

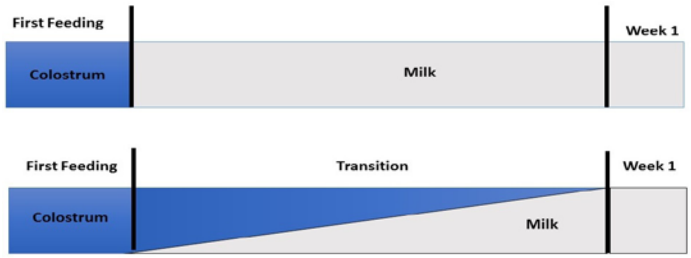

Figure 1. Conventional and transition colostrum and transition milk feeding programs.

In addition to feeding colostrum during the first day of life, there is evidence that feeding transition milk to calves after the first day of life has health benefits (Conneely et al., 2014). Colostral IgG availability and absorption are the main focus of research involving calves during this first week, but it is worth considering the possible added benefits of transition milk after the first meal or day of life (Vasseur et al., 2010). Transition milk is most commonly characterized as the milk after the first milking, during the first days of lactation (Figure 1). The nutrient composition between true colostrum, transition milk, and whole milk are very different from the standpoint of nutritional and bioactive compounds (Blum and Hammon, 2000), which leaves an interesting and potentially useful gap in our knowledge – a gap that is undoubtedly worth investigating.

First months of life

After colostrum and transition milk are fed to calves they are transitioned to feeding programs utilizing milk or milk replacer. These programs aim to encourage starter intake (conventional) or to allow calves to consume milk they would typically get from the dam (elevated). Conventional feeding programs usually limit milk consumption to around 10% of birth body weight (BW), which is roughly 4-5 L/day at a typical solids concentration of 12-13% (Khan et al., 2007 a,b; Silper et al., 2014). It is thought that by decreasing milk intake, starter intake will increase, leading to enhanced rumen development (Tamate et al., 1962), along with reduced feeding costs. However, lower rates of BW gain (0.3 to 0.5 kg/day) are often observed (Jasper and Weary, 2002) compared to elevated feeding programs (approx. 0.75 kg/day averaged over several trials; Soberon and Van Amburgh, 2013). In elevated milk feeding programs, dairy calves can be fed *ad libitum* or often 20% of their birth BW, which is roughly 8 L/day at a typical solids concentration of 12-13% (MacPherson et al., 2016).

Whether on a conventional or elevated plane of nutrition, calves are typically provided with milk twice daily on commercial dairy operations, which is a drastic contrast to how calves feed *ad libitum* or naturally feed with their dam (Egli and Blum, 1998). There is concern that feeding more milk, especially when calves are only fed twice a day, may lead to abomasal ulcers and a decrease in insulin sensitivity in milk-fed calves (Berends, 2015); however, it should be noted insulin sensitivity was not altered in calves fed elevated planes of milk at different meal sizes and frequencies (2x 4 L/meal or 4x 2 L/meal; MacPherson et al., 2018). Previous studies have shown that veal calves fed large amounts of milk replacer develop reduced insulin sensitivity (Hugi et al., 1998; Blum and Hammon, 1999), but it should be noted that this decrease appears to be a natural progression as calves age (Gerrits, 2019). A study by Bach et al. (2013) also investigated the effect of plane of nutrition (high vs. low) on insulin responses to high plasma glucose in dairy calves and found that all calves were able to control glycemia. However, results from Bach et al. (2013) also showed that calves fed a high plane of nutrition (8 L/day) needed significantly higher insulin to control their suddenly high plasma glucose levels compared to calves fed a lower plane of nutrition. In contrast, recent studies by MacPherson et al. (2016, 2018) demonstrated that feeding an elevated plane of nutrition in two or four meals per day had minimal impact on glucose metabolism and insulin sensitivity, which may be associated with the calf's ability to slow down the delivery of large meals from the abomasum to the intestine. The major difference between the studies by Bach and colleagues and MacPherson and colleagues was that the calves in the studies by MacPherson et al. (2016, 2018) were fed elevated planes of nutrition from the first week of life, which may be a critical developmental window for the calf to adapt to the higher level of milk.

Another area of milk/milk replacer feeding that is gathering attention is altering macronutrient composition to assess growth, nutrient digestibility, and gut health/function. Previous studies have adjusted energy sources (fat or lactose) in milk replacer – with the main takeaway being an increase in fat deposition – and observed the connection between metabolizable energy and protein intake (Tikofsky et al., 2001; Hill et al., 2008). There may be more to the story when it comes to fat inclusion, though, considering the bioactive nature of lipid molecules found in whole milk (e.g. sphingomyelin and phytanic acid; Keenan and Huang, 1972; Chalfant et al., 2004; Zandbergen and Plutzky, 2007), as well as the increased fat intake from the liquid diet resulting in decreased mortality in pre-weaned calves (Urie et al., 2018). This is an area of debate that is difficult to investigate considering overlapping roles of metabolites in the body. Nonetheless, it offers an interesting area to focus on next.

Weaning

Under natural conditions, the gradual weaning process occurs over several`weeks, when milk supply from the dam declines and solid feed intake increases – a process which occurs at approximately 10 months of age (Reinhardt and Reinhardt, 1981). In the past decade, researchers have focused on alternative milk feeding procedures in an attempt to improve calf performance. Commercial dairy production systems usually implement an early and abrupt weaning procedure compared to the natural weaning process. In early weaning programs (4-6 weeks of life), calves have limited access to milk or milk replacer (10% of birth BW) in order to limit feed costs, encourage early intake of starter feed, and facilitate rumen development (Kertz and Loften, 2013).

Calves consuming high quantities of milk experience a challenge at weaning because of low solid feed intakes prior to weaning (Jasper and Weary, 2002), leading to concerns that the calf's digestive tract is not accustomed to the digestion of solid feed following weaning (Terré et al., 2007). A previous study has shown that delaying age of weaning increased total weight gain in calves fed an elevated plane of nutrition before weaning yet decreased the transient reduction of weight gain at weaning (Meale et al., 2015). Recently, Eckert et al. (2015) reported that calves fed milk replacer on an elevated plane of nutrition during the pre-weaning stage had greater starter feed intake and weight gain during the weaning period when weaning was extended from 6 to 8 weeks of age. Furthermore, later-weaned calves were better able to cope with weaning compared to early-weaned calves, as they had higher solid feed intake during weaning transition.

In addition to weaning later in life, a weaning protocol termed the "step-down" was developed to minimize the challenges of weaning from high amounts`of`milk or milk replacer. In the first paper reporting the step-down protocol (Khan et al., 2007a,b), calves received higher amounts of milk during the early weeks of the feeding period compared to the conventional method, followed by lower amounts of milk until weaning. Khan et al. (2007a,b) reported that intake of solid feed and weight gain increased during weaning in calves fed higher planes of milk through the step-down method compared to those fed milk conventionally. When feeding with automation, the step-down protocols can be less abrupt, as milk can be gradually declined on a daily basis. Sweeney et al. (2010) showed that the ideal step-down period for calves fed an elevated plane of nutrition was 10 days as it encouraged dry feed intake and maintained growth during the weaning period. More research is required to determine the interaction between age of weaning and step-down protocols – especially around the post-weaning and post-transition nutrition programs – in order to develop more sound protocols that avoid declines in growth during weaning.
During the weaning process, the gastrointestinal tract undergoes significant changes, with the total volume of the`rumen increasing from 30 to 70% of the entire forestomach (Warner et al., 1956), enhanced expression of metabolic genes (Connor et al., 2013), and altered microbial populations (Meale et al., 2017). The physical growth in rumen tissue accommodates absorption of the end products of ruminal fermentation to meet the demands for growth (Figure 2; Baldwin et al., 2004). And the maturation of both the rumen tissue transcriptome and microbiome are the result of exposure to substrates in the form of starter. Interestingly, changes in the expression of genes regulating growth during rumen development appear to be correlated with changes`in the rumen microbial population. A recent study revealed that the expression of genes belonging to the first line defense mechanisms, gut barrier functions (i.e., toll-like receptor, β-defensin, peptidoglycan recognition protein 1, claudin 4, and occludin), and bacterial diversity, changed response to the introduction of solid feed during the weaning process (Malmuthuge et al., 2013). Also, current findings from next generation DNA sequencing techniques show that the rumen microbiota of pre-ruminant calves have a similar functional capacity to a mature ruminant (Jami et al., 2013). Li et al., (2012) showed that species of the`genus *Bacteroidetes* phylum decreased, while bacteria belonging to the *Firmicutes* and *Proteobacteria* phyla increased in response to the weaning process. Interestingly, lower gut microbiota also undergoes transformations during weaning, with the microbial diversity increasing in the fecal microbiota (Li et al., 2012), which may be due to functional changes, such as increased permeability (Wood et al., 2015), in the gastrointestinal tract. However, limited literature is available regarding the influences of pre-weaning feeding regimens and weaning on the lower gut of dairy calves. This paucity of information ultimately underlines`the amount of future research still needed to fill the gap in our understanding.

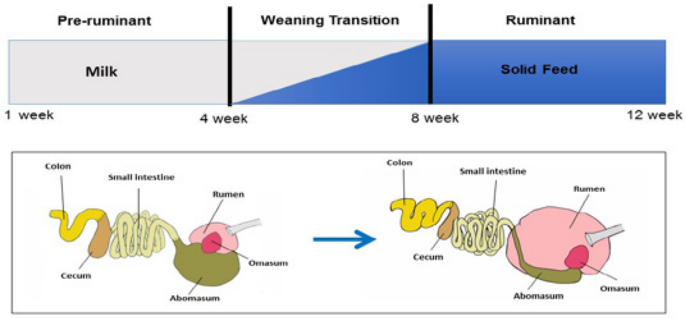

Figure 2. Gastrointestinal development of calves during transition from liquid to solid feed in commercial production systems.

Conclusion

Nutritional management of dairy calves, in particular colostrum feeding, plane of nutrition, and weaning strategy, results in great differences in growth performance, health and gastrointestinal development. Strategies to optimize gastrointestinal health and development of calves are encouraged due to the high prevalence of mortality and morbidity related to abnormal gastrointestinal function. Moreover, feeding an elevated plane of nutrition pre-weaning has the potential to impact long-term cow health and future milk production. The long-term impacts of particular feeding regimens during the first week, first months and weaning period are currently unknown. As such, they represent a significant knowledge gap in calf nutrition. More research examining the impact of nutrition schemes from the first hours, weeks and months of life is required to properly understand the influence that gastrointestinal function has on the health and performance of future calves.

References available upon request.

Welfare of Dairy Calves and Heifers: Relevance to the Animal, the Producer and the Consumer

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Defining animal welfare and its scientific study

Welfare (also referred to as well-being or quality of life) describes the state of an individual animal: is it faring well, poorly, or somewhere in between? The public has increasing interest in the welfare of animals managed under human care. Decisions about how farm animals are raised involve ethical judgments, which can be informed by scientific evidence. Scientific research in animal welfare includes both social- and biological-science approaches to understand stakeholders' perspectives and animals' needs, respectively.

A common framework for thinking about animal welfare includes 3 overlapping types of ethical concerns various stakeholders hold regarding the animal's: 1) biological functioning, 2) internal emotional (affective) states, and 3) ability to express their "nature." Decades of research have provided substantial knowledge about the biological functioning aspects of dairy cattle welfare, including measures of health, growth, production, and reproduction. There has also been growing interest in studying the subjective internal experiences of animals to understand how to minimize negative affective states and provide opportunities for positive ones. For domestic animals, questions about naturalness relate to understanding the evolutionary history of the species and how to provide appropriate opportunities to express important behaviors.

Social science research has found that different groups of stakeholders such as producers and non-farming consumers vary in how they prioritize these 3 areas of animal welfare. Producers, veterinarians, and others directly involved in the dairy industry tend to place the highest value on biological functioning. Non-farming citizens also consider it important for animals to be healthy and thriving, but they also place emphasis on other aspects of welfare. For example, questions sometimes arise about pain management for routine procedures such as dehorning, whether animals have social companionship, or the extent to which they have freedom of movement and opportunities to perform a wide range of species-relevant behaviors.

We will discuss 3 examples of how these types of concerns pertain to dairy calves and heifers, and how scientific research has shown us potential solutions for the benefit of the animal, the producer, and for improving public acceptance.

Managing pain is important when dehorning calves

The routine practice of dehorning induces pain, which is a key concern for stakeholders. The majority of Holstein calves would normally develop horns. For the safety of other cattle and their human handlers, the horn buds are typically destroyed before they become attached to the skull, in a procedure known as disbudding. Technically, dehorning refers to the less-common practice of amputating developed horns on older cattle, but this term is also used interchangeably in the industry to describe disbudding.

In the U.S. and Canada, disbudding is most commonly performed by hot-iron cautery, although the use of caustic paste has been growing in popularity. Producers using caustic paste tend to disbud calves at a younger age and are less likely to administer pain relief. In parts of Europe, paste dehorning is prohibited by law. A considerable body of research has established that disbudding causes pain and stress, regardless of the method used. The conventional wisdom is that calves should be disbudded as young as possible, and indeed, horn buds should be destroyed before they adhere to the skull around 8 weeks. However, according to some studies on other species such as sheep, experiencing a painful procedure soon after birth can increase long-term pain sensitivity, suggesting caution should be used in disbudding day-old calves.

Regardless of the disbudding method, the best practice recommended by veterinary organizations (AVMA, AABP) to manage pain is to combine a local anesthetic (e.g., lidocaine) with a non-steroidal anti-inflammatory drug (e.g., meloxicam). In Canada and parts of Europe, pain control is now mandatory. In the U.S., the number of producers regularly using pain relief has increased in the last decade, but still represent less than half of farms, in part because here the medications require a prescription. It is important for U.S. producers work with their veterinarians to provide pain relief during dehorning to both improve the animal's experience and meet consumers' expectations.

Social companionship for improved welfare and performance of pre-weaned calves

In the U.S. and Canada, most pre-weaned dairy calves are housed singly. Individual rearing became standard practice in part based on concerns about calf morbidity and mortality, with social isolation seen as reducing the risk of direct calf-to-calf disease transmission and allowing for ease of individual monitoring before the advent of modern automated technologies. However, the poor health and performance sometimes observed in large groups of calves was often confounded by low milk allowance (resulting in insufficient nutrient intake and reduced immune function) and poor ventilation in older facilities, along with other management risk factors such as poor sanitation, bedding, and dynamic (as opposed to all-in/all-out) grouping practices.

In the last decade, numerous studies have shown that, when managed well, rearing pre-weaned calves in pairs or small groups has many benefits for both animal welfare and performance. Social housing improves social and cognitive development, with calves showing better behavioral flexibility and adaptability to change, including a greater willingness to try new feeds, compared with those reared individually. This translates into better resilience to weaning stress. Across studies (particularly when fed higher milk allowances), socially housed calves perform at least as well as individually housed calves in terms of solid feed intake, bodyweight at weaning, and average daily gain. Solid feed intake before weaning is important for stimulating rumen function, and early-life growth translates to earlier onset of puberty and higher milk production at maturity. Additionally, housing calves in groups requires an increase in total space, which allows for the expression of a wider range of natural behaviors including play. In parts of Europe, social housing for pre-weaned calves older than 2 weeks is mandatory.

One concern some producers have with social housing is the potential for calves to engage in undesirable cross sucking. Calves are highly motivated to express natural suckling behavior, including on each other or objects in their environments. Providing appropriate outlets for suckling can reduce the incidence of cross sucking, such as by feeding milk through a teat instead of an open bucket or providing “dummy” or “dry” teats that remain accessible to the calf for at least 20 min after milk ingestion. Cross sucking has been observed to increase directly after weaning, presumably in response to a drop in energy intake. Calves who are better established on solid feed are less likely to cross suck, so step-down weaning based on starter intake (rather than calf age) can help reduce cross sucking.

Brushes provide appropriate behavioral outlets for calves and heifers

Although cross sucking is an undesirable oral behavior, cattle also engage in normal oral manipulation of objects in their environment (related to their mouth movements when grazing). If appropriate objects are provided, cattle will make use of them to express these behaviors. For example, when hemp ropes are mounted in the pen, both 2-week-old dairy calves and older feedlot cattle will regularly chew on them. Another normal oral behavior is when cattle lick and groom their social companions or themselves. Self-grooming can also be expressed as rubbing or scratching against objects in the environment. It has become increasingly common for dairy producers to provide brushes for adult cows to use for grooming. A recent study found that lactating cows will put forth great effort to gain access to a rotating mechanical brush. This gained popular media attention, which highlights an opportunity for producers to showcase to the public how they provide their cattle with outlets for important behaviors.

Some rotating mechanical brushes are marketed specifically for youngstock, and a study on 2-week-old calves found they used these brushes daily. In a recent study we conducted in Canada, we provided 20-week-old dairy heifers with simple, 10” deck scrub brushes. When the heifers were first introduced to the pen with brushes, they began using them within less than 4 minutes on average, and some heifers approached the brushes after only 8 seconds. The heifers used the brushes primarily for grooming their heads, but also chewed on the bristles. Heifers used the brushes equally whether they had stiff vs. extra-stiff bristles, although the latter became flattened less quickly and thus may be more durable. To date, no direct comparison has been made between mechanical rotating brushes and simple brushes. Since heifers willingly use simple brushes daily, these may be a low-cost option for providing opportunities for both grooming and oral behaviors.

Weaned dairy heifers at the University of Wisconsin heifer-rearing facility in Marshfield, WI are housed in pens of 8 with wall-mounted scrub brushes. Photos by Nancy Esser, superintendent, Marshfield Agricultural Research Station.

Take-home points

- Animal welfare encompasses not only health and performance, but also the animals' internal feelings (e.g., pain) and appropriate opportunities to perform behaviors important to their species.
- Disbudding (dehorning) causes pain regardless of the method, and pain-relief medications are recommended. Minimizing pain is important for both the animal's internal experience and meeting consumer expectations.
- Raising pre-weaned calves in pairs or small groups improves both animal welfare and performance – a win-win for calves, producers, and consumers who expect animals to have social companionship.
- Brushes provide an appropriate outlet for natural behaviors. Young heifers willingly use both mechanical rotating brushes and simple brushes (e.g., deck scrubs or broom heads).

References available upon request.

NOTES

Use of Deep Nasopharyngeal Swabs for Bovine Respiratory Disease Testing

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Introduction

Deep nasopharyngeal swabs have been validated as a viable alternative to trans-tracheal wash or bronchial-alveolar lavage in cases of bovine respiratory disease and are superior to nasal swabs especially for Mycoplasma bovis. The technique is simple and safe to perform and is very reliable.

Materials required for sample collection and submission:

1. **Double Guarded Culture Swab (33-inch length):** For bacteriological culture or viral and bacterial real time PCR, one swab is required for each animal sampled. If the submitting veterinarian wants bacteriology and virology real time PCR and bacterial culture done then two swabs are needed for each animal sampled.
2. **Bacterial Transport Media:**
3. **M6® Liquid Real Time PCR Transport Media**
4. **WVDL General Submission Form:** An electronic copy is available at www.wvdl.wisc.edu. Click on the submission guidelines link and select the forms option to download the WVDL General Submission Form. The forms can be filled out either manually or electronically.
5. The double guarded culture swabs, real time PCR transport media (M6®) and the bacteriological culture media (Amies with charcoal) can be purchased from the Wisconsin Veterinary Diagnostic Laboratory Madison (WVDL), WI. An electronic copy is available at www.wvdl.wisc.edu. Click on the submission guidelines link and select the forms option to download the pharyngeal swab order form. The pharyngeal swab order form can be found in the supplies order section of the document. The pharyngeal swab order form can be filled out either manually or electronically.

Allow sufficient time (3-5 working days) for delivery of the kit. The cost of the bacterial culture kit which includes six double guarded culture swabs and bacterial transport media (Amies with charcoal) is $40.00. The cost of the viral and bacterial real time sampling kit which includes six double guarded culture swabs and M6® transport media is $55.00. The cost of the bacteriology/virology real time PCR and bacteriological culture sampling kit which includes 12 double guarded culture swabs, six bacterial transport media and six M6® transport media and a next-day air return shipping label is $75.00. In addition to the cost of the kit, the WDVL will also charge for the shipping costs to the clients as well.

Livestock producers can purchase a kit with a valid credit card. The cost of the kit does not include the testing costs. Pharyngeal swab samples must be submitted to the laboratory by a licensed veterinarian. Testing will not be done unless the WVDL receives a completed General Submission Form that is signed by a veterinarian. Livestock producers should coordinate the collection of samples with their herd veterinarian.

Collection procedure: Real Time PCR for bacteria and viruses

Veterinarians should plan on sampling 4-6 animals during an acute outbreak of respiratory disease. If at all possible, samples should be collected **before** the onset of antimicrobial treatment. Samples **must be chilled within 1-2 hours of collection**.

1. Restrain the animal's head. The animals head **cannot** move. Movement of the head can cause the swab to **break off** in the pharynx.
2. Clean the nostrils with a clean, disposable cloth.
3. Measure the distance from the nostril to the medial canthus of the eye.
4. Remove the twist tie from the culture swab.
5. Insert the 33-inch, double-guarded culture swab into the **ventral** meatus of the nose and advance it the pre-measured distance from the nostril to the medial canthus of the eye. Swabs placed in the dorsal meatus of the nose cannot advance far enough to obtain a deep pharyngeal sample.
6. Retract the culture swab approximately 1-2 inches.
7. Push the inner blue PVC swab sheath through the end of the outer clear PVC tube.
8. Push the polyester-tipped polystyrene swab through the blue PVC swab sheath for a distance of roughly 1-2 inches. Vigorously rotate the swab against the pharyngeal mucosa for **30-45 seconds.**
9. Retract the polyester tipped swab into the blue PVC swab sheath.
10. Remove the entire double guarded swab from the animal's nose.

11. Using a clean pair of scissors cut the polyester tipped swab roughly **5-6** inches from the tip. **Do not cut the swab too short;** short swabs are difficult to remove from the transport media. Place the swab in the liquid transport media (M6®).

12. Label the liquid transport media legibly with the animal's identification number or name. Please make sure the animal's I.D. matches exactly the I.D. on the WVDL General Submission Form.

If the samples cannot be shipped immediately, they should be temporarily stored at 4 °C.

Collection procedure: Real Time PCR for bacteria and viruses plus conventional bacteriological culture

1. Restrain the animal's head. The animals head **cannot** move. Movement of the head can cause the swab to **break off** in the pharynx.
2. Clean the nostrils with a clean, disposable cloth.
3. Measure the distance from the nostril to the medial canthus of the eye.
4. Remove the twist tie from the culture swab.
5. Insert the 33-inch, double-guarded culture swab into the **ventral** meatus of the nose and advance it the pre-measured distance from the nostril to the medial canthus of the eye. Swabs placed in the dorsal meatus of the nose cannot advance far enough to obtain a deep pharyngeal sample.
6. Retract the culture swab approximately 1-2 inches.
7. Push the inner blue PVC swab sheath through the end of the outer clear PVC tube.
8. Push the polyester-tipped polystyrene swab through the blue PVC swab sheath for a distance of roughly 1-2 inches. Vigorously rotate the swab against the pharyngeal mucosa for **30-45 seconds.**
9. Retract the polyester tipped swab into the blue PVC swab sheath.
10. Remove the entire double guarded swab from the animal's nose.
11. Using a clean pair of scissors cut the polyester tipped swab roughly **5-6** inches from the tip. **Do not cut the swab too short;** short swabs are difficult to remove from the transport media. Place the swab in the bacterial transport media. **Make sure the polyester-tipped swab is fully immersed in the transport media**.

12. Repeat the procedure in the other nostril. Place the polyester tipped swab in the liquid (M6®) transport media.

13. Label all the transport media legibly with the animal's identification number or name. Please make sure the animal's I.D. matches exactly the I.D. on the WVDL General Submission Form.

If the samples cannot be shipped immediately, they should be temporarily stored at 4 °C. Maintaining swabs at 4 °C instead of at room temperature increases the recovery rate of bacterial pathogens from diagnostic samples.

Shipping requirements

- **Completely fill out** the WVDL General Submission Form. The form can be filled out either manually or electronically. Request the WVDL complete respiratory panel which includes real time PCR for viruses and bacteria plus bacteriological culture for important respiratory pathogens.
- Send the samples **overnight** with a sufficient number of ice packs to ensure they remain cold during shipment to the laboratory. The laboratory should receive the samples no later than 24-36 hours after collection.
- If possible, clients should schedule shipments to avoid weekend and holiday delivery of samples to the laboratory.

References available upon request.