Guidelines for Successful Dairy Heifer Development

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Success for a dairy heifer development program means that the growing phases of a heifer's life were managed to achieve high milk production early in first lactation with minimal variation or negative health events. It means managers managed the immune system to maximize immune-competence, controlled body condition scores and weights, and monitored desired hip height, feed efficiency and average daily gains at key target points based on mature cow height and weight.

However, heifer development programs have not traditionally been a major focus for dairy producers. As long as the cost per day for growth seemed reasonable and death rates remained below 5%, producers were satisfied. Dairy producers commonly state that more intense management systems for heifers require too much effort and are not cost effective.

Intensive management systems are not for all dairy operations; however, changes in the dairy industry over the past three to four years are driving change. Furthermore, operations that have intensified their management over time are experiencing reduced disease incidence and mortality losses, reduced treatment and labor costs and improved average daily gains through the first 70 days of age and beyond.

The industry is currently in a situation where there are higher feed costs, yardage costs, land values, cull cow values, sexed semen technology, dairy heifer inventory and beef prices. Currently, there is also a shortage of feeder replacements and the realization that currently you can purchase a springing heifer for $200 – $400 less than actual rearing costs. Therefore, one must focus more on the heifer business enterprise. Today's economy does not automatically give every heifer a lactation career opportunity. The earlier culling decisions can be made, the more profitable the heifer rearing program.

As an industry, managers monitor important performance indicators, but generally track those with far too much lag-time to be immediately useful. First lactation milk production, age at first calving and age at first breeding are just a few of these interesting, but lagging, measures. The industry has been reluctant to record and monitor early life indicators like birth weights, passive transfer, average daily gains to 70 and 150 days of age, and disease events such that culling decisions can be made prior to investing in completely rearing an animal.

This reluctance carries significant performance and economic costs. For example, research from Cornell and other institutions shows that passive transfer has life-long effects on average daily gain and feed efficiency (Faber et al., 2005).

Growth rates within individual herds exhibit a remarkable amount of variation. For instance, track the days of age that Holstein heifers in a well-managed operation take to reach a hip height of 51 inches. On farms where weight and hip height are actually measured, variations of plus or minus 60 days from the average have been observed. This variation results from factors like passive transfer, genetics, disease incidence and environmental conditions. This variation demonstrates that dairy producers can no longer set a target age for first breeding without minimally monitoring hip height.

Heifer management without recording and monitoring the most relevant key performance indicators would be like managing your lactating herd without milk weights or bulk tank records.

The purpose of this paper is to focus on key areas of nutritional management, especially the first 100 days of age, and to suggest new key performance indicators that most heifer management programs either do not record or use to their full potential. From field experience, the following eight bottlenecks or phases of heifer development are areas where heifer development programs are often inadequate.

Phase 1—Colostrum Harvest and Delivery – Day 1

Harvesting and delivering an adequate volume of clean, high-quality colostrum in a timely manner must be the foundation of all successful dairy heifer development programs. Nutrients in colostrum, especially energy, are critical for generating body heat, maintenance and growth. There are also hormones and growth factors related to expression of genes involved in weight gain, reproduction and mammary development.

In addition, colostrum also contains components that transfer immune function to the calf. These components are immunoglobulins (IgG, IgA and IgM), white blood cells (macrophages, neutrophils, T and B lymphocytes) and other factors like cytokines, growth factors, vitamins, minerals and tripsin inhibitors plus nonspecific antimicrobial agents like lactoferrin and lysozyme (Godden, 2012).

Success or failure of passive transfer is dependent upon the dam's plane of nutrition and previous exposure to vaccines and environmental pathogens during gestation. The timeliness, cleanliness, amount and quality of colostrum harvested and delivered are the most important factors.

Colostrum quality is highly variable, especially from first-lactation heifers. Currently, producers must rely on a colostrometer or Brix refractometer to monitor quality. Large dairy operations with protocols in place for administering colostrum have found that it is easier to manage by feeding larger volumes sooner in a hygienic manner. The current recommendation is to feed 10% of the calf's body weight within 30 minutes of birth followed by 5% of body weight in 8 – 12 hours. For a 90-pound Holstein calf that is 9 pounds of colostrum at birth (4 quarts) and 4.5 pounds (2 quarts) 8 – 12 hours later. If esophageal feeders are used properly, passive transfer can be accomplished quicker and with less labor than bottle feeding of colostrum.

Cleanliness affects absorption of IgG. Colostrum is easily contaminated by preexisting intramammary infections or via fecal material during harvest. Common pathogens often found in colostrum are *E. coli*, *Salmonella spp*., *Mycoplasma spp*., Bovine Leukosis Virus, *Listeria monocytogenes*, *Campylobacter jejuni*, *Staphylococcus aureus*, *Mycobacterium bovis*, *Brucella abortus* and *M. avium susp. paratuberculosis* (MAP). Microbes may block passive transfer of IgG and these microbes can proliferate during storage and in feeding equipment.

The pathogen exposure for newborn calves can be minimized by following these recommendations:

- Do not let calves suckle their dam
- Clean and disinfect the udder before milking
- Sanitize milking, storage and feeding equipment
- Feed colostrum within 1 – 2 hours of birth
- Do not store colostrum in refrigerator more than 48 hours. Freeze it as soon as possible if you are not going to use it immediately.

Vaccination programs administering antigens for *E. coli*, Roto and Corona viruses in late gestation and again more than five weeks prior to freshening stimulate colostrial antibodies for these specific diseases. Well-balanced diets 30 days prior to freshening that meet the dam's metabolizable protein and energy needs, as well as preventing hypocalcemia, have been shown to reduce the incidence of fresh cow disease and to enhance the fetus' immune system as well as that of the dam.

The benefits of achieving successful passive transfer of IgGs are reduced treatment and mortaility rates (NAHMS, Wells, 1996), improved growth rates and feed efficiency (Fowler, 1999; Gaber et al., 2005; Nocek et al., 1984; Faber, 2005), decreased age at first calving (Faber et al, 2005), and increased first and second lactation milk production (DeNise, 1989; Faber, 2005).

Critical data to record for later determination of individual and pen level outcomes include:

- I.D. number
- Birth date
- Birth weight
- Twin+/-

- Breed
- Sex
- Calving ease
- Dam Identification

Additional information about the dam includes days carried calf, days in close-up pen, lactation number, previous lactation mature equivalent milk production and mature body weight. If available, dam mature body weights can be used to set target weights for breeding and first calving for offspring. It is also recommended to record total serum protein at 48 hours and results of the BVD ear notch test.

Phase 2—Ramping Up Milk Intake – Metabolizable Energy & Protein – Week 1

The first decision management must make is what to feed and how much. The composition of whole milk on a dry matter basis for both Jerseys and Holsteins is shown in Table 1.

Table 1. Milk Composition: Average Milk Components from 2010 CDFA Herd Survey n=14/112

As Fed	**Jersey Milk**	**Holstein Milk**
Butterfat %	4.74%	3.57%
True Protein %	3.65%	3.10%
Total Solids Non-fat %	9.36%	8.81%
Total Solids %	14.10%	12.38%
Water %	85.90%	87.62%
Dry Matter Basis	**Jersey Milk**	**Holstein Milk**
Butterfat %	33.62%	28.84%
True Protein %	25.89%	25.04%
Total Solids Non-fat %	66.38%	71.16%
Total Solids %	100.00%	100.00%
Water %	0.00%	0.00%

What to feed?

If a calf is left on its mother, it will nurse between six and 10 times per day and consume somewhere between 16 and 24% of its body weight per day as milk (Corbett, 2012). A 100-pound calf would then consume 16 – 24 pounds of whole milk per day (1.9 to 2.8 gallons). If whole Holstein milk is 12.5% total solids, 16 – 24 pounds of whole milk equates to 2 – 3 pounds of total milk solids per day. Two to 3 pounds total milk solids can result in daily gains of 2 – 3 pounds, depending upon environment conditions, calf size and daily gain.

Most milk replacer companies recommend that 1 pound of dry powder be added to 1 gallon of water and that 1 gallon of mixed product be fed to each calf per day (1/9 = 11.1% solids). This amount is only one-third to one-half the amount that a calf would normally consume if left on its mother.

Table 1 shows that whole milk is 25 – 26% true protein. Most milk replacers are 20 – 22% protein. A traditional milk replacer program compared to a calf left on its mother is providing the calf with one-third to one-half the volume and one-third the protein. It is clearly evident if you are going to feed milk replacer, one must formulate for at least 12.5% solids and 25 – 26% protein and feed a minimum of 6 quarts volume. The higher protein milk replacers promote more lean tissue gain as well as improve efficiency of gain.

Table 2 summarizes the current information about the requirements for growth of the calf based on the body composition data derived since the 2001 NRC was published (Drackley, 2005). This table shows the updated nutrient requirements of a 100 lb calf under thermo neutral conditions.

Table 2. The energy and crude protein requirements of calves from birth to weaning (Van Amburgh and Drackley, 2005)

Rate of Gain lb/d	ME[a] mcal/d	DMI lb/d	ADP g/d	CP g/d	CP %DM
0.45	2.4	1.2	87	94	18.0
0.90	2.9	1.4	140	150	23.4
1.32	3.5	1.7	193	207	26.6
1.76	4.1	2.0	235	253	27.5
2.20	4.8	2.4	286	307	28.7

Normal fat content of milk replacers is 15 – 22%. Whole milk from Table 1 shows Holstein milk at 29% fat (DMB) and Jersey milk at 33% fat (DMB). Individual producers have reported feeding fat at up to 25% levels during cold winter months.

Some producers report success by increasing solids up to 18%. My experience has been that exceptional management must be in place to eliminate variation from batch to batch and the added solids must mirror the osmolality of whole milk at 271 mOsmol/kg. It is mandatory that calves have access to fresh water at all times if the strategy is to increase solids. Stools will be softer even with proper osmolality.

How much to feed?

Traditionally, the industry feeds 2 quarts twice a day. Even when whole milk is fed at 2 quarts twice a day, calves receive less than one-half of what a calf nursing its dam would consume. Managers on several calf ranches have switched to 3-quart bottles and some have switched to three-times-per-day feeding. From a practical standpoint, it's recommended to feed 3 quarts twice a day at a minimum and 3 quarts three times a day at the maximum if you are using 3-quart bottles. It is also recommended that solids be at 12.5% to 14% for most operations because of concerns about batch-to-batch variation. Very good management can go up to 18% solids.

Pasteurized hospital milk is another other source of milk commonly used. It is recommended that you check each batch for solids as variation from 8% to 14% solids have been observed—depending on source and type of animals in the hospital pens. Larger operations have also had success identifying high somatic cell count cows, placing them in a separate pen, and sending this milk to the calf ranch where it is pasteurized.

These decisions increase the daily inputs for feed and labor, but have resulted in improved heifer average daily gains and significant decreases in scours and pneumonia. Reduced morbidity and mortality also result in lower pharmaceutical and labor costs.

Bucket feeding is another option that some calf ranches use. It is easier to feed larger volumes of milk, but more of a challenge from a sanitation standpoint.

Keep in mind that one program does not fit all operations. Different programs require different input costs for feed, labor, and yardage. Most calf ranches are paid on a cost per head per day basis which is not as conducive to good performance as if one is paid on a cost per pound of gain basis.

The industry should consider analyzing wet calf performance using the partial budget below.

In this example, calves are feed 2 quarts of a 26% CP and 20% fat milk replacer mixed at 12.5% total solids either two or three times a day. The milk replacer costs $2,600 per ton. Daily feed cost increases from $1.38 to $2.07. The example increased the yardage/labor cost $0.15 per head per day for the extra labor for the extra feeding. In order to breakeven in this scenario, producers would need an extra 0.6 pounds of average daily gain. No value has been placed on the reduction in disease incidence and the reduced drug and labor costs that would be expected.

	2 Times a Day Feeding	**3 Times a Day Feeding**
Ration Description	26/20 Milk Replacer	26/20 Milk Replacer
Cost/Ton DM	$2,600.00	$2,600.00
Cost/Ton AF	$325.00	$325.00
% Dry Matter/Solids	12.50%	12.50%
Intake DM	1.06	1.59
Yardage/Labor	$0.75	$0.90
Daily Feed Cost	$1.38	$2.07
ADG	1.50	2.09
Cost/hd/day	$2.13	$2.97
Cost/lb. gain	$1.42	$1.42

One cannot do an analysis like the one above without average daily gain (ADG) numbers. This is why it is suggested that producers record individual birth weights and individual weights out of the hutch. They can then calculate ADG by subtracting birth weights from weight out of hutch and dividing by days on feed (days in hutch). Managers can then look at performance of cohorts or groups of calves by week, month, season, source or disease incidence.

In addition to recording individual weights out of the hutch, it is recommended to record disease events like scours and pneumonia, number of days for the health event, and treatments used. If the operation records this information, one can consider early culling based on individual average daily gain and number of disease events. Marketing opportunities are usually better for early culling at 150 days on feed than at 70 days.

In the dairy industry today, optimal rumen development is the goal but not at the expense of reduced performance during the milk-feeding phase. Reducing milk intake with the intent of driving up dry feed intake at an earlier age is not the objective nor is it economically justified. The objective should be to transition from milk protein and energy to plant protein and energy as quickly and as efficiently as possible. In younger animals, the plant protein and energy is less digestible (metabolizable). The dairy industry has lengthened the days on milk in response to the performance lag they experience when transitioning to dry feed too early. Calf starter grain mixes containing highly digestible protein and energy sources have allowed some operations to reduce days on milk up to a point.

Phase 3—Weaning – Week ~8

Weaning is the time in a dairy calf's life when management asks the calf's digestive tract to switch from milk protein and energy to plant protein and energy. Milk and milk replacers are more costly than starter feeds on a per ton basis but the feed efficiency of milk solids is better than plant sources. The younger the calf (5 – 6 weeks), the lower the digestibility of the plant source protein and energy. We now have modeling programs for young calves, but they are not capable of accurately predicting the metabolizable protein and energy actually available to the very young calf during the weaning process (<10 weeks).

Experience has changed weaning recommendations and weaning should be based on calf starter intake vs. days of age. It can be cumbersome to measure calf starter intake in large operations but it can be done. Do not wean an animal until it is consuming 2.5 to 3.0 pounds of calf starter for three consecutive days. All schedules for transitioning from milk to starter feed need to be adjusted by each operation based upon calf performance. Performance is driven by your colostrum program, the volume and solids of milk fed, the environmental conditions and disease incidence.

There is variation in the number of days of age when calves are ready for removal of milk. Producers cannot afford to keep all calves of a cohort or age group on milk until the last one is ready to wean. It is recommended that you have a protocol in place that allows the slower developing animals to stay on milk at least an extra 7 to 10 days. These animals need to be recorded in your record-keeping system as delayed weaning. This is another factor to consider for later culling decisions.

Free choice water is essential for calf starter dry matter intake. Calves will generally double their starter intake in the 7 days following complete removal of milk. Do not introduce hay until in group pens for at least 2 weeks.

All calf starter grain mixes are not formulated equally! Crude protein (CP) and energy are not as important as metabolizable protein and energy. Some ingredients are more palatable than others. Palatability and digestibility of the properly formulated calf starter, as well as the development of the calf's digestive system, are keys to a successful transition to plant protein and energy.

In my opinion, the main source of protein should be soybean meal. Calves transitioning from milk to dry feeds cannot utilize poor quality bypass proteins such as corn distillers grains. The grains should be processed and heat treated for better gelatinization of the starch, thus better digestibility. A coccidiostat should be included in the formula at a proper dosage level. An example of a calf starter grain mix is shown below.

Example: Calf Starter Grain Mix

Ingredient	% Ration	% Pellet	% TMR
*Hi-Pro Soybean Meal	33.25%	70.74%	
*Diamond V® XP	4.00%	8.51%	
*FERMENTEN®	2.75%	5.85%	
*Fine Ground Wheat	4.50%	9.57%	
*Calf Starter Mineral-Vit	2.25%	4.79%	
*Extra Bond	0.10%	0.21%	
*Flavor	0.10%	0.21%	
*Mold Inhibitor	0.05%	0.11%	*47.00%
Steam Flaked Corn	31.50%		31.50%
Steam Flaked Barley	15.00%		15.00%
Vegetable Fat	0.50%		0.50%
Molasses Cane	6.00%		6.00%
	100.00%	100.00%	100.00%
Ration Analysis			
Crude Protein %DM	25.20%		
Sugar %DM	8.57%		
Starch %DM	37.80%		
EE %DM	3.46%		
Lasalocid mg/lb	23.33		
FERMENTEN gms/lb	11.24		
Ingredients are Pelleted with vegetable fat sprayed on pellet prior to adding corn, barley & molasses to total mix.			

Calf starters are often purchased on price rather than quality. Instead, this decision should be based on calf performance.

Average daily gain while in the hutch is one of the key numbers to base your decision upon. The Ration Comparison spreadsheet shows the relative value of two starter feeds. The example compares an 18% calf starter grain mix to a 22% CP as fed. The difference is $40 per ton. The example assumes that dry matter intakes are the same as well as yardage/labor. The 22% CP calf starter requires the calves to gain 0.12 pounds more per day in order to break even. Without performance numbers, one usually makes an error by choosing the lower performing, less expensive feed.

Ration Compare Spreadsheet

Ration Description	18%CP	22%CP
Cost/Ton AF	$ 400.00	$ 440.00
% Dry Matter	87.43%	87.57%
Intake DM	6.76	6.76
Yardage/Labor	$0.75	$0.75
Daily Feed Cost	$1.55	$1.70
ADG	1.9	2.02
Cost/hd/day	$2.30	$2.45
Cost/lb. gain	$1.21	$1.21

Phase 4—Group Lag – Week ~9 to~17

Many calf operations experience a “lag phase” when calves are moved from the hutches to group pens. Operations that require calves to consume about 7 – 8 pounds of calf starter grain mix before leaving the hutch experience less lag and/or better performance during the transition to groups.

Consider the initial group size as well; as smaller groups translate into less stress. Groups of 10 – 20 head per pen on large operations seem to work well. Not all animals like to eat in lockups so it is advantageous to provide some starter grain mix inside the pen.

In addition, a dry, draft-free bedded area is required to assure that calves lie down. Temperature, moisture, hair coat and wind velocity have a large impact on daily maintenance requirements. Today’s nutritional models demonstrate this very nicely.

Adequate fresh water close to the feeding area is also essential. Do not introduce hay in the ration until the animals are in group pens for at least 2 weeks. Mixing 10 – 15% of good quality chopped alfalfa hay with the calf starter seems to work well for most operations. This can be fed until the animals have been in group pens for approximately 4 weeks. Table 3 below shows the timeline for ration changes.

Table 3. Example Ration Changes by Weeks of Age

GROUP LOCATION	SMALL GROWER PENS 10, 20 or 40			LARGE GROUP PENS 160							
GROUP AGE	Week 11-12	Week 13-14	Week 15-18	Week 19-22	Week 23-26	Week 27-30	Week 31-34	Week 35-38	Week 39-42	Pre-Breed
RATION - LBS/HD/DAY AS FED										
CSGrain Mix	8	8								
Grow Pellet			3	3	3	3	3	3	3	3
Flaked Corn			3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Alfalfa Hay		0.8	1.1	1.6	2.1	2.5	3	3.66	4	4.33
Oat Hay			2.20	3.20	4.20	5.00	6.00	7.33	8.00	8.66

Phase 5—Grower Grain Mix – Increasing % Forages – Week ~16

At approximately 15–16 weeks of age (110 days), the calves can be transitioned to a grower ration. A grain mix or grower pellet that contains protein, vitamins, minerals and coccidiostat/growth promoter can be mixed with good quality forages.

In response to higher feed costs, the industry has gradually increased the amount of forage fed (lowered digestibility) and decreased the quality of dry concentrate fed (lowered digestibility at an earlier age). This management decision has moderated feed costs, but what has been the production response? Most managers are not monitoring ADG or total cost per pound of gain during the growing phase (weight out of hutch to 150 days of age). Without these performance indications, it is not possible to make good management decisions.

Capturing body weight information at 5 months of age can solve this dilemma. This is a time when vaccines are normally administered; animals are already being handled and you can maximize labor efficiency.

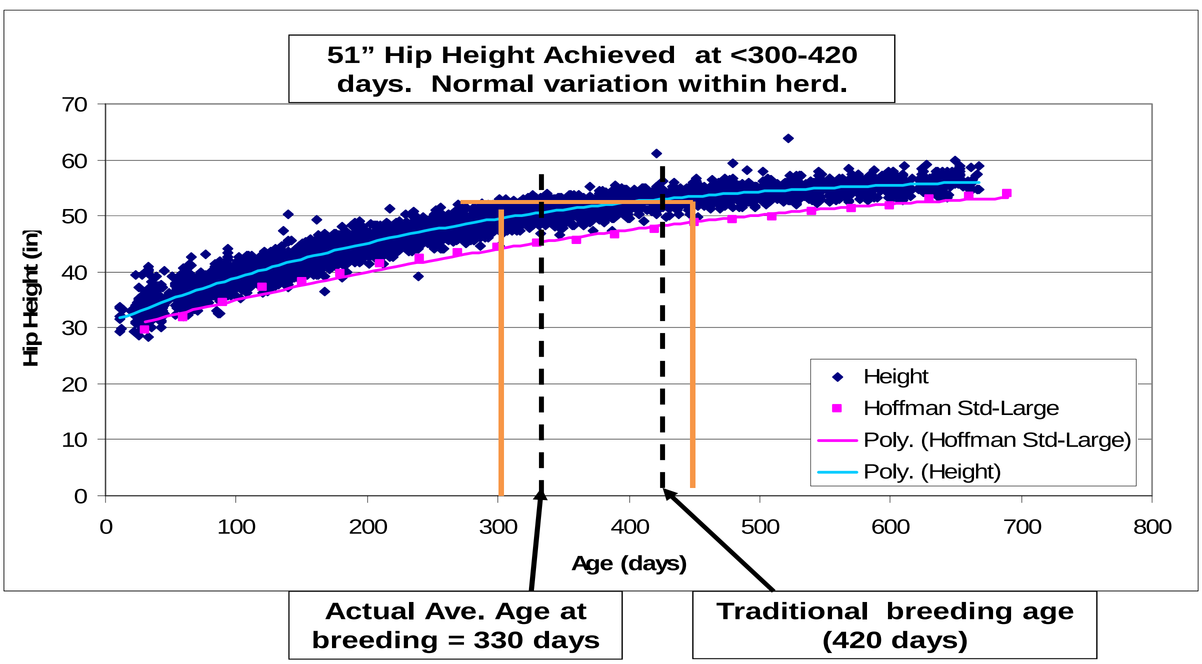
With this information you can make better ration decisions as it is an opportune time to make early culling decisions. Under present marketing conditions, this is a good opportunity to allow your underperforming heifers to make a future career change. Beef feeder markets are good and ~400 lbs. is a good time to market dairy animals for beef production programs.

Phase 6—Introduction to Breeding Pen – 10 Months/51-52" Hip Height

Movement to the breeding pen must be based primarily upon accurate hip heights and body weight measurements, with age as a secondary parameter. Holsteins should be 51 – 52 inches at the hip when entering the breeding pen. It is recommended that you do not breed Holstein heifers before 10 months of age even if they have achieved the hip height and weight targets. In well-managed programs, approximately 20% will be adequate size by 10 months of age.

Variation in age of animals attaining target hip height and body weight is greater than most people realize. A normal, well-managed Holstein heifer development program will have more than 90% of the animals at an adequate size to breed between 10 – 14 months of age. This variation is normal and is due to genetics, growth rate, feed efficiency and disease. Age at conception is the key performance indicator to monitor for heifers in the breeding pen. It is also important to record movement to breeding pen so that 21-d pregnancy rates and insemination risks are calculated correctly.

Waiting too long to initiate breeding results in wasted days on feed and, often, over-conditioned heifers. Frame growth slows down as heifers mature. Older heifers tend to gain excessive body condition. This results in more calving difficulties and metabolic disease. The graph below is from more than 7,000 measurements in a Holstein heifer herd. Note that even though the same rearing program was followed throughout, several animals were 51 inches at the hip at less than 10 months of age while others were 14 months of age before attaining desired hip heights.



Phase 7—Movement to Close-up Pen – 3 Weeks in Close-Up – DCC<250

The most common mistake in this phase is not getting springing heifers on the close-up diet for more than 21 days before freshening. Move heifers to the close-up pen before they reach 250 days carried calf. The key numbers to monitor are days in close up pen and dry matter intake. Monitor variation as well as averages. Days in close up pen should be greater than 21 and the average dry matter intake for Holstein heifers greater than 24 pounds.

The second most common mistake is not feeding the rumen microbes to provide ~1200 gms metabolizable protein. The fetus and mammary gland are developing at a very fast rate as the end of gestation nears, resulting in increased requirements for metabolizable protein and energy, while dry matter intake is declining. The heifer also has requirements for her own maintenance and growth as well as the immune systems of both the fetus and dam. When requirements for metabolizable protein and energy are not met, the animal begins to mobilize protein and fat.

If metritis is a concern with fresh heifers, feed a negative DCAD diet to increase serum calcium levels around freshening. Low blood calcium (hypocalcemia and subclinical hypocalcemia) has been shown to increase the incidence of fresh cow diseases (Santos et al., 2012).

Phase 8—Animal Comfort and Welfare – Animal Husbandry – Day 1 to Lactation

This paper would not be complete without briefly touching on animal comfort and welfare—animal husbandry.

In today's society, consumers want the ideal. If you say you are doing it, you had better be able to prove it. Leadership is about taking your operation to where it needs to be. Therefore, protocols must be in place for housing, feeding, breeding, moving, and handling and treating all ages of livestock on the farm.
There must be written consequences for individuals who do not follow protocols. Protocols must be in writing and training programs must be documented. These records are the only way to defend the practices on your farm.

What will your message be when asked to explain castration or dehorning on your operation? Don't allow your organization to think "if" we are audited. Rather, be prepared for when you are audited so you can communicate and demonstrate that you have a realistic plan in place. The dairy industry's success depends on our ability to assure consumers that we are doing the right thing and our ability to prove it (Walker, 2012).

Conclusion

In today's dairy industry, heifer development is essential and should be considered an opportunity area for most herds. Today's input costs are requiring more intense management. This management style requires different key performance indicators than we have traditionally used. Average daily gain and feed efficiency numbers are required to make the management decisions that yield the best return on your heifer development dollars.

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