Virtual Beef

ISSN 2291-188X VOLUME NO. 20 ISSUE NO. 64 SUMMER 2020

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Ministry of Agriculture, Food & Rural Affairs

Ontario

Managing Bulls after the Breeding Season

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Over the course of the breeding season, bulls can lose between 100 and 200 lbs. of weight. To achieve a tight calving pattern that will deliver both a uniform crop of calves and a calf per cow per year requires a breeding season of around 63 days. This means that for a mature bull running with 36 or more cows at any one time, there is little time available for feeding and resting during this intensely active period. It's completely understandable that after this level of exertion that post breeding recovery can take between 4 and 8 months. A good recovery period is essential for bulls to be fit and ready for next year's breeding season. Post breeding recovery is important for all ages of bulls but special attention to this recovery should be given to young bulls that are still growing (i.e. those less than 36 months).

Mature bulls that are in good condition at the end of the breeding season will easily recover any weight lost through access to good quality grazing followed by good quality winter forage (i.e. hay) without the need for grains or other supplementary feeding. Target hay quality of around 8% to 10% crude protein. The aim is to get bulls into ideal body condition score, i.e. 2.5 to 3, for the start of the breeding season but not fat. Over-conditioned bulls at the start of the breeding season will have low sperm counts and display lower breeding activity than a bull in ideal condition. Bulls that are thin at the end of the breeding season may need some supplementary grains to help with weight recovery – the amount of grains will depend on the nutritional quality of grazing and other forages available after the breeding season.

Young bulls are still growing so they need access to good quality grazing after the breeding season. Grain supplementation may or may not be needed depending on the quality and quantity of high-quality pasture available. Body condition scoring and feed testing is important prior to the start of the winterfeeding period. From those results a winter-feeding program can be formulated so that the young bull can gain 1½ to 2 pounds per day depending on the magnitude of weight loss during the breeding season. Winter diets should target around 10 – 12 % crude protein level.

Producers who run two calving seasons (spring and fall) often are in the situation of double using their bulls. In this situation bulls must recover their body condition in the short time between breeding seasons. In these situations, its important producers plan for the post breeding management of their bulls and ensure both high quality pasture and supplementary grains are available to get those bulls back into shape as quickly as possible. Young bulls may not be the best choice for this type of system as they would potentially have to gain over 2½ lbs. per day to recover body condition between breeding seasons, depending on the weight loss incurred.

Where bulls are maintained in a coral or indoors post breeding, adequate space should be provided to allow the bull to get exercise. Daily exercise is necessary so that the bull has built up the stamina to put in the distance required during the next breeding season. Simply placing water and feed at opposite sides of the barn or coral will force the bull to walk between stations, thereby getting the necessary daily exercise. Be careful when putting multiple bulls together after the breeding season – introductions should be done slowly to avoid fighting.

It's critically important for a successful breeding season that the performance of breeding bulls is examined closely while they are with the cows. Pay close attention to herd estrus behavior; note cows that are mated and if they show estrus again approximately 21 to 45 days later. Identifying and rectifying a situation where a bull that may be infertile or have sub-clinical fertility is critical to ensuring a good breeding season. Such a situation may require the replacement of the bull with another bull or using timed AI to save the current year's breeding season and to avoid issues with subsequent breeding seasons.

There are several factors that must be considered when making decisions around culling a beef bull. The main reason beef bulls are culled is for reproductive failure, which, unfortunately, is sometimes only recognized when cows are scanned. This can have a significant negative impact on next year's calf crop and a significant negative economic outcome from reduced calf sales. It is therefore imperative that the breeding herd is watched for breeding repeats to quickly prevent a subclinical bull becoming a breeding disaster.

Other culling decisions relate to issues of age. As bulls age they become less active and their breeding performance declines. Health issues is another common culling criterion, particularly related to feet and legs, which should be examined after the breeding season. If injuries have occurred, these should be treated, and it should be determined if they will heal adequately enough to enable the bull to perform well next year. Where treatment is not likely to be successful, this should be determined early so decisions around next year's bull can be contemplated. The movement of older bulls move should also be observed to determine if arthritis is becoming a problem.

Where beef cow culling practices revolve around retaining home produced heifers, bulls will need to be culled to prevent inbreeding. This necessity is less of a problem on farms that run multiple bulls, but good breeding records must be maintained to prevent inbreeding.

Producers should also note the degree of dystocia (calving difficulty) that can be attributed to an individual bull. In some cases, this may not be obvious initially but over time as the cow herd changes as new breeding females with different genetics enter the herd, dystocia may become a problem. The primary cause of dystocia is fetal-maternal mismatch, i.e. the calf being too big at the time of calving to be born easily. Birth weight, which determines size, is strongly genetically determined by the male line.

The temperament of bulls can change and an initial quiet bull may become aggressive and dangerous over time. No matter how good the quality of calves or the number of calves that a bull produces, an aggressive and dangerous bull must always be culled from the herd, and the sooner the better.

Finally, producers should also consider the quality of calves being produced. Although a lot of emphasis is placed on the capacity of the cow to breed a good quality calf, it must be remembered that 50% of that quality comes from the bull. Producers should carefully consider if the poor quality of calf produced is a bull or cow factor. One of the ways to identify this is to examine the quality of calves produced by that set of cows bred to the bull. Where the overall quality is good, any poor-quality calf is likely to be related to the genetics of the cow rather than the bull. Where the vice versa though is true, the decision to cull will depend primarily on economics, i.e. will a new bull increase the quality of calves sufficiently to justify the cost of acquiring that new bull.

Once the breeding season ends, it's important to start getting breeding bulls back in good shape. In most cases, access to good quality grazing followed by good winter forage is all that is required. The end of the breeding season is also a good time to think about the role the breeding bull plays in the overall breeding program. Consideration should be given to such factors as bull health, presence of daughters in the herd, bull temperament, history of calving difficulty and calf quality when making decisions around culling. Ideally, decisions around culling should be made as early as possible once the breeding season is completed to allow as much time as possible for research into and finding the ideal replacement.

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Nitrogen Grows Grass: A look at how much N grasses really need

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Like Ontario, Finland's nitrogen fertility recommendations for grasses are based off research from the 1960s and '70s. Since grass varieties and production practices have changed over time, Termonen and colleagues decided to revisit the nitrogen responses of timothy and meadow fescue to determine if the existing recommendations are still appropriate.

Plots were established at two locations in 2014. Between 2015 and 2017, three cuts per year were harvested from each plot. The total annual nitrogen rates were 0, 150, 200, 250, 300, 350, 400, and 450 kg N/ha. These rates were split-applied so that 44%, 36%, and 20% of the total N was applied to first, second, and third cut, respectively. P and K were applied so as not to be limiting; micronutrient deficiencies were addressed in the establishment year. The cut height was 7 cm.

Unsurprisingly, higher nitrogen rates resulted in higher grass yields. Even at 450 kg N/ha, yields were still increasing with added nitrogen. The maximum N rate recommended in Finland is currently 250 kg N/ha annually, but the work by Termonen and colleagues suggests agronomic benefits of N application up to about 390 kg/ha annually. When the researchers compared their yield results to those from older work, they found that grass yields at 250 kg N/ha in the mid-20th century were 70% of yields at the same N rate in the recent trial (8 000 kg DM/ha vs 11 500 kg DM/ha).

They attribute higher yields and N demand in contemporary grasses to three things: improved crop genetics, climate change, and more intensive crop management. Breeding efforts have improved grass yield potential in northern Europe by about 0.4%-0.5% per year, which would account for about half of the difference in yields observed by this trial compared to Finnish work in the 1960s and '70s. Climate change has caused milder winters and a longer, warmer growing season that enables more grass production. Since the original nitrogen fertility work was conducted, Finnish farmers have transitioned from a 2-cut system to a 3-cut system. These things together may explain the recent higher grass yields, N demand, and N use efficiency.

Crude protein content increased with higher N application and peaked at 18% on a DM basis. The authors did not specify at what stage of maturity the grasses were harvested. When compared to historic data, it seems that older varieties were directing more nitrogen to protein formation, while the recent study found more N going to biomass production (yield). N rate had the greatest effect on third cut crude protein content, and the smallest effect on the protein levels of first cut.

Higher N rates increased the proportion of stems in second and third cut timothy, which lowered the digestibility. Meadow fescue did not change its leaf:stem ratio over subsequent cuts as N rates increased. This may be due to the different growth habits of these species; timothy is a jointing grass while meadow fescue is non-jointing. The decline in digestibility as N rates increased was more detrimental to overall quality than the increase in crude protein. As always, this shows there is a trade-off between yield and quality in forage production.

Nitrate-nitrogen (NO_3-N) levels in the forage were below 2 000 ppm (DM basis) at nitrogen rates less than 350 kg/ha per year. NO_3-N concentrations above 2 200 ppm can cause acute nitrate poisoning in cattle. Nitrogen applications of 250 kg N/ha annually kept NO_3-N levels below 1 000 ppm, which is generally considered safe for non-pregnant livestock.

Termonen and colleagues' work shows that grass responses to nitrogen have changed over the last 60 years. A combination of improved grass genetics, enhanced production methods, and changing growing conditions contribute to higher N demands and N-use efficiencies. The way grasses use nutrients and how we define overall quality has also changed somewhat.

This study also highlights the trade-off producers face when it comes to providing nitrogen for forage grasses. While the cost of establishing a mixed stand is much less than that of applying nitrogen, even a good stand of white clover – the most generous legume with its nitrogen – can only provide up to 200 kg N/ha. High grass yields require more nitrogen than legumes can supply. Choosing between high yields and low input costs is ultimately an individual decision based on land values, pasture terrain, forage requirements, and the operator's preferred production methods.

Source: Termonen, M., P. Korhonen, S. Kykkanen, A. Karkonen, M. Toivakka, R. Kauppila, and P. Virkajarvi. 2020. *Effects of nitrogen application rate on productivity, nutritive value, and winter tolerance of timothy and meadow fescue cultivars*. Grass and Forage Science. 75(1):111-126.

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Getting Cows Bred in a Fixed Time Program

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As a summer student at (what was) the New Liskeard College of Agriculture Technology (NLCAT), I was hired to work on a research program that looked at synchronizing cows so they would all calve within a tight time frame. I was told to expect to be very busy right from the get-go, as my first day of work was the start of the expected calving date. Unfortunately, or fortunately for a green, wide-eyed university student, pregnancy results of the synchronizing program, using a product called Synchromate B, were very low, resulting in a slow, uneventful calving season. Undeterred, the research has continued, trying different programs and methods for synchronizing the beef cows from the NLCAT to today's New Liskeard Agriculture Research Station (NLARS).

That summer we tried a method where we removed the calves from the cows for 48 hours, hoping to stimulate reproductive hormones. What I remember is we stimulated a lot of cranky cows. The game changer for synchronizing cows at NLARS occurred in the mid 1990's with the advent of the use of the CIDR-Ovsynch program. This program involves inserting a progesterone drenched plastic T into the cow's vagina and using other hormone therapies to program the cows for synchronized breeding. NLARS is one of the research stations associated with the University of Guelph. Working closely with Guelph reproductive researchers, NLARS has fine-tuned the process, providing the industry with a standard process for using artificial insemination effectively on the farm, and synchronizing cows so calving occurs within a close timeframe. Currently cows and heifers are synchronized using hormone therapy and breeding them on day eight from the start of the synchronization.

The products used in the process include:

- CIDR: Controlled Internal Drug Release device
- GnRH: Gonadotropin Releasing Hormone
- PG: Prostaglandin

Figure 1. CIDR (Controlled Internal Drug Release Device) and applicator

These products can be used strategically to manipulate the estrous cycle of the cows in the herd so that all cows can be inseminated at the same time. This allows for labour saving and effective use of resources required for artificial insemination. The cows will also calve in a tighter calving group, resulting in labour and efficiencies at calving time as well.

Figure 1. Fixed Time Insemination Protocol (First A.I.)

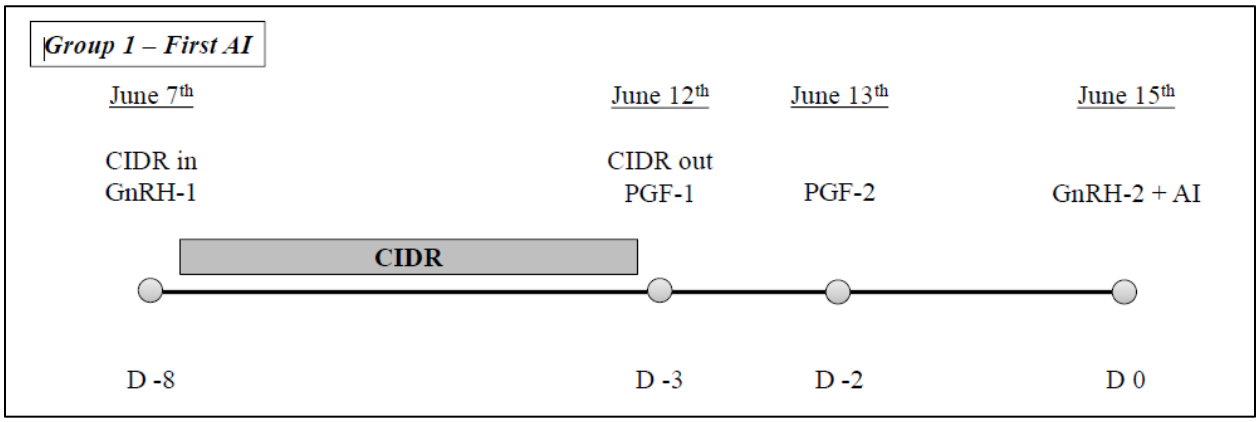
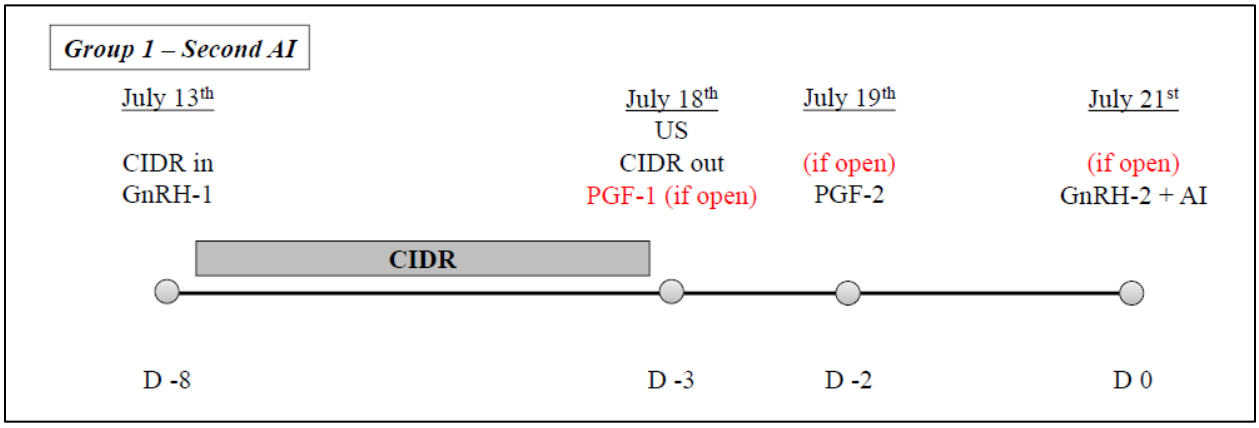
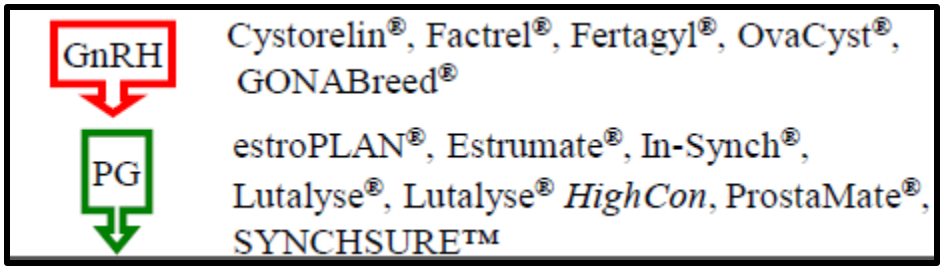


Figure 2. Fixed Time Insemination Protocol (Second A.I.)





*Product Trade Name examples provided by Beef Reproductive Task Force 2016

The cows and heifers are programmed at the same time and bred all at the same fixed time.

At day 28 from the insemination date, the breeding females are reprogrammed with CIDRs, and given GnRH. At day 33 from insemination, the CIDRs are pulled, and the females are ultra-sounded for pregnancy. Any female that is not detected as pregnant is given prostaglandin. The non-pregnant females get a second prostaglandin the next day. On day 36 from the first insemination they are artificially bred again.

This process, while very labour intensive over short periods of time, has proven very effective in getting animals pregnant.

Table 1: NLARS Pregnancy Rates from Fixed Time Insemination

	First Sync	Rebred	Overall
Pregnant females	161	47	208
Open females	69	22	22
Total females in group	230	69	230
Conception rate	70%	68.2%	91%

When you consider that a good bull will impregnate around 70% of the cows he breeds the first time around, the results for the first fixed time insemination is about as good. By following up with the second fixed time A.I., 91% of the breeding females are bred within a 36-day breeding period.

Cost Comparison

Table 2 provides the costs for the programming and breeding of cows artificially. These prices were worked on a basis of 100 cows, and then converted back to a cost per cow, based on pregnancy rates, and usages each time.

CIDRs are reused for the second synch. Only one pregnancy check cost was inputted. While two are required, it is assumed that a regular bull bred herd would also incur the cost of one pregnancy check. No semen costs were inputted. An assumption was made that the cost for a bull to service a cow would be the same as a straw of semen.

Table 2. Cost of artificial insemination using the CIDR-Ovsynch program

Cost per Cow Pregnancy[1]		
Item	1st Synch	2nd Synch
CIDR	$20.00	
GnRH (2)[2]	$5.20	$3.38
Prostaglandin (2)[3]	$8.30	$2.49
Labour $20 / hr[4]	$6.67	$2.00
AI Service	$15.00	$4.50
Pregnancy Check	$5.00	
Total	$60.17	$12.37
Total cost per cow based on 91 % Pregnancy Rate		**$72.54**

[1] Priced based on %, using 100 cows
[2] GNRH given to all cows 2 X first time and 1.3 X the second time based on 70 % pregnancy first insemination
[3] Prostaglandin given to all cows 2 X 1st Synch, and 2 X 30 % at 2nd Synch
[4] 5 cow handlings at 4 minutes each per cow

The total cost for breeding a cow through artificial insemination in this example is $72.54.

Cost of a bull

How does this compare to having a bull around? Accounting for the approximate feed and health costs for caring for a bull, the cost of getting a cow pregnant by a bull is estimated to be $52.50 (*Table 3*).

Table 3. Bull costs per cow

Input	**Rate**	**Cost**
Stored Feed for a 2000 lbs animal @ 2.5% intake	240 days @ $5 per day	$1,200.00
Pasture Grazing	125days @ $3 per day	$375.00
Total cost per pregnant cow*		**$52.50**

Costs include feed and health, plus yearly semen test
*Assumes 30 services per bull

While on paper a bull may appear $20 per pregnancy cheaper, there are many advantages to this detailed artificial insemination protocol not captured in this price comparison. These advantages include:

- Shorter breeding period and tighter calving groups. Having a tight calving group provides more marketable calves.
- A.I. allows for targeted mating of cows and heifers. One can select calving ease bulls for heifers, perhaps carcass trait bulls for older cows, etc.
- The fixed time A.I. program reduces labour, making use of this technology more practical.
- Eliminating walking bulls can eliminate bigger, more aggressive animals, reducing safety concerns around the livestock. Bulls also tend to do a lot of damage to facilities and fences just by rubbing on them.

Each farm needs to evaluate whether and how artificial insemination can work on their farm. Research over many years at the New Liskeard Agriculture Research Station shows that it can be effective.

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Improving Efficiencies in a Feedlot Feeding Program

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Looking for opportunities for production efficiencies on-farm is an important aspect of improving your bottom line. Tight profit margins often prompt an assessment of efficiencies that can be made on the farm. Since feed inputs represent a significant share of input costs on a feedlot, it's a logical approach to look to feeding strategies to take stock of potential areas for improved efficiencies.

Measuring feed to gain (F:G) is the most common approach to assessing feed conversion. Often when feed efficiency is discussed, the focus tends to be on aspects of the ration itself that help improve feed efficiency and the genetic merit of cattle in converting feed into pounds of gain. These ration attributes are very important, and include composition of the ration (ingredients), grain processing, additives, and growth promotants.

This article will cover some practical feeding aspects that are often left on the periphery of discussions about improving efficiencies in a feeding program. These are aspects that should not be overlooked when fine-tuning production efficiencies to help increase profitability on farm.

Assessing your feed storage approach

Depending on your feed storage approach, there can be a considerable amount of feed waste before it even reaches the feed bunk. With any stored forage, the presence of oxygen can lead to decomposition of the silage by aerobic organisms, leading to dry matter losses. In a bunker silo, this can be a result of poor packing, insufficient cover on the silage pile, oxygen exposure or water seeping at the walls, and/or mismanagement of the face of the pile. Packing to achieve a bulk density of at least 45 lbs as-fed/cubic feet reduces exposure of feed to oxygen. Managing feed-out from a bunker or tower silo is an important aspect of reducing dry matter losses. Recommended removal rates are 4 inches/day in the summer and 3 inches/day in the winter. This must be balanced with removing just enough feed for feeding as dry matter losses occur when silage is exposed to oxygen. A disturbed or rough face surface can result in dry matter losses in the range of 1-3%.

Although dry commodities are not as vulnerable to spoilage, exposure to the elements can result in losses. Storing dry commodities in bins, commodity sheds, bags, etc. helps to reduce exposure to moisture and prevent spoilage and losses. Furthermore, it's important to protect feed commodities from rodent or other wildlife damage. With any feed ingredient, shrink can also occur where feed trucks are overfilled and particles are lost to the wind. Protective shelters and coverings over conveyors and feed loading areas can prevent losses to the wind.

Feed Testing

Making assumptions about the nutritional value of feedstuffs is costly as a result of either over- or under-feeding nutrients to cattle. Working with your feed advisor to test home-grown and purchased feedstuffs leads to more accurate ration balancing. The introduction of NIRS technology has helped to reduce the costs of feed testing. Furthermore, purchased ingredients may come with a certificate of analysis or guaranteed analysis, which may help you reduce feed testing costs. The small investment in feed testing can help save thousands of dollars through precision in ration balancing over the course of the feeding period.

Mixing Consistency

The objective with a TMR (total mixed ration) is to promote uniformity in the feed mix so that every mouthful is consistent. Providing a consistent ration can help improve feed efficiency and reduce digestive upsets. A mixer test can help determine if a uniform mix is being achieved. A mixer test typically involves taking a series of samples (roughly 10 samples) at equal intervals from the bunk, fresh after feed delivery or directly from where feed is dispensed as the feed truck or mixer empties out. A substrate (often a mineral) is tested in all the samples to determine how homogenous or uniform the mix is. The assay results can be used to calculate the coefficient of variation and determine whether the mixing is adequate. Mixer tests should be done routinely to ensure consistency in feeding, but especially with any significant changes to the ration, after adjustments to equipment are made or new equipment installed. Your mixer test should reflect your typical mixing routine (mixing time, order ingredients are added to the TMR, batch size, etc.).

Bunk Management

Improper bunk management can result in digestive orders, eratic dry matter intake, and poor performance. It is estimated that poor bunk management can reduce dry matter intake and average daily gain by up to 10-15%. Astute feedlot operators will pay attention to what cattle are telling them through the feed bunk by adjusting rations daily and responding to potential health or performance issues. Researchers from South Dakota State University have developed a 4-point bunk scoring system that assists feedlot operators in consistently and objectively monitoring intake (Table 1).

Table 1. 4-point bunk scoring system

Score	Description
0	No feed remaining
½	Scattered feed remaining; most of the bottom of the bunk is exposed
1	Thin uniform layer of feed remaining (~ 1 corn kernel deep)
2	25-50% of feed remaining
3	Greater than 50% of feed remaining with crown thoroughly disturbed.
4	Feed is generally untouched. Crown of feed from previous feed still noticeable.

Adapted from Pritchard, R. South Dakota State University.

This scoring system helps operators estimate actual DMI rather than rely solely on feed delivery records. Recording and graphing this data allows the operator to visually see trends in dry matter intake over a feeding period. While bunk management varies from operator to operator (e.g. slick bunk vs ad libitum), the success in bunk management is anchored in consistency and diligence in monitoring. This consistency is important in:

- Timing of feeding (for best results, within 15 minutes of scheduled feeding time daily)
- Timing of feed calls before first feeding
- Personnel making the feed call
- Feed mixing order and mixing time

Since ruminal pH is influenced by rate of feed digestion, bunk management must consider factors that influence ruminal pH such as forage to concentrate ratio, grain source and processing methods, and feeding frequency.

Fecal Testing

Testing on the back end is another means of evaluating your feeding program. Monitoring starch digestion in feedlot cattle is an important aspect of assessing feed utilization efficiency, managing input costs, and gaining a better understanding of cattle performance and health. A fecal starch analysis is an effective tool for monitoring starch digestion. It provides a measure of the concentration of undigested starch and this unutilized starch represents a direct cost to the feedlot operator. Researchers have found that an increase in 1% fecal starch results in a 0.162 Mcal reduction in net energy for maintenance (NE_m) in cereal grains. Thus, a fecal starch analysis provides important insight into feed utilization efficiency and high values should prompt a review of areas where feed utilization efficiency could be improved.

A fecal starch evaluation can be used as an indicator of the impact of grain processing on total tract starch digestion when grain is the primary or only source of starch in the ration. Most commercial labs offer fecal starch analysis, either by NIRS

or wet chemistry. Ideally, fecal starch levels should be as low as possible but a fecal starch value of greater than 13% suggest that changes need to be made to increase feed utilization efficiency.

Reducing environmental stress

Exposure to environmental elements can reduce performance and increase energy requirements and dry matter demand. Keeping pens and scrape alleys clean help minimize energy losses associated with cattle walking through deep manure (or mud in open lots). Furthermore, reducing barriers to get to the bunk (e.g. deep manure or mud) helps to encourage intake.

Record Keeping

Lastly, it cannot be overstated, record keeping is an important monitoring tool to understand where inefficiencies lie and where there's opportunity to increase profitability. This is true of any business for both production and financial variables. Record keeping is the backbone of any certification program but is also critical to sound planning, benchmarking, and decision making for the feedlot.

Conclusions

Although each feedlot has a unique set of conditions, there are several practices that can help improve feed margins on-farm, and these practices can be adopted by any feedlot. Reducing waste, testing feed and fecal samples for improved ration balancing, bunk management, reducing environmental stress, and sound record keeping are a selection of factors that should be considered to improve feed margins.

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Genetic Expression Profile of Beef Quality Traits that Influence General Criteria to Purchase by Consumers

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Meat quality traits such as meat colour and marbling are important because of their strong impact on consumer acceptance as visual indicators of meat freshness and juiciness. Consumers assess beef quality through physical aspects, including visual appearance. Studies indicate that consumers are willing to pay more for beef cuts that are bright red in colour and that presents different patterns of fat content, matching the individual requirements of each type of consumer. Thus, marbling and meat colour are important traits to consider in a breeding program.

Some studies have characterized the biochemical patterns of beef colour to explain the multitude of biochemical interactions during the aging process, which impacts the final appearance of beef. A study by Gagaoua et al. (2017) investigated the meat colour trait in the rib eye steak of young Aberdeen Angus and Limousin bulls. These authors suggested the possibility of using biomarkers, or biological indicators, that can be used to classify meat cuts sampled at early post-mortem according to colour.

Marbling refers to the extent of fat that is deposited intramuscularly, or inside the muscle tissue, and can affect other meat quality traits such as colour and tenderness. According to Jung et al. (2016), the correlation between marbling and juiciness

is around 0.67, which is moderately high. This means that by improving marbling, we can often increase the sensory flavour and juiciness. Additionally, increased marbling can compensate for the effects of increased cooking temperatures on less tender muscle. Furthermore, increased marbling has the potential to yield more beneficial fatty acids (i.e. omega 3), which has been identified as an important factor for more nutritious and healthier food (Cánovas et al., 2012).

Despite the importance of these traits, genetic and physiological understanding of beef colour and marbling is growing slowly and still little is known about the genes determining these traits and their functions. This represents a significant unexplained source of variation of phenotypes remaining in beef cattle. While there are challenges in reducing this variation, there is potential to identify genetic markers that are associated with marbling and colour in beef cattle along with a precise understanding of the biology underlying these traits. This will allow for a more effective improvement in meat quality through genetic selection and feeding management. Thus, functional genomics studies using the new – OMICS technologies such as transcriptomics could help to clarify the genetic architecture of these traits, ultimately to enhance the reliability and accuracy of selection methods for beef quality traits.

In this sense, one of the research lines in the Cánovas Lab at the Univeristy of Guelph have been studying the muscle transcriptome profile associated with meat quality using high throughput –OMICS technologies such as transcriptomics with RNA-Sequencing. This new technology aims to identify the specific gene forms (mRNA isoforms) that are been expressed in the muscle of animals with higher marbling compared to animals that have less marbling. In addition, the research team is digging even deeper to identify the biological markers responsible for the different patterns of genetic expression presented by animals that result in different marbling profiles.

One of those projects was conducted in collaboration with UNESP in Brazil (Albuquerque Lab), and the preliminary results are promising. So far the study has identified genes, such as hemoglobin, that have showed different patterns of expression between Nellore cattle with bright red meat and greater marbling compared to animals with dark coloured meat with reduced marbling. The hemoglobin gene produces an important protein responsible for determining meat colour.

The collagen gene has shown different patterns of expression between animals with high and low levels of beef marbling and tenderness (Muniz et al., 2020). This study identified structural variants (markers) possibly responsible for modifying the collagen protein in animals with different levels of marbling. These preliminary results have shown that the genetic mechanisms that possibly control meat colour and the levels of marbling could be connected each other. The next steps of this research includes validation of these results in beef breeds used for the Canadian meat production system.

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