Virtual Beef

ISSN 2291-188X VOLUME NO. 20 ISSUE NO. 63 SPRING 2020

In This Issue

This publication is available in electronic format at www.omafra.gov.on.ca/english/livestock/beef/news.html. Single paper copies may be obtained by calling 1-877-424-1300.

Direct general questions and suggestions to: Megan Van Schaik, Editor at Megan.VanSchaik@ontario.ca or call 519-820-4175. For inquiries regarding content of a specific article contact the author.

Ministry of Agriculture, Food & Rural Affairs

Ontario

Feeding High-Grain Rations to Feedlot Cattle

Megan Van Schaik, Beef Cattle Specialist, OMAFRA, Guelph
Dr. Katie Wood, Assistant Professor, University of Guelph

Least cost-formulation of rations is dependent on commodity pricing and availability, which means that ingredients will move in and out of rations or inclusion rates will change depending on the price, availability, nutritional value, and antinutritional properties associated with an ingredient. In recent years, DDGS (dried distillers grains with solubles) and DGS (distillers grains with solubles) have become a mainstay in feedlot rations as it has been a cost-effective and widely available ingredient for feeding energy and protein to cattle. In addition, the low starch content and highly digestible fibre components make distillers a relatively "cool" source of energy for the animal, when compared to high starch feeds. Therefore, including distillers in a finishing rations to displace those rapidly fermentable grains can help reduce the risk of digestive upsets in the feedlot.

Recent reductions in ethanol production has created a shortage of DDGS and DGS, coproducts of the ethanol production process. As a result, the cost of these by-products has increased significantly and so there has been pressure to shift to more economical feed ingredients. To replace protein in the rations, other protein commodities, higher rates of non-protein nitrogen sources, such as urea, and in some cases, more wheat is going into rations to achieve higher protein levels and maintain energy levels at reasonable cost. To maintain the energy density of these finishing rations, cereal grains have been increased as a percentage of the ration. These higher inclusions of grains in rations increases rumen fermentation and risk of digestive upsets such as acidosis and bloat, and therefore careful management of these rations is very important. This article intends to outline some management considerations for rations with high grain inclusion rates.

Management

Managing the Feed Bunk

Rations that include high levels of readily digestible carbohydrates (grains) require sound bunk management to mitigate risk of digestive upsets such as bloat and acidosis. Maintaining consistency in intake, diet, and management is key to minimizing these risks. Some of these strategies include:

- ***Ensuring adequate bunk space***. Inadequate bunk space and aggression at the bunk can result in inconsistencies in dry matter intake and gorging by aggressive cattle at the bunk. Recommended bunk space (minimum) for finishing cattle is 6" where fed ad libitum, 8-10" when feed is present most of the time, and 18" when limit fed. These recommendations are based on twice a day feeding.
- ***Adequately mixing the ration (TMR)*** to reduce feed sorting and inconsistency in intake. The objective with a TMR is to have consistency in feed with every mouthful. A mixer test can help determine if that consistency is being delivered in the TMR and a uniform mix is being achieved. Mixer tests should be done with any significant changes to the ration or after adjustments in equipment and mixing time are made. A mixer test should reflect your typical mixing routine (mixing time, order ingredients are added to the TMR, etc.) with adjustments being made as necessary according to your test results.
- ***Increase feeding frequency.*** Increasing feeding frequency helps to prevent gorging at the feed bunk, another risk factor for feedlot acidosis.
- ***Consistent timing of feeding.*** Similarly, consistent timing of feeding helps to prevent gorging at the feed bunk and inconsistent eating patterns. It is recommended that feeding occurs within 15 minutes of scheduled feeding time daily.
- ***Dietary transition and adaption.*** As with any ration change, slowly increasing the amounts of rapidly digestible carbohydrates in the ration provides opportunity for adaptation by the rumen microbes and helps to reduce risk of digestive upsets. A step-up approach to increasing energy in the ration is an effective means of reducing risk of acidosis.
- ***Include adequate levels of forage in the ration.*** The objective of including roughage in a feedlot ration is to provide adequate physically effective NDF to stimulate chewing and rumen motility to maintain rumen health and cattle performance.

Grain Type and Processing Method

Grain type and degree of processing influences the rate and extent at which they ferment in the rumen, which can impact cattle health and performance. As a rule, wheat and barley ferment the fastest whereas corn ferments the slowest, however this hierarchy is influenced by the type and extent of processing (*Figure 1*).

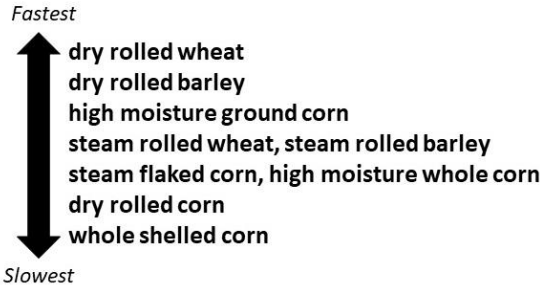


Figure 1. Rate of digestion as influenced by grain type and processing method. Adapted from Stock and Erickson (2006)

Grain is processed to achieve increased starch availability and digestibility in feedlot rations. Generally, the greater degree of processing is related to improved dry matter and starch digestibility, which can translate into improved feed conversion efficiencies. *Table 1* provides a summary of the impact of various processing methods on corn as a feed ingredient for cattle. Processing grains through steam-flaking, rolling, or grinding with a hammermill enhances total tract starch digestibility. However, in any processing scenario, particle size distribution and specifically the extent of fines produced must be monitored to manage risk of reduced rumen pH and digestive upsets.

Table 1. Relative impact of processing methods on corn (no impact to major impact)

Processing Method	Expose endosperm	Decrease particle size	Disrupt endosperm matrix	Disrupt starch granules	Increase rate of fermentation	Improve intestinal digestion
Dry rolling	Major	Minor	No impact	No impact	Medium	Minor
Grinding	Major	Major	No impact	No impact	Medium	Minor
Steam flaking	Major	Medium	Minor	Minor	Major	Medium
Ensiling	Minor	No impact	Medium	No impact	Medium	Minor

Adapted from Zinn et al. (2011)

In a summary conducted by Owens et al. (1997), the authors obtained data from various studies looking at the effects of grain type and processing on feedlot performance. Data was included only if roughage inclusion rates were under 15% dry matter (30% if corn silage was primary roughage source), if the grain portion of the ration was a single grain type and single processing method used, if the grain portion represented over 55% of the ration on a dry matter basis, and if feedlot cattle had been fed for more than 99 days.

Table 2. *Feed efficiency of cattle fed grains processed by various methods (least square means)*

Processing Method	Feed efficiency (feed:gain)			
	Barley	Corn	Oats	Wheat
Dry roll	6.25	6.57[a]	6.01	6.59[a]
High moisture	-	6.43[a]	-	-
Steam roll	6.19	5.87[b]	6.18	5.92[b]
Whole	6.66	5.95[b]	-	-

Adapted from Owens et al. (1997)

a,b,c superscripts represent significant differences, where means within a column with different superscripts are significantly different (P<0.05)

The study found that more extensive processing (high moisture, steam rolling) generally improved feed to gain compared to dry rolling grain, suggesting that energetic efficiency was improved through extensive processing such as steam flaking (*Table 2*). Interestingly, the feed efficiency of whole corn appeared to be higher than that of dry rolled corn, which the author attributed to the low inclusion of roughage in the rations studied (on average 6 % DM for whole corn rations). More recent studies have yielded similar results, where dry corn ground to a fine particle size did not necessarily improve

performance in finishing cattle, and dry matter intake tended to decrease in the late finishing period. Similarly, these results were thought to be attributed to a subacute acidotic response.

Where is the sweet spot for grind size and extent of processing? Unfortunately the answer is not straight forward, as it is a function of a number of variables, including overall composition of the ration, type of grain processing, and moisture levels. The amount of roughage and certain coproducts in the ration also has an impact on feed efficiency as related to grind size. Some studies have shown that the impact of processing method for corn grain may be influenced by inclusion of wet distillers grains, suggesting that there is a positive effect of wet distillers in binding fines and improving uniformity in the diet. However, more research is needed to fully understand the interaction between various feed ingredients and grain grind size.

In addition to providing physically effective fibre, the inclusion of forage in the ration may also offset the increased rate of fermentation associated with fine particle size and risk of digestive upsets. Work out of North Dakota (Engel et al., 2014) looked at the effects of fine grinding or dry rolling corn compared to whole corn in rations with higher inclusion rates of roughage. The outcomes of this study were different than those found through summarized reports by Owens et al., and the authors attributed this to higher levels of roughage in the ration. The authors concluded that when forage levels are adequate (greater than 15.5% DM) in the ration, improved feed efficiencies can be achieved when fine-grinding corn.

Steam-flaking or steam-rolling is a nice processing option that tends to increase the overall total tract digestibility of starch. This occurs because the combination of moisture and heat during the steam-flaking process gelatinizes the starch and disrupts the protein matrix encapsulating starch granules in the kernel. Steam flaking, and other forms of further processing such as ensiling, can also influence the site of starch digestion in the digestive tract. Steam flaking and ensiling grains tend to shift digestion to the small intestine which not only contributes to increasing digestive efficiencies, but also reduces risk of ruminal acidosis. Studies have shown that energetic efficiency can be increased by 20% when corn is flaked rather than dry rolled, although this may vary depending on other dietary factors. Keep in mind, however, that fines can still be produced during the steam-flaking process. Flakes that are thinner and are subjected to a longer steaming time before flaking results in a flake that is less brittle and less likely to produce fines.

University of Nebraska research suggests that feeding a combination of different grains or like grains subjected to different processing methods, such as a combination of high-moisture grain and dry grain, can have positive benefits to performance and can reduce risk of acidosis. According to University of Nebraska data, this blended approach to feeding grains can increase gain and feed efficiency. In their study, cattle gained 2.9% faster and were 4.3% more efficient when offered a diet where the grain fraction consisted of 67-75% high moisture corn and 33-25% dry corn. The beneficial effects of the blended grain approach were reduced as the proportion of high moisture corn decreased. The complementary effect of having two grain sources or grain processing methods is the result of balanced starch digestion between the rumen and small intestine.

Monitoring Particle Size

In the absence of hard and fast recommendations for particle size distribution across all feedlot cattle ration scenarios, it is important to have a sense of grain particle size distribution for ration formulation purposes and when trouble shooting animal performance and health issues. The underlying principals are that an abundance of fines from processing in the ration puts cattle at higher risk of digestive upsets and rations that include grains that are under-processed may not lend to desired performance results. Other factors such as the complement of ingredients in the ration, corn vitreousness, and moisture levels will also impact starch digestion and rumen health. Keep in mind that *intended* particle size distribution may differ from *actual* particle size distribution, and settings/maintenance on processing equipment must be monitored. How can particle size be monitored in grains?

- *RoTap Sieving* – This is the standard laboratory method for determining particle size distribution. This method involves a sieve stack, including 13 sieves and a bottom pan, and automated sieving motion. The RoTap procedure allows for calculation of the mean particle size and standard deviation of the sample. This procedure generates quantitative measures but is time consuming and the RoTap is inconvenient for on-farm use. Most feed mills have RoTap equipment and where possible, could be used on a sample for fine turning.

- *Manual Sieve Stack/Relative Corn Index* – A sieve stack that can be taken on farm to assess particle size distribution. The sieve stack consists of sieve mesh sizes of #4 (4.75 mm), #8 (2.4 mm), #16 (1.01 mm), #30 (0.54 mm) and a bottom pan. The Relative Corn Index was developed by Dr. Mike Hutjens (University of Illinois) and can be used as a relative measure to monitor particle size distribution in grains. This is a quick assessment that can be done on-farm and is particularly helpful in monitoring changes in particle size distribution; however, the RoTap method provides more quantitative results.
- *Processing Index* – An index that measures the degree of grain processing using bulk densities. The Processing Index is the bulk density of the processed grain expressed as a percentage of the bulk density of the grain prior to processing. *Figure 3* illustrates the relationship between processing index and fecal starch concentration.
- *Flaking density* – The flaking density is used exclusively for flaked cereal grains and relates to the bulk density of the grain after processing. Bulk density is usually expressed in g/L.

Impacts of corn vitreousness

The form and make-up of starch and the proteins that interact with starch in the endosperm of corn kernels also impact digestibility of grain. The endosperm of the grain contains a protein matrix that encapsulates starch granules. Vitreousness describes the nature of the endosperm of the corn kernel, where high vitreousness represents “hard” endosperm and low vitreousness represents “soft” endosperm. Increased vitreousness reduces total-tract starch digestibility. Vitreousness varies depending on the corn hybrid and maturity. Flint corn has high vitreousness, flour corn has low vitreousness, and dent corn hybrids typically fall in between, depending on the genetic make-up of the variety. Vitreousness can be monitored through physical and chemical testing.

There are a number of ways to manage vitreousness, but keep in mind that most commercially available hybrids have a moderate range of vitreousness. On the front end, vitreousness is a trait that can be selected for or against during corn hybrid selection. Short season corn hybrids typically have more flint-based genetics than long season hybrids. On the back end, vitreousness can be managed through processing techniques. Ensiling and steam flaking reduce the impact of vitreousness on starch digestion. Steam flaking has been found to reduce the negative effects of vitreousness on starch digestibility in corn and interestingly, steam flaking more vitreous corn seems to yield less fines than vitreous corn.

Feedback Mechanisms

Monitoring Fecal Starch

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.

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.

Keeping tabs on roughage in the ration

All ruminant rations require some level of roughage to maintain rumen motility and balance in rumen microflora. Where high-concentrate diets are fed, roughage included in rations ideally should have a large enough particle size to stimulate chewing and saliva flow (good “scratch”) with a goal of achieving uniform mixing and reducing feed sorting. Remember that not all roughage types are created equal. For the sake of defining forage levels, the common approach is to sum the hay components plus 50 percent of the corn silage. This is because digestibility of corn silage is higher. Different roughage sources provide varying degrees of effective fibre that contributes to scratch factor and influences overall rumen health. A Penn State Particle Separator in conjunction with lab analysis for NDF can be used to help determine levels of physically effective fibre in the ration. For maintaining rumen health, it is recommended that this level be 7-10% DM for feedlot cattle.

Cattle Performance

Cattle performance is always an important feedback mechanism and thought should be given to grain type, inclusion rates, and particle size when reflecting on gains, feed efficiency, and dry matter intake. Monitor feed intakes daily and make adjustments where necessary. Watch for potential indicators of digestive issues, such as drastic fluctuations of dry matter intake, feed refusals, foundering cattle, and inconsistencies in manure.

Processor Feedback

Understanding liver abscess rates is an important feedback mechanism for monitoring rapidly digestible carbohydrate load in the ration. High rates of condemned livers due to abscesses may indicate that ration adjustments are necessary. Having cattle on feed, especially a high carbohydrate diet, longer than anticipated, also increases risk of liver abscesses. Liver abscesses in fed cattle are on the rise in Canada. According to the National Beef Quality Audits, A+ liver abscesses (Elanco scoring system) increased from 2% in 1999 to 9.9% in 2010/2011 to 19.3% in 2016/17. Feedback on rate of condemnations due to liver abscesses is valuable feedback for your feeding program.

Conclusions

Cattle performance and health are influenced by ration formulation, and attention must be paid to the type, amount, and processing methods of grains included in the ration. When DDGS are replaced in finishing rations with higher rates of urea and grain, attention to bunk management and monitoring feedback mechanisms is prudent. Monitoring and fine-turning grain processing through measuring particle size distribution and monitoring fecal starch is an important aspect of avoiding digestive upsets in feedlots and optimizing feed utilization efficiency.

References

- Canadian Cattlemen's Association. 2018. National Beefy Quality Audit, 2016/2017 Plant Carcass Audit: An Executive Summary for the Canadian Beef Industry.
- Corona, L., Owens, F.N., and Zinn, R.A. 2006. Impact of corn vitreousness and processing on site and extent of digestion by feedlot cattle. J. Animal Sci., 84: 3020-3031
- Correa, C.E.S., Shaver, R.D., Pereira, M.N., Lauer, J.G., Kohn, K. 2002. Relationship Between Corn Virtuousness and Ruminal In Situ Starch Degradability. J. Dairy Sci., 85:3008-3012.
- Engel, C.L., Anderson, V.L., and Schauer, C.S. 2014. Effects of corn particle size and forage level on performance and carcass trains of yearling steers during finishing. North Dakota Beef Report.
- Fox, D. G. and Tedeschi, L.O. 2002. Application of physically effective fiber in diets for feedlot cattle. Publication AREC 02-20, Amarillo: Texas A&M Research and Extension Center
- Lalman, D., and Sewell, H. Rations for Growing and Finishing Beef Cattle. University of Missouri Extension.
- Lundy, E., Loy, D., and Dahlke, G. 2015. Iowa Beef Center Feed Bunk Management. Iowa State University Extension and Outreach.
- Owens, F.N., Secrist, D.S., Hill, W.J., Gill., D.R. 1997. The effect of grain source and grain processing on performance of feedlot cattle: a review. J Animal Sci, 75: 868-879.
- Mahanna, B. 2009. Digestibility of corn starch revisited: Part 1. Feedstuffs, volume 81 issue 6.
- Mahanna, B. 2009. Digestibility of corn starch revisited: Part 2. Feedstuffs, volume 81 issue 10.
- Moya, D., He, M.L. Jin, L., Want, Y., Penner, G.B., Schwartzkopf-Genswein, K.S., McAllister, T.A. 2015. Effect of grain type and processing index on growth performance, carcass quality, feeding behaviour, and stress response of feedlot cattle. J. Animal Sci., 93: 3091-3100
- Niraula, Rajan. 2018. Planning a New Beef Housing Facility: Some important design features to consider. Virtual Beef, OMAFRA.
- Schwandt, E.F., Wagner, J.J., Engle, T.E., Bartle, S.J., Thomson, D.U., and Reinhardt, C.D. 2016. The effects of dry-rolled corn particle size on performance, carcass traits, and starch digestibility in feedlot finishing diets containing wet distiller's grains. J. Anim. Sci., 94:1194-1202
- Selger, Bill. 2014. Use of grain sieves for evaluation of processed corn grain. Progressive Dairyman.
- Stock, R.A. and Erickson, G.E. 2006. Associative effects and management – combinations of processed grains. Oklahoma State University Cattle Grain Processing Symposium, pp. 166-172
- Swanson, K.C., Islas, A., Carlson, Z.E., Goulart, R.S., Gilbery, T.C., Bauer, M.L. 2014. Influence of dry-rolled corn processing and increasing dried corn distillers grains plus solubles inclusion for finishing cattle on growth performance and feeding behaviour. J. Anim. Sci. 92:2531-2537.
- Zinn, R.A., Barreras, A., Corona, L., Owens, F.N., and Plascencia, A. 2011. Comparative effects of processing methods on the feeding value of maize in feedlot cattle. Nutrition Research Reviews, 24: 183-190

---------- VB ----------

Megan Van Schaik, Beef Cattle Specialist

Ontario Ministry of Agriculture, Food & Rural Affairs

Megan.VanSchaik@ontario.ca

Dr. Katie Wood, Assistant Professor, University of Guelph

---------- VB ----------

Fecal starch analysis – What can it tell you about your feedlot ration?

An Important Feedback Mechanism for your Feeding Program

Emily Conlin, Beef Cattle USEL Student, OMAFRA, Megan Van Schaik, Beef Cattle Specialist, OMAFRA, Guelph and Dr. Katie Wood, Assistant Professor, University of Guelph

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. While feed efficiency is often measured through a feed conversion ratio, taking other measurements such as fecal starch into consideration helps to improve feed use efficiency. A fecal starch analysis is an effective tool for monitoring starch digestion as fecal starch represents starch in the ration that has gone undigested. 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.

Most commercial labs offer fecal starch analysis, either by NIRS or wet chemistry, within a $20-$25 price range. NIRS tends to be more cost effective than wet chemistry with quicker results. For the sake of accuracy, integrity in sample collection and submission is important. A few considerations for sample collection protocol include:

- Contact an accredited laboratory for detailed sample collection instructions and sample jars (do not use plastic sample bags!)
- Take multiple samples rather than a spot sample for a representative sample. Take at least 5 samples from different animals at random per pen to mix together, making a composite sample.
- Samples obtained should be taken as freshly expelled manure. Look for cattle defecating and immediately take samples from fresh manure. Make sure the samples aren't contaminated by bedding or other substances as this can lead to inaccuracies in results.
- Composite (mix) individual samples proportionally and freeze samples prior to sending to the lab.

How do your feedlot fecal starch results stack up?

The objective of a feeding program is to optimize feed efficiency to reduce feed costs whilst maximizing gains in cattle. A high fecal starch result indicates lost opportunity and inefficiencies in feed utilization. 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. Data was collected in 2019 on Ontario feedlots (*Figure 1*; n=16), and *Table 1* provides the results from the Ontario benchmarking study as well as data collected in a study by Schwandt et al. (2017) in the American Midwest.

Table 1. Fecal Starch (% of fecal DM) results from Ontario and Midwest US benchmarking studies

	Fecal Starch (%)					
	n	Mean	SD	Min	Max	Source
Ontario	16	12	4.8	5.3	20.1	Wood, Van Schaik, and Conlin, 2019 (unpublished)
Midwest US	34	19	6.5	7	36.6	Schwandt et al., 2017

*n represents the number of farms from which composited fecal samples were taken

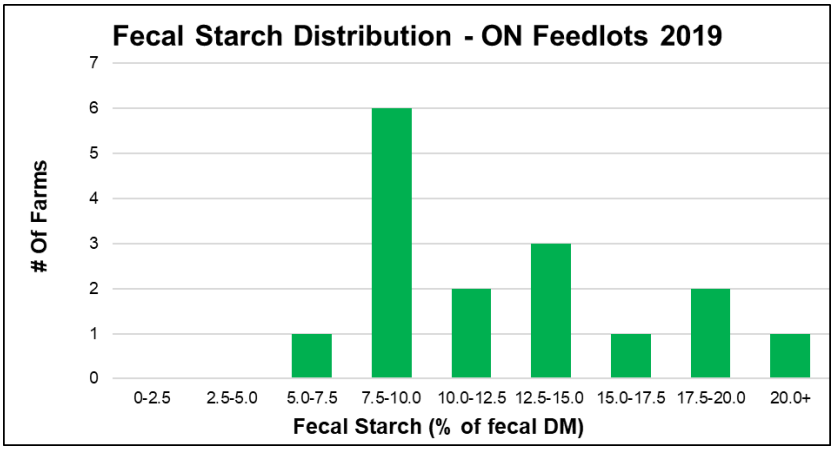


Figure 1. Distribution of fecal starch concentration based on pooled fecal samples from 16 commercial feedlots in Ontario (2019)

What factors need to be considered when fecal starch is high for cattle fed corn-based diets

- *Particle Size Distribution* – 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. Increased degree of processing is related to improved dry matter and starch digestibility. However, the extent of fines produced must be monitored to manage risk of reduced rumen pH and digestive upsets (e.g. bloat). Particle size distribution is influenced by processing method and settings/maintenance on processing equipment. Processing grains through steam-flaking, rolling, or grinding with a hammermill enhances total tract starch digestibility.
- *Corn Vitreousness* – Vitreousness describes the nature of the endosperm of the corn kernel. Increased vitreousness reduces starch digestibility and vitreousness varies depending on the corn hybrid and maturity. Ensiling and steam flaking reduce the impact of vitreousness on starch digestion.
- *Kernel Processing: Corn Silage* – Particularly important in rations with high corn silage inclusion (e.g. grower rations), the degree of kernel processing in corn silage impacts starch utilization

References

- Mahanna, B. 2009. Digestibility of corn starch revisited: Part 1. Feedstuffs, volume 81 issue 6.
- Mahanna, B. 2009. Digestibility of corn starch revisited: Part 2. Feedstuffs, volume 81 issue 10.
- Stanford, K., Swift, M., McAllister, T., Gibb, D. 2015. Fine tuning fecal starch can cut your feed bill. Beef Cattle Research Council. Retrieved April 27, 2020.
- Schwandt, E.F., Thomson, D.U., Bartle, S.J., Reinhardt, C.D. 2017. A Survey of Dry Processed Corn Particle Size and Fecal Starch in Midwestern US Feedlots. Kansas Agricultural Experiment Station Research Reports. Volume 3: Issue 1.

---------- VB ----------

Emily Conlin, Beef Cattle USEL Student

Ontario Ministry of Agriculture, Food & Rural Affairs

Megan Van Schaik, Beef Cattle Specialist

Ontario Ministry of Agriculture, Food & Rural Affairs

Megan.VanSchaik@ontario.ca

Dr. Katie Wood, Assistant Professor, University of Guelph

---------- VB ----------

Effect of Weight at Turn-Out to Pasture on Average Daily Gain

James Byrne, Beef Cattle Specialist, OMAFRA, Lindsay

Producers whom background cattle on pasture typically expect their animals to deliver good performance through high average daily gains (ADG). This expectation is based on the correct assumption that grazed pasture can deliver high animal performance and do so relatively cheaply. However, very often this is not what is observed by producers. In many situations producers find that their animals do not perform as expected and growth rates may be even lower than what they observed over the winter-feeding period.

Cattle often lose weight when they go from winter feeding in confinement to grazing on pasture. This can be attributed to a period of acclimatization for animals to adapt from a confined feeding regime of mainly dried forages to the new grazing regime of fresh pasture. This transition that often results in weight loss is partly due to the time required by the rumen bacteria to adapt to the new fresh forage diet after a dry forage/grain diet while in confinement.

The degree of weight loss is also influenced by the difference in the plane of nutrition between the confined state and the grazing state. As an example, a typical backgrounding diet provides 1.6 Mcal/lbs to 2.4 Mcal/lbs of net energy, depending on the rate of grain, whereas a typical May/early June pasture has a net energy content of approximately 0.73 Mcal/lb. Where the plane of nutrition in the confined state is higher to that of to the plane of nutrition at grazing, (as in the example), weight loss can be significant. If on the other hand, the plane of nutrition is similar between the confined state and pasture at turnout, weight loss will be minimal.

Outside of this short period of acclimatization, animal weight and age at turnout can play a significant role in animal performance at pasture. Research has demonstrated that cattle that are younger and weigh less gain faster than cattle that are older and weight more. This reason for this observation is that as animals gain weight and mature, they lay down more fat. As the amount of fat increases, the percentage of energy in the diet that must go towards maintenance increases, reducing the amount of energy that can go towards gain, thereby reducing average daily gain and therefore performance. When this is combined with poor pasture management resulting in a lot of mature poorly digestible pastures, the reduction in average daily gain seen in mature and heavier animals can be significant.

Research has also shown that animals kept on a low plane of nutrition during the winter-feeding phase grew faster over the pasture grazing phase compared to animals that were kept on a high plane of nutrition over the winter-feeding phase and were heavier at turnout. This effect is referred to a compensatory growth and is an effect that producers can harness to maximize productive and economic efficiencies from livestock at pasture. It must be noted that compensatory growth rarely delivers 100% compensation – lighter animals at turnout, despite high average daily gains over the grazing period, rarely attain the final weight heavier animals at turnout achieve at pasture, even with their lower average daily gains. It has been shown that animals over 700 lbs at turnout show the greatest capacity for compensation but very light animals, i.e. those under 500 lbs, have the least capacity for compensation. Although compensatory growth is well known, it is not well understood and there is significant variation between individual animals in their capacity to compensate. The benefit to producers from this effect is to reduce the cost of production through lower feed costs over the winter-feeding period, when feed costs are typically high, with the knowledge that the animals will “make it up” over the grazing period when feed costs are significantly lower. High average daily gains over the grazing period are necessary to justify the winter feed cost savings.

OMAFRA beef specialists and Victoria Community Pasture (Woodville, Ontario) undertook a trial over the Summer of 2019 to demonstrate the effect of weight at turn out on average daily gain and to observe the effects of compensatory growth. In early 2019, Victoria Community Pasture installed a new handling facility which allows easy recording of the weight of each individual animal as they arrive and leave the pasture. From this, very accurate average daily gains for each animal over the grazing season can be obtained. The focus of the study was to determine if weight at entry onto the pasture had any impact on average daily gain over the grazing season and if compensatory growth could be observed.

Figure. 1: Heifers grazing at Victoria Community Pasture, Woodville, Ontario, 2019

For the purposes of the study 220 heifers were selected and were rationally grazed in two separate pastures. On arrival each animal was weighed, and the weight electronically recorded. A grazing period of 150 days from May 20th to Oct 16th, 2019 was observed. At the end of the grazing period each animal was weighed, and the weight electronically recorded. The average daily gain (lbs. per day) was calculated and data from all 220 animals in the study was collected for analysis. Animals were divided into weight ranges and the average daily gain for each weight category was calculated as presented in *Table 1*.

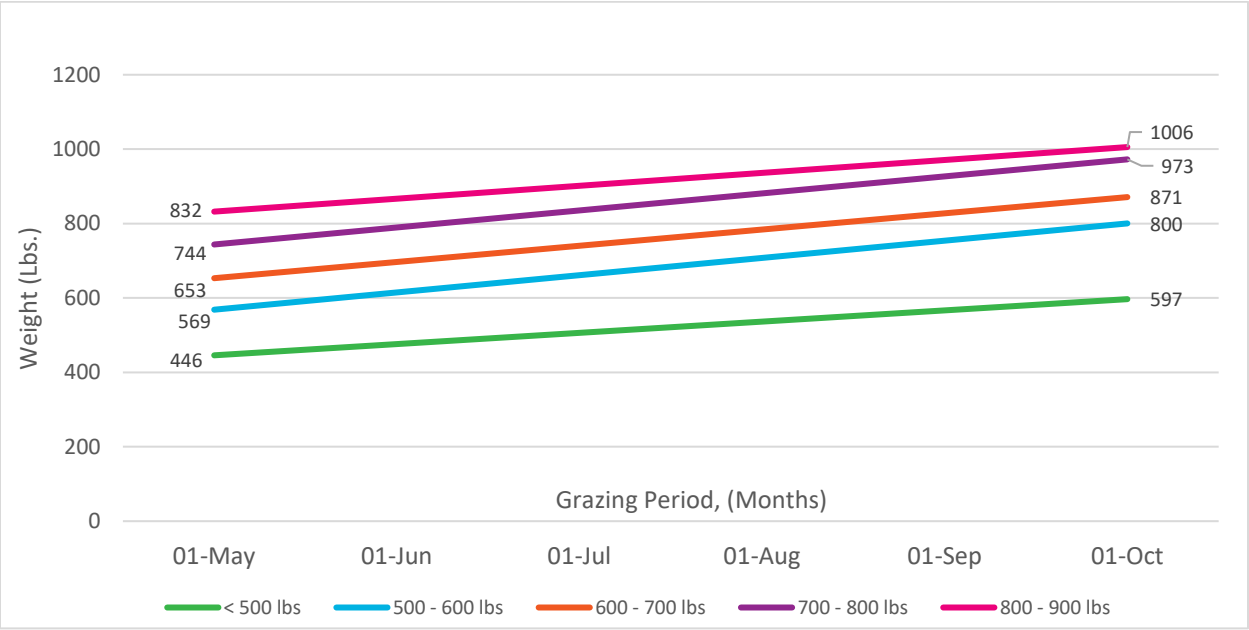
Table 1: Impact of weight at turnout to pasture on gain and average daily gain

Weight Category (lbs.)	Weight at Start (lbs.)	Weight at End (lbs.)	Gain (lbs.)	Average Daily Gain (lbs. per day)
< 500	446	597	151	1.01
501 - 600	569	800	231	1.54
601 - 700	653	871	218	1.45
701 - 800	744	973	229	1.53
801 - 900	832	1006	174	1.16

(Byrne & Van Camp, 2019)

As presented in Table 1., the results demonstrate that animals that weighed less than 500 lbs. and animals that weighed greater than 800 lbs. have the poorest average daily gain at pasture following turnout. This observation agrees with the literature. Animals in the 500 to 800 lbs. range were similar in total gain and average daily gain, suggesting there is a wide ideal weight range to turn out cattle onto pasture. However, the compensating capacity of each group of animals must also be measured to properly assess the impact of weight at turnout. Compensating capacity is a measure of how the end weights of a lighter group of cattle at turnout compare to the end weights of a heavier group of cattle at turnout at the end of the grazing season. It is expressed as a % of the final weight of the heaviest group at turn out. Graphically it appears as a narrowing of the gap between two weights from the start of the grazing period to the end. This is illustrated in Figure 2.

Figure 2. Relationship between compensating capacity of cattle and weight.



(Byrne & Van Camp, 2019)

Figure 2 shows the compensating capacity of different weight classes from the start to finish of the grazing season. The animals in the 700 – 800 lbs. range at turnout had the greatest capacity for compensation as they compensated within 96% of the final weight of the heaviest group at turnout.

Compensating capacity is an important financial measurement. In this trail animals in the 700 – 800 lbs. range, at turnout, which would cost less to feed over the winter period compared with the heaviest group at turnout, weighted almost as much at the end of the grazing season as the heavier group, which would have cost more to feed to the heavier weight over the winter. Therefore, the lighter group at turnout would more profitable than the heavier group when both groups are sold at the end of grazing season. Although the animals in 500 – 700 lbs. weight ranges had similar performance to animals in the 700 – 800 lbs. range, these animals would be unable to compensate sufficiently over the grazing period for their reduced sale price to be sufficiently offset by the feed cost savings over the winter-feeding period.

Implications for producers

This trial demonstrated the importance of liveweight at turnout on performance at pasture with those animals in the 500 to 800 lbs. range having the greatest capacity to perform over the grazing season. But within that range, animals in the 700 to 800 lbs. range have the most potential to be the most profitable as they have compensated enough to justify the lower weight at turnout through feed cost savings over the winter-feeding period. However, the ideal target weight range at turnout for individual producers will vary depending on their individual winter cost of production.

Planning for turnout to achieve good performance at pasture begins at the start of the winter-feeding period. Producers should work with their nutritionist to develop a feeding regime that will produce cattle at turnout within the individual producers target weight range. After turnout good pasture management is critical to achieve the high growth rates necessary to deliver economic compensation. If grassland management is poor, average daily gain will be poor and animal performance will be insufficient to justify the feed cost savings achieved over the winter-feeding period.

The importance of having high quality pasture available over an extended period of time to drive high growth rates in compensating animals cannot be overstated. To achieve the high growth rates required, pastures must be maintained in the vegetative state for as long as possible.

Optimizing the performance and profitability of backgrounding cattle at pasture requires fall planning of the winter-feeding regime of cattle that front loads performance, turning out those cattle at an ideal target weight and getting high performance by providing high quality pasture over an extended period of time. This approach, through practice, will help deliver sustained performance and profitability.

Acknowledgements

OMAFRA would like to thank the management, staff and consignors at Victoria Community Pasture for their help with this trial. OMAFRA would like to acknowledge the assistance provided by Matthew Van Camp, OMAFRA SEO Student, in data collection and analysis.

References:

- Yarrow, N.H., Penning, P.D. and Johnson, R.H. 1996. The effect of plane of winter nutrition and sward height on the performance of steers grazing grass/white clover swards. Grass Forage Sci. 51:424-433
- Jannasch, R.W., Charmley, E. and Rodd, A.V. 2002. The effect of spring turnout date on weight gain by cattle on native pasture. Can. J. Anim. Sci. 82: 575-585
- Charmley, E. and Boyd, J. 1997. Factors influencing weight loss of steers upon turnout to pasture. Can. J. Anim. Sci. 77:744-744
- Nams, V.O. and Martin, R.C. 2007. The effects of turnout date to pasture on cattle weight gain. Can. J. Anim. Sci. 87:527-534
- Hironaka, R. and Kozub, G. 1973. Compensatory growth for beef cattle restricted at two energy levels for two periods. Can. J. Anim. Sci. 53: 709 – 715.
- Thompson, E. and Bickel, H. 1980. The efficiency of compensatory growth in beef cattle. Ann. Genet. Sel. Anim. 12 (1): 125.
- Ashfield, A., Wallace, M., McGee, M. and Crosson, P. 2014. Bioeconomic modelling of compensatory growth for grass-based dairy calf-to-beef production systems. J. Agr. Sci 152: 805-816

---------- VB ----------

James Byrne, Beef Cattle Specialist

Ontario Ministry of Agriculture, Food & Rural Affairs

James.Byrne@ontario.ca

---------- VB ----------

Managing Digital Dermatitis in Beef Cattle

Dr. Cynthia Miltenburg, Lead Veterinarian Animal Health and Welfare, OMAFRA

Summary
Digital dermatitis is a painful foot condition causing lameness. The disease has been associated with several different bacteria, primarily a group of bacteria called *Treponema* spp. These bacteria survive best in wet or muddy conditions and the disease is highly contagious once an animal in a group becomes infected. Prevention and control of the disease depends on prompt detection and treatment of affected cattle.

What is digital dermatitis?
Digital dermatitis is an infectious disease of cattle. It was first identified in dairy cattle in the 1970s, but the cause of disease was not initially clear. Numerous microorganisms have been identified on the surface of lesions, many which may be associated with the environment, the lesions themselves, or both. The resolution of lesions in response to treatment with antibiotics suggested a bacterial cause. The disease is now recognized to be polybacterial, meaning multiple bacteria must be present to produce the condition. Substantial evidence exists that several species of the bacteria *Treponema* from the spirochaete family are consistently associated with disease. Other bacteria may be involved to facilitate colonization of the skin and lesion development. The profile of bacteria associated with lesions may differ between farms and change overtime as the lesion progresses.

The disease is characterized by painful lesions on the feet. Initially, lesions are raw, red, circular ulcers with a strawberry appearance, hence why the disease is sometimes referred to as strawberry foot-rot. Typically, lesions occur on the back of the foot, just above the heel and are more common in the hind feet. Chronic lesions may extend up in between the claws and develop hair-like projections with a warty appearance, thus another common name for the disease is hairy heal wart. A scoring system is used for lesions to describe stages from new active lesions, to healing or chronic lesions. The progression of lesions is often associated with increasing severity of lameness. The disease is highly infectious once an affected animal is introduced to a naïve group, although new infections may not be initially apparent as the lesions are slow growing and develop over several months.

The disease is mostly found in cattle kept in confinement, and globally is found frequently in dairy cattle. Identification of the disease in beef cattle has increased over the last decade. Feedlot animals are at greater risk due to confinement. Typically, heavy cattle close to marketing are most often affected. Cattle that are severely lame may display signs such as shifting weight between legs or walking on toes to avoid pressure on the lesions. The severe pain associated with infection makes it an important animal welfare issue for cattle.

Diagnosing Digital Dermatitis
Generally, a diagnosis of digital dermatitis can be made based on the history and signs in the herd. Cattle will need to be restrained in an appropriate foot chute to examine feet closely and visualize the lesions. Once the characteristic lesion is observed, a diagnosis is easily made.

Economic impacts of digital dermatitis
Studies to assess the impact of digital dermatitis have been undertaken in dairy cattle where negative effects on reproduction and milk production losses have been reported in addition to treatment costs. There has been little such research in the beef sector. One 2017 research study reported the presence of active digital dermatitis lesions negatively impacted growth performance, final live weight, and hot carcass weight in finishing beef cattle.

Prevention and management of digital dermatitis
Muddy or wet conditions and purchasing animals are the two most common risk factors for the development of digital dermatitis. Although bacteria are ubiquitous in cattle and the environment, of the more than 20 species of *Treponema* that have been associated with digital dermatitis, none are considered part of the normal bovine flora. Therefore, the introduction of these bacterial species typically occurs when affected cattle are purchased and mixed with unaffected animals. Other factors that can contribute to digital dermatitis outbreaks are high humidity and poor hygiene. Insufficient

hoof trimming and the use of contaminated equipment has been associated with the risk of disease in research from dairy cattle.

Lesions may not be seen for 4 to 5 months after entry into the feedlot, consistent with the average amount of time lesions take to develop and coinciding with animals being ready for slaughter. The occurrence of disease in animals close to marketing can be particularly problematic. Residues may be incurred if lesions are treated with antibiotics or analgesics and transport of severely lame animals is inappropriate and prohibited.

Control of disease should focus on preventing risk factors as well as resolving the lesions in affected cattle. Prompt detection of lesions and efficacy of treatment can influence the severity of lesions. The most common form of individual treatment is the use of a topical antibiotic compound, either as a powder, paste, or spray on the lesion. There are few studies examining the appropriate dose of topical antibiotic, and treatment is considered off label. Historically, bandages have been applied after the antibiotic, but this may be counter productive if bandages quickly become soiled and manure and debris are trapped against the affected foot. This approach to treatment in feedlot animals is challenging because it is labour-intensive and a single treatment might not fully resolve the lesion. Lesions are often reduced in size and improvement in lameness score is noted, but long term, lesions tend to fail to completely resolve and become worse again. The susceptibility of bacteria to the most commonly used antibiotics (tetracycline or oxytetracycline) varies in research, and there may be poor response to treatment for some of the bacteria most prevalent in digital dermatitis lesions. Repeating treatment until a return to healthy skin has been achieved may be necessary.

Control of disease via group hoof disinfection is also used, typically by passing cattle through a footbath. Pulling individual animals with more advanced lesions for treatment can be done as previously discussed, while footbathing may control early lesions from progressing to more severe lesions in less obvious cattle and reduce transmission. A multifaceted approach is likely most effective for feedlots.

The most widely used chemicals in footbaths include copper sulfate, zinc sulfate, formaldehyde and antibiotics. Copper sulfate, although shown to be efficacious in research studies due to its antimicrobial nature and ability to harden hooves, is damaging to the environment. Human health concerns regarding formaldehyde, a carcinogenic compound, discourages its use. Several alternative footbath products have become available, some with limited evidence for cure rates similar to copper sulfate when evaluated in dairy cows. However other reports are only anecdotal or are poorly controlled studies, and research evaluating recurrence of lesions is generally lacking as are feedlot studies. However, the use of footbaths in feedlots is increasing. Moving animals through a footbath on arrival may help to control disease from animals that enter with digital dermatitis. Long, wide footbaths can allow multiple animals to walk through at a time and ensure each foot is exposed to the solution. Short, narrow footbaths can easily be avoided by cattle. The length of contact time required will vary by product, and label or veterinary directions should be consulted. Some products may require several minutes contact time. After foot-bathing, cattle should stand in a dry area so that the footbath solution can dry on the feet. For feedlots, there lacks a consensus for how often cattle should be using a footbath. Several times during the feeding period (monthly) has been suggested, and more often (weekly or bi-weekly) if cases are being diagnosed. The key to any footbath is changing the solution when it becomes soiled with manure to ensure efficacy of the foot bath solution.

Other management strategies have been largely unrewarding. Research efforts to develop a vaccine have not been successful to date. Mineral nutrition is considered important in general hoof health and lameness and should be evaluated, particularly if increasing prevalence of lameness in the herd. There is however little research identifying specific deficiencies associated with digital dermatitis or supplements to reduce the disease. To manage the disease, it is necessary to maintain lameness and treatment records. These should include the type of lameness (digital dermatitis or other diagnosed diseases), the treatment given, success, and usage of the footbath. This information can monitor disease prevalence and treatment success and inform future risk mitigation and control strategies.

References:

- Evans NJ, Murray RD, Carter SD. Bovine digital dermatitis: Current concepts from laboratory to farm. *Vet J*. 2016;211:3–13.
- Gillespie A, Carter SD, Blowey RW, Evans N. Survival of bovine digital dermatitis treponemes on hoof knife blades and the effects of various disinfectants. *Vet Rec*. 2020;186(2):67.
- Glynn, T., Footrot in Sheep: 3. Treatment, *Note Number AG0447,* Published August 2003

- Kulow M, Merkatoris P, Anklam KS, et al. Evaluation of the prevalence of digital dermatitis and the effects on performance in beef feedlot cattle under organic trace mineral supplementation. *J Anim Sci*. 2017;95(8):3435–3444.
- Plummer PJ, Krull A. Clinical Perspectives of Digital Dermatitis in Dairy and Beef Cattle. *Vet Clin North Am Food Anim Pract*. 2017;33(2):165–181.
- Shearer JK, Plummer PJ, Schleining JA. Perspectives on the treatment of claw lesions in cattle. *Vet Med (Auckl)*. 2015;6:273–292.
- Shearer, J. K. and P. J Plummer. Digital Dermatitis in Cow/Calf and Feedlot Cattle. (2015). *Veterinary Diagnostic and Production Animal Medicine Publications*. 95.
- Wilson-Welder JH, Alt DP, Nally JE. The etiology of digital dermatitis in ruminants: recent perspectives. *Vet Med (Auckl)*. 2015;6:155–164.

---------- VB ----------

Dr. Cynthia Miltenburg, Lead Veterinarian Animal Health and Welfare

Ontario Ministry of Agriculture, Food & Rural Affairs

Cynthia.Miltenburg@ontario.ca

---------- VB ----------