

Virtual Beef

ISSN 2291-188X VOLUME NO. 23 ISSUE NO. 70 SUMMER 2023

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Ministry of Agriculture, Food
& Rural Affairs

Ontario

Finding the ideal proportions in mixed hay

Christine O'Reilly, Forage & Grazier Specialist, OMAFRA

Alfalfa/grass mixes are a staple in Ontario hay production. Common reasons producers give for growing mixed hay rather than a single species include replacing nitrogen fertilizer applications, increasing the crude protein content of the forage, and providing yield insurance in case of alfalfa winterkill. The proportion of grasses and alfalfa included in these mixes varies widely. Current guidelines are not clear as to what the ideal ratio is for alfalfa/grass mixes.

In a paper published in 2022, Xue and colleagues looked at how the proportions of alfalfa and orchardgrass in a mix affect yield, protein, and greenhouse gas emissions. Mixes are described in Table 1. The researchers also compared how the mixes responded to different rates of nitrogen fertilizer (0, 50, or 100 kg N/ha).

Table 1. Alfalfa/orchardgrass mixes studied by Xue et al. (2022)

Treatment	**Proportion of Species by Seed Weight**
Alfalfa alone	100% alfalfa
75:25	75% alfalfa, 25% orchardgrass
50:50	50% alfalfa, 50% orchardgrass
25:75	25% alfalfa, 75% orchardgrass
Orchardgrass alone	100% orchardgrass

The trial plots were established in September 2015. Nitrogen treatments were applied as urea at green-up in the spring. Four cuts per year were taken off the plots in 2016 and 2017 when alfalfa reached early bloom stage.

Yield

Orchardgrass alone was the lowest-yielding mix at each N rate. Without applied nitrogen, the orchardgrass alone and 25:75 mix had yields that were statistically lower than mixes that were 50% or more alfalfa. Increasing the alfalfa content above 50% did not have a statistically significant affect on yield. When either 50 kg/ha or 100 kg/ha of nitrogen was applied to the 25:75 mix, yields were not statistically different from the mixes with more alfalfa. These results align with the rationale from Ontario producers who grow mixed hay to reduce or eliminate nitrogen fertilizer applications on their forge crop.

Protein

Although there are many factors that contribute to forage quality, Xue and colleagues focused on the amount of protein. Nitrogen is a key component of protein, so adjusting the proportion of alfalfa in the mix and changing the rate of nitrogen applied to the crop are most likely to affect protein. Crude protein is an estimate of the total protein content of a forage. As a rough guide, a beef cow needs her diet to contain 7% crude protein in mid-pregnancy, 9% crude protein in late pregnancy, and 11% crude protein after calving to support milk production.

Unsurprisingly, increasing the alfalfa content in the mix increased crude protein. This finding supports the "more protein" reason given by Ontario producers who grow alfalfa-dominated mixes. However, in this study even orchardgrass alone could provide enough crude protein (11-13%) to support a beef cow in early lactation.

If the cow herd is being fed only forage with a mineral supplement, an alfalfa-dominated mix may not be required to meet their crude protein requirements. However, cattle that are component fed or fed a TMR are usually eating diets that consist of some low protein ingredients, such as corn silage, which reduce the overall protein content of the ration. In these situations, it is typically less expensive to grow forage with more protein in it than to purchase a protein supplement. In all cases, a forage analysis is recommended to ensure that the nutritional requirements of the livestock are being met.

Greenhouse Gas Emissions

This study investigated which mix and nitrogen fertilizer rate produced the lowest amount of greenhouse gas emissions from fermentation in the rumen. Xue and colleagues incubated forage samples in rumen fluid for 48 h to estimate the enteric methane and carbon dioxide emissions.

Methane and carbon dioxide emissions were lowest from orchardgrass-dominated mixes. Emissions were not significantly different between the 50:50 and alfalfa-dominated mixes. Increasing nitrogen fertilizer rates increased the methane and carbon dioxide emissions in orchardgrass-dominated mixtures. At 100 kg N/ha, the emissions from the 25:75 mix were not significantly different from the 50:50 or alfalfa-dominated mixes.

This study did not explore greenhouse gas emissions related to the use of synthetic nitrogen fertilizer in producing the crop. Using more nitrogen fertilizer will increase emissions. Other studies use nitrogen use efficiency (NUE) measures as part of assessing the impact of synthetic nitrogen fertilizer, but the method Xue and colleagues chose for NUE in this study does not allow for that kind of analysis.

Conclusions

Mixes that are at least 50% alfalfa yield well without added nitrogen. These results emphasize the importance of getting a forage analysis done to ensure that the nutritional needs of the cattle are being met. The class of cattle and how they are being fed should be considered when determining the proportion of alfalfa and grasses in a mixed hay stand. These results indicate that Ontario producers who grow mixed forage to reduce nitrogen applications and increase protein content are justified in doing so.

Mixes that are less than 50% alfalfa produce less enteric greenhouse gas emissions. Grass-dominated mixes rely on applied nitrogen to yield well, and synthetic N sources can have significant greenhouse gas emissions associated with their use. As emissions feature strongly in agri-environmental discussions, understanding the sources of greenhouse gases on Ontario farms may become more important to managing them in the future.

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Managing Heifers for Breeding

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The backbone of a cow calf production system is the selection and integration of heifers into the beef herd. In Ontario, the replacement rate varies considerably between farms but on average lies between 10 – 20%. Decisions around which cow to cull range from age of cow, breeding success, calf rearing success, quality of calf, temperament of cow etc. In the majority of cases culling is based on the failure to breed with age a close second.

As the replacement heifer is the foundation of a productive cow herd, the choice of heifer and her development can greatly impact the economics of the farm operation through her genetics, future performance, and longevity. Time of first calving has a major influence on life time productivity, which is one of the most important traits to consider. Research throughout the world has consistently shown that targeting first calving at 24 months maximises lifetime productivity, provided the cow continues to produce a calf per cow per year.

Picture 1: Breeding Heifers with bull as pasture, Cambray, Ontario. James Byrne, OMAFRA.

To calf at 24 months heifers must be bred by 15 months of age. The onset of puberty in cattle is determined by weight, age and breed. Weight is the major factor. The age at which puberty occurs is breed dependant with larger, later maturing breeds coming into puberty later than smaller, earlier maturing breeds.

% of heifers in heat	Angus	Hereford	Charolais	Angus x Hereford	Simmental x British	Lim x British
50	550	600	700	550	650	650
65 - 70	600	650	725	600	700	700
85 - 90	650	700	750	650	750	750

Figure 1: Weight at which 14 – 15 month old heifers reach puberty.

The table above shows the effect of weight on the % of heifers in a herd which show heats. For example, where a producer intends to breed angus heifers 50% of the angus heifers to be bred will show heat at 550 lbs weight. This will have increased to 65% of those to be bred by the time they are 600 lbs and by the time the heifers reach 650 lbs, 90% of the angus heifers selected for breeding will have shown heat. The table demonstrates that earlier maturing breeds reach puberty at a lighter weight than larger framed, later maturing breeds. Farmers should bear these target weights in mind when selecting heifers to breed. Feeding the correct nutrition to heifer calves is important to ensure heifers reach their target weight by 15 months of age.

Replacement beef heifers should attain 65 to 70% of their potential mature weight by the time they are bred at 14-15 months of age. Heifers should gain an average of 1.25 to 1.75 lb. per day from weaning to first breeding or 250 to 350 lbs. during the first winter (depending on breed). This means cows with a mature weight of 1300 lbs should weigh 845-910 lbs at first breeding. For a mature weight of 1400 lbs, the target breeding weight should be 910-980 lbs.

Lifetime productivity rates are affected by feeding management during critical phases. Research has shown that energy intake in excess of requirement can lead to the infiltration of fat into the developing udder which may restrict milk production in those heifers as cows later in life. Poor milk production leads to poor calf performance and earlier culling than planned for that animal.

Medium Framed Heifers				Large Framed Heifers			
Body Weight (lbs)	**Dry Matter Intake (lbs)**	**Total Protein (lbs)**	**TDN (lbs)**	**Body Weight (lbs)**	**Dry Matter Intake (lbs)**	**Total Protein (lbs)**	**TDN (lbs)**
400	10.03	1.08	6.65	500	12.75	1.24	7.82
500	11.86	1.16	7.86	600	14.61	1.33	8.97
600	13.60	1.24	9.01	700	16.41	1.41	10.07

Table 2: Nutrient Requirement for Replacement Heifers (Growing at 1.25 lbs per day).

Table 2 shows the ideal nutrient requirement of growing heifers at various body weights. Medium framed heifers have a lower feed requirement at the same weight as large framed heifers. Producers must be conscious of the frame type of heifer on their farm to avoid underfeeding or overfeeding.

Producers should plan breeding of heifers at least 3 weeks before breeding the rest of the herd. Heifers take longer to cycle post calving than mature cows. By starting breeding heifers 3 weeks earlier than the mature herd, first calf heifers will cycle for their 2nd breeding at the same time as the main herd. A breeding season of 45 days is adequate for heifers provided they are in good nutritional status. To maximise the return from heifers it's important to pregnancy check all heifers and cull those not in calf.

Heifers are very sensitive to calving difficulties. Research by Ontario Veterinary College has shown that on average 22% of first calf two olds require assistance and work by the University of Arkansas has shown that up 34% of first calf 2 year olds require assistance. Heifers must not be over or underfed as both conditions can lead to calving difficulties. The birth weight of the calf is related much more to genetics than to nutrition. Underfeeding will restrict the growth rate of heifers, reduce the size of the pelvis and increase the rate of calving difficulty. Overfeeding equally reduces the size of the birth canal through fat deposition.

Ideally heifers should not be winter fed with mature cows. Heifers are more timid than mature cows and are easily bulled away from feed. This can easily lead to heifers losing body condition and consequently calving down in poor condition. Heifers that calf in poor body condition are slow to rebreed and are at greater risk of calving difficulties. Feeding heifers way from the main herd allows for the easy introduction of supplementary feed if it is required. To reduce the number of groups on a farm, mature cows in poor body condition can be fed alongside the heifer group as their nutritional requirements will be similar. Target the best quality forage to the heifer group and monitor their body condition. Supplementary feeding with grains should be provided to any heifers that starts to lose body condition.

First calf heifers should be separated away from the main herd prior to calving. Calving should be monitored closely, but not obtrusively to avoid increasing stress on the animal which may delay calving, and provide assistance where necessary. The calving process takes about an hour in mature cows but can take over 2 hours with first calf heifers.

Always check that the newborn calf has sucked. First calf heifers are very inexperienced in allowing calves to suckle and assistance may be required. Great care must be taken when handling calves of heifers. A previously quiet heifer may become extremely dangerous and unpredictable post calving.

The best method to reduce the risk of calving difficulties with first calf heifers is to breed heifers to a low-birth weight bull. Calving ease is the relationship between calf birthweight and cow pelvic size. Research has shown than in 80% of cases where calves die at birth they were normal, presented in the correct “diving” position and that the cause of death was suffocation. These types of deaths are primarily due to a mismatch between calf birth weight and dam pelvic size. Calf birthweight varies between breeds and within breeds but a clear distinction exists between smaller framed, earlier maturing breeds and larger framed, later maturing breeds. Producers should select bulls with low calf birth weight when breeding heifers.

Pelvic measurements have been used by some producers as a means of selecting heifers for breeding. The University of Nebraska has developed ratios that can be used to determine the calf birthweight that a heifer could potentially successfully deliver. Measurements are taken at 12 to 13 months of age using a pelvimeter and from those measurements a maximum calf birthweight can be determined.

In Australia, pelvic measurements are primarily used as a culling tool to successfully identify abnormally small or abnormally shaped pelvises rather than as a breeding selection tool. These situations, if left unidentified, are associated with extreme calving difficulty, resulting in caesarean delivery and even death of the calf, cow or both.

Good selection and management of heifers for breeding is critical to the genetic advancement of the herd and the long term profitability of the beef farming enterprise.

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Weak Born Calf Syndrome

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Introduction

The profitability of cow-calf operations depends on successfully breeding and delivering a live calf from each dam and raising that calf to weaning weight. Once pregnancy has been confirmed, the hopes for the calving season are that cows calve in a timely manner and without assistance, and that every newborn calf quickly stands and begins to nurse.

Weak calf syndrome (WCS) describes a newborn calf that is born alive but lacks the normal level of vigour of a beef calf. These calves are slow to stand and may or may not nurse. They are often described as depressed or weakened. Many such calves die shortly after birth, especially during cold or wet conditions. Often producers will assist these calves by tubing the calf with colostrum or colostrum replacer, segregating the pair for increased observation and treatment, or continue to provide milk directly to the calf if suckling is not being observed. This care is intensive and time consuming, but a significant portion of these calves die despite these efforts. Affected calves that do survive are more likely to have decreased growth rates and experience additional illness preweaning compared to calves born without weak born calf syndrome.

Typically, a small number of calves are born with this condition, however it occasionally presents as an outbreak with an unusually high number of calves affected in a single calving season. WCS may be seen in conjunction with an increase in abortions (death of the fetus before 260 days of gestation, approximately 3 weeks before full term) or an increase in stillbirths (death of the fetus before or during calving at full term). Narrowing in on the timing of losses is important to understand the risk factors and further investigate the cause. It is possible that the herd may see an increase in abortions and stillbirths in addition to weak born calves or only WCS, depending on the cause.

There are several risk factors for WCS, and it may be multifactorial in a herd. Working with the herd veterinarian and nutritionist to investigate the individual risk factors can help mitigate the risk of recurrence in future calving seasons.

Nutrition and Trace Mineral Provisions

Variations in feed quality and quantity can contribute to the under supply of protein or energy or result in vitamin and trace mineral deficiency. The nutrient requirements of beef cattle increase significantly in the final trimester of gestation when most of the fetal growth occurs. Pregnant cows must be provided with sufficient nutrition to meet the dam's requirements, the growth of the fetus in utero, and to provide the calf with sufficient resources to stand and nurse after birth.

Research conducted in the 1970s at the University of Idaho was the first to identify that WCS was significantly associated with the amount of protein eaten by the cow during the last 60 days of pregnancy. Calves born to protein-deficient cows cannot generate body heat as well as calves from cows with adequate protein diets. Similarly, a deficit of energy puts calves at risk. Energy requirements vary by cattle age (heifer vs cow), breed or size, and with environmental conditions (increased with extreme cold weather). Body condition is an important indicator of energy balance in cattle. Cattle that calve with a lower body condition score have been shown to have calves that take longer to stand after birth. Notably, although calves born to cows experiencing nutritional restriction typically have lower birth weights and growth rates, cows fed an adequate level of energy are not at risk of elevated birth weights that could be associated with calving difficulties.

Deficiency of selenium and iodine have also been associated with WCS. Much of Ontario is selenium-deficient resulting in low selenium content in forages and requiring the provision of selenium from supplemental sources. If pregnant cows are deficient in selenium, they are unable to provide calves with sufficient stores. A research study from Western Canada that examined neonatal calves that died before 3 days of age found degenerative muscle lesions in a large proportion of calves that were likely associated with low selenium status. Vitamin A and Vitamin E deficiency have also been associated with WCS, especially where cows were consuming low quality stored forages. Both vitamins are more plentiful in green forage and have lower levels in harvested forage. To address this risk, it is best to work with a nutritionist to deliver trace mineral supplementation to all gestating cows. Additionally, giving newborn calves a Vitamin E/Selenium injection at birth reduces the risk of treatment before weaning and death.

Calving Conditions

Cows or heifers that calve with difficulty due to a large calf or malpresentation are at greater risk of having a calf with WCS. A review of calves that failed to breath at birth or failed to stand and nurse that were submitted to a veterinary investigation centre in the United Kingdom found trauma to calves from delivery, including bruising and hemorrhage or broken ribs in a majority of submitted calves. Calves involved in a difficult birth can experience low oxygen levels from stress or prolonged delivery which reduces their capacity to stand and nurse.

Similarly calving in bad weather (cold and/or wet) can result in lower feed intake by the dam and a longer time to deliver a calf. A wet calf born into cold, wet conditions is quickly at risk of hypothermia (low body temperature). These calves must spend more energy to keep themselves warm which may contribute to a lack of stamina or vigour.

Infectious Disease

Bovine viral diarrhea virus (BVDV) is capable of causing several different manifestations of disease, including congenital problems in calves. The disease presentation in cows and calves depends on what point during gestation the cow was exposed to the virus and the strain of BVDV. BVDV can cross the placenta and infect the fetus, however the results of infection are typically seen months later. Infection between 4-6 months of development can result in congenital malformations of the eye or central nervous system or the birth of premature, stillbirth, or weak calves.

Another disease Leptospirosis has been found in some weak born calves, but the significance of this finding remains unclear and requires further investigation.

Prevention of WCS

If cows are entering calving having lost body condition in late gestation, it’s a good idea to prepare for the possibility of WCS. Giving cows a clean, dry, sheltered places to calve will protect calves from cold weather risk. Early examination and observation of cows for progression of calving is wise to minimize risk to calves from dystocia. Calves should get up and nurse within an hour of birth. If this fails to happen, intervention and special care will be necessary to make sure the calf gets colostrum.

To prevent the risk of WCS, our goal is for optimal dam nutrition. Evaluation of forages for quality, particularly in drought conditions, and evaluation of the protein and energy levels in the ration can address the risk for WCS. Monitoring body condition score throughout gestation can ensure needs are being met. Providing a mineral supplement at the targeted per head rate will mitigate the risk of deficiencies. Consumption is best when mixed in with other feed, but free choice provision is also an option. Talk to the herd nutritionist to choose the right product and rate – not all supplement is equal. Where possible, separation of cattle into feeding groups will help make sure all cows get equal access. Review of the herd vaccination program and its delivery to make sure all cows and heifers are protected against BVDV is a good idea.

Finally, if an increased incidence of weak born calves occurs, working with a veterinarian and herd nutritionist will help determine the cause. Conducting a postmortem on deceased calves can provide information on the energy stores of the calf, mineral levels, and rule out infectious causes. Review of the ration and its delivery with a nutritionist can identify opportunities for refinement to reduce the risk of the condition recurring.

Summary

Weak calf syndrome, where calves born fail to stand or nurse, is a risk when adequate protein and energy levels have not been met, mineral or vitamin deficiencies exist, calves experience a prolonged or difficult calving or are born into cold, wet conditions. Infectious causes such as BVDV can also cause weak born calves. Working with a nutritionist to ensure requirements of pregnant beef cattle are met and timely intervention to support newborn calves can reduce the risk.

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When fibre is more than just filler

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For feedlot producers, it is no secret that including fibre in high-grain rations is important for maintaining rumination and supporting rumen and gut health. Although higher forage inclusion has a nutrient dilution effect in the ration and can decrease cattle finishing performance, including some fibre is important to overcome performance decreases due to poor gut heath and associated disorders like liver abscesses. However, many producers and nutritionists often only think about fibre in terms of an inclusion rate of the ration and give little consideration to the type and form of fiber used in the finishing ration. While there is no set fibre requirement for finishing cattle, considerations to grain type and processing, and type of fibre in the ration are likely also important considerations in optimizing fibre in feedlot rations. Undigestible fibre, usually defined as undigestable neutral detergent fibre (uNDF), is the fibre fraction which is resistant to ruminal degradation and may have different functional roles in supporting gut health than forages lower in uNDF. However, little is known about how different fibre types perform when included in finishing rations at the same inclusion rate. Other meta-analysis work by our group led by Melissa Williams, suggests that an estimated uNDF value from feed libraries is better at predicting feedlot performance than actual measured NDF values reported in the studies. This suggests that there is more to learn about fibre, even if only a small component of the ration.

What we did?

The purpose of this study was to investigate the interaction between undigestible NDF (uNDF), using differing forage sources, and starch fermentability, using different grain processing methods on animal performance, feeding behavior, and ruminal pH in feedlot steers.

Two different fibre sources: Corn Silage(CS;low in uNDF), and mixed Haylage(HL; high in uNDF) and two grain sources: high-moisture corn(HMC,) and rolled corn (RC), were used to create four diets of similar nutritive value and the same forage inclusion rate of 5%(Table 1).

Table 1: Diet and chemical composition of high-grain finishing rations

Ingredient Composition (%DM)	CS-RC	CS-HMC	HL-RC	HL-HMC
Haylage	0	0	5	5
Corn Silage (~40% grain)	7	7	0	0
Rolled Corn	0	83	0	85
High Moisture Corn	83	0	85	0
Soybean meal-based trace mineral premix[z]	10	10	10	10
Chemical Composition, %DM				
DM %	66.8	79.5	68.7	83.0
CP	11.91	11.54	12.23	11.73
NDF	9.14	9.9	10.28	10.01
uNDF240[y]	1.57	1.75	2.02	1.87
Starch	59.78	61.93	58.65	60.28
NEm, Mcal/kg	2.21	2.20	2.19	2.20
NEg, Mcal/kg	1.49	1.48	1.47	1.47

[z] 75%SBM, 12% Limestone,Floradale Feed Mill ruminant micro premix with 33 ppm of Monensin, and urea, fed as a mash

After a 4-week step-up, Angus crossbred steers (n=96, 505±54 kg) were fed their respective diets for 114±26d before slaughter. Steers were fed free-choice and feed intake (DMI) and feeding behavior data were collected using Insentec feeders at the Ontario Beef Research Centre-Elora. Bodyweights were collected monthly, and for the last four weeks prior to slaughter continuous ruminal pH was measured using indwelling pH probes (12 steers/treatment). A blood sample was obtained 4 wks prior and 1 week prior to slaughter for analysis of acute phase proteins as an indication of whole body inflammation. At slaughter, liver abscesses and gut health scores were assessed for indications of inflammation.

What we found out?

Although diets were very similar in their nutrient composition, steers on the CS diet had greater (P<0.02) ADG and F:G for the first half of the finisher period (Figure 1). However, these differences disappeared for the second half or overall finisher period between forage or grain sources, or their interaction. Steer DM intake did not differ (P=0.53), but time spent at the feeder (min/day) was greater (P=0.03) for RC steers. At slaughter, steers fed HMC treatments had greater (P<0.03) final body weights and hot carcass weights. However, no differences were found for ruminal pH during the last 4 weeks before slaughter, but pH of cecal digesta at slaughter was greater (P=0.0002) for HMC when compared to RC. Rumen fluid of RC steers had greater (P<0.01) total volatile fatty acids, and butyrate concentration than HMC fed steers, where cecal digesta had greater (P=0.03) propionate concentration for CS-RC fed steers over all other treatments. The acute phase protein, serum amyloid A was found to be greater (P=0.04) in steers fed CS over HL fed steers 4 weeks before slaughter, but these differences did not persist at 4 d before slaughter. Although not enough animals were enrolled on this study to evaluate differences in liver abscesses, numerically there were more abscesses on HL than CS, where corn processing was almost identical. However, a large study would be required to study this effect properly.

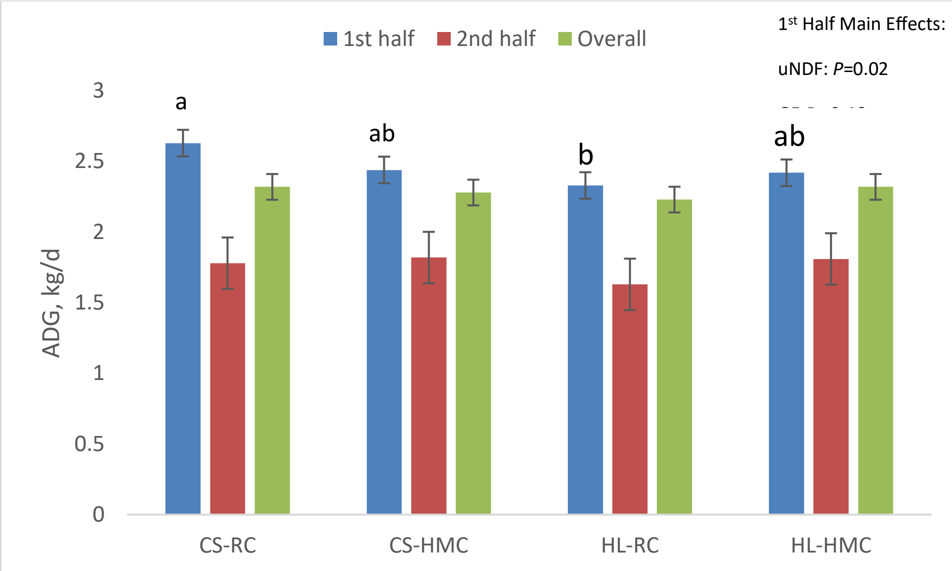
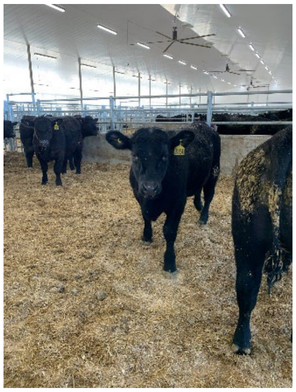


Figure 1: Average Daily Gain for the 1st half, 2nd half, and overall period for steers fed diets with corn silage (CS) or haylage (HL) and rolled corn (RC) or high-moisture corn (HMC) during the finishing period. Similar coloured bars differing in superscripts, differ significantly ($P \leq 0.05$)

What does this mean?

Although diets were very similar in energy and protein content and contained the same forage inclusion rate, differences in fibre type and starch fermentation had some important differences which could have implications in animal health and performance. Diets lower in uNDF improved early gain and feed conversion but may result in increased health risks as indicated by increased SAAs in the blood compared to higher uNDF fibre, although HL had numerically greater liver abscess scores. Future work should investigate if switching uNDF sources halfway through finishing would benefit performance and health. Starch fermentation characteristics showed RC had altered fermentation characteristic compared to finely processed HMC, as indicated by differences in rumen and cecal differences in volatile fatty acid production, and may have helped to improve final and hot carcass weight. With limited differences in other performance or gut health parameters measured, suggests that rolled corn would be beneficial over finely processed HMC. This data shows that even small changes in diet type can have implications on economically important traits for feedlot producers. Although many nutritionists may not include uNDF as part of their typical feed analysis package, better understanding the type of fibre--beyond simply a fibre inclusion rate, may help us better understand a true fibre requirement for high-grain fed feedlot cattle.



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