

Virtual Beef

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Direct general questions and suggestions to: Havelah Carter, Editor at havelah.carter@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

Effect of grazing regime on cattle and land performance

Nicole Burghgraef, beef cattle summer assistant and James Byrne, Beef Cattle Specialist, OMAFRA

There are several different types of grazing management systems that producers can use when grazing cattle on pasture. These can be broadly divided into "unmanaged" and "managed" systems. In an "unmanaged" grazing system, there is limited management of the grazing livestock or pasture. Conversely, "managed" grazing systems have a greater degree of pasture and livestock management.

Continuous grazing is the best example of an "unmanaged" grazing system. Although the livestock are monitored by the farmer, (e.g., health of cows and calves, breeding status of cows, pasture availability etc.), it is categorized as "unmanaged" because little to no attention is paid to the management of the pasture. A continuous grazing regime usually requires no internal fences, or extra labour to move cattle around to different areas of the pasture.

Set-stocking and rotational grazing are examples of a "managed" grazing system. Both systems require internal fences, additional sources of water and extra labour to move animals between sub-divisions. Although "managed" grazing systems are more expensive to implement due to extra internal fences, additional water source requirements and moving livestock between different areas of the pasture, there are also significant benefits. Rotational grazing is promoted to producers as the best form of grazing; however, scientific evidence does not always support this. Advantages and disadvantages of each grazing regime and the results from our research trial evaluating the potential differences in profits between grazing systems on a per animal and per acre basis will be discussed below.

Figure 1. Heifers grazing in a continuous grazing system. Photo taken by James Byrne.

Types of grazing systems

Continuous grazing requires the lowest maintenance. This grazing system is defined by unrestricted and uninterrupted access to an area of pasture where the animals graze the same area for the whole season. The main advantage of this grazing system is that it is simple and inexpensive. A disadvantage that comes with using continuous grazing is that it can degrade the quality and productive capacity of pastures over time. Additionally, the stocking rate is typically kept low on continuously grazed pastures to ensure an adequate supply of pasture for the duration of the grazing period. This very low stocking rate allows livestock to be more selective in what they graze, which leads to weeds and other unpalatable plants maturing, setting seed and populating the pasture more densely. This can also lead to bare patches being left in the pasture. With no vegetation keeping the topsoil in place, the risk of erosion increases substantially which can result in localized nutrient leaching. Above all, the biggest disadvantage of a continuous grazing regime is the low stocking rate, which limits the number of animals that can be grazed per acre and therefore, limits the farmers total potential income from that area of pasture.

Rotational grazing consists of a large pasture being fenced off into smaller paddocks, ideally all the same size. The pasture is typically divided into at least 10-12 smaller paddocks and sometimes up to 30 depending on the overall acreage. Cattle are moved to a new paddock every few days. Dividing the pasture allows the producer to balance livestock needs with the amount of forage available. The rotation can be in a sequential order or based on forage yield where growth and dry matter content are estimated, and the cattle are moved into the highest yielding paddock. Rotational grazing is sometimes called 'intensive rotational grazing' or 'management intensive grazing' due to the amount of organization and time required. There are significant benefits to rotational grazing when it is properly managed. These include enhanced quality and higher yielding pastures, better utilization, and potentially faster regrowth. These advantages allow for producers to have a higher stocking rate, and improved weed control as the livestock are forced to be less selective. The higher stocking rate can potentially increase beef output per acre and therefore, revenue may also increase. Furthermore, manure will be spread more evenly around the pasture resulting in balanced nutrient cycling. There are some disadvantages to the system. More labour and materials are needed for this type of grazing regime compared to other systems because of the added fencing, water sources and shelter needed for each paddock. In addition to that, the physical labour required to move the cattle every few days can take up valuable time, (James, 2011).

A set stocking grazing system is an intermediate between continuous and rotational grazing. It typically consists of the pasture being divided into fewer, larger paddocks. Set stocking is defined as rotating approximately every five days, however, the average length of time cattle spend in each paddock is usually 10-14 days. The benefits are like rotational grazing, but it costs less to maintain. Fewer fences are needed to divide the pasture and less labour is involved as the cattle are moved less often than in a rotational system. Utilisation rates in a set stocking system are slightly higher when compared to a continuous system and slightly lower than a true rotational system as a result of the stocking density.

Figure 2. Heifers grazing in a rotational grazing system. Photo taken by Nicole Burghgraef.

Our project

As rotational grazing practices are promoted as the ideal grazing method, our goal for this project was to compare the value of monetary gain per animal and per acre between each type of grazing system (continuous, rotational, set stocking) and determine how economically beneficial, rotational grazing is, or not, compared to the others. This project was completed on a farm that uses all three types of grazing systems. Herds of only heifers were used to reduce variability and to keep data consistent. Data was collected from one rotationally grazed pasture, one set stocking pasture, and four continuously grazed pastures. We analyzed the farm's annual reports to gather the data needed on herd head counts, total herd gain in pounds, and average gain per animal over the grazing season. The reports also provided the acreage of each pasture. In order to ensure a consistent analysis was completed on all pastures, acreage was recalculated on an adjusted basis to account for areas that are not grazable such as woodland and swampy areas of the pastures. From this data, stocking rate (number of heads per acre), and pounds gained per adjusted acre over the grazing season was calculated.

Using market prices from the Beef Farmers of Ontario Weekly Market Report, an average price per pound gained for three weight categories was determined (700-799 lbs, 800-899 lbs and 900+ lbs). The weight categories were created based on the weights of the heifers at the end of the grazing season. The value of gain per animal and the value of gain per acre for the years 2013-2021 for the different grazing systems was calculated using the three weight categories. The average value of gain for each grazing system between 2013 and 2021 was calculated to establish a single value for each type of grazing system on a per animal and per acre basis. The percentage differences in the values compared to the rotational grazing system was then calculated.

Results

In line with previous research there was no significant difference in gain per animal between grazing systems, however, there was a significant difference in value of output per acre (**Table 1**). Rotational grazing produced, on average, $386 per animal. The set stocking system returned 6% less at $364/animal and the continuous grazing system produced 6% more than the rotational grazing system at $409/animal. On a per acre basis, rotational grazing had the lowest income at $209 gained per acre. Set stocking did 56% better with $326/acre and continuous grazing did 59% better at $332/acre.
It must be noted that the rotational grazing pasture analysed for the project did not actively use the entire pasture available. When the actual grazed area of the rotationally grazed pasture is used in the calculations, the performance difference between the systems is reduced to 16% and 18% between the set stocking and the rotational grazing system and the continuous and the rotational grazing system, respectively.

Table 1. Value of gain (VOG) on a per animal and per acre basis of each grazing management system and the difference compared to the rotational system.

Grazing system	VOG/animal ($/animal)	Difference	VOG/acre ($/acre)	Difference
Rotational	386.25		209.18	
Set Stocking	363.62	-6%	326.1	+56%
Continuous	409.36	+6%	332.19	+59%

Discussion

The goal of this project was to examine how profits differ between grazing systems on a per animal and per acre basis. The results above demonstrate that the type of grazing system used does not have a significant impact on individual animal performance. This was expected as individual cattle have a limit on the amount of pasture they can consume, regardless of the management system used. Assuming that pasture intake is adequate under any grazing system, performance will be equal, allowing for normal variability, between cattle.

The type of system does, however, influence how well the land performs by the number of cattle that can be grazed per acre. In theory, rotational grazing can produce higher performance and higher output on a per unit of land basis, but this relies on good pasture management. The results exemplify that rotational grazing is not always as rewarding as it has been made out to be and, in this case, it performed poorer than continuous or set stock grazing systems. When a rotational grazing system is poorly managed, the benefits will not be seen. This is an important fact, particularly when a producer is considering changing their current grazing regime to a rotational grazing system. Careful consideration should be given to understanding the management requirements of a rotational grazing system and the costs involved. The investment in rotational grazing systems costs more due to the added fencing, additional water sources and added labour of moving the cattle every few days. However, under a well managed rotational grazing system, the return on investment should still be greater than the initial costs.

Rotational grazing systems offer the best opportunity to optimize output from grazed pasture compared to other grazing systems by enabling the grazing of more animals per unit of area. However, rotational grazing systems require appropriate management in order to realize this improved output.

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With contributions from James Byrne, OMAFRA Beef Cattle Specialist, and Christine O'Reilly, OMAFRA Forage and Grazing Specialist

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James Byrne, Beef Cattle Specialist
Ontario Ministry of Agriculture, Food & Rural Affairs
James.Byrne@ontario.ca

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New ways to measure efficiencies in the cow herd

Dr. Katie Wood and Lauren Finlay, University of Guelph

With the cost of feed, land, and inputs all on the rise, it is no surprise that improving feed efficiency is one of the key approaches to improving profitability in the cow/calf sector. However, defining feed efficiency in the mature cow herd can be very challenging. Traditional measures of feed efficiency usually involve comparing some measure of inputs (usually feed intake) to measures of outputs (usually growth, weight gain, milk production, etc.), resulting in metrics like feed conversion ratios and residual feed intake. However, in mature beef cows these measurements are difficult to measure accurately, are costly and require specialized equipment, and are tough to measure on pasture systems.

Further complicating this challenge is that minimizing feed intake may not be the #1 goal in optimizing efficiency for grazing cows. When cows graze or are fed a low-quality forage diet, feed intake may need to increase to get enough nutrients for milk production or maintaining body condition. Therefore, metabolic efficiency may be a trait of interest. Heat production can be calculated based on the products of respiration (CO_2 and O_2) and digestion (methane gas) and therefore, may reflect a cow's basal metabolic rate and maintenance requirements. Cows with lower maintenance requirements can better utilize nutrients for production.

With increased research interest in methane production from the livestock sector, research focusing on methane mitigation has increased. Beyond the environmental goods and services aspect of methane mitigation, reduction in enteric methane emissions also has direct benefits to improving production efficiencies, as about ~10% of dietary energy is lost as methane as part of rumen fermentation in forage fed cows.

Our research at the University of Guelph is interested in the relationships between gas emissions from beef cows and more traditional measures of feed efficiency. Using these observed gas emissions, we may be able to calculate other metrics which may closer represent metabolic efficiency, a potentially more accurate measure of efficiency for beef cows. In addition, we also were interested if methane and gas emissions measured in the dry lot were similar when the same group of cows were raised on pasture.

In the first study, 60 Angus crossbred pregnant cows were fed a common forage-based total mixed ration in the barn for approximately 3 months leading up to calving. Feed intake was measured on individual animals using Insentec Feeders and every week pens of cows were cycled through the C-Lock Greenfeeder trailer to measure the methane, carbon dioxide, and oxygen of each individual animal (Figure 1). In addition to performance, feed intake, and gas measurements, and individual animal heat production was calculated using modified Brouwer (1965) equations which adjust for urinary energy losses (HP_{obs}). This observed heat production was also compared to predicted heat production calculations from NRC Nutritional Requirements for Beef Cattle (2016) and therefore provide a "residual heat production" metric (HP_{resid}), which may reflect individual cow differences in metabolic rate. Respiratory quotient (RQ) is the ratio of CO_2 to O_2 and serves as another measure of metabolic rate. These new metrics may give us insights into underlaying metabolic efficiencies in cows.

Figure 1. C-Lock Greenfeed trailers being used to measure enteric gas emissions from cows on pasture at the Ontario Beef Research Station

After this measurement period, cows were ranked by different efficiency traits including, feed intake as a percentage of body weight (BW), residual feed intake, and our new trait "residual heat production". The 1st and 4th quartile of each of the different efficiency rankings were compared. Differences in feed intake were observed for the three efficiency measurements (Table 1). Residual heat production classified cows also differed in residual feed intake (RFI) and DMI/KG between the first and last quartiles, suggesting that this new measure of efficiency is consistent with the more traditional measures of feed efficiency. No differences between gas emissions were observed for HP_{resid} ranked cows, however since these data are used in the calculation of HP_{obs} this may be partially due to artifacts of the calculation of heat production itself.

Table 1. Differences in efficiency traits and gas emissions between the most and least efficient quartiles of cows as grouped by either residual feed intake, dry matter intake per kg of metabolic body weight, or residual heat production

	RFI			DMI/kg of $BW^{0.75}$			$HP_{residual}$		
item	Least Efficient	Most Efficient	P-Value	Least Efficient	Most Efficient	P-Value	Least Efficient	Most Efficient	P-Value
DM Intake, kg	17.7	13.5	<0.001	18.2	13.1	<0.001	17.4	13.3	<0.001
DMI/Kg of BW, kg	0.117	0.09	<0.001	-	-	-	0.117	0.09	<0.001
Residual Feed Intake (RFI)	-	-	-	2.01	-1.85	<0.001	0.92	-0.653	0.04
HP_{obs}, MCal/d	23.6	22.4	0.16	23.2	22.5	0.40	-	-	-
CH_4, g/d	285.7	250.5	0.007	275.9	251.4	0.07	258.1	261.6	0.45
CO_2, g/d	10617	9873	0.04	10378	9919	0.21	10005	9553	0.19
O_2, g/d	7451	7128	0.24	7336	7137	0.48	7135	6751	0.15

In the second part of the study, these same cows were assigned to a pasture groups of 8 cow-calf pairs, managed on the intensive rotational grazing pastures at Ontario Beef Research Centre. Every week, pasture groups were rotated into the Greenfeed evaluation field where gas exchange measurements were also measured on individual animals. Cows were ranked for their methane output from the dry lot experiment and compared to individual cow rankings from the pasture measurement period. Rankings were maintained for methane, carbon dioxide, oxygen, calculated heat production, and metabolic BW ($P < 0.02$), but respiratory quotient rankings were not significantly maintained between dry lot and pasture (Figure 2). This may be due to differences in the metabolic state between the measurement periods (ie dry and pregnant in dry lot vs lactating on pasture).

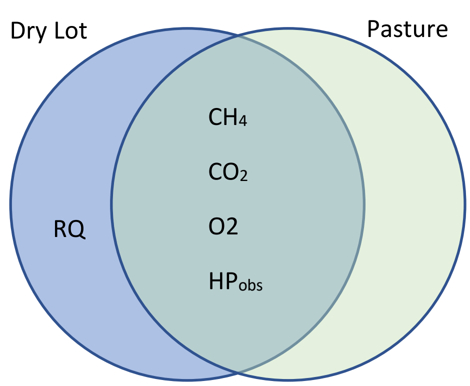

Figure 2. Animal rankings of traits which were correlated ($P \leq 0.05$) between dry lot and pasture Greenfeeder measurements.

So, what does this mean for producers? Firstly, this data indicates that methane mitigation studies conducted in the research barn (dry lot) are likely applicable to pasture-based systems. Secondly, residual heat production may offer some advantages over traditional feed efficiency measures: 1) it does not require measurement of feed intake directly, so may be able to be used on pasture systems where individual feed intake measurement is not possible, 2) although it still requires equipment to measure gases, the measurement period is much shorter (~2 weeks on pasture) than lengthy feed intake studies, 3) Unlike RFI, the predicted HP is based on equations developed by NRC using large datasets, so $HP_{residual}$ may be able to be more compatible across different contemporary groups, than with RFI rankings.

There is still more research to be done to further develop and validate residual heat production as trait to identify metabolically efficient/inefficient cows, but these novel metrics can help improve the accuracy of selection for these economically important traits in the cow herd.

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Dr. Katie Wood and Lauren Finlay
University of Guelph

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An overview of beef on dairy crossbred cattle in the beef industry

Havelah Carter, Beef cattle specialist, OMAFRA

Inseminating dairy cows with conventional beef semen has become a popular practice to accelerate genetic improvement within a herd. While the genetically superior cows are bred using sexed semen to ensure their progeny are female, the cows with less attractive attributes are bred to beef semen to avoid passing their genetics to herd replacements. Additionally, the integration of this practice can produce healthier calves via heterosis while both improving calf prices and reducing semen costs for dairy farmers. Likewise, Ontario beef producers can profit through improved traceability, as well as a year-round supply of calves.

The popularity of this practice has seen a 20% increase in use over the past eight years. This symbolizes producers' willingness to incorporate it into their production system. However, with this rapid adoption, several associated challenges may impact related sectors.

Studies completed in the United States indicate that beef on dairy crosses may have similar, if not superior, eating quality compared to conventional beef due to an enhanced tenderness (Foraker et al, 2022). However, the higher bone percentage in beef on dairy crosses may discount the carcass due to a reduced proportion of red meat. Beef on dairy crosses produce fewer yield grade 4 and 5 carcasses compared to conventional beef cattle due to their reduced fat coverage. When compared to straight dairy cattle, beef on dairy crosses produces more yield grade 1 and 2 carcasses due to their improved muscling (Foraker et al, 2022).

Beef on dairy crosses are less uniform and have variable carcass size and variable carcass quality compared to conventional beef. This is a result of a combination of genetic predisposition of the offspring due to the genetics of it's specific sire and dam and several environmental factors occurring throughout various life stages (Figure 1). Additionally, producer reports indicate that beef on dairy crosses tend to be less timid than conventional beef cattle which could be attributed to how they were reared in early life. Although the hybrid vigour of beef on dairy crosses can hold many benefits, including reduced morbidity and mortality rates compared to Holsteins, the attributes of dairy cattle still tend to be identified in a feedlot setting with beef on dairy crosses being more susceptible to digestive diseases. Liver abscess rates are between 40 and 60% in beef on dairy crosses and only 15 to 30% in conventional beef cattle (Foraker et al, 2022). Although there is minimal evidence that supports the cause of the increased incidence of liver abscesses, it is likely due to a combination of a digestive system that is not as well suited to high concentrate diets, and an increased length of time on feed to finish (Amachawadi & Nagaraia, 2016; Abdela, 2016).

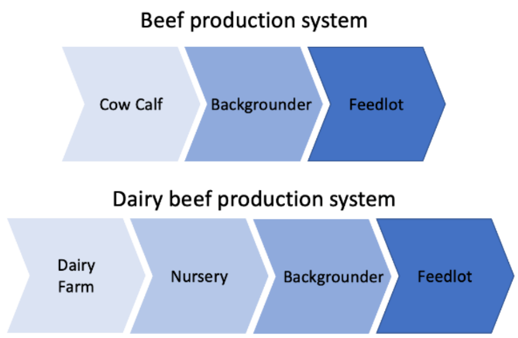

Figure 3. Production systems of conventional beef cattle and beef of dairy crossed cattle.

A dairy producer has three main attributes to consider when selecting a beef sire for their cows: conception rate, calving ease, and birth weight. This genetic selection will play a role in the development and efficiency of the beef on dairy crosses. However, traits that are related to the long-term profitability of these terminal crosses such as weaning weight as well as carcass weight and quality are often overlooked. Several countries have developed beef on dairy indices that not only select for calving ease, but also for traits such as calf vitality, ADG, and carcass quality (Berry, 2021). An emphasis on these performance traits when selecting a sire may improve the viability of beef on dairy crosses in a feedlot setting.

The physical performance of an animal is only partially dependent on its DNA. Environmental and management factors which mainly occur after birth also have a major impact on its growth, development, health, and productivity. Adequate colostrum consumption within the first 12 hours of life is vital to calf success. The rich concentrations of immunoglobulins, known as antibodies, nutrients, and growth factors are necessary for the calf's development and early life health. Research shows that calves who receive less than 6L during the first 24 hours will have reduced lifetime performance compared to calves fed 6 L or more (Godden, 2019). This is shown in research completed at Oklahoma State University where Dr. Selk determined that the risk of disease is three times higher for cattle who had inadequate immunoglobulin levels as a calf in a feedlot setting

The most common practice is for calf rearers to raise beef on dairy crosses under the same protocols as veal calves. Once they are approximately 150 kg, they are shipped to a backgrounder and raised in the same production system as conventional beef cattle where they are transitioned to a high concentration finishing ration.

There is limited research that has observed the response of beef on dairy crosses to conventional growing and finishing settings. During the nursery stage, beef on dairy cross calves may require alternative milk replacer volumes and components and their optimal weaning age and strategy could be different compared to veal cattle. Similarly, there are still questions related to when and how to transition these calves to forage, and from forage to a high-concentration feedlot diet.

Calf management protocols tend to differ across dairy farms and calf-rearing facilities. This variance, paired with the increased likelihood of co-mingling which can amplify morbidity and mortality rates can often contribute to inconsistencies at the finishing level. The rapid adoption of this practice requires further exploration to optimize its benefits. Emphasis should be placed on identifying the most effective management protocols to improve consistency and provide quality cuts to align with current market trends. Considering the reduced initial cost of a beef on dairy crossed calves compared to conventional beef calves and their availability in Ontario, all industry stakeholders must take further steps to better understand how to optimize the production efficiency of beef on dairy crosses.

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Havelah Carter, Beef cattle specialist
Ontario Ministry of Agriculture, Food & Rural Affairs
havelah.carter@ontario.ca

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Protect your feed supply from corn rootworm

Tracy Baute, Field Crop Entomologist, OMAFRA; Christine O'Reilly, Forage and Grazing Specialist, OMAFRA; and Havie Carter, Beef Cattle Specialist, OMAFRA

Corn rootworm is a serious pest of continuous corn. For 16 years, producers growing corn-on-corn have relied on hybrids with rootworm Bt traits (Bt-RW), sometimes called "below-ground protection", to minimize crop damage. Since 2019, populations of corn rootworm with resistance to Bt-RW have been identified in Ontario with an increasing number of fields and counties reporting damage by this pest each year. Beef producers who grow corn for grain or silage to feed their herd need to be proactive about how they grow corn going forward to protect their feed supply and mitigate the spread of rootworm resistance.

Growing continuous corn for more than three years enables corn rootworm to thrive. Corn rootworm larvae hatch in early summer and feed on corn roots (Figure 1). Root damage prevents the crop from taking up enough water and nutrients to reach its full yield potential. Additionally, plants may be stunted and become unstable, "goosenecking" at the base to try to restabilize the plant (Figure 2) making it more susceptible to lodging in adverse weather conditions. Lodged corn is difficult to pick up with the harvester and increases the risk of soil contamination in silage. Soil elevates ash levels and may introduce bacteria that can cause clostridial contamination, butyric fermentation, and reduced feed intakes. Adult corn rootworms are beetles that emerge in July and August to feed on corn silks, which can impact pollination and kernel set, and reduce grain yields and the starch content of silage (Figure 3). The adults then lay their eggs in the soil of corn fields, where the eggs overwinter. If corn is planted in the same field the following year, the cycle continues, larvae eat the roots, and the corn rootworm population builds.

Figure 1. Significant root clipping from corn rootworm larvae. J. Smith, UGRC.

Figure 2. Goosenecking of Bt-RW plants from trying to stabilize after significant root clipping.

Figure 3. Silks can be clipped by adults which impedes with pollination of the ear.

Significant yield loss occurs before symptoms are even noticed. For every root node clipped, there is a 15 to 18% grain yield loss. While the impact of corn rootworm damage on silage yields has not been thoroughly documented, the impact is expected to be equal to or greater than in grain, because both quality and yield are affected. Additional crop loss occurs when portions of the field lodge due to this root clipping, making harvest difficult or impossible.

While many seed companies carry hybrids with Bt-RW traits, switching hybrids does not solve this problem. All the Bt-RW traits available have similar modes of action, and the Bt-resistant corn rootworm populations have increasing cross-resistance. This means that corn rootworm can survive on any Bt-RW hybrid, even if it hasn't been grown in that field before. Other management techniques are required to keep corn rootworm populations low.

Insecticides

Soil-applied insecticides have been tried in the U.S., where Bt-resistant corn rootworm is already widespread. Corn rootworms are so adaptable that within a couple of years of applying insecticides to Bt corn, U.S. producers had rootworm populations resistant to both Bt and insecticides. The delayed emergence of corn rootworm adults exposed to Bt and insecticide means that only resistant adults are left to mate with each other; susceptible adults have already mated and laid eggs.

By using soil-applied insecticides without Bt-RW hybrids in medium-risk rootworm years (e.g., second-year corn), and follow with Bt-RW hybrids without insecticide for the higher risk third-year corn. It is strongly discouraged to use both Bt-RW hybrids and soil insecticides together as it changes the emergence timings of resistant individuals and can speed up resistance to Bt. While soil-applied insecticide could be used on its own with a non-Bt hybrid in second-year corn, after-market installation of an insecticide box to the corn planter is expensive (>$50,000 for a 12-row planter).

Some growers have suggested using foliar insecticides to target the adult beetles, in hopes of keeping them from laying eggs and continuing populations into the next season. However, this is not a recommended practice for a very good reason. Rootworm adults don't all emerge from the soil at once. Emergence is staggered over a month or more. The millions of beetles per hectare sprayed are replaced within a matter of days by newly emerged adults. Furthermore, the adults have likely already mated and laid their eggs in the soil before an application is made. Next year's population is already set, whether or not a foliar insecticide is used. This practice of spraying adults was used in the US and has led to resistance to many foliar products. This is no longer a recommended practice in the US or Canada.

Best strategies for corn rootworm management in continuous corn

Crop rotation is the most effective and least expensive way to keep corn rootworm populations low. Larvae live in the soil and don't move around much, so if they don't find corn roots where they hatch, they starve to death. Corn rootworm larvae do not feed on legume roots, so implementing a legume crop like soybeans or alfalfa into the field is an excellent way to break the corn rootworm lifecycle (Figure 4).

In feedlot situations, the need for feed can make rotating out of corn more difficult. There is room for up to three years of corn-on-corn without significant corn rootworm destruction. By rotating a field out of corn, populations crash and take at least two to three years to build back up enough for the crop to need protection again. That means first- and second-year corn won't need, and shouldn't be using, Bt-RW hybrids. Save the Bt-RW hybrids for third-year corn, then rotate out of corn again A staggered approach to get into this rotation can help manage the feed supply in the short term. Select the highest risk fields first; this could be the field with the longest history of corn and the same Bt traits planted or a field showing signs of rootworm injury and high adult populations. (Figure 5).

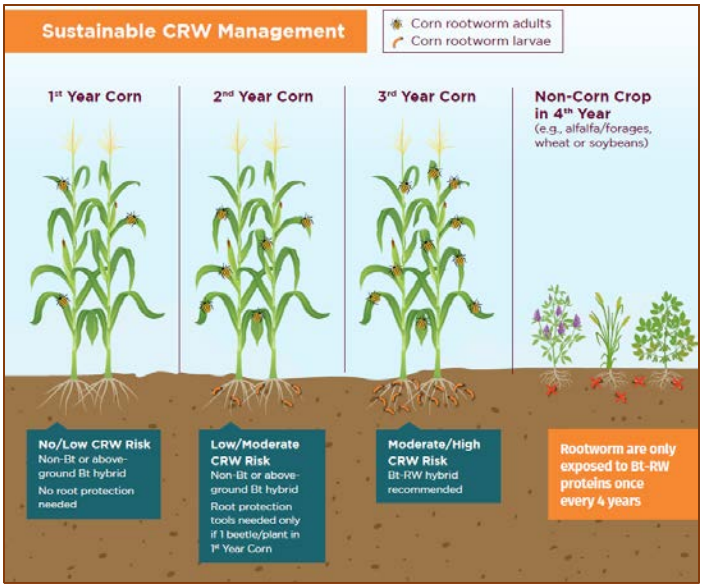

Figure 4. Sustainable corn rootworm management. Diagram taken from the Manage Resistance Now Factsheet "Managing Corn Rootworm in Bt Corn in Continuous Corn Fields." Note: above-ground Bt hybrids targets other pests, like European corn borer and western bean cutworm, and does not impact corn rootworm.

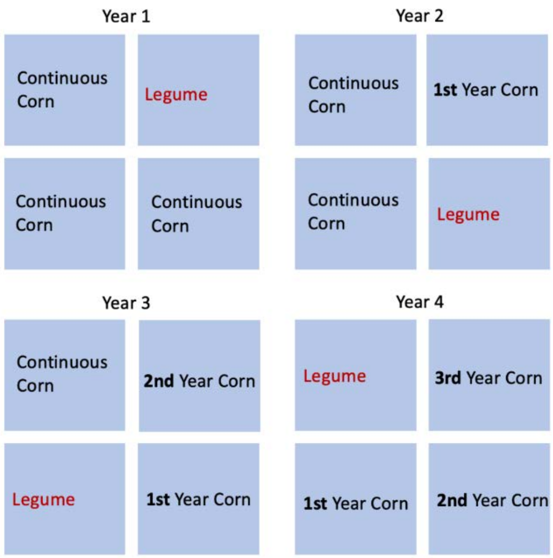

Figure 5. 4-year rotation protocol for corn rootworm management in continuous corn.

Biocontrol Nematodes

An additional new management tool that looks for rootworm management are biocontrol nematodes. These naturally occurring species of nematodes, reared and tested by Cornell University, have shown good, long-term effectiveness at suppressing corn rootworm populations. A one-time application that costs approximately $70 per acre can persist for more than 10 years and reduce root clipping by 50 to 90% compared to roots in untreated areas. The most practical and beneficial timing to apply nematodes would be at the beginning of the legume crop year (figure 5) as they take a full growing season to establish. This method ensures maximum efficacy when corn is planted the following year. First and second-year corn following nematodes will not likely require any rootworm management. Considering corn rootworm has developed resistance to all other management strategies, it is likely that they will be able to develop a similar defense strategy against biocontrol nematodes (Shields, 2020). To mitigate this risk, it is necessary to continue to plant corn varieties with the Bt-RW trait to continue to kill susceptible rootworm larvae. Furthermore, an alternative solution is to match the nematodes with a full rate of soil-applied insecticide. With proper usage, biocontrol nematodes may be the best tool to restore durability in Bt-RW hybrids.

Scouting

Although your corn might look normal, most of the damage will likely be underground. This means you may be experiencing serious economic losses without recognizing the devastation in the field during the growing season or at harvest. It is important to assess root injury, especially at silking and to implement the use of sticky cards in your field to evaluate the adult rootworm activity levels and to help you determine the mitigation strategy required for the following growing season. Implementing prevention practices at planting will always be more effective than rescue strategies.

Bt-resistant corn rootworm poses a major threat to beef farms that use grain and silage corn for feed. It is also important to consider that high corn rootworm populations will spill out into neighbouring fields to find food, lay eggs and cause crop damage. As you prepare to order corn seed for 2023, talk to your seed supplier or agronomist about implementing a crop rotation to manage corn rootworm without Bt-RW traits.

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Tracy Baute, Field Crop Entomologist; Christine O'Reilly, Forage and Grazing Specialist; and Havie Carter, Beef Cattle Specialist
Ontario Ministry of Agriculture, Food & Rural Affairs
tracey.baute@ontario.ca
christine.oreilly@ontario.ca
havelah.carter@ontario.ca

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Salmonella Dublin: An emerging risk for Canadian cattle farms - Precautions for beef producers

Cynthia Miltenburg, DVM, DVSc., Lead Veterinarian Animal Health and Welfare, OMAFRA

Salmonella Dublin is an emerging disease in the Canadian cattle sector that beef farmers may become more familiar with in the coming years. The full name for *Salmonella* Dublin is *Salmonella enterica* subsp. *enterica* serotype Dublin, however practically and for the purposes of this article, it is commonly referred to as *Salmonella* Dublin.

Salmonella Dublin belongs to the *Salmonella* bacteria family which has over 2600 unique serotypes. While other *Salmonella* infections typically are gastrointestinal in nature, *Salmonella* Dublin most commonly presents as pneumonia making it tricky to initially differentiate from other causes of respiratory disease. However, it has unique features compared to other causes of bovine respiratory disease that prioritize it for prevention.

Introduction and Transmission of *Salmonella* Dublin

Salmonella Dublin is host adapted to cattle, meaning cattle are primarily responsible for propagating and maintaining the disease via newly infected cattle that shed the bacteria, as well as chronic carrier animals that periodically shed the bacteria. However, *Salmonella* Dublin can cause disease in other species; people, dogs, rodents, goats, sheep, and horses have become infected.

Salmonella Dublin can be introduced to a farm either by the purchase of an infected animal or via footwear, clothing, equipment, or machinery that comes from an infected farm. Transmission is fecal-oral and typically happens when feed, water, milk, or colostrum are contaminated with feces or animals encounter a contaminated environment such as a calving pen. The *Salmonella* Dublin bacteria enter the gastrointestinal tract and then spreads through the bloodstream into the animal's organs. Calves and cows near parturition are particularly susceptible. The disease is characterized by high levels of illness and deaths – calves may die very suddenly without many symptoms or present with respiratory disease that does not respond to typical antibiotic treatment. *Salmonella* Dublin can also cross the placenta and cause abortion in pregnant cows, usually in the last third of gestation.

One important feature of the strains of *Salmonella* Dublin found in North America is that they are multidrug resistant. A recent report of Canadian samples found many were resistant to 5 of 6 families of antibiotics. This makes treatment of *Salmonella* Dublin infections challenging and requires prioritization of management and cleaning and disinfection to stop the spread of the disease to other cattle.

Diagnosing the disease and responding to an outbreak

Since *Salmonella* Dublin is just one of several diseases of risk for cattle, any deceased cattle should be presented to the herd veterinarian for a postmortem diagnosis. Tissue samples can be collected and sent for laboratory analysis that will confirm if *Salmonella* Dublin was present or if another bacteria or virus is to blame. Confirming the cause of disease will ensure that appropriate prevention measures can be put in place and that a suitable treatment regime is adopted for subsequent cattle that present with illness. Outbreaks of respiratory disease that fail to respond to treatment protocols should also trigger a veterinary visit for further investigation.

Risks to people and cattle handlers

Salmonella Dublin can be transmitted from animals to people. Although many of the infections worldwide are foodborne from consumption of unpasteurized milk or milk products or insufficiently cooked meat, cattle owners have an additional risk for direct contact with infected cattle. *Salmonella* Dublin bacteria are shed in the feces, milk, and vaginal discharge of infected animals. Cattle handlers can be exposed when handling sick cattle, manure, bedding, or contaminated equipment or surfaces in the pen. Transmission can occur if one touches their mouth, nose, or eyes before thorough handwashing.

Salmonella Dublin can cause severe infections in humans. Although infections in people are not common, when they do occur, a high proportion of individuals develop a bloodstream infection that can be life-threatening and require hospitalization. Young children or those with reduced immune function are at increased risk. Since *Salmonella* Dublin is typically multidrug-resistant, high-priority antibiotics are needed to treat human infections.

Keeping negative farms negative

At this time, a very small number of beef farms are believed to have been infected with *Salmonella* Dublin. Prevention measures taken now can help keep it this way. Tracking of *Salmonella* Dublin cases reported through laboratory submissions in Ontario suggests dairy producers and calf-feeders have been more affected to-date. The risk for the introduction of *Salmonella* Dublin can be managed with farm biosecurity measures.

For cow-calf producers, having a closed herd reduces the risk of introducing the disease. Where cattle purchase is necessary, knowing the herd of origin, sampling newly purchased animals, and isolating new purchases can minimize the risk of transfer to herdmates.

For veal, calf-feeders, and feedlot operations, there is a greater risk for introduction through the comingling of animals from multiple sources. Wherever possible, minimizing the number of sources of purchase can reduce the risk. For calves that are sourced directly from a dairy herd, a screening test of the bulk tank can indicate if the dairy farm is low or high risk. Some calf-feeders request a test result on a quarterly basis as part of their prevention plan. All-in/all-out management and reducing contact between age groups can reduce the risk of transmission within the herd should *Salmonella* Dublin be introduced and allows for adequate cleaning and disinfection of pens between groups. Herd veterinarians can provide a cleaning and disinfection protocol that will specifically address the robustness of *Salmonella* Dublin which will remain in the environment unless proper disinfection occurs. There is currently no vaccine for *Salmonella* Dublin available in Canada.

For all beef farms, attention to biosecurity for visitors, including friends and neighbours that live on other cattle farms, and professionals such as veterinarians, nutritionists, transporters, and others that travel to multiple farms is paramount. Ensure visitors are not wearing footwear that has been on other farms, and where possible, load cattle or deadstock without having vehicles brought up to the farm. Careful consideration should be given to any equipment, vehicles, trailers, or machinery that needs to be shared between premises and disinfecting if sharing is necessary.

Summary

Salmonella Dublin is a new disease for the Ontario cattle sector, but management and prevention are similar to other pathogens that are spread via feces. The risk for human infections and the multidrug-resistant nature of *Salmonella* Dublin elevates the risk for individual cattle farms and the greater cattle industry if this pathogen becomes established. Since most farms are believed to be negative at this time, attention to biosecurity on farms can help keep it this way.
Note: Producers wishing to learn more about Salmonella Dublin can check out the resources at https://calfcare.ca/salmonella-dublin/

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Cynthia Miltenburg, DVM, DVSc., Lead Veterinarian Animal Health and Welfare
Ontario Ministry of Agriculture, Food & Rural Affairs
cynthia.miltenburg@ontario.ca

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