The Value of 4R Nutrient Stewardship **in Canadian Forages**

4R nutrient stewardship

Fertilizer Canada

CFGA
Canadian Forage & Grassland Association
Association canadienne pour les plantes fourragères

Introduction

As forages are Canada's largest cultivated crop, it is vital to consider the benefits of using 4R Nutrient Stewardship to expand the yield, quality, profitability and sustainability of Canadian forages. Anticipating a global population of 9.7 billion people by 2050, there will be an increasing demand for high yield and quality from all crops, including forages.[1] Fertilizer Canada's 4R Nutrient Stewardship offers proven, science-based best management practices (BMPs) that aim to improve crop yield and increase economic return, while minimizing negative environmental impacts. With forage crops accounting for 39 per cent of Canada's land devoted to crop production, consideration for applying 4R Nutrient Stewardship to these acres is important to achieving agricultural sustainability goals and further increase profitability.[2]

Canadian Forage Crops

Currently, 33.8 million acres are devoted to cultivated forage, seed and feed production.[2] Generating the largest production volume per year, the average annual yield of a base case (6 years before re-seeding) Canadian forage crop is 1.73 tonnes per acre.[5,6] Including the 36 million acres of native unimproved pastures or rangeland, Canada's almost 70 million acres of forages have a direct economic value of almost $5.1 billion annually ($4.3 billion from cultivated forages and $810 million from native pasture). After wheat ($7.3 billion annually) and canola ($5.2 billion annually), forages are Canada's third most lucrative crop.[7] However, with forage crops as the primary input for Canada's $11 billion dairy and beef sectors, the total economic value of Canadian forages surpasses the reported value of $5.1 billion per year. Furthermore, most are unaware that Canadian forages have an indirect ecological-goods-and-services contribution of approximately $1.9 billion annually.[7] Recently, there has been a large growth in the international demand of Canadian forages. It is estimated that Canadian forage exports increased from approximately 650,000 tonnes annually in 2011 to over 5 million tonnes in 2016.[8]

Presently, fertilizer application to Canadian forage crops is marginal, with approximately 25 per cent of pasture and hay crops and 15 per cent of alfalfa crops receiving fertilizer applications.[5] In comparison to annual crops, the application of fertilizer to Canadian forages is uncommon. Historically, preconceptions such as low economic return, adequate nutrient supply via legume components, and large, weather dependent yield margins hinder the use of fertilizer on forage crops. Previously, it was thought that purchasing more land was more cost effective than using fertilizer to increase yields on current land base.[5] An escalating demand to produce more food on less land is challenging growers to consider alternative BMPs. Between 2011 and 2016, there was a decline in both the area of hay and alfalfa cropland (16.6% or 2.8 million acres) and pasture (4.4% or 2.2 million acres).[9] With less available, more expensive cropland and rising fuel costs; purchasing more land is no longer the most cost effective option. Actually, it may no longer be a possibility by 2050. It is estimated that by this date food production will need to increase by 70 per cent, while expansion of land under cultivation will only increase by nine per cent.[10] Applying 4R Nutrient Stewardship BMPs to Canadian forages could increase crop production and revenue per acre.

$5.1 billion

Direct economic value of Canada's almost 70 million acres of forages

40%

of Canadian land devoted to crop production is dedicated to forages, making it the country's largest culivated crop

$11 billion

The value of Canada's beef and dairy sector, which is supported by Canadian forages as their primary input

In addition to questioning the economic benefit, weather-dependent yield responses has prompted concern when considering applying fertilizer to forage crops. 4R Nutrient Stewardship BMPs address soil and weather concerns to minimize loss of nutrients after application, which is both economically and environmentally beneficial. Often, it is assumed that a nitrogen-fixing legume is an adequate supply of all nutrients. Legumes, such as alfalfa, fix atmospheric nitrogen and enhance soil fertility, which, although beneficial, cannot be considered a sufficient fertilizer source in itself. The nutrient uptake of alfalfa is rather high. Therefore, other macronutrients such as Phosphurus (P), Potassium (K) and Sulphur (S) must be supplemented with manure or fertilizer. Alfalfa removes fairly large quantities of all macronutrients, and if cultivated and exported as alfalfa hay, these nutrients are not returned which could leave soil depleted. In the sandy soils of Manitoba, Kopp et al. reported that per cent carrying capacity was doubled (57%) when alfalfa was incorporated with fertilizer, compared to alfalfa alone (28%).[11] Furthermore, soil fertility is poor with high levels of nutrient removal and inadequate fertilization. Low forage crop yields from this soil commonly result in termination of the stand through tillage and re-seeding. Depending on the regions, Canadian forage stands are maintained for only 3-9 years.[5] This process is unsustainable and can cause consequential damage to Canadian soil. When incorporating a legume component, such as alfalfa, re-seeding restrictions must be considered. Alfalfa crops can require a 12 month rest period to ensure root auto-toxins diminish in the soil.[12] Thus, it is suggested that producers plant an annual crop during the rest period, until the soil is ready for another alfalfa crop.

4R Nutrient Stewardship

4R Nutrient Stewardship is a science-based international standard for on-farm nutrient application. Applying the Right Source of nutrients at the Right Rate, at the Right Time and in the Right Place optimizes plant available nutrients and lowers nutrient loss. By implementing 4R Nutrient Stewardship BMPs, growers can sustainably increase yields and profitability on their farms. The 4R framework strives to balance sustainability and profitability in order to achieve the environmental, economic and social goals of a growing population. Applied research conducted by the 4R Research Network is further developing 4R Nutrient Stewardship by evaluating BMPs across all agricultural regions of Canada. This provides growers with site-specific BMPs that account for various soil, weather and cropping systems, as well as the necessary tools to further modify BMPs for local needs and conditions.

At approximately 4 million acres across Canada, the total number of acres counted under the 4R Nutrient Stewardship program has doubled since 2015. Key performance indicators showcase the current environmental, economic and social value of 4R Nutrient Stewardship. The 46,892 tonnes of CO_2e potential N_2O emissions reduced by Nitrous Oxide Emissions Protocol (NERP) farms, the estimated $80 to $200 per acre profit increase achieved using BMPs on a PEI demonstration farm and expanding awareness nationally through the 4R Designation program are a few notable examples. 4R Nutrient Stewardship relates this information to producers through Canada wide demonstration farms, e-learning courses, and a number of other resources. Through this interactive platform, producers are given the necessary tools to sustainably increase their on-farm profits while reducing the agricultural sector`s environmental impact.[13]

4 million

acres of land counted under the 4R Nutrient Stewardship program in 2017

46,892

tonnes of CO_2e potential N_2O emissions reduced by Nitrous Oxide Emissions Protocol (NERP) farms

The Value of 4R Nutrient Stewardship in Canadian Forages

The value of 4R Nutrient Stewardship in Canadian forages is multi-faceted. First, current practices are unsustainable. 4R Nutrient Stewardship offers the potential to sustainably increase on-farm yields, without expanding in land base or depleting soil of available nutrients. Second, applying fertilizer to the 33.8 million acres of cultivated forages is extremely profitable for both producers and stakeholders. Third, the yield, quality and longevity of a forage stand could be improved by offering adequate nutrient supplies to reach yield potentials. Lastly, preliminary research highlights the potential for site-specific BMPs, while the 4R Research Network is an example of the research opportunities that 4R Nutrient Stewardship could offer to Canadian forages. In 2014, the Canadian Forage and Grassland Association (CFGA) reported research to develop a web based tool to grow forages on sites with oil and gas activity.[14] 4R Nutrient Stewardship could provide BMPs to revegetate forges on these sites and return soil health while minimizing potential nutrient loss.

> " If nutrients are removed from the soil and not returned, eventually the soil will be depleted. The long-term economic risk of soil degradation is arguably greater than the short-term economic risk of applying fertilizer to forage crops, especially with science-based BMPs that can lower nutrient loss on-farm."

Current practices are unsustainable

More expensive, less available cropland

Current management practices for Canadian forage crops are unsustainable. Alternative practices and nutrient management must be considered to increase forage crop yields without expanding land base and without depleting our valuable resources. Considering the escalating costs and reduced availability of cropland in Canada, purchasing more land is no longer the most cost effective method to increase forage crop yields. In addition, with less available cropland, producers are often not able to purchase more land close to their farmstead. The distance between current and new cropland could raise a number of economic and environmental concerns. The producer must now travel and transport livestock to this location. This increases a number of on-farm costs, especially with rising fuel prices. Travelling this distance also increases a producer's greenhouse gas (GHG) emissions. 4R Nutrient Stewardship is interested in helping farmers increase their on-farm profits while being climate-smart. By applying fertilizer, producers could increase crop yield on their current land base, which would eliminate the need to purchase more, displaced crop land.

Incorporating legume components: alfalfa

By incorporating nitrogen-fixing legumes (such as alfalfa), it is assumed that a forage crop is supplied with an adequate amount of each required nutrient. However, this assumption often leads to insufficient supplies of P and K to meet crop nutrient demands. Without adequate nutrient supplies, forage crop yields decline, which often results in termination of forage stands via tillage and re-seeding.[5] This is unsustainable and begins a detrimental cycle, as soil is continuously depleted in an attempt to increase crop yield. More importantly, when the forage crop is harvested these nutrients are removed from the field and not returned unless manure or fertilizer is added annually. Applying 4R Nutrient Stewardship to Canadian forages can increase crop yield while simultaneously helping to maintain soil nutrients and health. Previously, forage growers have been concerned with the high economic risk of applying fertilizer to forage crops. However, applying the Right Source of nutrients at the Right Rate, at the Right Time and in the Right Place could lessen nutrient loss and ultimately, lowers the economic risk. In addition, we must consider long-term sustainability and economic risk.

International demand: exporting Canadian forage crops

With an increasing international demand for Canadian forage crops, it is of interest to sustainably increase the yield and quality of Canadian forage crops. In 2011, it was estimated that approximately 600,000 tonnes of Canadian forage crops are exported each year. However, in 2016, 2 million tonnes of Canadian forages were delivered to Japan alone. In addition, China purchased 1.3 million tonnes of alfalfa, making Asia the largest market for Canadian forages. However, due to the recent drought and lack of irrigation water in Saudi Arabia, 2.6 million tonnes of Canadian forages were exported to Saudi Arabia in 2016.[8] The yield and quality of Canadian forage crops must increase to compete with such international demands. It is unrealistic and unsustainable to expect Canada to meet such demands by expanding the number of forage crops or increasing crop land space. We must foresee that international demands will continue to rise with a growing global population. In addition, the nutrient content per weight should be considered, especially with an interest in shipping hay internationally.[26] Without converting more Canadian land into forage crops, we must consider 4R Nutrient Stewardship to intensify current forage crop production and quality in an attempt to meet rising international demands in a sustainable manner.

Profitable opportunity

Applying 4R Nutrient Stewardship to Canadian forages is a very profitable opportunity; not only for producers on-farm, but also for the industry on a larger scale. Without a regular application of manure, the majority of forage crops are significantly under fertilized in relation to their yield potential. Therefore, with approximately 40 per cent of forage crops receiving either solid or liquid manure application, 60 per cent of the forage acres are considered under fertilized.[3] Assuming that other nutrient sources (such as soil) are fully utilized, the application of fertilizer to these acres could increase cultivated and pasture forage crop yields by approximately 10-30 per cent. With this, it is important to note the fairly conservative yield increase of 10-30 per cent. In some areas, such as Ontario, soil testing and soil infertility suggest that forage crop yields in this area could double or triple with the application of 4R Nutrient Stewardship. Given Ontario's high land cost, increasing forage crop production with nutrient inputs is likely the more economical option in comparison to purchasing more land.

In Brazil, new techniques and technologies, including nutrient management, have been shown to increase forage crop yields and on-farm profits.[15] This research is challenging growers to abandon outdated techniques and consider proven nutrient management practices to increase their production yield and on-farm profits. Recently, a British Columbia farm reported a 1.6 tonne/acre forage crop yield increase with a net return of $2.70 for every dollar invested in fertilizer.[16]

Current need for forage crop based research program

There is a lack of research efforts placed on Canadian forage crops. Without proven production methods, variety selection and field testing, forage crop producers do not have the necessary information to meet crop nutrient demands and produce a good crop. There is a current need for a strong, well established research program to provide the necessary information to increase on-farm profits and reduce environmental impacts. 4R Nutrient Stewardship has worked to provide producers with proven, science-based BMPs to optimize nutrient availability and reduce nutrient loss. These BMPs are transferrable to suit specific forage crop needs and conditions. The established 4R Nutrient Stewardship framework combined with preliminary research provides a strong platform to launch a research program focused on applying fertilizer to Canadian forage crops. In western Canada, alfalfa and grass forage crops saw a yield production increase when fertilizer was added according to specific crop needs and soil type.[18,19] Research shows that forage crops respond well to fertilizer applications, with an increase in both yield and quality. However, this research notes it is important that the forage crops be optimally fertilized. This showcases the potential for 4R Nutrient Stewardship BMPs which aim to optimize nutrient availability and reduce nutrient loss.

Investigating 4R Nutrient Stewardship for Canadian forage crops

Aiming to match crop demands; the Right Source matches fertilizer type to crop needs, the Right Rate matches the amount of fertilizer to crop needs, the Right Time makes nutrients available when the crop needs them and the Right Place keeps nutrients where crops can use them. Fundamentally, the Right Source, Right Rate, Right Time and Right Place are all related. For example, the Right Time cannot be determined without simultaneously considering the Right Place. Table 1 displays that relatively large amounts of nitrogen (N), phosphorus (P), potassium (K) and sulfur (S) are removed by alfalfa hay, grass hay and other forage crops.[4, 16]

Table 1: Uptake of Macronutrients for various forage crop types according to expected yields[4,16]

Crop	Yield (ton/ac)	Uptake Macros (lbs/acre)			
		N	P_2O_5	K_2O	S
Alfalfa Hay	5	261-319	62-76	270-330	27-33
Clover	4	194-237	50-61	181-222	10-12
Grass	3	92-113	27-33	117-143	11-14
Barley Silage	4.5	130-180	46-60	114-132	14-21
Corn Silage	5	140-172	57-70	181-222	12-14

Right Source

The Right Source of fertilizer must be provided to ensure that the selected fertilizer matches specific crop needs. All required nutrients must be provided to achieve an increase in yield. Available fertilizer placement can influence what source of fertilizer should be used on the crop. It is ideal to apply fertilizer sub-soil to reduce nutrient losses to the environment. However, this placement is challenging for forage crops.[15] Previously, surface broadcasting was the most common way to apply N as Ammonium nitrate to a grass crop. In addition to volatilization losses associated with surface applications, Ammonium nitrate is no longer available in western Canada.[20] Urea has replaced Ammonium nitrate (AN) in western Canada but poses a higher risk of nutrient loss to volatilization. Although AN is available in eastern Canada and can be surface applied to forage crops, the resulting nutrient loss can have environmental and economic consequences. Banding fertilizer in forage crops has been previously studied which resulted in an uneven increase in yield. However, N recovery from urea was reported to increase by 20 per cent (16 per cent in spring) with a fall sub-banded application in comparison to surface broadcast. In 1994, slow release urea was unpractical in comparison. However, an increase in technology and use of innovative nutrient sources can lower the economic risk associated with modern fertilizer.[11] Enhanced efficiency nitrogen sources could be used to equally deliver nutrients to a forage crop while reducing nutrient loss via volatilization. Today, marketed enhanced efficiency nitrogen sources are able to prevent N loss through various pathways (leaching, denitrification, volatilization, etc). Specifically, for forage crops, sub-soil placement is a challenge and surface broadcasting results in nutrient loss through volatilization. Urease inhibitors could be used to prevent the formation of ammonia and, ultimately, prevent loss of N to the atmosphere through volatilization.

Fertilizing forage crops with livestock manure has become more common with the increase in Canada's livestock industry. For forage crops, it is of interest to identify a low-disturbance method to apply nutrients that will maximize crop response but reduce nutrient losses to the environment. In a recent study by Bittman et al., a sub-surface deposition (SSD) slurry applicator was compared to conventional broadcasting and surface banding.[21] Relative to broadcasting and surface banding, it was found that the manure applicator increased both yield and nitrogen uptake while reducing ammonia loss.[21] 4R Nutrient Stewardship could meet current research needs by using such data to begin a 4R Research Network for Canadian forages. Science-based, proven BMPs such as applying livestock manure to forage crops via a SSD slurry applicator would provide producers with the necessary tools to ensure maximum crop response and minimal environmental impact.

Often, soil is phosphorus (P) depleted which limits the yield potential of a forage crop.[19] If manure is applied to meet N demands, it is most likely that an adequate about of phosphorus is included in this application. Although legumes, such as alfalfa, fix atmospheric nitrogen and as a result do not require nitrogen fertilization, the legume utilizes P and K from the soil. Without the addition of nutrients via manure or fertilization, there are inadequate amounts of macronutrients for the alfalfa or alfalfa-grass crop to reach yield potential. This can result in an increased risk of soil degradation and erosion.

Right Rate

The Right Rate of nutrients provides a crop with the specific amount of nutrients that crop requires. Each crop requires similar nutrients, but the amount of fertilizer that the crop requires depends on crop type, soil conditions and the amount of nutrients that are currently available. Preliminary research investigating fields in Alberta, Saskatchewan and Manitoba report that N application results in a forage crop dry matter yield increase. However, it is noted that this increase in yield is strongly dependent upon climate, soil and grass type. The dry matter yield increase and response to N application was found to be associated with rainfall.[11] This example displays the strong connection between Right Rate and Right Time and is evidence that one principle cannot be determined without considering the others. In another study, a single application was compared to multiple, annual N applications divided over a number of years. Although a single application of a larger amount of N gave a higher yield in the first year, the yield subsequently decreased each year. Furthermore, annual application of N was compared to split N applications. A single annual application resulted in higher, first-cut yields but was lower than the split N application crop during the second-cut. Therefore, when two or more cuts of hay are harvested, it has been recommended that a split N application be used to ensure consistent production.[11]

Knowing the amount of specific nutrients a forage crop removes per acre can be used to determine the amount of nutrients required by the plant. Fertilizer Canada has previously compiled that 3 tons/ac yield of grass hay removes 100 pounds per acre (lb/ac) of nitrogen (N), 30 lb/ac of phosphorus pentoxide (P_2O_5), 130 lb/ac of potassium oxide (K_2O) and 12 lb/ac of sulphur (S).[4] Recently, Top Crop reported that applying 75 lb/ac of N, 60 lb/ac of P_2O_5, 100 lb/ac of K_2O, 30 lb/ac of S, and one lb/ac of boron (B) on a British Columbia ranch increased forage crop yield from 2.9 tonnes per acre to 4.5 tonnes per acre.[16] Similarly, in Brazil, an increase in dry matter yield is reported when fertilizer was added. Here it was recommended that approximately 90-130 lb N/ac, 50-180 lb P_2O_5/ac and up to 30 lb K_2O/ac be added to a grass hay crop in that climate.[22] By considering the Right Time, the uptake of nutrients is optimized and loss of nutrients to the environment is reduced. The 4R Nutrient Stewardship framework is interconnected, reducing the economic and environmental risks of fertilizer application by accounting for site and crop specific nutrient demands.

To increase the forage protein content for livestock, fertilizer containing inorganic N can be applied. Previously, nutrients have often been applied in excess (improper rate) resulting in large N losses to the environment through leaching, denitrification and volatilization. Without matching fertilizer to crop needs, excess N can lead to toxic levels of nitrate-N. Like all crops, it is important to optimally fertilize forage crops to increase quality and protein content without generating toxic levels of nitrate-N through nutrient loss. In addition, it has been shown that choosing the Right Source of fertilizer for N applications can reduce the formation of nitrate-N.[11] Forage crops are considered the primary input for Canada's $11 billion dollar beef and dairy sector. This extends the impact of improper nutrient management for forage crops, and emphasizes the value of using 4R Nutrient Stewardship to sustainably increase forage crop productivity and quality.

Right Time

Fertilizer must be applied at the Right Time to ensure that nutrients are available when the crop needs them. The Right Time depends upon the Right Source, Right Rate and Right Place. In addition, application timing must consider soil and weather conditions. Usually, it is recommended that N applications be applied in early spring. However, in Saskatchewan, it was found that autumn N applications resulted in greater forage grass yields and quality. This study is evidence that the Right Time depended upon the Right Rate. Specifically, if the N was applied in a single application then autumn application resulted in higher forage crop yields. However, if the application of N was split, then early spring application produced higher yields.[11] Similarly, the Right Source must be considered when determining the Right Time. If enhanced efficiency fertilizers are used as the Right Source to reduce nutrient loss through volatilization, then the fertilizer must be added earlier rather than later to anticipate slow release. The Right Time, like the other principles of 4R Nutrient Stewardship, can lower the economic and environmental risk associated with applying fertilizer to Canadian forage crops.

Right Place

While it is ideal to apply fertilizer sub-soil to reduce nutrient losses to the environment, this placement is challenging for forage crops. Therefore, fertilizers are commonly surface applied.[15] With this placement limitation, 4R Nutrient Stewardship can minimize nutrient loss by accounting for surface application. For example, the Right Rate and Right Time for surface application depend on the source of nutrients. To reduce N loss through volatilization, producers are encouraged to use ammonium nitrate or ammonia sulfate. When high rates of N are applied in this form, it is recommended that N be applied during the beginning, middle and end of a rainy season. If ammonium nitrate is unavailable, urea can be used as an alternative source.[31] However, with a higher risk of N loss, soil moisture and weather conditions are considered in order to apply urea immediately prior to rain to optimize nutrient delivery and reduce nutrient loss.

In summary, preliminary research has shown the benefit of applying fertilizer to forage crops, but producers need an established resource to equip them with the necessary tools to implement BMPs on-farm. 4R Nutrient Stewardship provides producers with site-specific, proven BMPs to increase their crop yields and on-farm profits. For forage crops, a lack of proven, specific application methods has resulted in an increased economic and environmental risk. By applying 4R Nutrient Stewardship to forage crops, producers can sustainably increase crop production without decreasing on-farm profits. When applied nutrients are successfully delivered to the crop, nutrient loss is reduced.

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Fertilizing cultivated forages vs. pastures

Almost 70 million acres of Canada are devoted to forages, but these acres are divided into harvested forage stands (33.8 million acres) and pasture (36 million acres).[2] With this division, it is important to consider the potential value of 4R Nutrient Stewardship on each forage crop type. Most information on nutrient management is for harvested forage stands such as timothy grass or alfalfa; therefore, it is likely more common for cultivated forage producers to use or consider applying fertilizer to increase crop production. Applying fertilizer to pasture can introduce challenges not seen with cultivated forages. For harvested forage stands, an increase in production could be directly measured via dry matter yield. Measuring the output gained from applying fertilizer pasture crops is arguably less direct, making it more difficult for producers to quantify the benefits of their investment. Livestock return approximately 60-90 per cent of the nutrients to the soil and crop nutrients are often managed through rotational grazing or short period grazing.[23] However, moving livestock will become increasing more difficult with less available, more expensive land. The Canadian Cattleman reported on a study that suggests we must improve forage productivity is to ensure future competitiveness of the Canadian cattle industry.[24] This is true for all forage crops, including pastures. Although it may be more difficult to directly measure an increase in pasture yield, there are additional concerns for pastures that could be addressed by 4R Nutrient Stewardship. Some examples include reducing methane production, increasing protein content and longevity of the forage stand and reducing overgrazing and soil erosion.

Reducing methane production by increasing forage quality

Since livestock graze on pastures, the entire life cycle must be considered. The most significant source of methane, a potent GHG, is from dairy farms. Approximately 14.5 per cent of global human-made GHG emissions are a result of the livestock supply chain. More specifically, grazing generates 20 per cent of the total livestock contribution.[27] As cows digest feed, rumen microbes release methane. Therefore, altering livestock feed may result in an increase or decrease in methane production. Recently, research done by Ontario Ministry of Agriculture, Food and Rural Affairs, University of Guelph and The Dairy Farmers of Ontario identified a number of management practices that could reduce livestock methane production. Increased forage quality improves dry matter intake and nutrient digestibility, which can reduce methane production per unit of feed.[25] Furthermore, when considering milk production, these BMPs could reduce the amount of greenhouse gas emissions per unit of milk produced. Increasing the levels of non-structural carbohydrates (NSC) can increase milk production by 5-10 per cent.[28] As previously mentioned, an increase in forage quality through improving forage protein content can be achieved through nutrient management. However, improper nutrient application could generate toxic levels of nitrate-N. Implementing 4R Nutrient Stewardship BMPs ensures nutrient availability is optimized to increase forage crop quality and reduce livestock methane production while nutrient loss is reduced to prevent the formation of toxic nitrate-N.

Overgrazing and soil conservation

When forage production is low and forage crops are scarce, overgrazing can occur. Overgrazing is especially problematic for sheep and goats that have sharp hoofs and tend to bite plants close to the ground. This is not sustainable, as soil erosion can occur leading to low yields and exhausted resources.[29] Although cattle do not pose such an intensive risk, there are approximately 10 times more beef and dairy agricultural operations in comparison.[30] Currently, management of cattle through rotational and short-period grazing is used to prevent overgrazing. These practices require that livestock be moved between pastures, demanding large areas of cropland. With decreasing available cropland, we must anticipate implementing alternative practices to increase forage crop production per acre. Applying 4R Nutrient Stewardship to pasture crops could improve crop production and sustainably prevent overgrazing and soil erosion.

4R Nutrient Stewardship to help grow forages on poor soil conditions

The CFGA recently reported on a new web tool that will be used to help select the best species and management practices to grow forage crops on land disturbed by oil and gas activity.[14] In a regional based pilot project, Peace River Forage Association (PRFA) is working to develop a web based tool that can be used by producers or oil and gas workers to revegetate rangeland. Pipelines, roadways and well sites have resulted in poor soil conditions. There is an interest to determine what species and fertilizer conditions are best to grow something on these sites as quickly as possible in order to prevent invasive species and soil erosion.[14] Attempting to grow forage crops on depleted soil without proper nutrient management would either result in suboptimal forage production or nutrient loss having negative environmental impacts. 4R Nutrient Stewardship could be a value by offering BMPs to match fertilizer conditions with specific crop demands and soil conditions.

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Conclusions

In conclusion, there is great value in applying 4R Nutrient Stewardship to Canadian forages. Preliminary research highlights the need and potential for an established science-based program to provide site-specific BMPs to forage crop producers. Increasing forage crop production by expanding cropland base is unsustainable. Crop land is less available and more expensive than it was in the past. Producers now have to purchase more expensive land at further distances from their home, which has economic and environmental consequences. Applying 4R Nutrient Stewardship to Canadian forages is a profitable opportunity. Producers would be offered proven, science-based techniques to sustainably increase their forage crop production.

Key Messages

- Sustainably intensify forage crop production by applying 4R Nutrient Stewardship to Canadian forage acres.
- Decrease the agricultural sector's environmental impact by returning removed nutrients to soil, minimizing nutrient loss and potentially reducing methane production.
- Provide Canadian forages with a 4R Research Network constructed program to develop and strengthen 4R Nutrient Stewardship BMPs for the key forage crops across a variety of Canadian regions and climates.

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