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Cover Cropping on the Prairies

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Abstract

Cover crops can bestow numerous agronomic, environmental, and economic benefits to farmers. Despite this, cover crops are often viewed with scepticism by Prairie farmers due to the limitations of the short growing seasons and the unpredictable weather patterns in the region. Early adopter Farmers are innovating cover crops to adapt this practice to Prairie cropping systems and environmental conditions. The recent uptake in cover crop use by farmers in neighbouring US states and in Eastern Canada has encouraged an increasing number of Prairie farmers to experiment with cover crops. However, there is a lack of information on how farmers in the Prairies are using cover crops. It is an important time to hear from farmers about their needs for research and knowledge transfer, with farmers wanting to know how to use cover crops to meet their goals, and policy makers wanting information to design conservation BMP programs to meet environmental targets. Lack of information has been a major hurdle for farmers interested in adopting the practice, and for the developing a policy to support cover crop use. To fill these knowledge gaps the 2019 Prairie Cover Crop survey was developed to provide information to farmers, agronomists, researchers, policy makers, and government organizations that will play an important role in the future of cover crops for the Prairies. A total of 211 early adopters of cover crops completed the survey, growing over 83,000 acres of cover crops across the 3 Prairie Provinces. Cover cropping was found across many different climatic and geographical areas across the Prairies, and was grown in rotation with dozens of cash crops in multiple farming systems of various tillage, herbicide and management regimes. This highlights the diversity of cover cropping on the Prairies. These surveys are ongoing and have profound implications for the future of implementing policy surrounding cover crops.

Introduction

Cover Crop Definitions

A cover crop is grown to cover the soil, at times when the soil would otherwise be left bare (Kasper and Singer, 2011). This allows for a better utilization of solar radiation, mimicking natural ecosystems which have plants continuously growing when the ground is not frozen, and maintaining groundcover year-round, provides greater protection from erosion (Kasper and Singer, 2011).

Cover crops in the Prairies take two main forms, either being grown during the full season or grown to provide soil cover during the 'shoulder' season between cash crop harvest and the planting of the next cash crop in the spring. Shoulder season cover crops can be seeded as an intercrop at any point during the cash crop lifecycle from planting to harvest. They can also be planted shortly after cash crop harvest in order to grow through the fall shoulder season providing soil cover and other benefits before the planting of the subsequent cash crop in the spring. Full season cover crops are grown instead of a cash crop over the entire growing season. Farmers may select to dedicate a full growing season to cover crops to replace summer fallow, after an extreme weather event - such as flooding or hail has destroyed a cash crop, to manage problem soils (such as salinity), as green manure crops to add nitrogen in organic systems, or as a forage source in a grazing system.

Cover Crop benefits

Canadian farmers are well placed to benefit from cover crops as many of the most popular crops grown in Canada only grow, and thus provide soil cover, for around four months of the year. Many of these crops do not leave significant residues after harvest, especially soybeans, edible beans and peas, crops harvested for straw, and potatoes. This leaves soils poorly covered for much of the year and so vulnerable to erosion (Coote, 1984; Blackshaw et al., 2007; Blackshaw, 2008). The often dry climate, high winds, can leave Prairie farmland at risk from wind erosion, particularly if the land is irrigated or uses tillage (McConkey et al., 2010). Erosion not only have negative impacts on crop production, but the transportation of soil particles by wind and water transport nutrients, pesticides, pathogens and toxins (McConkey et al., 2010).

The Pan-Canadian Framework on Clean Growth and Climate Change was developed to reduce Canada's greenhouse gas emissions and build resilience to climate change. Cover crops may have the ability to provide part of the solution for meeting Canada's targets by reducing reliance on nitrogen fertiliser production and their associated greenhouse gas emissions, reducing direct greenhouse gas emissions, as well as creating sinks for greenhouse gasses in the soil (Camargo et al., 2013). Cover crops can also alter field surface albedo so that an increased level of shortwave radiation is reflected to the atmosphere (Kaye and Quemada, 2017). However, cover crops protruding out of the snow in northern environments in the winter may minimise this effect (Kaye and Quemada, 2017). Cover crops can also aid with adaption to climate change as they can improve the resiliency of Canadian agriculture to extreme weather events and climatic changes (Kaye and Quemada, 2017).

As well as being environmentally beneficial, cover crops can also provide several economic benefits (Yanni et al., 2020), including increased yield, reduced fertiliser costs, reduced pest, disease and weed pressures, and reduced spending on crop protection (Morton et al., 2006). The ability for leguminous cover crops to provide nitrogen is particularly beneficial, with some cover crops being able to provide between 45 and 224 kg ha⁻¹ of available nitrogen for subsequent crops (Bergtold et al., 2017). O'Reilly et al. (2012) conducted an economic analysis of using cover crops in Bothwell and Ridgetown, Southern Ontario. O'Reilly found that cover crops were as profitable, or more profitable than those with no cover crops, at both sites, both when fertilized with nitrogen and without. However, these economic benefits are often not well reported to farmers. As a result, farmers often focus primarily on the upfront costs of planting cover crops. This has hindered cover crop adoption (Schipanski et al. 2014). Therefore, there is great need to demonstrate to Prairie farmers the economic benefits and costs of cover crop use.

Current State of Cover Cropping on the Prairies

However, before we can determine the suitability of cover crops for mitigating climate change and protecting soil on the Prairies, it is first vital to understand the current state of cover cropping in the region. With this information researchers and policy makers can assess common agronomic practices and distribution of cover crops. This will ensure that future policies and research are tailored to the current realities of Prairie farms.

Despite the potential economic, environmental, and agronomic benefits that cover cropping can provide to farmers in Western Canada, cover crops are often viewed with scepticism by Prairie farmers. This in part due to the limitations of the short growing season which limits the opportunities for cover crop planting, management, and termination, as well as limiting the potential total cover crop. Unpredictable weather patterns in the region, including excessively dry or wet conditions, sometimes within one growing season can also make establishment difficult.

The recent uptake in cover crop use by farmers in neighbouring US states, particularly North Dakota, and Minnesota (Singer et al., 2007; (Sustainable Agriculture Research and Education, 2013; 2020), has resulted in several stories about cover crops entering farm media which Prairie farmers are consuming, making cover crops and soil health a trending topic among Prairies farming circles. With each passing year, more Prairie farmers are experimenting with cover crops, however we still do not have a picture of how many farmers are using cover crops on the Prairies. In 2015 the Canadian farm census predicted the proportion of farm acres planted with cover crops on the Prairies to be in the range of 1 - 15%. However, it is likely this percentage acreage of cover crops is too generous, as winter cereals were classed as cover crops. Consequently, there is still a major gap in the knowledge of how many farmers are using cover crops on the Prairies.

Limited data is available about cover crop use on the Prairies at present, and there has been no recent study to investigate how or why cover crops are being used by early adopter farmers. Many of these early adopters have questions they would like to see addressed through research and extension, making it an important time to listen and ask to about their experiences.

This lack of information has resulted in farmers not having access to the best information for making decisions when they are thinking about whether to grow cover crops, which has held back this potentially beneficial practice. Farmers would benefit from up to date unbiased local data which shows where cover crops are being grown, why they are being grown and information on cover crop agronomy. This would put cover crops into context for Prairie farmers. Additionally, there is need for decision makers involved in policy to be able to first determine how and why cover crops are being used on the Prairies before evaluations can be made on how best to encourage their use.

Objectives

To fill these knowledge gaps, the Prairie Cover crop survey began in 2019 with five major outcomes:

- 1 Determine the current extent of cover cropping in the Prairies**
- 2 Determine how cover crops are being used in the Prairies**
- 3 Determine why farmers are using cover crops**
- 4 Determine what cover crop farmers would like to see in future research or extension**
- 5 Create a network of farmers who are users of cover crops**

Methods

2019 Prairie Cover Crop Survey

The 2019 Prairie Cover Crop survey was developed for early adopter farms that grew cover crops in Manitoba, Saskatchewan, and Alberta during the 2019 growing season. In our survey we have defined a cover crop as a crop that is planted primarily to provide soil cover and / or other agronomic benefits aside from being a major cash crop. Cover crops which are also grown for grazing are counted as a cover crop in our definition.

The survey contained three sections – with the first being questions about the cover crop, the second focused on questions about the farm operation, and the third second asked more detailed questions about cover crop goals and the agronomics of how they were grown.

The survey link was distributed between October 2019 and April 2020, primarily through networks of cover croppers / farmers. Existing contacts known to grow cover crops were sent the link via email. Hundreds of organizations and businesses which service farmers were contacted to help promote the survey to their stakeholders, including commodity, industry, and environmental organizations, agronomists, seed companies, and local and Provincial governments. The survey was also promoted through extensive use of social media, especially Twitter and Facebook. Facebook posts were made on agricultural, and community Facebook groups across the Prairies. These groups varied in size from dozens to tens of thousands of members.

2019 Prairie Cover Crop Survey Results

Cover Crop Distribution

One of the fundamental goals of the 2019 Prairie Cover Crop Survey was to learn how many farms have already started growing cover crops as well get an estimate of the number of acres where cover crops were grown. At the time the survey started, it was unknown if 20, 50, or 100 farms would respond to the survey. In total 211 farms (Table 1) responded to the 2019 survey, growing among them over 83,000 acres of cover crops.

The survey determined that cover crops use is not limited to one area of the Prairies. Cover crops were grown as far north as the Peace River Valley in Alberta, right the way down to the US border, including some of the driest regions of Alberta and Saskatchewan (Figure 1-3), with farms located within 38, 46, and 52 rural municipalities in Alberta, Saskatchewan, and Manitoba, respectively. Of the farms that responded to the survey, 51% percent grew a shoulder season cover crop and 76% of respondents grew a full season cover crop (Table 1).

Table 1. Cover crop season type and number of respondents by province.

Number of Farms			
Province	Shoulder	Full	Total
Alberta	22	45	55
Saskatchewan	25	47	58
Manitoba	61	69	98
Total	108	161	211

Cover Crop Acres

A total of 83,467 acres of cover crops were grown by respondents across the Prairie Provinces in 2019. The majority of total cover crop acres as well as shoulder cover crop acres as well as shoulder season cover crop acres were grown by respondents located in Manitoba. Almost half of all full season cover crop acres were grown by respondents in Saskatchewan (Table 2).

Table 2. Total acres of cover crop season type grown by the 211 farms that responded to the 2019 Prairie Cover Crop Survey by Province.

Area (acres)			
Province	Shoulder	Full	Total
Alberta	5071	7047	12118
Saskatchewan	9263	16943	26206
Manitoba	34326	10817	45143
Total	48660	34807	83467

2019 Prairie Cover Crop Survey Manitoba

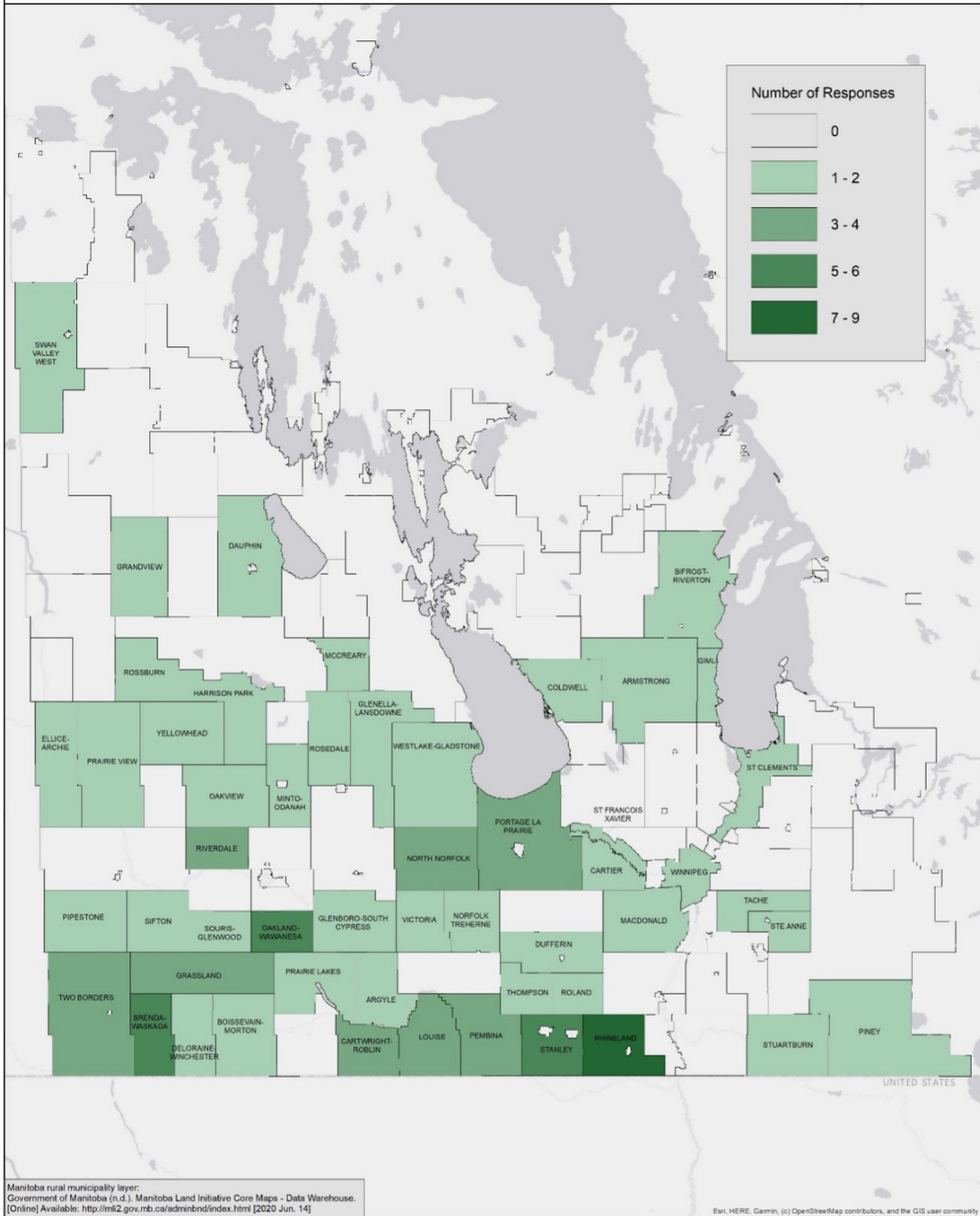


Figure 1: Distribution of farms in Manitoba that responded the 2019 Prairie Cover Crop Survey

2019 Prairie Cover Crop Survey Saskatchewan

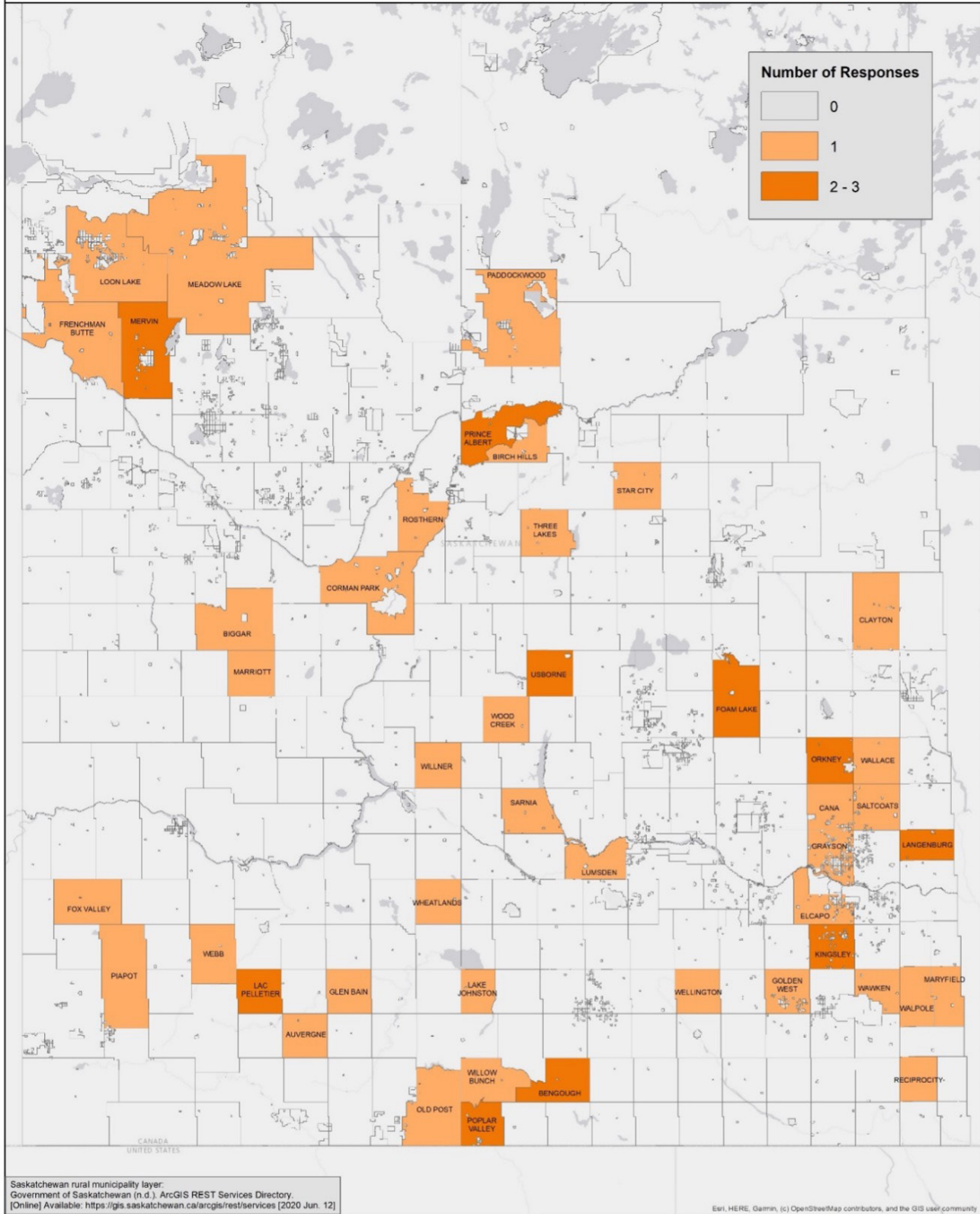


Figure 2: Distribution of farms in Saskatchewan that responded the 2019 Prairie Cover Crop Survey

2019 Prairie Cover Crop Survey Alberta

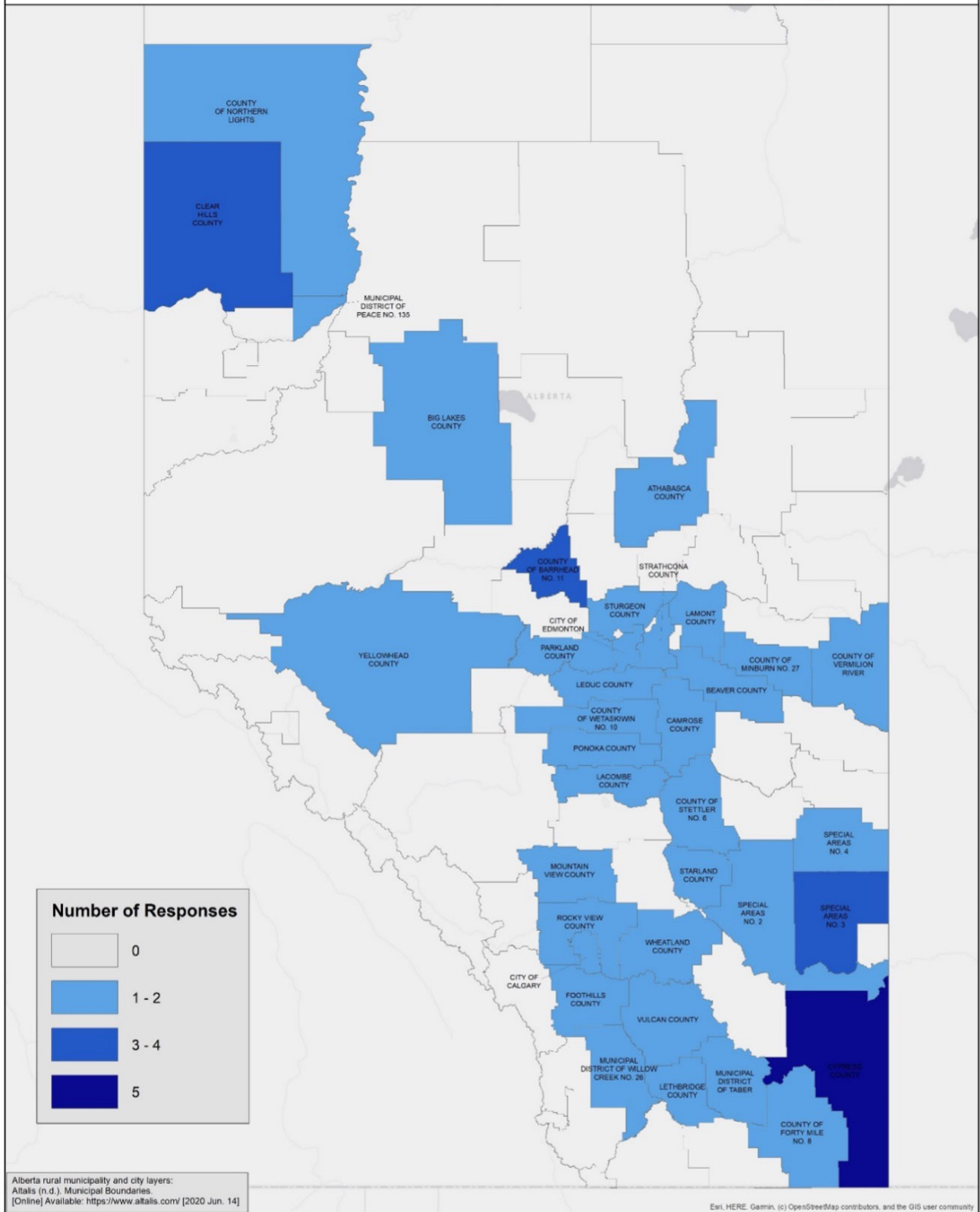


Figure 3: Distribution of farms in Alberta that responded the 2019 Prairie Cover Crop Survey

What farms are growing cover crops?

Respondents were asked to characterize their farm type by selecting multiple characteristics from a list. Respondents identified many different characteristics with annual grain crops as the most common followed by livestock (Figure 4).

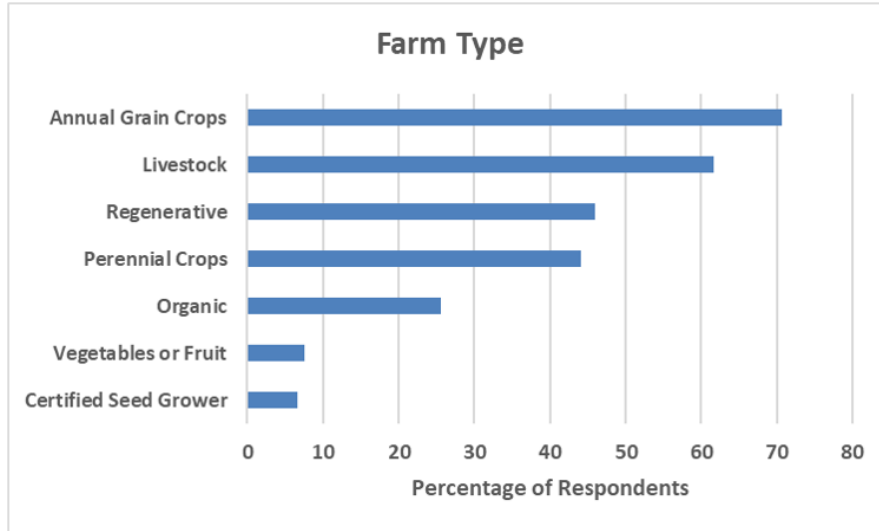


Figure 4. Characteristics of the 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop Survey

What crop types did cover crops follow in rotation?

The 2019 Prairie Cover Crop Survey showed that cover crops were grown in rotation with dozens of cash crops commonly grown in the Prairies. Cereal crops dominated with oats, spring wheat and fall rye being the most common cash crops preceding a cover crop, with canola taking the fourth position (Figure 5).

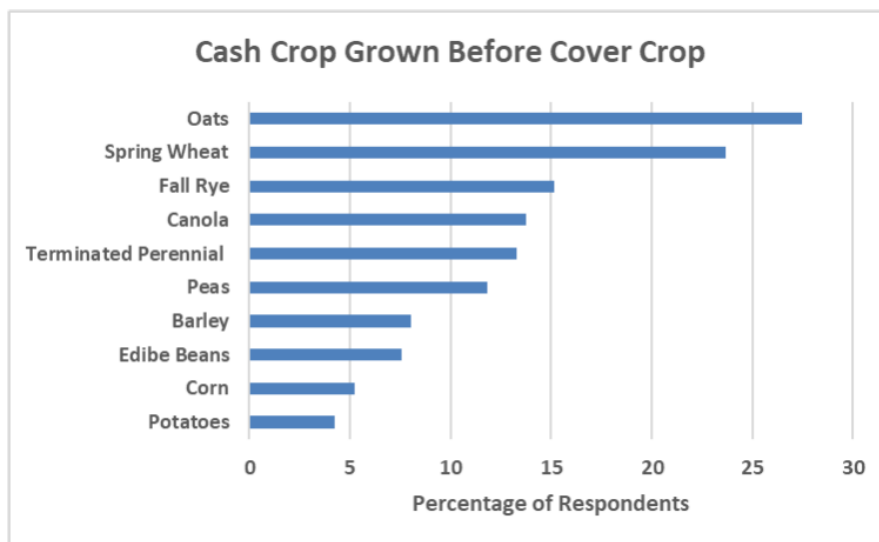


Figure 5. Cash crops grown before cover crops for the 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop Survey

How long have respondents grown cover crops?

We were interested to learn how long farms on the Prairies have been growing cover crops. It was believed the number of farms using cover crops in the Prairies has been increasing in recent years but there was no evidence to back up this statement. The survey results indicate that the majority (82%) of respondents had grown cover crops prior to the 2019 growing season, with 31% had grown cover crops for more than 5 years (Figure 6).

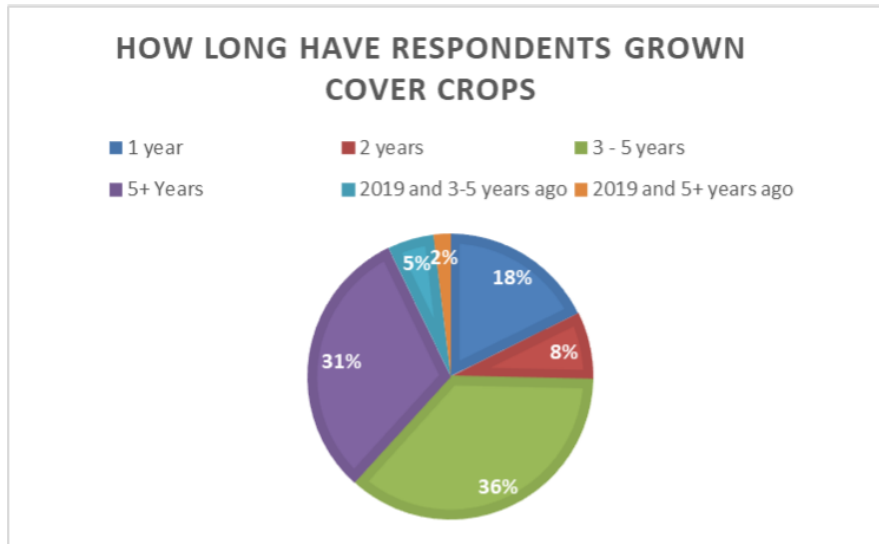


Figure 6. How long the 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop have grown cover crops

Why are cover crops being used?

Another major aim was to determine why cover crops are being grown. The common reasons respondents grew cover crops were related to soil health. Across the Prairie Provinces, build soil health at 91%, keep living roots in the soil at 79%, and feed soil biology at 76%, were the three most common reasons for growing cover crops (Figure 7). Farms were not asked if economics were a factor when deciding to grow a cover crop, but 4% of farmers wrote in the comments box that 'financial gains' were a reason for growing cover crops.

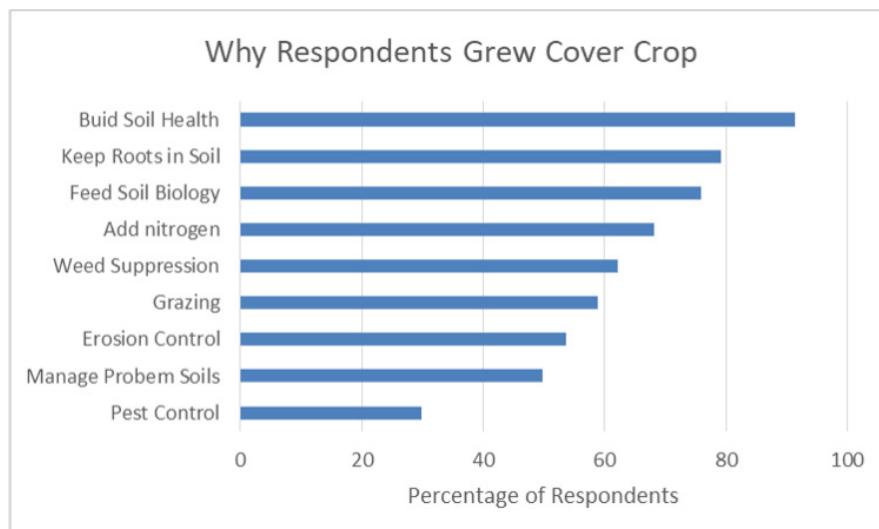


Figure 7. Why the 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop grew cover crops.

Cover Crop Species Diversity

A common question asked is how many species should be included in a cover crop. Selecting multiple species creates a more diverse crop with different species complementing each other potentially providing additional benefits to the farm. However additional costs are incurred with the addition of each species. The majority of respondents seeded cover crops as mixtures of two or more species (Figure 8). Mixtures of two to five species were the most common, accounting for 44% cover crops grown (Figure 8).

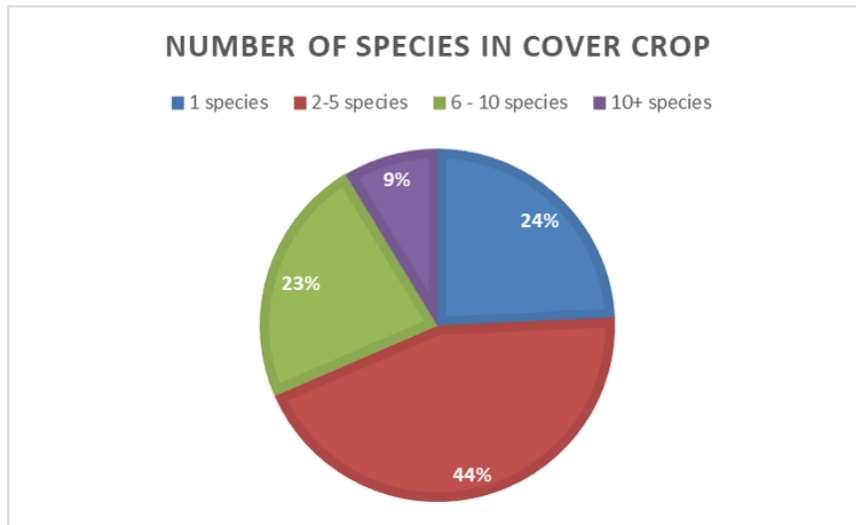


Figure 8. How many species were in cover crops. Data 276 responses from the 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop grow cover crops.

Cover Crop Species

A common question asked is how many species should be included in a cover crop. Selecting multiple species Oat was the most common cover crop grown, at 60% of all respondents, followed by clover, peas, and radish (Figure 9). Most of these species are widely available to farmers, with most being common cash or forage crops. These species represent different cover crop types, which are typically grown to achieve different goals. For example, clover, hairy vetch and sweet clover are grown to fix atmospheric nitrogen, and radish is often grown to combat compaction and increase infiltration.

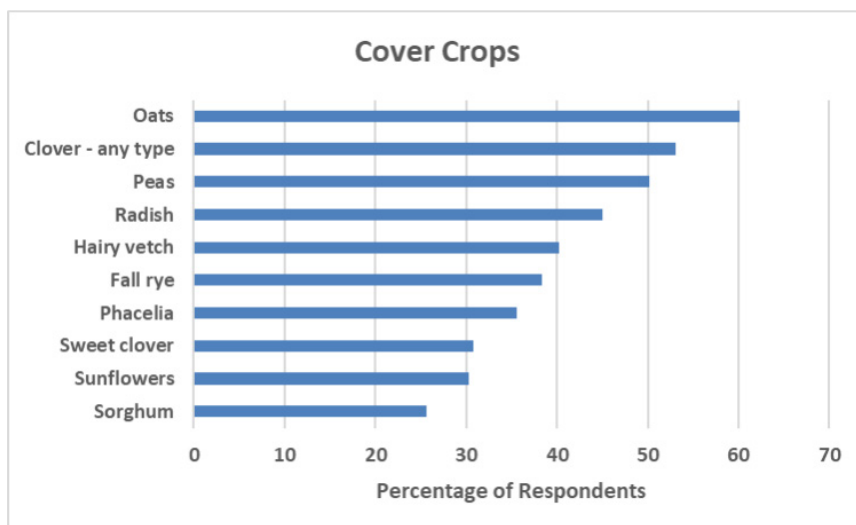


Figure 9. Most common cover crop species grown by the 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop Survey.

Cover Crop Use Through Intercropping

Across the Prairie Provinces, 54% of all farms that responded established cover crops as intercrops with cash crops (Figure 10). Within each province, the percent of respondents that had established cover crops as intercrops increased from east to west. The number of farms that used intercropping to establish cover crops was higher than expected. This finding is important as it reveals that developing intercropping strategies for growing cover crops may be a very important area of research to enable increased adoption on Prairie farms, especially on drier areas of the western Prairies.

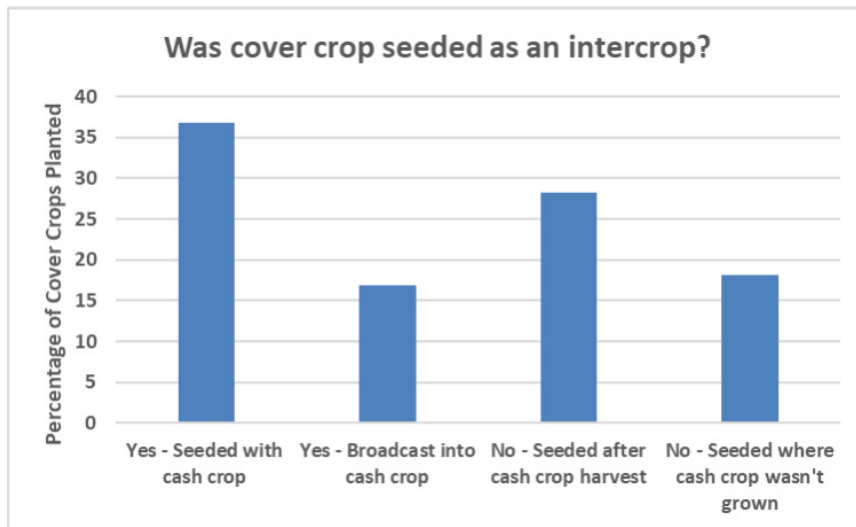


Figure 10. If cover crop was seeded as an intercrop. Data from the 237 responses from 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop grew cover crops

Cover Crop Seed Cost

What farmers paid for cover crop seed varied greatly on the Prairies, with 18% of farms growing their own seed and 6% paying more than \$50 an acre. However, most cover crops (54%) grown by survey respondents cost between \$10 - \$30 per acer (Figure 11).

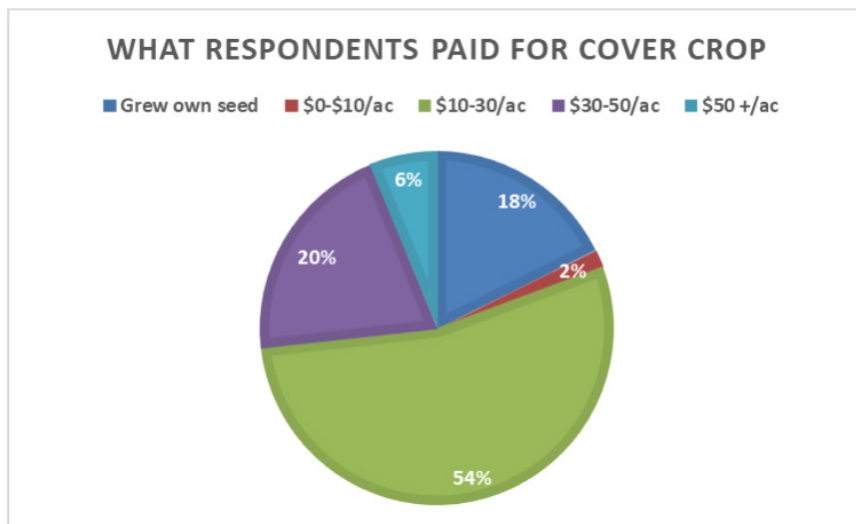


Figure 11. What farms paid for seed. Data from the 243 responses from 211 farms growing cover crops that responded to the 2019 Prairie Cover Crop grew cover crops

Research and Extension

We were aware of several barriers which were influencing the ability and willingness of Prairie farms to adopt cover crops. Some of these barriers can be addressed through research and extension. Therefore the 2019 Prairie Cover Crop Survey respondents were invited to comment on what they would like to see addressed through research and extension. Some 52% of survey respondents replied with their insights and thoughts.

This survey demonstrated farmers are willing to engage with researchers to highlight what areas they feel need to be addressed. This shows farms, researchers and policy makers can work alongside to provide farmer driven research and solutions. Involving farms in the process fosters a relationship between the farming community, extension workers, researchers and policy makers. Future policy could benefit greatly from listening to farmers themselves and what they feel needs to be addressed. This will allow future research or policies to be farmer led and address real problems preventing cover crop adoption.

Above all, farmers want to be able to access more evidence-based advice, especially on which cover crops would work best in their area and for their specific goal. There is also a desire for best management practices for cover crop agronomy and how to integrate cover cropping into their system, e.g. last planting date, broadcasting into a cash crop, when to terminate cover crop etc. Farmers are also keen to know how many cover crop species would be optimum for their mix, which cover crop species work well in a mix and which do not, and which cover crops would be best for their system. Farmers are interested in knowing recommended seed rates and depths for sowing cover crops, especially if they are sowing mixes containing seeds of species with differing sizes. Farmers would also like to see which warm season species can have significant growth in prairie climates, and which cover crop species can successfully overwinter.

In addition to more evidence-based agronomy, many farmers mentioned that they would like to see more research, especially taking place in the prairies, to quantify the benefits of growing cover crops. Some of the major themes coming from farmers are quantify the effect of various cover crops on the availability of nitrogen to subsequent crops, how much carbon is sequestered through growing specific cover crops, if cover crops will cause a moisture deficit for cash crops, how cover crops effect water infiltration, the suitability of cover crops for grazing, and any effect of cover crops on cash crop yield. A number of farmers stated that they are most interested in the economic benefits of growing cover crops – a cost / benefit analysis which would quantify the effect of cover crops on herbicide and nitrogen inputs with the cost of seed and labour etc.

Some farms fear that cover crops may affect their crop rotation by not allowing enough time between plant groups which attract the same pathogens, making it difficult to control pests or diseases – e.g. through the inclusion of brassicas in a cover crop mix, or by increasing the number of grasshoppers. Some farmers are concerned about herbicide carryover, or the inability to control weeds by mixing different species in the same field.



Conclusions

The 2019 Prairie Cover Crop Survey has shown that it is possible to cover crop across a wide range of locations and environments, across the three Prairie Provinces. Cover crops have been found to be grown as far north as the Peace River Valley in Alberta, right the way down to the US border and even the relatively dry regions of Alberta and Saskatchewan. The survey highlights the diversity of farmers who use cover crops and they are being used to achieve dozens of different goals. Cover crops were found to follow dozens of the major cash crops grown in Canada, by farmers of every size and pesticide management system. Cover crops are being grown in a variety of different ways – both as full season cover crops and in the shoulder season, with cover crops being started as an intercrop and other being planted after cash crop harvest.

This diversity of cover crops use in the Prairies may help cover cropping seem a more achievable goal for interested farms, with the potential to expand cover cropping on the Prairies. The survey has also helped to dispel many of the prominent opinions surrounding cover crop use in Western Canada, including that cover crops cannot be grown in many regions of the Prairies, or that cover crops are only grown by certain groups of farmers - such as organic farmers. The survey highlights the need for more than a simple one size fits all approach to cover cropping on the Prairies. It is likely that any policy aimed at incentivising cover crops or the creation of any best

management practices is divided into ecological zones based on growing season and moisture availability in the fall. Best management practices should also be created for different farm types. Cover crops are managed differently depending on their overall goal. Therefore, full and shoulder season cover crops must be treated as separate entities, as well as cover crops which are grown with the intention to be grazed as opposed to cover crops which will not be grazed by livestock.

The baseline statistics generated from the survey will be highly beneficial to farmers across the Prairies, being the first of its kind to determine how farmers are using cover crops on the ground. This research will become a resource for interested farmers which will put cover cropping into context for farmers on a Provincial level. This will assist farmers by seeing what farmers in their area are already doing and then use this for their own decision-making process. The research could also be used help to identify best management practices, and advise how cover crops could be best implemented into regional agricultural systems best. This has the potential to lead to more farmers making the decision to uptake cover crops and make decisions which are better suited to their local situation. This will be invaluable for policy makers to see how potential policy changes may be received by farmers.

Ongoing Research

Following the success of the 2019 Prairie Cover Crop Survey, a 2020 Prairie survey was launched on October 1st 2020. This survey was of a much larger scope to provide a fuller picture of the current state of cover cropping on the Prairies, and gather information that would be the most useful to Canadian farmers, researchers and policy makers.

Talks began in January 2021 with the Ontario Cover Crop Steering Committee for a similar survey to be run for Ontario farmers. With these talks the Prairie Cover Crop survey was adapted to reflect the cropping systems and language used in Ontario, and the 'Ontario Cover Crop Feedback' launched on February 2nd 2021.

The 2020 Prairie Cover Crop Survey and the 2020 Ontario Cover Crop Feedback which had these objectives in addition to the 2019 objectives:

- 1 Determine what benefits cover croppers have observed while growing cover crops, and how long it took to see these benefits. This includes the effect of cover crops on farm net profit.**
- 2 Determine what problems farmers have faced while using cover crops**
- 3 Determine how cover crop use could be supported**
- 4 Determine where those growing cover crops get their information**
- 5 Determine what would encourage farmers who didn't grow a cover crop to adopt cover crops**

These surveys will have a significant impact on future cover crop policy, as they seek to answer what would enable cover crop use on the Prairies, including tax incentives, payments for storing carbon, and reductions in crop insurance premiums. In particular, the inclusion of farmers who did not grow a cover crop in the 2020 cover crop surveys in the Prairies and Ontario is invaluable for determining a strategy of how best not only to support existing cover croppers but how best to bring new cover croppers into the fold. We hope that this research will also help create conversation between farmers, agronomists, researchers, and policy makers about an emerging practice with the potential to conserve and build the health and productivity of soils across the Prairies.

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