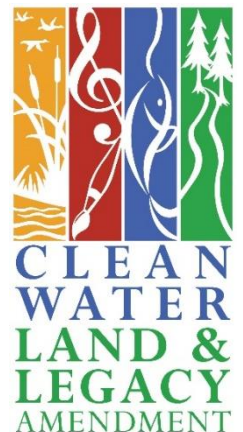




Vegetative Cover in Minnesota: Prospects and Challenges

*Opportunities for Pasture and Forage, Cover Crops, Small Grains and
Perennial Crops to Improve Water Quality*

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Executive Summary

The Vegetative Cover Study was initiated to learn whether there are economically viable opportunities to expand environmentally protective crops to improve water quality, targeting areas with highly vulnerable groundwater in Minnesota. The primary focus of this study is on those crops and cropping systems that have traditionally been grown in Minnesota, including perennial crops, small grains, and cover crops, with the premise that these were historically grown profitably, and therefore there is an opportunity to grow them again.

Related study goals are:

- To identify existing and potential barriers to adoption of additional vegetative cover.
- To identify actions that the Minnesota Department of Agriculture and its partners can take to capitalize on opportunities, overcome or mitigate barriers, and increase chances for success.

There are both opportunities and challenges in establishing vegetative cover to improve water quality in areas with highly vulnerable groundwater. These are summarized in the next few pages and further discussed by cover type on pages 18-27. Vegetative cover is defined for the purpose of this study as **vegetation that keeps the soil covered throughout the year**, particularly in spring and fall. This may include a single crop (e.g. alfalfa) or a cropping system (e.g. cover crops following corn silage).

By contrast, summer annual row crops typically leave the soil bare (without vegetative cover) from October to June, exposing it to erosion from wind and water and potential nutrient runoff and leaching into surface waters, subsurface tile drains or groundwater. Increasing vegetative cover is an important strategy to help protect water and soil resources.

Vegetative cover includes, but is not limited to, the following categories:

- Perennial forage crops such as grass, alfalfa and red clover for haying and grazing;

Vegetative Cover and Groundwater/Drinking Water Protection

As stated in the [Minnesota Nitrogen Fertilizer Management Plan](#), current agricultural crop production systems require the input of nitrogen fertilizer to increase production. The nitrate form of nitrogen is very soluble in water and can leach into groundwater. Nitrate in groundwater is a public health concern, especially for infants under six months of age. This is important since approximately three out of four Minnesotans rely on groundwater for their drinking water supply. The Minnesota Department of Agriculture (MDA) is the lead state agency in Minnesota for nitrogen fertilizer and has authority to regulate its use, if necessary, to protect groundwater quality.

The Nitrogen Fertilizer Management Plan and Groundwater Protection Rule acknowledge that in some parts of the state, especially those with coarse-textured soils, typical best management practices for corn and soybean may not be sufficient to prevent or reduce nitrate leaching. In these cases, the MDA encourages farmers to consider Alternative Management Tools (AMTs), including increasing vegetative cover on the landscape. **Continuous cover can be achieved by diversifying crop rotations, adopting perennial cropping systems and incorporating cover crops.** All the vegetative cover strategies examined in this study can help to achieve the goal of protecting water resources.

- Cover crops such as winter cereal rye, oats, and red clover for grazing, feed and/or soil health benefits;
- Small grains, including wheat and oats, as well as winter annuals such as cereal rye and winter wheat;
- Emerging specialty crops such as Kernza® (perennial wheatgrass) and oilseeds (harvestable cover crops) for food, oil and other uses.

There is considerable overlap between these categories since many cover types have similar end uses. For example, cover crops are frequently grazed, while small grains can be used as cover crops.

Small grains such as spring wheat are included because they are harvested earlier in the season than corn for grain, and therefore offer opportunities for establishment of cover crops. This opportunity is also present for silage corn. Other crops such as sugar beets and potatoes also provide opportunities for cover crops within the rotation but are not discussed in this report. Likewise, perennial grasses planted in buffers or other conservation areas are not discussed in this report, since they are not typically grazed or harvested (although these practices are permitted in some areas).

The term “forage” is used in several ways. In general, “forage” includes any plant eaten by grazing livestock, as well as plants cut and then fed to livestock, especially as hay or silage. For the purpose of this report, “perennial forage” refers to alfalfa and other legumes, and grass hay and other grasses that are grazed or harvested, but not to corn silage. However, these terms are used somewhat interchangeably by the interviewed farmers and other stakeholders.

Study areas: Three study areas with highly vulnerable groundwater were identified (see Figure 1): the Central Sands (10 counties), southeast (7 counties) and southwest (3 counties). Each region has unique vulnerabilities to nitrate contamination of groundwater: coarse-textured, sandy soils and shallow distance to groundwater in the Central Sands region; fractured limestone and shallow topsoil of the karst topography in the southeast; and limited water supplies drawn from alluvial channels near the surface and problematic deeper groundwater in the southwest.

Study methods: Interviews were conducted with 36 farmers and 66 allied industry partners who either interact with farmers directly or have an interest in vegetative cover. Of the farmers surveyed, 29 farmed in one of the three study areas.

Interview Highlights*

On Grazing

Grazing keeps the brush and weeds down on non-tillable acres.

A healthy environment for cattle; good for the land. No erosion after gully washers.

We graze pasture to improve our soil quality, improve our species, and utilize the land we own as well as make our cattle production profitable.

Better for the cows: they harvest their own food and distribute their own manure. They are healthier.

I'm always interested in refining my management abilities for pasture. Fundamentally, I would like to get a better handle on what level of productivity I should expect from my pastures, measured in Animal Unit Grazing Days per Acre. Corn producers have an objective goal of, say, 200 bushels per acre -- pasture productivity is more difficult to measure, and it's harder to know if I'm coming close to my potential.

When it's not in pasture you have a hard time putting it back into pasture – seeding, fencing, water.

Always more animals than pasture. Annual forages and cover crops are used to fill the gap.

Keep livestock in the community. Better markets would help. Lower property taxes, based on the land's producing ability, could encourage more pasture.

I need more land, but with land being dominated by commodities, it's hard to buy or rent it.

The consultant also engaged with participants at field days, farm management association meetings, and related conferences. A selection of responses from interviews and questionnaires are shown in the sidebars on the following pages. This report represents a ‘snapshot in time’ during 2018-2019 and may not be representative of all stakeholders. This report captures the thoughts and ideas of individuals who were interviewed because of their experience and expertise, as well as others encountered through the outreach and interview process.

Opportunities

Pasture, grazing and forage

The study area counties include some of the most heavily populated dairy areas in the state, indicating that there is still plenty of opportunity for vegetative cover to be utilized as feed in these areas. However, opportunities vary between dairy cattle and beef cattle.

Most of the interviewed farmers who graze livestock are grazing beef cattle on pasture. Of the dairy farmers in the study, only one grazed their milking herd, although nine grazed heifers and five grazed dry cows.

The majority of dairy farms in Minnesota feed milking cows in confinement. Confined feeding offers more control over the cow’s diet and results in higher milk production. However, many producers graze dry cows and heifers.

Corn silage is harvested earlier in the season than corn for grain; therefore, it offers opportunities for establishment of cover crops.

- Corn silage has become a greater portion of the feed ration for dairy cows, often replacing haylage. Alfalfa hay and haylage were once looked at as the foundation of a dairy cow’s diet. However, challenges in harvesting hay or haylage under current weather patterns have caused many producers to shift to a larger percentage of corn silage.
- Custom silage operators harvest many acres and could provide an audience for focused outreach and assistance to plant cover crops within the study areas.

Interview Highlights

Forage Production

Forages follow livestock. Farms are primarily growing alfalfa and corn silage and harvesting grass hay out of waterways and buffers. Farms are constrained from expanding forages because of several factors, including work, weather, transportation, storage, and the fact that it is tougher to market.

I would benefit from more specific knowledge about managing diverse perennial grass/legume pasture/hay land. I'm not sure I am optimizing the productivity of my forage production. I have questions about harvest timing, maturity management, managing the process of dormancy in the fall, and extending the grazing season without damaging the sward in the fall and winter.

With all the rain, difficult to put up quality hay.

It helps cut feed costs.

Simple, easy, and most return per acre.

Many mid-sized producers work off-farm jobs. Adding forages to the mix adds time/labor they feel they don't have. The bigger operations have little or no need for forages, unless they are a dairy.

Very important as part of contour strip cropping to stop erosion.

Hay is more profitable than corn and soybeans but it's hard to change it into cash, with weather and market risks.

Allow CRP harvesting with a lower payment.

Offer functional crop insurance for foragers.

- Large dairies that purchase corn silage and other forages in bulk may be interested in improving the sustainability of their operations by offering direction or incentives to their silage producers to incorporate cover crops.

Alfalfa remains important in the dairy ration but is subject to many uncertainties, from weather to volatile markets. It also requires significantly more equipment and labor from the producer throughout the growing season, compared to corn and soybeans. In addition, the introduction of distillers' grains in the dairy ration has provided a cheaper protein source and a better-balanced ration for ruminant animals.

New uses for alfalfa are being explored by USDA and partners, including protein extraction for aquaculture feed and other foods. However, near-term opportunities can be identified in both large dairies and smaller integrated operations. At least one large Minnesota dairy is encouraging planting of low-lignin alfalfa, which can provide improved fiber digestibility even if harvest is delayed for a few days.

Packaged hay products also offer opportunities for growth.

These include:

- Dry hay for pet food and bedding
- High-quality blended feed for horses containing alfalfa and grass
- Packaged feed for chicken and goats (including both grains and alfalfa)

Beef cattle operations are still well-suited to grazing and forage harvest. Interviews indicate that smaller livestock producers are more likely than larger ones to grow their own forage. The number of beef cows in Minnesota has remained relatively steady in the last five years (about 370,000). However, the number of small livestock producers has declined in recent years (The number of Minnesota farms with livestock in all size categories except the largest – 500 or more cattle or calves – declined from 2012 to 2017). Producers located in sensitive groundwater areas could be targeted for incentive payments and technical assistance to expand and diversify their forage production.

Incentives to assist in establishment of small beef herds and grazing practices can offer the next generation a pathway into farming, especially given the financial and knowledge barriers to entry into both crop farming and dairy farming.

Interview Highlights

Cover Crops

It's a struggle to implement cover crops here in the north because of the harvest schedule – little or no window between getting the crop off and freeze-up.

It works best after small grains and silage – grazing for cattle when possible, building soil health in corn and soybean to get water into the soil, and capturing excess nutrient benefits.

If you have a leader farmer in the area who's successful with cover crops, others will start doing it.

Highlight short-term gains, such as better access to fields in wet conditions.

Small Grains

Among farmers considering cover crops and small grains, some see no future in the dominant corn/soybean model. Others are looking to reduce fertilizer, pesticide, and drainage tile costs. Others are using them to transition to organic certification to capture premium prices or looking for opportunities to bring the next generation onto the farm.

Small grains offer less risk than forage crops, fit the grain farmer skills and mindset, and are potentially as profitable, or more so, than corn and soybeans.

Emerging Crops

Farmers are interested in new crops but cautious... they are apprehensive and not confident that there will be a market. Subsidies will be needed... a risk mitigation pool for farmers.

There is a need for protein from alternative sources to satisfy customer demand. Peas/pulses/beans as food additives have good market potential.

There needs to be a favorable policy environment and a production incentive program to reduce risks.

Cover Crops

The use of cover crops is growing throughout Minnesota and gaining traction in the three study areas, although the percentage of acreage in cover crops remains low – ranging from around 2% to 8% of cropland in the study area counties in 2017 (see Table A4). The benefits of cover crops include soil health, erosion control, reduced tillage and fuel costs, and livestock grazing after the primary crop is harvested (known as aftermath grazing). Challenges include Minnesota’s short growing season and unpredictable weather, the lack of adequate financial incentives, equipment and labor requirements, and the fact that successful establishment often requires several years of experimentation.

Increasing the availability of cost-share funds is an important strategy. **Contracts of 3 to 5 years are essential to allow producers enough time to gain sufficient experience with cover crops.** Board of Water and Soil Resources’ (BWSR) Clean Water Fund-supported [Projects and Practices grants](#) require a minimum duration of three years for land management practices such as cover crops. A pilot program, the [Cover Crop Demonstration Grant](#), was initiated in 2019 to increase adoption of cover crops in response to record-breaking rainfall and flooding that prevented planting of primary crops across much of Minnesota. USDA programs, including Environmental Quality Incentives Program (EQIP), Conservation Security Program (CSP), and a new [Soil Health and Income Protection \(SHIPP\) Pilot](#) program, may also provide opportunities. The Minnesota Agricultural Water Quality Certification Program (MAWQCP) provides opportunities for incorporation of cover crops and established a soil health endorsement which may increase cover crop adoption. As of July 2020, MAWQCP has established over 63,900 acres of cover crops.

Working with farmers who are already using cover crops would provide an opportunity to build on existing success and expertise. Those farmers who have been most successful with cover crops could be incentivized to plant additional acres. More importantly these innovative farmers can share their expertise through peer-to-peer learning, such as through the Minnesota Soil Health Coalition or other informal farmer-led networks.

Small Grains

Opportunities for small grains may increase due to consumer demand and the current weakness in markets for corn and soybeans. Wheat acres have slowly increased in Minnesota in response to these trends. Since small grains can be important constituents of livestock feed, additional opportunities may emerge if ethanol production and related production of dried distillers’ grains continues to decline. Small grains can be utilized in food and beverages, and in animal bedding. The benefits of small grains in conjunction with cover crops and in multi-year rotations for pest and disease control and soil health should also be emphasized. However, there is limited capacity to grow small grains (due to equipment and storage requirement, farmer capabilities, etc.), and local markets for oats, wheat and barley are limited.

Emerging Crops

Emerging perennial crops, (Kernza®), and winter annual “cash cover crops” (camelina and pennycress) developed through the work of the University of Minnesota’s Forever Green Initiative and its partners, **are being “ramped up” to field scale**, in hopes of gaining footholds in the broader marketplace. While acreage will remain small for the near future, there are expanding opportunities to establish these crops in vulnerable wellhead protection areas while continuing to build supply chains and market opportunities.

Cross-cutting Issues

Supply chain bottlenecks are an overarching question that cuts across most of the crops under discussion. Lack of equipment to plant, cultivate, harvest, store, and process these crops, particularly alfalfa and emerging crops, can hinder their adoption. Many small grains and perennial forages were traditionally grown in Minnesota, and while farmers are likely capable of growing these again, the “hurdles” of specialized equipment, cost, and time constraints are prohibitive. Agricultural dealerships and conservation districts can play key roles in filling some of these gaps. **Grants to farmers or these supporting organizations could be prioritized to purchase needed equipment for planting, processing and harvest of alfalfa, small grains and emerging crops.**

Both co-ops and custom operators can provide assistance with planting/harvesting. **Outreach and educational efforts targeted to these operators – and to the farmers who might use their services – will be increasingly important.**

Opportunities by Region

Table 1 summarizes some of the primary opportunities in each of the study areas, based on the existing mix of crops, climate, growing season length, and opportunities identified farmer and stakeholder interviews and related research during 2018-2019. Opportunities for creating synergies between sectors are identified – e.g., between short season crops and cover crops, or between horse farms and high-quality dry hay production.

The high (H), medium (M), and low (L) potentials noted in the table are based on several objective and subjective factors, including compilation and analysis of National Agricultural Statistics Service (NASS) data, county crop information, and discussions with agricultural organizations, businesses, agency staff, and those interviewed for this study. Some of the data, such as NASS, are well-established; others, while important, are more subjective, such as the assumption that those surveyed are representative of regional conditions.

The intent is not to discount other opportunities that may arise in one or more regions, but rather to highlight those that currently appear most promising. With these opportunities come challenges, many of them economic – e.g., the costs of establishing cover crops or the lack of reliable markets for local hay. The MDA and partners could focus on addressing these challenges within each region going forward.

Table 1: Summary of Primary Opportunities by Region

Opportunity	Central Sands	Southeast	Southwest
Increased pasture-based grazing (i.e., beef cows)	H	H	H
Perennial forage production for livestock feed (i.e., dairy cows)	H	M	H
Perennial forage crops for specialty uses (horses, pet food/bedding)	M	H	L
Increasing cover crop adoption – peer-to-peer networks	H	M	M
Cover crops after corn silage	H	H	M
Cover crops after canning crops	L	H	L
Cover crops after dry edible beans and potatoes	H	L	L
Small grains for feed or food	H	H	H

Opportunity	Central Sands	Southeast	Southwest
Specialty crops such as Kernza, camelina, etc. for feed, fuel and food	E	E	E
Investment in planting and processing equipment and storage capacity for small grains and emerging crops	M	M	H

H = high potential

M = moderate potential

L = low or undetermined potential

E = emerging opportunity

How can the MDA and other state agencies work to overcome barriers to vegetative cover?

One factor that comes through clearly in interviews with farmers and allied professionals is the overriding economic imperatives that govern on-farm decision making. Farmers will respond to a practice or enterprise expansion/use when it is economically viable, profitable or results in cost-savings. Practices need to be sustainable long-term, and viable after subsidies end.

The MDA works with producers through its grant, loan, and marketing programs; these and other state programs are summarized in Appendix B. There are opportunities to utilize a number of these programs to provide increased incentives for vegetative cover, including small grains and winter annual crops.

This report should be considered a starting point to continue discussion of opportunities for increasing vegetative cover. It can be used regionally by farmers, agricultural organizations, and others to provide information, start new discussions, and build relationships that perhaps can lead to increased production of and expanded markets for vegetative cover. It can also provide supporting information for government agencies such as MDA, non-profits, farmer-led interest groups, and private businesses to explore market development.

I. Study Purpose

The primary goal of this study is to learn whether there are economically viable opportunities to expand vegetative cover acreage including perennial crops, small grains, winter annuals, and cover crops, to improve water quality, focusing on areas with highly vulnerable groundwater in Minnesota. A related goal is to identify existing and potential barriers to adoption of additional vegetative cover. Finally, the study identifies actions that the MDA and its partners can take to capitalize on opportunities, overcome or mitigate barriers, and increase chances for success.

The study is focused on three areas of the state with vulnerable groundwater: the Central Sands, southeast, and southwest regions (Figure 1). Sensitive areas in the following counties were included:

- Southeast: Houston, Fillmore, Winona, Olmsted, Wabasha, Goodhue, and Dakota counties
- Central Sands: Hubbard, Becker, Otter Tail, Todd, Douglas, Pope, Stearns, Benton, Morrison, and Wadena counties
- Southwest: Pipestone, Rock and Nobles counties

The study explores the challenges and opportunities facing producers working in four broadly defined practice areas:

- Pasture management and grazing
- Hay/Forage production
- Cover crops
- Small grains
- Emerging perennial crops

There is considerable overlap between these practice areas, but the study treats them separately in order to focus on the specific challenges and opportunities in each area.

II. Methods

Initial calls and contacts with conservation district staff in the three regions, other local partners, and state agency staff were made to identify farmers and allied agricultural industry partners involved in grazing, hay and forage production, cover crops, and other perennial or winter annual crops. In-person interviews, phone interviews and online questionnaires were the main study method. Additional participants engaged with the study at field days and other events.

The overall number of interviews and surveys was lower than expected due to challenges with the project contract. The original goal was to conduct over 100 interviews to capture a representative sample of farmers. Instead, we conducted 36 interviews with farmers and 66 interviews with allied

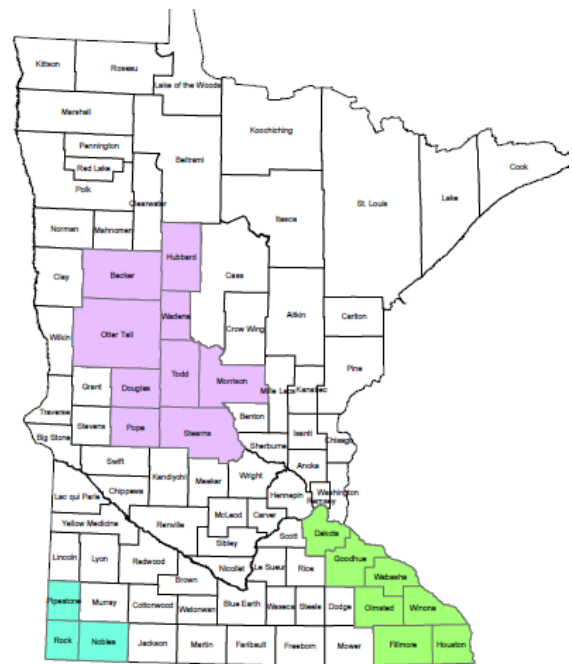


Figure 1: Regional study areas

industry partners who either interact with farmers directly or have an interest in vegetative cover. Agricultural industry partners included crop consultants, agricultural organizations, entrepreneurs, and researchers in areas such as agricultural economics and water resource protection. Interviews were supplemented with information from the National Ag Statistics Survey (NASS), research reports, and professional input. Overall, the survey information is not representative of all producers with pasture, or those who graze, grow forages and/or cover crops; rather it summarizes a big picture of challenges and opportunities a producer may experience in the region.

Of the 36 farmers surveyed, 29 farmed in the three targeted study areas. In addition to the interviews, 21 farmers responded to an online questionnaire; fourteen of these respondents farmed within one of the study areas. Appendix C includes detailed information on the demographics and farming practices of the respondents.

Interviews were based on a standard list of questions which were modified as needed to respond to individual comments and concerns. Questionnaires used a standard list of questions, included in Appendix D. Results have been combined and respondents are not identified except by location within one of the three study areas (a few responses from outside the study areas were also considered).

III. The Context: Agriculture in Minnesota and the study areas

Minnesota leads the nation in many aspects of agricultural production. As of 2019, the state ranks first in production of red kidney beans, sugar beets and turkeys. [Other rankings](#) from the National Agricultural Statistics Service indicate that Minnesota ranks:

- Second in value of hog and pig production, green pea production and sweet corn production
- Third in production of soybeans, spring wheat, oats, sunflowers for oil, area harvested for vegetables, and grain storage capacity
- Fourth in production of corn for grain, corn for silage, dry edible beans, and canola

In livestock and dairy products, Minnesota ranks sixth in cheese production, seventh in milk cows and milk replacement heifer inventory, and eighth in milk production and in the number of cattle and calves on feed. It ranks ninth in number of steers 500 pounds and over.

The 2017 Census of Agriculture provides the latest snapshot of agricultural land uses and practices in Minnesota. Many changes relevant to this study took place between the prior census in 2012 and 2017, as summarized below and in Table 1 in Appendix A. It is important to note that neither census year is truly representative: 2012 saw widespread drought, which affected crop yields, while 2017 saw ideal weather patterns and record yields in both corn and soybeans.

Key findings:

- Land area and cover: The number of farms in Minnesota declined by 8% while average farm size increased by 6%.
- The acres of farmland in Minnesota declined slightly, by 2%, while acres in cropland increased slightly, possibly in response to higher commodity prices early in the decade.

- Both permanent pasture and grazing land and the smaller acreage of pastured woodland declined by 27%. Approximately 4.2% of farmland remains in pasture. Woodland acres comprise a slightly higher percentage, 5.5%.
- Primary crops: Corn and soybean remain the dominant crops statewide, accounting for about 73% of all cropland.
- Small grains, specifically wheat, oats, and barley for grain, have seen dramatic declines, both since 2012 and over the prior 20 years, as shown in Figures 2 and 3.

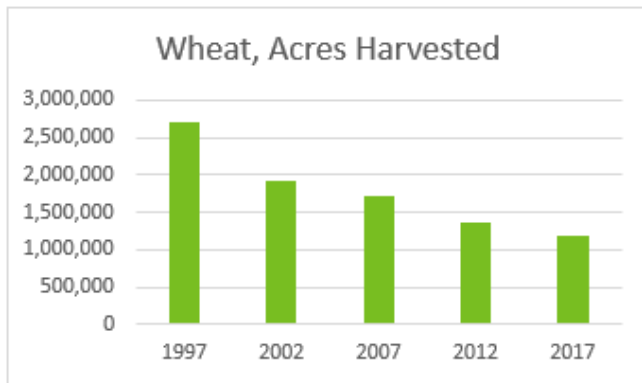


Figure 2: Change in wheat acres harvested (compiled with NASS data)

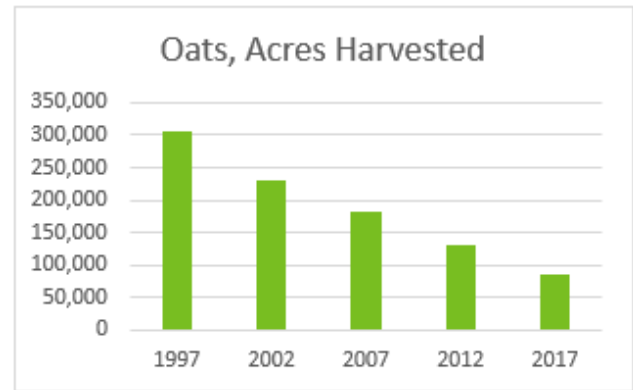


Figure 3: Change in oat acres harvested (compiled with NASS data)

- Cover crops:
 - [The acreage in cover crops reported increased by 42%](#), (from 408,190 acres to 579,147 acres) still comprising only 2.2% of farmland, or 2.6 % of all cropped acres.
 - The number of operations planting cover crops declined, from 5,661 to 5,302 (6.3% lower) between 2012 and 2017.
 - In 2017, Minnesota ranked 11th among the 50 states in cover crop acreage, behind Texas, all other Midwestern states, Nebraska and Pennsylvania.
- Forage crops
 - The acreage in perennial forage crops (hay, haylage, grass silage, greenchop) showed only a slight decline from 2012 to 2017. However, the major decline in hay and haylage occurred over the previous 15 years, as shown in Figure 4. Since 2002, harvested acres have declined by 45% (data pre-2012 were unavailable).

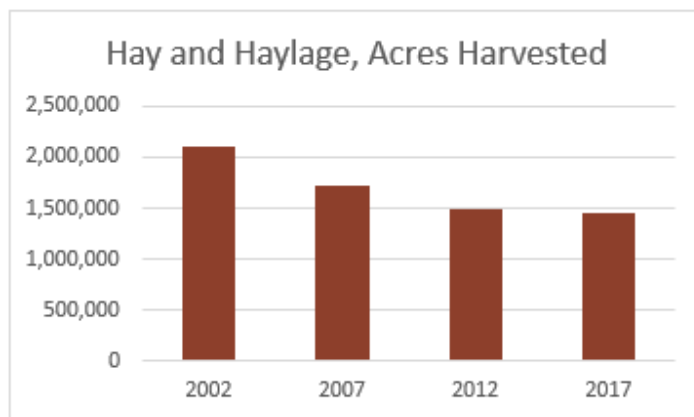


Figure 4: Hay and Haylage, change in acres harvested (compiled with NASS data)

Agriculture in the study areas

The maps in this section, developed by USDA NASS, can be used to compare the results of the 2012 and 2017 agricultural censuses. It is important to note that the maps use broad categories to show geographic distribution of crops and livestock, and do not capture all changes in acreage or livestock in each county. Furthermore, comparison of two individual years does not indicate a trend. Appendix A provides some additional detail.

Dairy cattle

Milk cow inventory maps from the 2012 and 2017 Census of Agriculture (Figure 5 and Table A3) show that the Central Sands and southeast study areas are strong dairy cattle areas. Although the number of herds are dropping in Minnesota, the total cow numbers in the Central Sands, southeast and southwest remained relatively steady, with Pipestone County (southwest) showing growth. **The study area counties in general are some of the most heavily populated dairy areas in the state, indicating that there is still plenty of opportunity for vegetative cover to be utilized for feed in these areas.** However, it is unlikely that this will include much land in pasture as most dairies harvest the feed and bring it to their cows. Only the 108 certified organic dairy farms in Minnesota are required to graze their cattle, since pasture grazing is required for at least 120 days per year for organic dairy production (2016 Certified Organic Survey, USDA NASS).

As dairy herd size increases, the availability of pastureland compared to cropland becomes a factor, as does travel distance for grazing cows. Some small dairies are able to continue to graze their herds. However, statewide, the number of herds in Minnesota is decreasing at a rapid pace (16.5% from 2016 to early 2019¹), while herd size is increasing (16.16% from 2016 to early 2019).

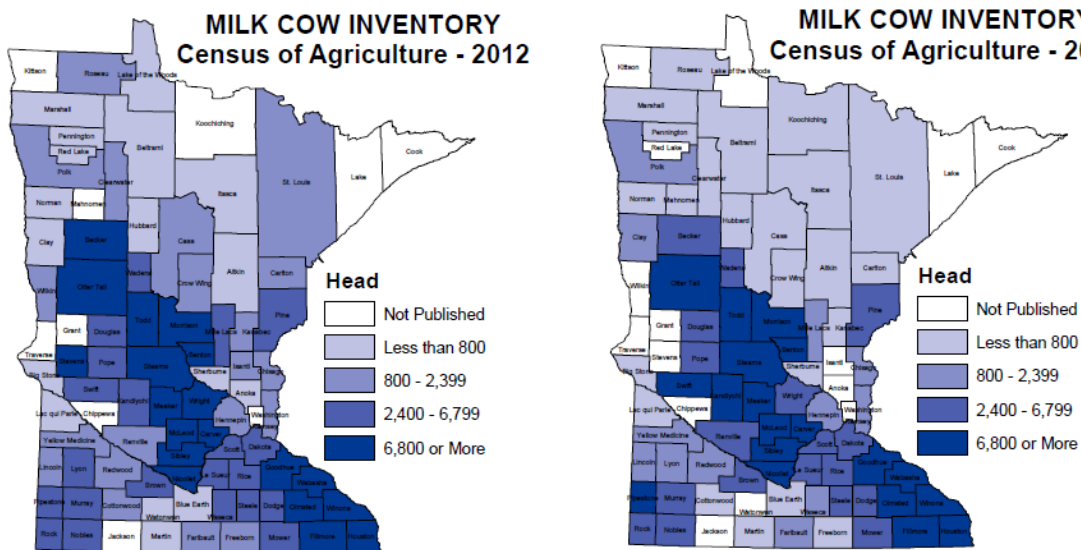


Figure 5: Milk cow inventories, 2012 - 2017 (NASS data)

¹ Minnesota Department of Agriculture

Beef cattle

The USDA NASS beef cow inventory comparison maps (Figure 6), as well as Table A3, tell a similar story for the same time period. The study areas are strong in beef cows and for the most part cow inventory numbers remain stable, with some growth in Douglas and Pope counties (Central Sands) and Nobles County (southwest). There is a slight drop in Wabasha County (southeast). **The strong beef cow numbers are particularly helpful in areas where there is a desire to have continuous vegetative cover, since farms with beef cow herds utilize grazing as their primary method of feeding when possible. This would include pastures, crop residues and increasingly cover crops.**

It appears that a significant number of farms with beef cows employ rotational or management-intensive grazing: 5,201 farms reported these practices in 2017, down from 5,604 in 2012.² If we assume that most grazing is done by beef cows, this would represent about 40% of the 13,339 Minnesota farms with beef cows in 2017.

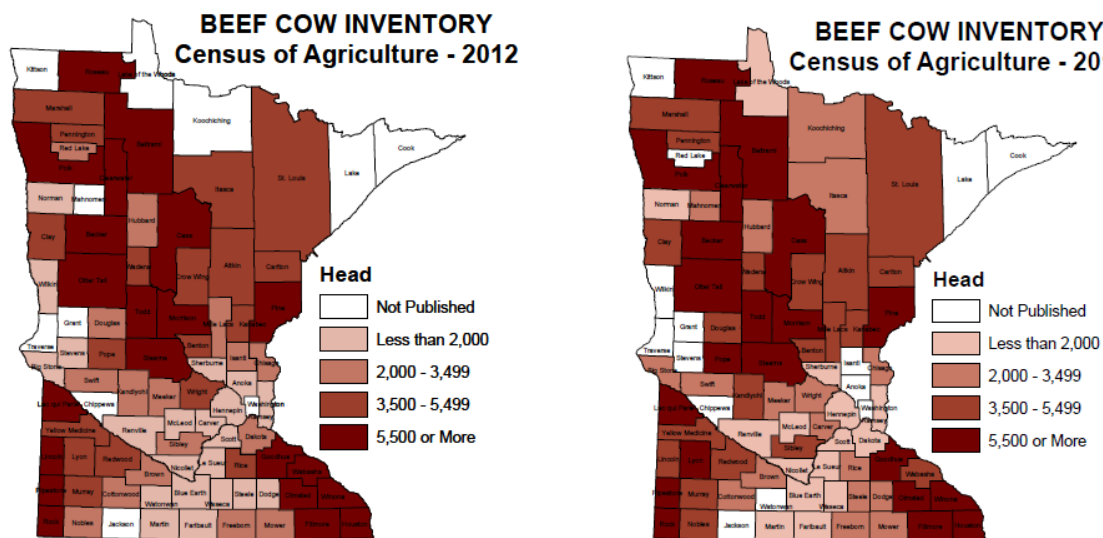


Figure 6: Beef cow inventories, 2012 - 2017 (NASS data)

Extent of pasture

Many of the counties in the study area are holding steady when it comes to dedicated pasture, although some have dropped (Nobles, Wadena, Olmsted) and one (Pope) has increased in pasture acreage (Figure 7). However, when all pastureland, including pastured cropland and woodland, is examined (Figure 8), several more counties, mainly in the southeast, have dropped to the next level of pastureland. The decrease may be due to conversion of grazing land to cropland, or combined uses. It is important to note that land recorded as cropland within NASS may also be subsequently grazed, but this use is not documented. Therefore, the maps may show a decrease in pastureland in those areas.

² https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1_Chapter_2_County_Level/Minnesota/st27_2_0043_0043.pdf

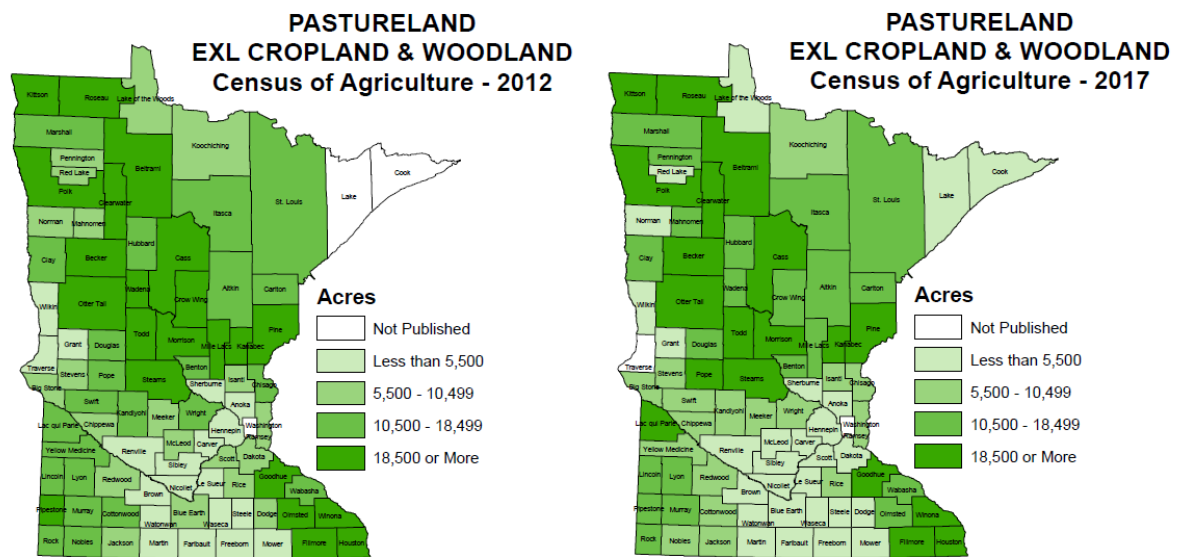


Figure 7: Pastureland acreage, 2012-2017 (NASS data)

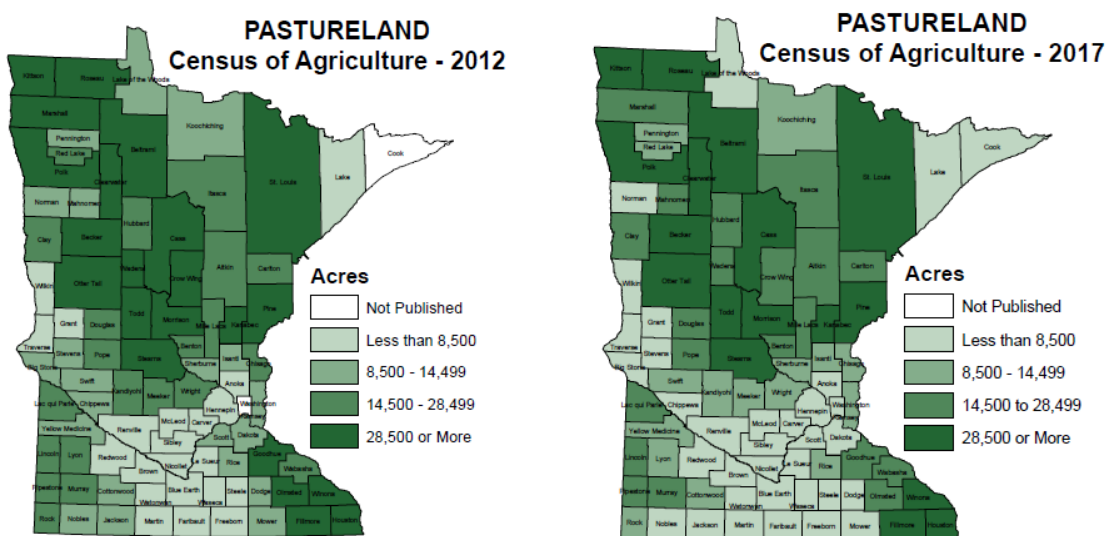


Figure 8: Pastureland acreage, including pastured cropland and woodland, 2012-2017 (NASS data)

Hay production

Hay production (including alfalfa and all other dry hay) was maintained at fairly stable levels across all study area counties (with the exception of Pipestone), although statewide the number of acres and producing farms has dropped (Figure 9). However, per acre yields across the state increased from 2012 to 2017. Figure 9 does not include haylage or green chop production, which also showed drops in acreage but an increase in yield per acre from 2012 to 2017. Overall, perennial forage acres as defined by the census – hay, haylage, grass silage, green chop – have decreased, but yield per acre has increased, resulting in just a small drop in total production.

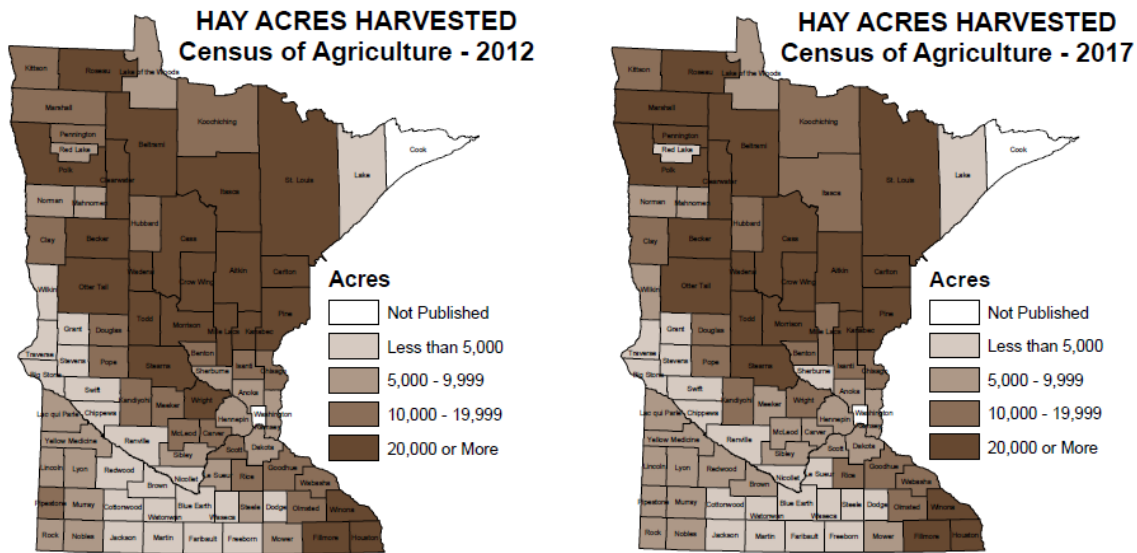


Figure 9: Hay acres harvested, 2012-2017 (NASS data)

Corn silage production

Although corn silage acres in Minnesota decreased from 2012 to 2017, yield per acre increased, resulting in an increased harvest of silage statewide. Corn silage acres remained fairly constant in the study areas, with the exception of Douglas and Pope counties, where production declined to the next size level (Figure 10).

Forages have always been considered the building blocks of the dairy cow diet and those forages have traditionally been dry hay and haylage followed by corn silage. However, in recent years the role of corn silage in dairy herd diets has increased. There are many reasons for this:

- Corn silage is an economical feed and yield per acre has increased over time making it even more attractive.
- Farms are able to harvest more tons of dry matter per acre than they would get from hay or haylage. Corn silage provides both forage in the leaves and stalks and grain in the corn.
- Corn silage is harvested in one pass, compared to three to four passes for other forages (haylage or dry hay), making it simpler to harvest – or hire someone to harvest – once a year.
- Having a consistent feedstuff aids in ration balancing and animal nutritionists have been able to improve feed efficiencies through the use of total mixed rations (TMRs) by dairies.
- Farmers also have more varieties of silage corn to choose from to meet the nutritional needs of their cattle.
- Corn silage can be harvested using the same equipment as conventional corn, whereas hay requires different harvesting equipment.

Because silage corn is harvested earlier in the season than corn for grain, it is well-suited to be followed by a cover crop.

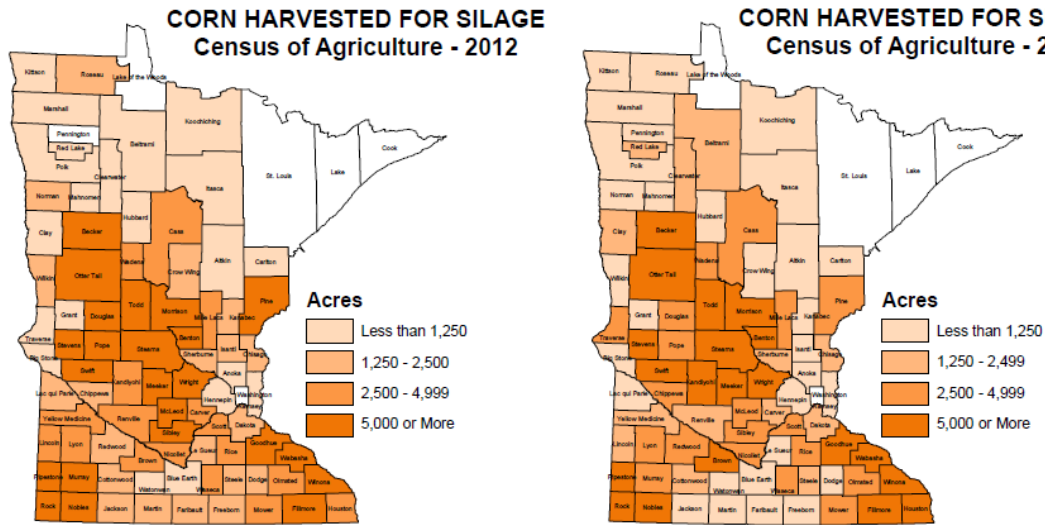


Figure 10: Corn harvested for silage, 2012-2017 (NASS data)

Cover crop use

The use of cover crops is growing throughout Minnesota and in the three study areas, although the percentage of acreage in cover crops remains low, as noted at the beginning of this section.

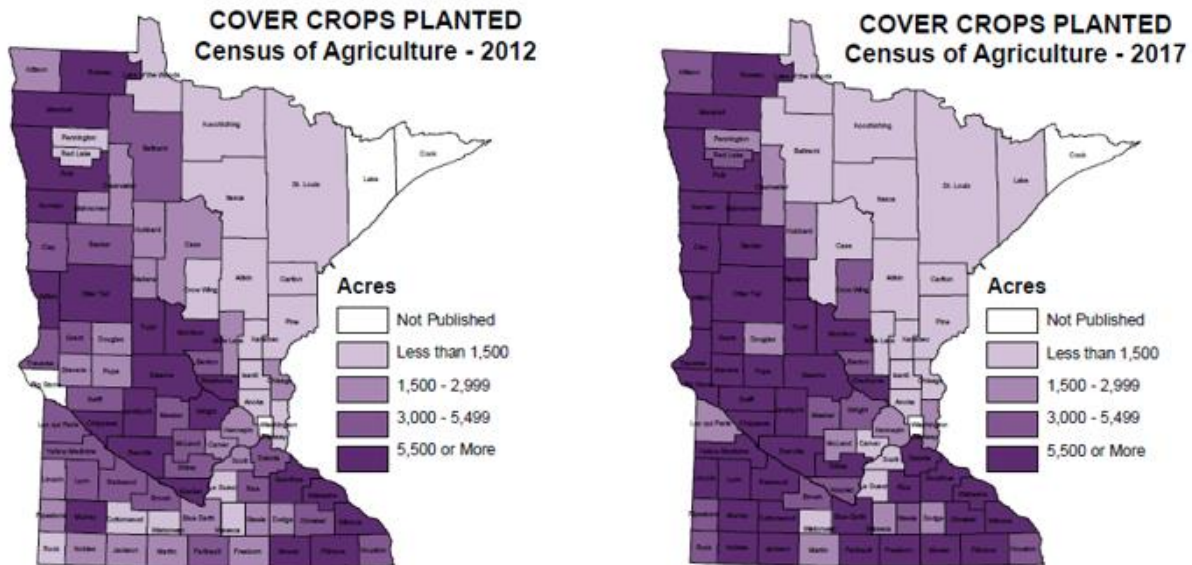


Table A4 and Figure 11 show the change in cover crops by county from 2012 to 2017. Cover crops in the

Figure 11: Cover crops planted, 2012-2017 (NASS data)

Central Sands area grew as to acres per farm, but the number of farms growing cover crops and the total acres of cover crops declined. Morrison and Stearns counties saw considerable declines in acreage, but that change does not appear on the map because of the acreage ranges used. Since weather variations have such a large impact on cover crop establishment, fluctuations in acreage are common from year to year. The declines in acreage in those counties may also be related to declines in the total numbers of cattle (milk and beef cows, heifers, etc.), given the role of cover crops for forage and

aftermath grazing. Morrison County saw a 7% decline and Stearns County saw a 21% decline in cattle numbers during this period.

While the number of farms planting cover crops also dropped in the southeast study area, the total number of acres in cover crops increased along with the acres per farm. In the southwest study area, cover crops increased across number of farms, overall acres and acres per farm. As noted above, however, comparison of two years over a five-year period does not constitute a trend.

Cover crop adoption increased in many areas in 2019 due to the unfavorable spring weather. To assist farmers who were unable to plant an insurable crop, the USDA's Risk Management Agency provided crop insurance ("prevent plant") benefits, as well as an opportunity for farmers to plant a cover crop on these acres and not lose crop insurance benefits. These farms also qualified for trade assistance payments of \$15 per acre. According to the American Farm Bureau, of the 20 million acres of prevent plant in the United States, more than 4 million acres of that land had been planted to a cover crop by August 22, 2019. It is unknown as to how many of these farms would have normally utilized cover crops in their operation, but the severe weather may have introduced another management tool to some farms who had not tried cover crops before.

Regional characteristics of the study areas

The tables in Appendix A provide county-level detail on the crop mix, livestock numbers, and conservation practices in the study areas, drawn from the 2012 and 2017 censuses of agriculture. Key findings from the 2017 census are summarized below, focusing on existing and potential opportunities to increase vegetative cover.

Central Sands

- **The region leads in forage production (hay, haylage)**, with 7 out of the 10 counties reporting at least 20,000 acres of forage grown. Stearns, Otter Tail, and Morrison counties reported the highest acreage.
- **The region also has the largest amount of pastureland**, with Wadena, Todd and Morrison counties with over 10% of farmland in pasture.
- **Spring wheat for grain** is grown in significant amounts in three counties, with the largest acreage in Becker and Otter Tail counties, each with around 30,000 acres in production.
- **Potatoes and vegetables** are grown in Hubbard and Wadena counties, although acreage is withheld to avoid disclosing data from a small number of producers.
- This region is a center of **dry edible bean production**, particularly kidney beans. Kidney beans are a short season crop that can be followed by a cover crop.
- **Stearns County leads in cattle production**, primarily dairy cattle.
- Morrison, Stearns, and Benton counties lead in **chicken production**. Morrison, Stearns, Becker, Otter Tail, and Todd counties also are centers of **turkey production**.
- Wadena County leads in **cover crop adoption**, with 13% of farms and 7.7% of cropland. Hubbard, Otter Tail, Morrison, and Stearns counties all have at least 3% of cropland in cover crops, although several counties have seen declines in acreage since 2012. Cover crop establishment is highly susceptible to weather conditions from year to year, so some variability is expected.

Southeast

- **This region leads in cover crop adoption**, with all counties except Houston showing adoption on over 10% of farms. Cover crops are planted on over 3% of cropland in Dakota, Wabasha, Olmsted and Winona counties.
- **Significant amounts of forage are grown in this region**: in all counties except Dakota, acreage ranges from just over 20,000 to 38,000 (Winona County).
- **Dakota County has a large acreage in vegetables and sweet corn**, probably related to its metro-area location, with easy access to consumers and farmers markets. Olmsted County, centered on the Rochester metropolitan area, also has significant acreage in these crops – which are mainly short-season crops.
- **Oats grown for grain** occupy small but noteworthy acreages in Houston, Fillmore, and Winona counties.
- **Horses and ponies are found in somewhat larger numbers** – 1,000 or more – in most counties, except for Wabasha and Houston, indicating potential markets for hay.
- **Turkey production** appears to be significant but numbers are withheld in all except Goodhue County.

Southwest

- The three counties in this region have relatively low levels of forage (hay and haylage) production but all three have some **small grain production**, primarily wheat in Pipestone County and oats in Rock County.
- **Hogs and pigs** are the dominant livestock in this region. A limited amount of barley has been used in hog rations, offering some potential for its expansion in this area.
- **Cover crop use is still relatively low**, but adoption increased in each county between 2012 and 2017, more than doubling in Rock and Nobles counties.
- Pipestone County has the highest levels of **cover crop adoption** (13% of farms) and **land in pasture** (8%).

IV. Agricultural practices of surveyed farmers

The majority of surveyed farms – 25 of the 29 farms included in the detailed data survey – have pasture, and 22 graze some livestock. About half of this group practice continuous grazing and half practice rotational grazing. Of the 29 surveyed farms, 28 grew corn and 19 grew soybeans. Crop farmers raised corn for grain alone, while those who had livestock grew corn for grain and silage in most cases. (See Appendix C for details.)

Regional differences in crops and land use:

- Central Sands farmers (on 16 farms surveyed) identified potatoes, kidney beans, cereal rye, and wheat as additional crops. Several noted that not all of their land was tillable; the remainder was in pasture.
- Southwest farmers (on seven farms surveyed) identified oats and peas as additional crops, as well as oats planted with alfalfa as a nurse crop.

- Southeast farmers (on six farms) mentioned rye and alfalfa as cover crops; also noted that hilly acres are not cultivated.

Allied stakeholders work with every type of farm, with dairy, beef and corn/soybeans being the most common, followed by small grains and hay/haylage. The majority work with farms that are growing forages, pasturing livestock and growing cover crops.

Grazing and pasture practices

- Of the surveyed farms, 25 out of 29 had pasture and 21 pastured their animals in some fashion.
- The 12 dairy farms surveyed generally did not graze their milking cows. Milk production is higher when feed is harvested and brought to the herd. Confined feeding provides more control over the cow's diet and enables the cow to pack in nutrient dense meals within a shorter period of time. This can lead to higher milk production compared to grazing.
- Many of the surveyed dairy farms who do not graze or only occasionally graze their milking herd reported grazing their dry cows and replacement heifers (5 farms grazed dry cows and 9 grazed heifers). Some actually graze some or all of their animals, while others keep the animals outside and allow them to graze what they can off the paddock, along with supplemental feed. Among the advantages of this "dry lot" system are that it reduces bedding requirements, gives the animal additional exercise and keeps the cattle off the concrete floor.
- All the beef cow/calf producers (14 farms) used grazing as their primary method of feeding during the grazing season; some extend the grazing season by grazing crop residue and/or cover crops. In addition to their cows, some farms graze their heifers and one farm grazes beef steers.
- Of the 21 farms practicing grazing, equal numbers (12) reported managed (rotational) grazing and continuous grazing (farmers could select more than one practice). Paddock systems were the most common type of managed grazing, with strip grazing and mob grazing also mentioned by seven respondents.
- Ten interviewed farms reported aftermath grazing (grazing after harvest of a primary crop). Nine grazed corn ground post-harvest, six grazed hay ground and cover crops, and one grazed wheat stubble. These same farms also had dedicated pastureland.
- There is limited "other" grazing on interviewed farms, including horses, poultry and sheep.

Among **allied stakeholders**, about two-thirds reported that farms they worked with had pastures, whether improved (planted with introduced species) or native vegetation. Most farms used a rotational grazing system with paddocks, but continuous grazing was also common. Aftermath (post-harvest) grazing on corn, cover crops, and hay was widespread, most commonly with beef cattle, but also with dairy cows, steers, heifers, sheep, and goats.

Benefits of grazing; obstacles to grazing:

Farms that grazed animals noted several key benefits. First, they find that animals are healthier on pasture. Second, it makes economic sense and utilizes ground that is not tillable. Another common reason cited is that livestock and pasture are viewed as good for the land.

The top reasons why the surveyed farms did not graze were: they did not have livestock; grazing doesn't fit into their feeding system; or there was not enough land available. High land values and rent prices

have prevented farmers from putting cropland back into pasture, although there are opportunities to reseed lower-producing fields using a grazing management system.

Constraints and possible incentives for expansion of grazing

The majority of surveyed farm respondents are planning to expand their pasture (17%) or keep it the same (41%). **The primary constraints to expanding pasture that study participants identified included time and labor; providing fencing and water; and finding enough land for pastures.** Another factor that limits grazing is generational: older cattle farmers are retiring, and unless they are transitioning a younger person into the operation, their knowledge base is lost.

Participants would consider expanding pasture if economics were favorable, if other pasture were available near them, or if a family member were interested in pasturing livestock. Most respondents would be motivated to expand by economic considerations, and some producers would be interested in government payments or incentives. Given the investment in time, management, fencing, watering systems and establishment, **producers need to be reasonably confident of long-term profitability in pasturing livestock,** comparable to keeping farmland in row crops.

Forage production practices

The majority of surveyed farms – 25 of the 29 included in the detailed data survey – reported that they raised hay and other forage.

- The most frequent forage that is grown is dry hay, followed by corn silage.
- All of the dairy farms surveyed raise haylage or baleage, and all but two grow corn silage.

Thirteen of the farms sold forage.

- The most common forage sold was dry hay. Neighbors were the most common buyers, followed by other informal contacts via word of mouth.
- The lack of more formal sales methods keeps marketing costs down, but perhaps limits the size of the consumer base and the potential for premiums on prices.
- Surprisingly, none of the farms used forage-specific websites, Facebook or other online outlets to sell forage, all of which would increase market reach, especially when farms outside of the immediate area are short of hay.
- Some farms sold 100% of their forage crop while others didn't usually sell, except for occasional sales to neighbors to help them out.
- Those farms that sold hay indicated that they had ample outlets to sell their hay.

Nineteen farms reported that they purchased forage, with dry hay and bedding (also sometimes fed as forage) the most commonly purchased.

- Purchased quantities varied from 5-50% of livestock needs, with an average of 25%.
- Those that reported tonnage averaged 165 tons purchased annually.
- Slightly less than half hauled their own purchases. Hauling distances ranged from 1-100 miles.
- Most of the purchased forage was being purchased for dairy or beef cattle.
- The most common hay source was neighbors, followed by contacts found via word of mouth. Other sources included family, "hay jockeys" and a supplier.

Quality and cost were the most important considerations by those purchasing forage. One farmer stated that the Sauk Centre hay market set the price for what was sold in the area even if one did not buy

there. The prices from this market are tracked and published by University of Minnesota Extension and offer insights to both the current and historical markets (see Figure 12 below).

Eleven out of 13 farmers that responded to the question said that they had adequate purchasing options. All 13 respondents purchased some or all their hay/forage from Minnesota growers, although some purchased wheat straw from Canada.

The majority of the allied stakeholders indicated that farms they work with grow forages, primarily alfalfa and corn silage. Other forages, including clover, grasses, legumes and small grains, were grown to a lesser extent. Forage was harvested primarily as haylage and dry hay, with lesser numbers also harvesting baleage.

Constraints and possible incentives for expansion of forage

Six farms responded to the question “If you don’t grow forages, what is stopping you?” **The main constraints identified were limited equipment and labor. Other constraints related to land availability, knowledge and timing of operations, weather, and production costs.**

Compared to western hay, which is grown under controlled irrigation, rain events and erratic weather patterns make growing hay and harvesting dry hay in Minnesota challenging. Winter kill in alfalfa also presents challenges. The high capital cost of haying equipment and the amount of work needed to harvest 3-4 crops of quality hay per year are also obstacles.

Fourteen farms responded to a question on incentives that would encourage them to grow forage or increase forage production. **The most common responses identified “higher profits” and “available markets.” Other potential incentives included availability of custom operators, availability of a cost share program or grants, low interest loans for equipment and storage, and additional livestock.**

Among farmers and allied stakeholders, the availability of hay markets is key to forage sales and purchases. There are several established hay auctions in the state and a number of lesser known auctions, which typically sell dry hay and straw and sometimes baleage and corn stalk bales. Among the largest auctions are those in Sauk Centre, Litchfield, Zumbrota, and Pipestone. The University of Minnesota provides an excellent resource for these auctions. In

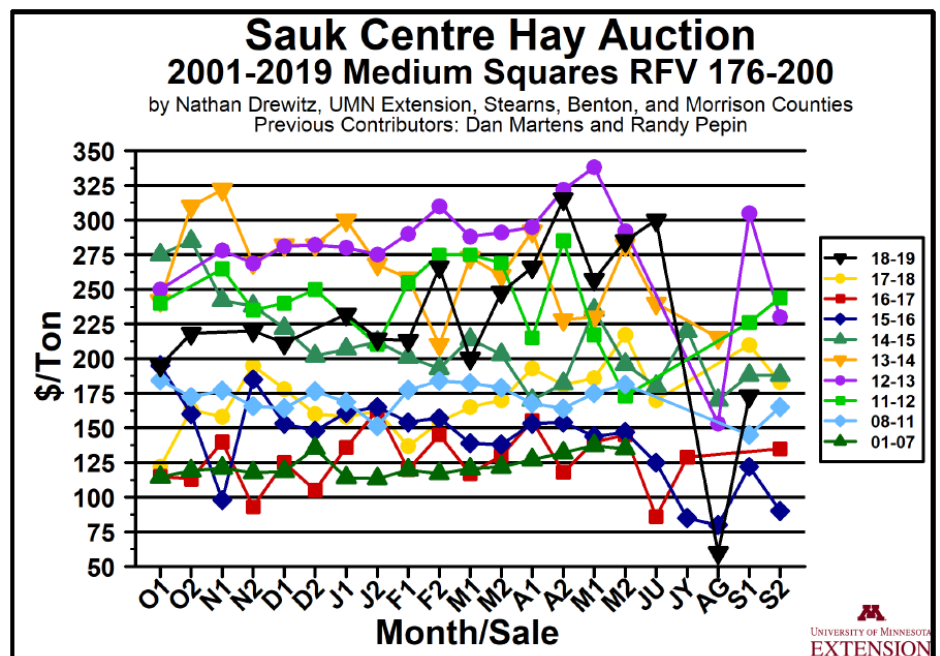


Figure 12: Example Hay Auction Pricing Summary, Sauk Centre Hay Auction, 2001-2019 Medium Squares RFV 176-200

addition to the auctions, they also provide a [list of sources](#) where one can purchase hay. On-line sales for horse hay are also popular although not tracked.

Prices from the Sauk Centre hay market tracked by University of Minnesota Extension show a wide range of prices within a season. In 2019 alone, a tested hay group showed a range of five times the lowest price to the highest price – a range that would be unheard of in corn and soybean markets. There are often significant differences from one year to the next. **The combination of price and weather uncertainties are hurdles for the hay producer to overcome.**

Opportunities for forage market expansion

In Minnesota we primarily think of large herbivores consuming hay, but **there is a growing and lucrative market in pet food for small herbivores such as guinea pigs** – orchard grass, timothy and alfalfa are popular pet feeds. Hay for large animals may go for \$100-250 per ton, but in the pet food trade, \$2,000-8,000 or more per ton is not an unusual price. The quality has to be exceptional, but if managed properly there is likely opportunity in this niche market.

According to the most recent American Pet Products Association (APPA) National Pet Owners Survey, small-pet ownership is at one of its highest levels in two decades, with 6.7 million households in the U.S. owning at least one small animal³. The pet food market has grown every year since 2001. As of the 2017-2018 National Pet Owners Survey, 6.7 million households have small animals as pets, including small herbivores. Horse numbers included in the survey encompass those considered as pets and not working horses.

Horses, as both pets and working horses, also offer an opportunity for additional forage sales. For example, one Minnesota grower is packaging a total mixed ration in a cube for horses: a lot of nutrition in a small package that is easy for horse owners to handle, since it comes in bags and not bulky bales. However, **Minnesota producers still face the challenges of getting dry hay processed under variable weather conditions and the transportation costs of getting the product to these specialized markets.**

Cover crop practices

Twenty-one of the 29 surveyed farms have grown/used cover crops in their farming operation. Ten of the 21 online questionnaire respondents reported using cover crops as well.

- Responses from the surveyed farms indicated that the majority of respondents (75%) felt they were average or above average in their understanding of growing/utilizing cover crops. The remainder were split between “poor” and “excellent” levels of knowledge.
- Farms used a wide range of practices and systems, including everything from single species (most commonly winter cereal rye) to multi-species mixes.
- Other cover crops included brassicas such as turnips, radishes and similar root crops, legumes such as red clover, and small grains such as sorghum, spring wheat, oats and triticale.
- Some utilize the forage through grazing or otherwise harvesting it, while others terminate the crop without using it for livestock feed.

³ National Pet Owners Survey: <https://www.iii.org/table-archive/22305>

Regional differences:

- In the Central Sands, benefits identified included weed suppression, better access to fields in spring, reduction of wind/water erosion, and prevention of nutrient runoff. More of the Central Sands respondents identified challenges using cover crops, primarily the shorter growing season and the narrow window of time between harvesting the primary crop and freeze-up.
 - Some reported planting after small grains, or using spring wheat and winter wheat after corn, then baling it for bedding.
 - Others reported the use of winter wheat, lentils, ryegrass and clovers following soybeans, the use of rye after corn silage and ahead of alfalfa, and the use of brassicas and rye following potatoes and kidney beans.
 - Some respondents noted cover crops are most effective in conjunction with no-till, not conventional tillage.
- Southwest respondents identified more opportunities and fewer challenges for cover crops. Practices included:
 - Planting rye, oats and radishes after small grains and corn silage, using both aerial seeding and interseeding into corn at the V3-V5 stage.
 - Planting winter rye for grazing by cow/calf pairs in early spring and planting brassicas in advance of a hay crop.
 - Long-season cover crops with 14-18 different species used for grazing beef cattle.
 - Improved soil health, enhanced water retention, and increased yield were cited as benefits.
 - Cutting red clover for sale as feed, then terminate for no-till planting.
- Southeast respondents identified fewer cover crop practices, although cover crop use is relatively high in this region. Cover crops mentioned included winter cereal rye, triticale, annual ryegrass and oats after corn silage, soybeans and corn for grain. Oats, BMR sorghum/Sudan grass, and red clover were also reported.

Allied stakeholders reported that among the farms they work with, **cover crops are gaining ground, especially for grazing, and that they are most effective for short-season crops or when there is livestock in the system.**

Benefits and obstacles to cover crop use

In addition to the regionally-specific responses mentioned above, questionnaire respondents cited many similar benefits:

- Soil health, nutrient cycling, better crops, build up organic matter
- Fill gaps in nutrition and availability of livestock forage
- Cut tillage and fuel costs while rebuilding the soil structure
- Erosion control
- Weed control

Obstacles included:

- Effort and expense of planting, with costs estimated at \$30 – 40/acre
- Timing and weather, especially when seeding in the fall (lack of time to establish the cover crop)
- Lack of livestock to graze the cover crops
- Lack of education, knowledge, and equipment (i.e., a no till drill) or custom operators
- Risks and uncertainties of economics and yield

Small grains, other short season crops, and specialty/emerging crops

This category includes both traditional small grains grown for food or feed and emerging crops such as Kernza® and oilseeds. There is growing interest in both categories, but also many challenges to be addressed regarding availability of equipment and supplies, markets and supply chains. Interviews with surveyed farmers did not address their use of small grains as primary crops, although some respondents mentioned using them as forage or cover crops. Interviews with allied stakeholders indicated some use of small grains for feed and forage among their clients.

Small Grains

A 2018 report, [Small Grains in Minnesota: Assessing the Feasibility of Local Supply Chains](#), from Renewing the Countryside and University of Minnesota Extension partners, provides a comprehensive overview of the status and potential for small grain cultivation. Key findings of the report are incorporated in this section.

Small grains – specifically, wheat, oats, barley, and rye – have long been staple crops in Minnesota and the Upper Midwest. However, production of small grains has declined across the region and state as acreage in corn and soybeans have increased.⁴ Newer corn varieties that mature more rapidly have enabled corn cultivation to spread further north and west. As discussed in Section III, harvested acres of wheat, oats, and barley have all declined dramatically in the past several decades.

Much of the small grain production in Minnesota is for livestock feed, although small grain varieties such as oats, buckwheat, and rye are also grown for human consumption. However, the largest food and beverage processors in the state source their grains from elsewhere, due largely to economies of scale. For example, Rahr Malting, one of the largest providers of malted barley for the brewing industry, sources its barley from Canadian and European sources. General Mills, one of the largest processors of wheat and oats for food, typically sources its oats from Canadian producers.

Small grains are short season crops, which makes it much easier to establish cover crops. Establishing cover crops in corn and soybeans can be challenging because of the short window of time that remains after harvest. “Even with the most advanced interseeding technologies, cover crop establishment success will be greater following short season crops. Wheat, barley, and oats make establishing cover crops much easier.”⁵ In addition, cover crops seeded following small grains can produce enough growth to be grazed or harvested for forage in the fall.

Oats

Given the decline in harvested acreage of oats (see Figure 3 and Table A1), it’s surprising that Minnesota remains the third largest producer of oats in the United States, behind North Dakota and South Dakota. However, oat production has declined throughout the country. “Once one of the Upper Midwest’s most popular crops, oats have struggled to compete with more profitable alternatives, and because fewer farmers have produced the crop, the downward cycle has continued as many elevators in the region

⁴ Bjerga, A., Cl. Hoffman, and D. Ingold. 2018. The consolidation of the American harvest. Bloomberg, Sept. 7, 2018. <https://www.bloomberg.com/graphics/2018-crop-shift/>

⁵ Wiersma, J., S. Wells, and J. Goplen. 2018. Small grains: an easier way to establish (and grow) cover crops. <https://blog-crop-news.extension.umn.edu/2018/04/small-grains-easier-way-to-establish.html>

have quit handling oats.”⁶ In Minnesota, most oats are grown in northwestern counties and in the Central Sands region, as shown in Table A2, but smaller quantities are also grown in southeast and southwest.

At the same time, the increasing popularity of oats as a gluten-free grain and of oat-based beverages indicates **the potential for growing oats for human consumption may increase**. Another current trend is a decline in ethanol production in Minnesota due to lower U.S. demand and a plunge in exports, which is leading to a decline in availability of dried distillers’ grains, a major co-product from ethanol production, used as protein-rich animal feed. Oats may emerge as a partial replacement.

Some conservation districts pay producers to plant oats in advance of conservation practices, such as grass waterways, which are constructed after harvest.

According to a number of allied stakeholders in the southwest region, grain elevators typically handle oats to blend for livestock feed but experience periodic shortages in summer. If cost-share or other financial incentives were available, it might be possible to increase the acreage of oats as a primary crop within multi-year crop rotations. **Availability of planting and harvesting equipment are also barriers that could be overcome with focused investments.**

Wheat, Winter and Spring

The majority of wheat grown in Minnesota is [spring wheat](#), mainly grown in the northwestern counties, from Norman County north to Kittson and Roseau counties. Portions of the Central Sands counties, including Becker and Otter Tail, also include fairly high acreages. The University of Minnesota has developed a number of hard red spring wheat varieties well-adapted to Minnesota’s growing conditions.

Challenges to wheat production include low prices, excess rainfall during planting and harvest, and “falling numbers,” a measure of possible or potential sprout damage in wheat kernels. As a spring crop, wheat offers ample opportunities to follow with a cover crop or second crop, but, as noted above, those practices have their own challenges.

Rye (Cereal Rye)

Cereal rye is typically grown as a winter cover crop or for grazing but is also used for flour and seeds for baking and for craft brewing and distilling. In 2017, just over 20,000 acres were harvested in Minnesota. “Cereal rye has recently gained attention as a winter cover crop in corn-soybean production systems. Seeded in the fall, cereal rye will grow before going into winter dormancy and resume growth early the following spring.”⁷

Research in Minnesota, Iowa and North Dakota has resulted in development of hybrid rye varieties, with higher yield and suitable characteristics for livestock feed. Trials of these varieties by Practical Farmers of Iowa point to the potential of cereal rye for multiple purposes. “As farmers begin to plant cereal rye for other purposes – cover crop seed, grain, straw, forage, hay or haylage production – they might seek to plant cereal rye varieties with distinct production characteristics.”⁸ Food-grade applications hold potential for locally-sourced grains or alcoholic beverages. Cereal rye remains the most common cover crop grown in Minnesota, and is used with many crops including corn, soybeans, and potatoes.

⁶ Muckey, E. 2018. Small Grains in Minnesota. <https://www.renewingthecountryside.org/publications>

⁷ Practical Farmers of Iowa. Cereal Rye Variety Trial 2019. https://practicalfarmers.org/wp-content/uploads/2019/11/19.FC_SG_Cereal-rye-variety-trial_FINAL.pdf

⁸ Ibid.

Barley

Like other small grains, barley was once among Minnesota's leading crops, but production has declined here as it has in other states; Minnesota currently ranks eighth among states in barley production. As with other small grains, Minnesota's northwestern counties are the center of barley production, with the highest acreages in Marshall and Roseau counties.

Barley is divided into two general types: two-row (the oldest form) and six-row. The barley improvement program at the University of Minnesota has developed a number of widely adapted spring six-rowed malting barley varieties. Most craft brewers now prefer two-row barleys for malting and brewing. While these varieties tend to grow best in a drier climate, some brewers in western Minnesota do purchase locally-grown barley.

Plant breeding efforts by the Forever Green Initiative are focused on developing [winter barley](#) (both two-row and six-row) as a winter annual planted in fall for use in malting. Winter barley will typically have higher yields than spring barley in many regions, while improving soil health and reducing nitrate leakage to groundwater. Winter survival of trial varieties is higher in southern Minnesota.⁹ **Increasing interest in small-scale craft beer production may contribute to increased demand for locally-grown malting barley.** However, widespread introduction of new varieties is likely two to three years away.

Other Short Season Crops

Any crop with a short growing season offers opportunities to establish cover crops. In Minnesota, short season crops include sweet corn and peas, dry beans, sugar beets, and potatoes.

Sweet corn and peas

In 2017, Minnesota ranked first in the U.S. for sweet corn and pea production; in 2019 it ranked second. The majority of these crops are grown in central, south-central, and southeast Minnesota, including Dakota and Olmsted counties (see Table A2). Because these crops are harvested before full maturity, nutrients such as nitrogen remain in the soil, and can be lost to leaching in the fall or the following spring.¹⁰ Planting a cover crop can minimize these losses while reducing erosion. Cover crops that can be planted following peas or sweet corn include winter rye, tillage radish, rape seed, and oats.

Edible Dry Beans

Minnesota was the national leader in kidney bean production in 2019. Most of the crop was grown in north-central and northwestern Minnesota. Beans have a shallow root system and do well in sandy soil with moderate irrigation. Otter Tail and Hubbard counties lead the region in dry bean acreage, while Pope and Todd counties each reported over 5,000 acres of dry beans.

Like other legumes, dry beans have the ability to fix a portion of their nitrogen needs from the atmosphere so nitrogen fertilizers may not be needed, especially if they follow crops fertilized with high amounts of nitrogen.

Markets for dry beans are difficult to access, since they are dominated by large producers in North Dakota. Beans also require a high level of weed management, especially for organic production.

⁹ <https://extension.umn.edu/small-grains-crop-and-variety-selection/winter-barley-emerging-crop#winter-survival-and-planting-date-1884760>

¹⁰ <https://blog-crop-news.extension.umn.edu/2018/09/in-2017-minnesota-ranked-1-in-us-for.html>

Sugar Beets

Sugar beets are grown primarily in northwest and west-central Minnesota, including Becker, Otter Tail, Pope, and Stearns counties.¹¹ Many producers plant cover crops in spring to protect emerging beet plants from wind erosion. Research by the southern Minnesota Beet Sugar Cooperative indicates that incorporating fall cover crops can increase yield in the following season.¹²

Potatoes

Potatoes are grown in sandy soils in central and northwest Minnesota, particularly in the Pineland Sands region of north central Minnesota, which includes parts of Hubbard, Becker, and Wadena counties. Most are grown under irrigation, resulting in concerns about the potential for cumulative impacts to groundwater. In addition to cover crops, potatoes benefit from a multi-year rotation that includes alfalfa, which can help to break soil-borne disease cycles.¹³

Specialty Crops / Emerging Crops

Farmer respondents were generally unfamiliar with the emerging crops discussed below, although a few had heard of Kernza®. Over half the allied stakeholder respondents indicated that the farmers they worked with were considering alternatives, including small grains, canola, and hemp. Reasons included interest in reducing fertilizer, pesticide, and drainage tile costs, reducing erosion, increasing organic matter in soil, and looking for profitable opportunities.

Kernza®

Kernza is the trademarked name for the edible grain harvested from the intermediate wheatgrass plant, developed as a promising new perennial grain crop by The Land Institute in Salina, Kansas, and the Forever Green Initiative at the University of Minnesota. With a deep, dense root system and long growing period, Kernza has been shown to reduce nitrate leaching to groundwater when compared to fertilized annual crops. It has attracted increasing interest from growers, processors, and large and small food manufacturers. Kernza is being used for baked goods, cereals, and brewing, but can also be used as a forage crop, with the potential for multiple harvest (forage and grain) in a single season.¹⁴

Since the interviews for this study were conducted in 2018, awareness of Kernza has increased dramatically, with products showcased at the State Fair, and has received substantial national media attention. Development of seed supplies, supply chain, and markets for Kernza have also advanced, with demand for seed outstripping supply. A new variety, MN-Clearwater, was introduced in 2019, and seed supplies will allow about 1,000 acres to be planted in fall 2020. Availability of processing facilities remains challenging – there is one processor in North Dakota, but capacity is limited. However, demand for cleaning, dehulling, milling, and malting is increasing, and it seems likely that Kernza acreage will expand in the next few years.

Winter Camelina and Pennycress

These crops are winter annual oilseeds that are being domesticated to fit Minnesota's conventional agricultural system. Both are cover crops that protect soil over the winter and early spring to reduce soil erosion, nutrient loss, and weed infestations. At the same time, they can act as double or relay "cash

¹¹ https://www.nass.usda.gov/Statistics_by_State/Minnesota/Publications/County_Estimates/2019/MN-CtyEst-Sugarbeets-17-18.pdf

¹² <https://www.smbc.com/News/index.php/2017/11/30/mpca-bulletin-beet-co-op-promotes-cover-crops-exceeds-phosphorus-reduction-credit-goals/>

¹³ <https://potatosoilhealth.cfans.umn.edu/about>

¹⁴ See <https://kernza.org/> for references and resources

crops” that produce oil, with uses ranging from human consumption (for camelina) to bio-jet fuel, bio-based plastics, and oilcake for animal feed. The University of Minnesota breeding program has been working to develop high yielding, non-shattering, and high germination varieties. **Both oilseeds are ideally suited to crop rotations in which they follow short season canning crops, (primarily sweet corn and peas, as discussed above) and are followed in spring by soybean.** While opportunities to establish the annual oilseeds in Minnesota are likely to increase, obstacles include restrictions against harvesting cover crops in USDA-NRCS programs, lack of crop insurance protection, and unfamiliarity with the crops among lenders, crop consultants, and other influencers.

Other Specialty Crops

Many other specialty crops are under development in Minnesota through the Forever Green Initiative and other University of Minnesota programs, including hazelnuts, perennial sunflower, silphium (a sunflower-related oilseed crop), and summer annual grains for double cropping. **As plant breeding and agronomy advances, opportunities for these crops will increase, although they still currently comprise small niche markets.**

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Selected Definitions

Rotational grazing can be practiced in a variety of intensities. Systems can range from 2 to 30 or more paddocks. Management intensive rotational grazing involves a higher level of management with greater paddock numbers, shorter grazing periods, and longer rest periods.

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1097378.pdf

Strip grazing involves the use of a movable electric fence, to give the stock a fresh strip of leafy grass per day. This allows farmers to allocate fresh grass to their stock for 1 or 2 days at a time.

<https://www.thatsfarming.com/news/grazing-system-farm>

Mob grazing is also known as ultra-high density grazing – grazing a large concentration of livestock in a small area for a short duration, with animals moved several times per day.

<https://grazer.ca.uky.edu/content/grazing-methods-which-one-you>

Appendix A: Detailed Tables

Source for all tables is the Census of Agriculture, 2012 and 2017

Table A1: Changes in Land Cover, Primary Crops, and Conservation Practices in Minnesota, 2012-2017

Land Cover, Primary Crops, Conservation Practices	2017	2012	Change (%)
Land Area and Land Cover			
Number of farms	68,800	74,542	-8
Land in farms (acres)	25.5 M	26.0 M	-2
Average size of farm (acres)	371	349	6
Cropland (acres)	21.8 M	21.6 M	0.9
Permanent pasture and grazing land (acres)	1.0 M	1.27 M	-27
Pastured woodland (acres)	345,600	439,300	-27
Crops (acres harvested)			
Corn for grain	7.8 M	8.3 M	-6
Soybeans	8.1 M	7 M	24
Wheat for grain	1.20 M	1.35 M	-13
Sugar beets	423,100	481,000	-14
Dry edible beans	160,600	150,150	7
Oats for grain	84,600	130,700	-55
Barley for grain	67,500	99,640	-48
Potatoes	46,280	48,210	-4
Forage (all hay, haylage, etc.)			
Hay	1.45 M	1.5 M	-3.5
Alfalfa hay	1.20 M	1.3 M	-1.1
Other dry hay	829,000	784,000	5.7
Corn for silage	382,000	n/a	
	330,500	361,200	-9
Conservation practices			
No-till acreage	1.1 M	819,000	33
Reduced till	8.2 M	6.1 M	34
Cover crops	579,150	408,190	41

Regional characteristics of the study areas

Table A2 summarizes the crop mix in the three study areas, Table A3 summarizes livestock numbers, and Table A4 summarizes conservation practices. Counties with higher acreage in each category are highlighted.

Table A2: Crop Mix in the Study Areas, 2017

Major Crops (Acres) – Harvested, 2017									
	Corn for grain	Soybeans	Corn for silage or greenchop	Forage (hay, haylage)	Oats for grain	Wheat for grain	Dry edible beans	Potatoes	Vegetables, sweet corn
Central Sands									
Becker	59,859	86,237	5,436	32,358		29,990			
Hubbard	11,214			15,402			8,412	(D)	(D)
Otter Tail	168,402	179,243		81,319		30,196	14,437		
Wadena	15,828	14,188		23,457				(D)	(D)
Douglas	63,660	82,326	3,038	16,013		10,702			
Todd	54,679	48,600	10,736	49,406		5,753			
Morrison	71,970	38,723	21,105	65,403			4,271		
Pope	115,033	93,627		13,150		5,318	5,769		
Stearns	182,828	114,288	40,242	95,352	11,100				
Benton	56,554	54,340	6,629	20,256					4,007
	800,027	711,572	87,186	412,116	11,100	81,959	32,889		4,007
Southeast									
Dakota	103,411	65,489		7,864					23,681
Goodhue	153,611	113,522	9,888	25,760					4,520
Wabasha	68,810	40,860	10,308	29,597					6,790
Olmsted	110,854	69,899	20,491	20,491					17,240
Winona	72,401	34,666	15,252	38,502	2,249				
Fillmore	136,887	82,605	8,469	30,469	1,570				
Houston	43,258	24,820	6,144	28,938	1,615				
	689,232	431,861	70,552	181,621	5,434				52,231
Southwest									
Pipestone	94,639	83,912	6,599	10,325		2,049			
Rock	127,899	113,772	8,309	7,463	1,544				
Nobles	185,989	176,225	9,386	8,043	555				
	408,527	373,909	24,294	25,831	2,099	2,049			

Table A3: Livestock Numbers in the Study Areas, 2017

Livestock (number of animals), 2017								
	Cattle, calves	Milk cows	Beef cows	Hogs, pigs	Horses, ponies	Sheep, lambs	Chickens	Turkeys
Central Sands								
Becker	26,645	6,279	6,154	(D)	382	316	2,743	578,604
Hubbard	6,841	411	3,148	1,052	551	511	2,716	65
Otter Tail	78,216	14,341	18,079	11,746	1,564	2,162	6,089	831,000
Wadena	12,818	2,576	4,237	181	585	877	3,999	(D)
Douglas	19,943	3,611	3,875	1,089	512	778	1,908	
Todd	55,660	14,498	11,302	10,740	1,879	3,016	12,002	899,194
Morrison	87,791	27,805	15,438	59,080	992	1,080	5,479,289	1,477,183
Pope	27,195	3,446	6,123	104,433	354	867	(D)	(D)
Stearns	198,361	66,524	11,343	84,707	1,490	2,610	4,102,606	2,734,124
Benton	33,372	10,404	4,013	25,398	492	990	2,894,028	
	546,842	149,895	83,712	298,426	8,801	13,207	12,505,380	6,520,170
Southeast								
Dakota	22,749	3,577	1,915	14,493	980	1,024	3,359	(D)
Goodhue	70,463	18,382	8,146	103,073	1,108	2,624	6,658	543,043
Wabasha	56,163	20,257	5,438	11,603	529	547	2,180	(D)
Olmsted	44,266	10,660	8,034	23,691	1,476	923	2,405	(D)
Winona	70,460	24,032	8,543	112,381	1,160	3,049	7,326	(D)
Fillmore	59,346	10,963	16,206	143,545	1,691	3,163	21,301	(D)
Houston	43,648	9,177	7,861	12,703	488	595	1,559	(D)
	367,095	97,048	56,143	421,489	7,432	11,925	44,788	543,043
Southwest								
Pipestone	59,712	6,910	9,181	361,314	330	3,964	(D)	(D)
Rock	93,683	3,880	5,561	299,729	195	2,057	(D)	(D)
Nobles	92,426	6,569	5,094	393,029	231	1,805	1,213	186,011
	245,821	17,359	19,836	1,054,072	756	7,826	1,213	186,011

Table A4: Conservation Practices; Land Use in the Study Areas; Change in Cover Crops, 2012-2017

	% 2017 Farms practicing no-till*	% 2017 Farms practicing reduced till*	% 2017 Farms with cover crops*	2017 Cropland acres	% 2017 Cropland in cover crops	2017 Cover crop acres	2012 Cover crop acres	% change 2012-2017	% Pasture-land**
Central Sands									
Becker	5	11	6	255,999	2.5%	6,367	5,365	19	7
Hubbard	7	7	8	53,391	4.7%	2,491	2,245	11	8
Otter Tail	7	20	7	576,163	3.4%	19,501	17,231	13	6
Wadena	4	12	13	75,336	7.7%	5,809	2,130	173	13
Douglas	8	23	5	205,324	1.4%	2,773	2,722	2	4
Todd	6	16	8	210,494	2.8%	5,808	7,438	-22	12
Morrison	7	23	8	232,790	3.9%	9,008	13,710	-34	11
Pope	8	26	8	280,326	2.1%	5,883	2,471	138	6
Stearns	6	28	9	515,928	3.3%	17,017	24,906	-32	6
Benton	7	23	6	155,769	2.1%	3,244	4,483	-28	7
				2,561,520	3.0%	77,901	82,701	-6	
Southeast									
Dakota	10	31	12	192,659	5.8%	11,174	5,033	122	2
Goodhue	14	34	11	329,994	2.8%	9,124	7,335	24	5
Wabasha	15	38	15	177,784	5.2%	9,327	6,590	42	6
Olmsted	15	30	12	209,399	4.5%	9,397	5,174	82	6
Winona	13	33	13	180,009	3.8%	6,836	9,866	-31	9
Fillmore	16	33	11	316,843	2.8%	8,853	9,752	-9	8
Houston	23	28	9	129,356	2.5%	3,280	4,715	-30	10
				1,536,044	3.8%	57,991	48,465	20	
Southwest									
Pipestone	14	27	13	206,004	2.1%	4,278	2,238	91	8
Rock	20	43	8	252,671	1.7%	4,281	1,193	259	4
Nobles	9	34	5	350,983	1.8%	6,473	1,707	279	2
				809,658	1.9%	15,032	5,138	193	

* percent of number of farms

** percent of land in farms

Appendix B: State Agricultural Grant and Loan Programs That Can Support Vegetative Cover

The following list does not encompass every state program that may be supportive of vegetative cover initiatives, but rather identifies those that most directly address the issues raised in this report.

Note also that many best management practices that support vegetative cover receive funding through USDA’s Natural Resources Conservation Service programs, particularly the [Environmental Quality Incentives Program](#) (EQIP) and the [Conservation Stewardship Program](#) (CSP). Both programs provide cost-share payments for specified practices such as cover crops, conservation crop rotation, and forage and biomass planting. Farmers generally access these and other federal and state programs through their local soil and water conservation district.

Agency	Program	Issues addressed
Loan and Information-Sharing Programs		
MDA	Cropland Grazing Exchange : matches livestock farmers with crop farmers who have forage (crop residues, cover crops, etc.) to harvest. Connections are made via an interactive map that shows the locations of farmers who have livestock to graze and farmers who have cropland they want grazed. Grazers may need to provide water and temporary fencing. Opportunities for grazing and harvest of hay on public land such as wildlife management areas can also be identified by contacting wildlife managers.	<i>Availability of grazing land.</i>
MDA	FarmLink : a list of Minnesota farm properties for sale or rent; also a means to connect retiring farmers with prospective farmers, and experienced farmers with beginning farmers.	<i>Availability of farmland for sale or rent; sharing of expertise.</i>
MDA	AgBMP Loan Program : a water quality program that provides low-interest loans to farmers, rural landowners, and agriculture supply businesses. The purpose is to encourage agricultural Best Management Practices that prevent or reduce runoff from feedlots, farm fields and other pollution problems identified by the county in local water plans.	<i>Need for support for BMP implementation.</i>
MDA	Rural Financing Authority : offers low-interest loan programs to farmers for a wide variety of activities, including land purchase, farm improvements, and livestock production facilities.	<i>Availability of funding for land purchase and capital investments.</i>
Technical Assistance Programs		
MDA/Multi-agency	MN Ag Water Quality Certification Program (MAWQCP): a voluntary program for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our	<i>Participants receive priority for technical and financial assistance to implement practices such as cover</i>

Agency	Program	Issues addressed
	water. Farmers who become MAWQCP-certified obtain regulatory certainty for ten years as complying with any new water quality rules or laws during that time.	<i>crops and other practices that improve soil health.</i>
MDA	Nutrient Management Initiative : Assists farmers and crop advisors in evaluating nutrient management practices on their own fields. Participants are compensated for their time.	<i>Ability to monitor nutrient management practices easily at a field scale. Need for peer-to-peer learning.</i>
Grant Programs – Research and Practice Support		
MDA	AGRI Crop Research Grant : funds applied crop research projects. Preference is given to projects for crops that have limited access to other research funds, projects with in-kind support, and projects involving access to underserved agricultural producers. Maximum award: \$250,000. Many awards have focused on breeding improvements to small grains and emerging crops.	<i>Need for ongoing research on improvements to small grains and emerging crops</i>
MDA	AGRI Livestock Investment Grant : reimburses investments in buildings or facilities for livestock production or livestock products, development of pasture for livestock use, and equipment for livestock housing, confinement, feeding, and waste management.	<i>Need for infrastructure for livestock, i.e., fencing, housing, etc.</i>
MDA	Agri Value-Added Grant : helps processors add value to Minnesota agricultural products by helping underwrite feasibility studies and purchase of equipment.	<i>Need for equipment for harvesting and processing small grains, alfalfa, etc. Need for additional research on utilization of small grains, etc.</i>
MDA	Sustainable Agriculture Demonstration Grant : funds projects that explore the profitability, energy efficiency, and environmental benefits of practices or systems. Applications from Minnesota farmers receive priority. Grantees must share project results with others.	<i>Need for research and peer-to-peer learning, on farm diversification using traditional and non-traditional crops and livestock, cover crops and crop rotations.</i>
BWSR	State Cost Share Program : provides funds to soil and water conservation districts (SWCDs) to share costs of conservation practices with producers for high priority erosion, sedimentation, or water quality problems. Structural or vegetative practices must be designed and maintained for a minimum effective life of ten years.	<i>Need for support for a wide variety of conservation practices.</i>
BWSR	Projects and Practices Grant : is a competitive grant supported by the Clean Water Fund that invests in on-the-ground projects and practices that will protect or restore water quality in lakes, rivers or streams, or will protect groundwater or drinking water. Eligible	<i>Need for support for conservation practices that are targeted to water quality improvements.</i>

Agency	Program	Issues addressed
	activities include many agricultural BMPs that promote soil health.	
BWSR	Cover Crop Demonstration Grant : pilot program established in 2019 is providing funds to five SWCDs to offer technical and financial assistance to new adopters of cover crops.	<i>Need for support for cover crop establishment</i>
Marketing Programs		
MDA	Minnesota Grown : a statewide partnership between the Minnesota Department of Agriculture and Minnesota producers of specialty crops and livestock, in place for over 30 years to identify and promote locally-raised products.	<i>Need to promote specialty crops, including small grains, and livestock, including grazed livestock, direct to consumers</i>
MDA	New Markets Cost Share Program : Offers reimbursements for e-commerce for Minnesota Grown members and registered food and beverage companies.	<i>Need for support for online</i>

Appendix C: Study Methods and Detailed Responses

Farmer Interviews and Profile

The evaluator interviewed 36 farmers, working with 34 farms, of which 29 were included in the detailed summary of responses. Four of the interviewed farms located outside the study areas were not included in the detailed data portion, although their comments were included in the summary, and one respondent from a farm in a study area did not provide detailed data.

Demographics

- 23 of the interviewed farmers were male, eight were female
- The online questionnaire included 14 males, four females; one who preferred not to say and two who did not respond.

Table B1: Farmer age range

Age	Number	Percent
Under 20	0	0.0%
20-30	1	3.2%
31-40	6	19.4%
41-50	7	22.6%
51-60	5	16.1%
61-70	6	19.4%
70+	0	0.0%
Not available/declined to say	6	19.4%
Total	31	100

*n= 31 interview farmers representing 29 farms **

Operations

- Farms were operated by 2.4 people on average, with a family member the most likely to be the other person or persons involved.
- Input on management decisions came from spouses, parents, children, and other family members.
- All farms used or more consultants to assist them in their farming operations, with an average of 4.62 consultants per arm with agronomists being the most prevalent.

Table B2: Whom do farmers consult with for their operations?

	Frequency	Percent Frequency
Agronomist	26	90%
Nutritionist	21	73%
Veterinarian	21	72%
Extension Educator	12	41%
Farm Business Management Instructor	7	24%
Lender	17	59%
Soil & Water Conservation District	15	52%
NRCS	12	42%
Other	3	10%

n= 29 surveyed farms; farms could make more than one selection

Acres owned and rented:

- Among surveyed farms, acres farmed ranged from 70 to 5,000 acres, with an average of 1,079 acres. The online questionnaire respondents reported a range of 10 to 5,000 acres with an average of 1,118 acres.
- Among the 24 farms that reported acres of owned and rented land, owned land averaged 802 acres per farm. Twenty farms reported cash-rented land averaging 469 acres, while two farms reported small acreages of shared rental land.
- Seven farms reported that their land farmed in 2018 increased from previous years, while three reported a decrease, 13 reported no change in land farmed and six did not specify.

Table B.3: Acreage of primary crops

Crop	Average acres	Range in acres	Number of farms reporting
Corn total	518	40-2,000	28
Corn grain	294	20-1,400	16
Corn silage	234	15-700	16
Soybeans	304	50-1,300	19
Small grains	155	15-600	10
Alfalfa – owned land	198	35-500	14
All hay including alfalfa	219	20-950	24

n=28

Nine farms did not specify how their corn crop was broken down between grain or silage; these are presumed to be all grain.

Pasture: A total of 25 interviewed farms reported pasture and 21 pastured their animals in some fashion. Twenty-four farms owned pasture, averaging 130 acres, while 8 farms rented pasture, averaging 199 acres (one farm rented only, the remaining owned and/or rented pasture). Farms included improved pasture, native pasture, and pastured woodland. Four of the farms did not have pasture.

Allied Stakeholder Survey

A total of 81 people considered allied stakeholders provided information for this study.

- Twenty-seven people who work directly with farmers were interviewed using a standard interview format (see below for organizations; see Appendix D for questions). An additional 15 responses were captured via an online questionnaire.
- An additional 39 people who have some professional involvement with vegetative cover and who may or may not have farmer contact were also interviewed, focusing on their area of expertise.

Types of farms and animal agriculture

Respondents worked with every type of farm, with dairy, beef and corn/soybeans being the most common, followed by small grains and hay/haylage. Hogs were also common, with 13 respondents, as

well as sheep, goats, poultry, and fruits/vegetables. The majority of interviewees indicated that they worked with farmers who grow forages, sell forages, pasture livestock, rent pasture to others, grow cover crops, or farm partially or entirely using organic practices.

Pasture and Grazing

Twenty-one of the 27 standard interview respondents indicated that they worked with farmers who had improved pastures, either on owned or rented property. Over 50% reported that they worked with farms that had native owned and rented pasture and owned pastured woodland. (Improved pastures are those planted with introduced species such as cool-season or warm-season perennial grasses and legumes.)

Nineteen of the standard interview respondents were able to provide detail on the grazing systems used by farms that they were working with. Rotational grazing using a paddock system was the most common, reported by 89% of the respondents, followed by continuous grazing, reported by 74%. Management intensive grazing and MOB grazing were the least frequently used.

Respondents reported that the majority of farms they worked with practiced aftermath grazing, including on corn and cover crops (both at 89%) and hay (84%). Beef cow-calf grazing was most common (85% of the respondents), followed by dairy cows (50%) and other classes of cattle such as steers and heifers (30-45%). Sheep (30%) and goats (20%) were also reported. Fifteen percent of respondents mentioned grazing of other animals: horses, elk and buffalo.

Forage

Nineteen of the 27 standard interview respondents indicated that farms they work with grow forages on both owned and rented land. All the farms that grew forage grew alfalfa, while 89% grew corn silage. Other forages, including clover, grasses, legumes and small grains, were grown to a lesser extent. Forage was harvested primarily as haylage (all) and dry hay (95%). Almost 80% also harvested baleage.

Cover Crops

Twenty-four of the 27 standard interview respondents indicated that they worked with farms that grow cover crops. They reported that the practice is gaining ground, especially for grazing, and works most effectively when there are livestock in the system or for short-season crops. Crops planted include winter cereal rye after corn silage, triticale and winter wheat, as well as root vegetables. About 70% of respondents stated that the farms they work with are planning on expanding the use of cover crops, while 45% are planning on keeping the same acreage (multiple clients and multiple responses exceeding 100%).

Organizations Interviewed

Representatives of the following organizations provided information as part of the allied stakeholder survey:

- Agricultural Research Service – USDA
- Agricultural Utilization Research Institute
- Bioeconomy Coalition
- Center for Farm Financial Management
- CoBank
- Compeer Financial
- Farm Business Management, MN State
- Forever Green Initiative, UMN
- GEVO, Inc.
- Green Lands Blue Waters
- Land Stewardship Project
- Mid-American Auction – Sauk Centre
- Minnesota Ag Water Resource Center
- Minnesota Board of Water and Soil Resources

- Minnesota Corn Growers
- Minnesota Department of Agriculture
- Minnesota Department of Employment and Economic Development
- Minnesota Department of Natural Resources
- Minnesota Rural Water Association
- Minnesota State University
- Natural Resources Conservation Service – USDA
- Pepsico (U of M, St Paul campus)
- Pheasants Forever
- Pipestone Water
- Riverland Community College
- Riverview Feed
- Sauk Center Hay
- Soil and Water Conservation Districts
- Square Deal Feeds
- Steffes Group Hay Auction
- Sustainable Farming Association of MN
- University of Minnesota – Departments of Agronomy and Plant Genetics, Applied Economics, Food Science and Nutrition
- University of Minnesota Extension
- University of Minnesota – Morris
- Zumbrota Hay

Appendix D: Questionnaires

Participant/Farm Profile

County _____ Date _____
Via Phone In-Person Electronic

1. Age range (circle one): under 20 20-30 31-40 41-50 51-60 61-70 70+ rather not say

2. What is your gender (circle one): M F

3. How many years have you been farming? _____

4. Type of farming operation - Which of the following best describes what you raise on your farm (Check all that apply)

Dairy _____ Beef _____ Hogs _____ Sheep _____ Goats _____ Poultry _____ Corn _____ Soybeans _____ Small Grains _____
Hay/Haylage _____ Fruit/Vegetable _____ Other _____

Livestock number of head

Dairy Cows _____ Heifers _____ Beef Cows _____ Heifers _____ Steers _____ Bulls _____
Sheep _____ Ewes/Rams _____ Lambs _____ Goats _____ Poultry _____ Other _____

5. Acres farmed in 2018: _____ owned _____ rented (cash) _____ rented (crop-share)

Has this increased or decreased from previous years? _____ Increase _____ Decrease

Comments _____

Crop Acreages:

Corn _____ grain _____ silage _____
Soybeans _____
Small grains _____, types _____

Forage Acreages:

Owned _____ Alfalfa _____ Mixed _____ Clover _____ Grass _____ Other _____
specify _____

Rented _____ Alfalfa _____ Mixed _____ Clover _____ Grass _____ Other _____
specify _____

Owned _____ Corn Silage Rented _____ Corn Silage

Other crops, (please specify) _____ acres _____ Other _____ acres _____ Other _____
_____ acres _____

Pasture Owned _____ Improved _____ native _____ pastured woodland
Rented _____ Improved _____ native _____ pastured woodland

Comments _____

Have used covers to rebuild soil health (4)

Is any part of the farm operated/managed organically? Yes No

Comments _____

6. The farm business is operated by (circle all that apply)

me my spouse parent/s child/children other family business partner
other _____

Comments _____

7. Who provides input on management decisions? (circle all that apply)

me my spouse parent/s child/children other family business partner
other _____

Comments _____

8. I consult with the following for my farming operation

agronomist nutritionist veterinarian Extension educator Farm Business Management Instructor
lender Other, please specify _____

Comments _____

Other general

Pastures

How would you rate your understanding of pastures/pasture management?

1=very poor 2=poor 3=average 4=above average 5=excellent 6= don't know

Comments: _____

Do you have pasture? Yes No Do you graze it? Yes No
Rent out to others? Yes No

Comments _____

Grazing System

Continuous grazing Rotational Grazing -strip grazing, RG- paddock, Mgmt Intensive Grazing
MOB grazing Other, please specify _____

Comments _____

Are any crops aftermath grazed? Please specify: hay _____ cover crops _____

Comments _____

What numbers and types of animals are you grazing?

Dairy Cows _____ Heifers _____ Steers _____
Beef Cow/calf _____ Heifers _____ Steers _____
Sheep _____ Goats _____
Other, please specify _____

Comments about grazing system:

If you graze, why do you graze?

If you don't graze, why not?

No livestock No neighbors with stock for rental opportunities Doesn't fit with feeding system
 Fences Work involved Getting water to stock Not enough land available to make it work
 Limited knowledge/experience w/grazing Other

Comments _____

Are you planning on expanding your pasture? yes no keeping the same dropping
 NA

Comments _____

What are the constraints, if any, to expanding pasture in your operation?

If you don't currently have pasture or are hesitating to expand your land in pasture, what would get you to consider adding or expanding pastureland?

Are there incentives that would encourage you? e.g. Cost share, grants, tax credits, other?

Hay/Forage production

How would you rate your understanding of growing hay/haylage/forage?

1=very poor 2=poor 3=average 4=above average 5=excellent 6= don't know

Comments _____

Do you grow hay/forage yes no

Forage is harvested as _____ dry hay _____ haylage _____ baleage _____ corn silage _____
 other _____

Comments _____

If yes, do you grow forage do you hire custom work? to plant yes, no harvest yes, no other yes, no

Comments _____

If you don't grow forage what is stopping you?

equipment knowledge labor timing of operations flexibility availability of custom operators
 market/marketing
 weather storage handling logistics costs

Other _____

Comments: _____

Are you planning on expanding your forage? yes no Keeping the same Dropping
 NA

Comments: _____

What are the constraints, if any, to expanding forages in your operation (storage, equipment, land)?

equipment knowledge labor timing of operations flexibility availability of custom operators
 market/marketing weather storage handling logistics costs don't
 know

Other _____

Comments: _____

If you don't currently grow forages or are hesitating on expanding your forage acreage, what would get you to consider adding or expanding forage acreage?

Are there incentives that would encourage you? e.g., cost share, grants, tax credits, other?

Do you sell forage? yes no

What type(s) of forage do you sell?

Forage is harvested as _____ dry hay _____ haylage _____ baleage _____
other _____

Where or how do you sell your forage?

neighbors word of mouth direct from grower classified ads forage specific auctions
auction markets that have a forage sales day online forage specific sites Craigslist Facebook

Website Other _____

How much of your forage crop do you sell?

Do you have ample outlets for forage that you sell or wish to sell?

Other comments:

Forage Purchasing

I purchase

hay bedding (straw, cornstalks) baleage haylage/silage Other

In a typical year I purchase approximately _____ percent of my forage needs or about _____ tons
_____ bales

I haul my own purchases yes no

I hire someone else to haul yes no charge per loaded mile _____ Other charge _____

Miles typically hauled ? _____

What is the limit to how far you would haul? _____

What are my primary considerations when purchasing? (Please rank) 1= most important (or check the important ones if they can't check) rank the top 1-3 if they have numerous

_____ Forage is tested _____ Quality _____ RFV _____ Protein _____ Hauling Distance

_____ Ease of loading _____ Availability of delivery _____ Form (rounds/squares) _____ Size

_____ Type of Forage _____ Quantity Available _____ Consistent Supply _____ Cost _____ Consistent Quality

Other

Species being fed

dairy beef sheep goats horses

Where do you buy forage?

neighbors word of mouth direct from grower classified ads forage specific auctions

auction markets that have a forage sales day online forage specific sites Craigslist Facebook Website

Other

Do you have enough forage purchasing options? Yes No

Explain:

Do you currently purchase forage from Minnesota growers Yes No

If no, why not? What would get you to purchase MN forage?

Cover Crops

How would you rate your understanding of growing/utilizing cover crops?

1=very poor 2=poor 3=average 4=above average 5=excellent 6= don't know

Comments: _____

Do you grow/use cover crops yes no

Types/practices

Cover Crops: please specify types _____ acres _____ owned/rented

System _____

Cover Crops: please specify types _____ acres _____ owned/rented

System _____

Cover Crops: please specify types _____ acres _____ owned/rented

System _____

Are you planning on expanding your cover crops? yes no Keeping the same Dropping
NA

Comments _____

What are the constraints, if any, to expanding cover crops in your operation?

If you don't grow why not?

seed availability cost knowledge landlord equipment insurance manure application timing

lack of market for harvest storage logistics of getting harvest to market distance of market

Comments _____

If you don't currently grow cover crops or are hesitating on expanding your cover crop use, what would get you to consider adding or expanding cover crops?

Are there incentives that would encourage you? e.g. Cost share, grants, tax credits, other?

Other

Are there tools/resources that you might suggest?

Other people that we should be talking to?

Other comments/notes

Allied Stakeholder Questionnaire

Participant Profile

1. Title

Where do you work

Nature of the work (how does it potentially relate to this project?):

Area(s) served:

2. What is your gender (circle one): M F

3. How many years have you been doing what you do?

What other work have you done

Comments:

=====

Pastures

Your thoughts on grazing (have they worked with it at all or have any understanding?)

What are factors in operations' decisions on grazing?

Do operations graze cattle? other species? On operations' land? On other land?

What are they grazing animals on, type of pasture or grazing?

What incentives would you suggest to increase grazing in MN?

=====

Forage

Your thoughts on forages (have they worked with it at all or have any understanding?)

Do operations grow forage?

What are they growing?

What are constraints to expanding land devoted to forage?

What incentives would you suggest to increase forages in MN?

What, if any, are forage equipment (planting, harvesting, handling, feeding) or storage constraints?

Are there any logistical issues with transporting forage or other products to or from markets?

Where do operations purchase/sell forage? Are their ample market outlets for both buyers and sellers?

What qualities are most important decision drivers when operations purchase feed? (e.g. cost, protein content, consistent supply, etc.)

If criteria are not met how do operations respond?

Would operations purchase Minnesota-grown feed and forage if it met purchasing criteria?

=====

Cover Crops

Your thoughts on cover crops (have they worked with it at all or have any understanding?)

Do operations grow cover crops? What are constraints to expanding land devoted to cover crops?

What incentives would you suggest to increase cover crops in MN?

=====

Market Opportunities

Are there market opportunities for other perennial crops or winter annuals (e.g. pet food, beer brewing, biomass for energy, cover crops, seed etc.)?

What are the constraints to the markets?

Storage Size of markets Distance to market Costs

Critical mass (enough others growing crop)

Would you be in the market for products that are would come from increased vegetative cover?

What would you be in the market for and how much?

=====

Are there tools/resources that you might suggest?

Other people that we should be talking to?

Comments/Overall Thoughts: