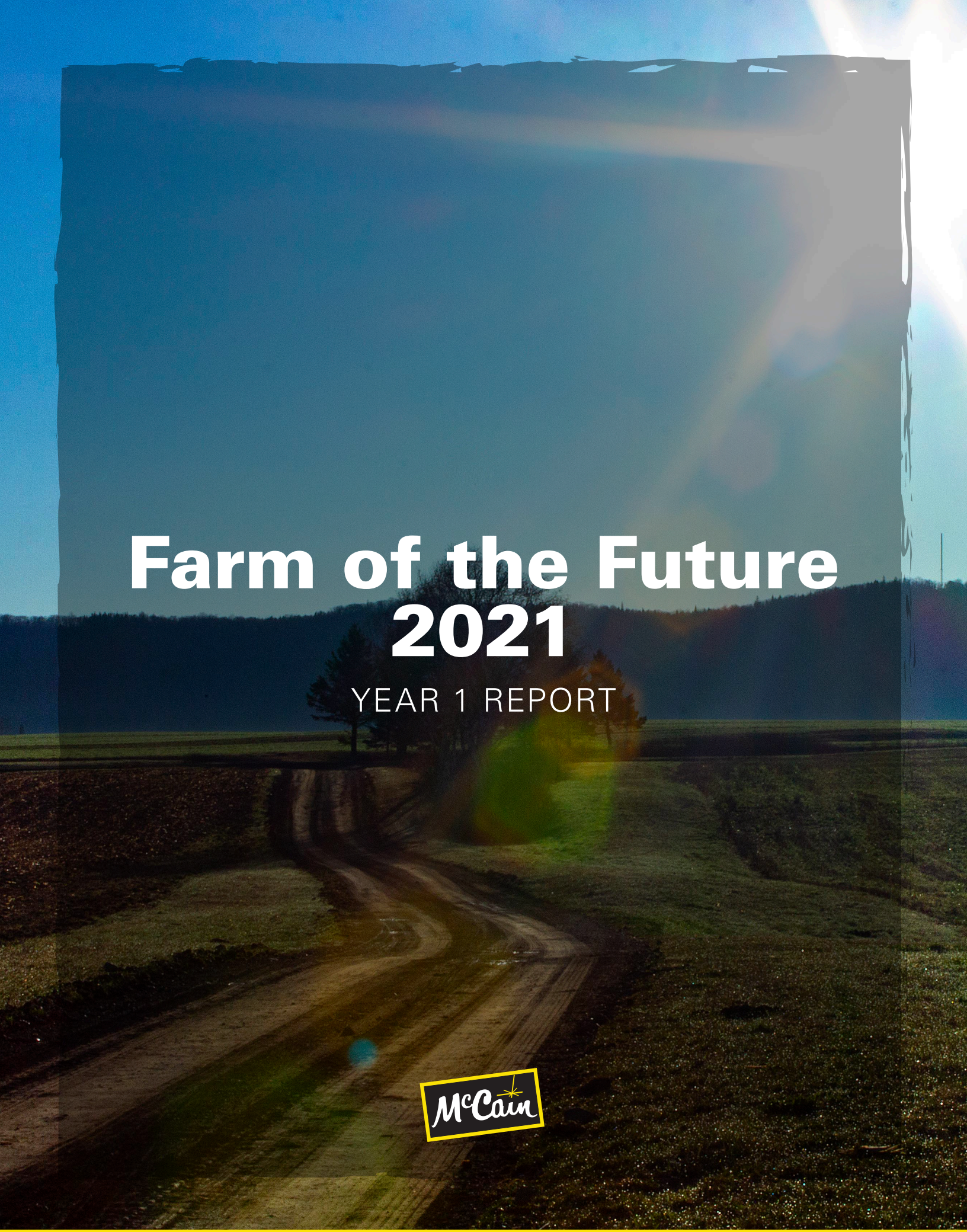


Farm of the Future 2021

YEAR 1 REPORT

McCAIN'S REGENERATIVE FARM OF THE FUTURE CANADA

Farming and agronomy are at the heart of McCain Foods.

Which is why we are prepared to have a frank discussion about the future of farming. Against a backdrop of an ever-growing population, changing weather, soil degradation and biodiversity loss, the future of global food systems is under pressure. We are on a journey to produce more planet-friendly food, and to get there we committed to implement regenerative agricultural practices across 100 per cent of our global potato acreage by 2030.

This means re-imagining the way we grow potatoes within the farming ecosystem, and that is exactly what we are doing with our Farms of the Future project.

We are investing in these commercial scale farms to increase the agronomic and economic resilience of our potato cropping system. It is where we are marrying modern technology and equipment with advanced farming practices and current scientific knowledge of ecological and agricultural principles to farm in a holistic way. By 2025, McCain will have three Farms of the Future operating in different growing regions around the world. The first, located just outside McCain's hometown of Florenceville, New Brunswick, in Canada, had its first fully operational season in 2021.

ABOUT FARM OF THE FUTURE CANADA

The McCain Farm of the Future Canada is located at 53 Waugh Road, Riverbank, New Brunswick. Overlooking the St. John River, it sits just south of Florenceville town centre and is in close proximity to the McCain airstrip and Highway 130 for easy customer and grower visits. Farm of the Future Canada owns 500 acres — 360 acres of cultivated land and 140 wooded and non-productive — and is renting an additional 160 acres on long-term basis.

OBJECTIVES

The potato industry is facing many challenges including productivity loss, increased input cost and changing weather patterns. The regenerative practices and innovative technologies introduced at Farm of the Future Canada aim to address these challenges of modern agriculture. In order to meet these challenges, Farm of the Future Canada is implementing McCain's principles of regenerative agriculture that focus on improving soil health, including:

- Armouring soils — preferably with living plants
- Minimizing soil disturbance
- Enhancing crop and ecosystem diversity
- Reducing agro-chemical impact
- Optimizing water use

By adopting these principles of regenerative agriculture, Farm of the Future is creating a path to a more sustainable, financially stable and environmentally conscious future for our growers. The Farm of the Future team is committed to transferring this knowledge to our growers so that they can have confidence in the economic and environmental business case for the adoption of these regenerative practices where appropriate on their own operations. Knowledge transfer requires grower engagement, which has been initiated at the farm through our first Field Day in summer 2021.

SUMMARY OF THE REGENERATIVE PRACTICES

The regenerative practices implemented in the first year of operation (CY21) at Farm of the Future Canada are summarized in Table 1. Most of these practices were straightforward and easy to implement. The most challenging practices included livestock integration, rotational grazing, and the controlled traffic farming system. Quantification of impacts of these practices is ongoing and will be communicated to growers going forward.

Table 1. Summary of practices implemented in CY 2021 at Farm

EASE OF IMPLEMENTATION	STRAIGHT FORWARD	MODERATELY CHALLENGING	CHALLENGING
Sustainable Ag Practices			
Moldboard plowing to conservation plowing	Y		
Fall bedding	Y		
Cover Cropping	Y		
Strip Cropping	Y	Y	
Green Manure	Y		
Animal Integration & Rotational Grazing		Y	Y
Absence of Fumigation		Y	
Row Spacing	Y		
Machinery & Equipment			
Seed Sizing	Y		
Controlled Traffic Farming			Y
Dammer Diker	Y		
Technology			
Decision support system - pest and disease	Y		
Precision Ag - Soil Optix® | Productivity Zones	Y		

A BRIEF DESCRIPTION OF REGENERATIVE AGRICULTURAL PRACTICES

Multispecies cover crop for green manuring

Picture 1. Annual multispecies cover crops

Multispecies cover crops were planted on over 160 acres (Picture 1). These types of cover crops are not only eye-catching but provides multiple benefits compared to single specie cover crop. In CY21, Farm of the Future Canada planted a total of 28 crop species in different fields to enhance biodiversity and regenerate soils. These crop species included nitrogen fixing legumes such as alfalfa, frosted berseem clover, red clover, faba beans, birdsfoot trefoil, black forage peas and chickling vetch. Warm and cool season grasses such as pearl millet, sorghum sudan grass, japanese millet, corn, timothy, arsenal meadow grass, brome grass, meadow fescue, oats, annual and perennial ryegrass and orchard grass. Plant species from the mustard family such as brown mustard, fodder rape, groundbreaker radish, kale, oilseed radish and purple top turnip.

Other species included were phacelia (Borage family), buckwheat (Knotweed family) and sunflowers (Sunflower family).

All of these species providing a number of benefits including:

1. Maximizing the amount of organic matter returned to the soil as green manure to feed the soil food web and increase soil organic matter.
2. Improving water infiltration thus decreasing risks of water run-off and soil erosion. The reduced run-off or soil erosion was observed in the fall 2021 following intense precipitation where cover crops were planted.

3. Increasing the nutrient cycling by allowing different root types, root systems and root structures to extract nutrients at different depth of the soil profile making them available for the subsequent crop.
4. Fixing nitrogen that will be available to the subsequent potato crop.
5. Removing soil compaction.
6. Decreasing the risks of soil borne-pest and diseases such as verticillium wilt and nematodes or suppressing weeds.

During our first year of operation, active green plants and roots covered Farm of the Future Canada soils for an average of 181 days. The rest of the time, crop residues from these cover crops prevented soil erosion.

Fall bedding and seeding cover crops

Fall bedding in combination with planting cover crops is not a common practice in New Brunswick or in other regions across North America. The introduction of fall bedding allowed Farm of the Future Canada to reduce tillage and successfully establish cover crops prior to the onset of winter. The cover crops seed mixture was seeded using an APV Air Seeder mounted on a basket hiller as a one-pass operation during the first week of September 2021 (Picture 2). Oats, brown mustard and buckwheat were seeded, although buckwheat did not establish well. However, oats and brown mustard established really well (Picture 3). These crops are not anticipated to overwinter; however, the plant residue left on the surface of the soil will provide an excellent cover to protect against soil erosion.

Picture 2. The APV air seeder for seeding cover crops.

Picture 3. Farm of the Future Canada Field J3: Prepared fall beds and seeded cover crops during the first week of September. Photo taken October 23.

We anticipate planting potatoes directly in the beds in spring without additional tilling. The soil residues will also improve water infiltration in the spring. The seed cost of planting oats at 30 lbs/acre and brown mustard at 4 lbs/was around $30 per acre. In one of the fields, fall rye was also planted as cover crop at 60 lbs/acre (seed cost $53 per acre). The objective was to compare the value of these different cover crops.

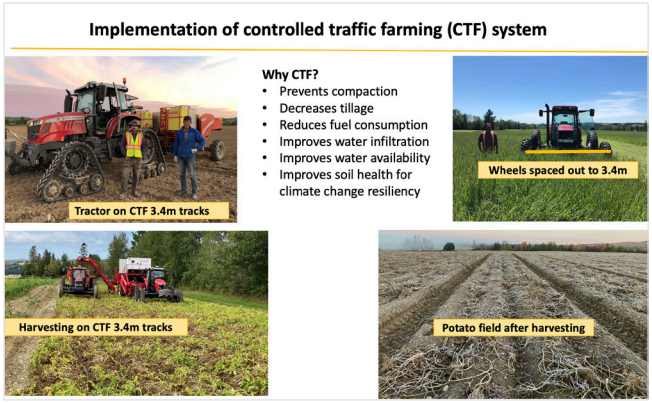
Different management strategies will be investigated on how to best terminate the fall rye cover crops in spring. The benefits of fall bedding along with planting cover crops include removing the need for inversion tillage (moldboard plow) in the fall and reducing the need for spring tillage prior to planting potatoes. Other benefits include reduced fuel consumption, soil compaction and soil erosion during the off season (fall, winter and early spring) as well as to increase our ability to improve soil organic matter and reduce soil-borne pests and disease pressure in the potato crop.

Controlled traffic farming system and other practices

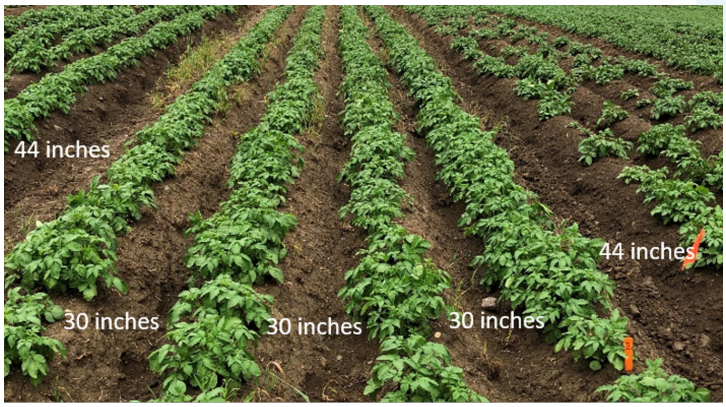
We successfully implemented a number of practices including CTF that will reduce soil compaction, soil erosion and tillage intensity. CTF is a farming system built on permanent wheel tracks, also called tramlines, where the crop zone and traffic lanes are permanently separated (Picture 4). A fundamentally important component of our CTF plan is GPS steering on our in-field equipment. We utilize a Raven GPS system with an RTK signal for sub-inch accuracy. The implementation of CTF at Farm of the Future Canada means that our plant spacing arrangement is slightly different than in a conventional planting system (Picture 5). In the CTF system, potatoes are planted in 4-row beds, each row spaced at 30 inches from one another. To accommodate for the wheel track (tramline) necessary in this system, the distance between the outside rows of adjacent beds is wider (43.9 inches), for an effective row spacing of 33.5 inches on average. To take advantage of the extra space between each 4-row bed, seed pieces in the outer two rows (rows #1 and #4) were planted at a higher density (tighter spacing) than the middle two rows (row #2 and #3). For example, two ounce Russet Burbank seed was planted at 16 inches in the outer rows and at 17 inches in middle rows. This plant spacing arrangements was designed to maximize light interception and photosynthesis allowing for greater light use efficiency boosting potato yield.

Other practices include chisel ploughing (Picture 6), basket hiller and dammer diker (Picture 7). A number of new technologies were also implemented including seed sizing prior to planting, decision support system for late blight

management and precision agriculture technologies (GPS RTK for sub- inch accuracy, variable rate planting, satellite-based remote sensing and soil mapping technologies).

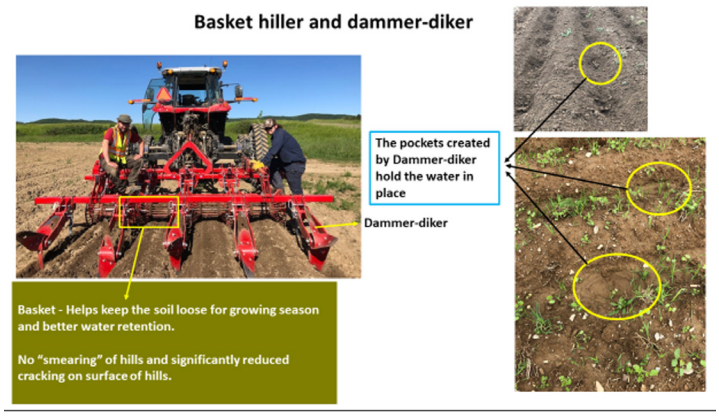


Picture 4. Controlled traffic farming system



Picture 5. Row distances 30 and 44 inches

Picture 6. Chisel plough



Picture 7. Basket hiller with dammer-diker

Livestock integration and strip grazing

Farm of the Future Canada also experimented with integrating livestock on the farm. The objective of the livestock integration was to incorporate manure without having to transport and spread it, which allowed for a more even application of manure by controlling the movement of cattle in the field. Livestock integration in cropping systems has the potential to increase production on cultivated lands and foster resilience and adaptation to climate change without proportional rises in environmental influences. We implemented strip grazing; a type of rotational grazing that involves confining livestock to a strip with fresh pasture for short periods of time (1-3 days). Strip grazing allows managing pastures by alternatively grazing and resting to allow regrowth of the grasses. At the Farm of the Future Canada, a movable fence in a linear orientation controlled the grazing area available to cattle.

Cattle were brought to Farm of the Future Canada from two local cattle producers. Annual and perennial pastures were established for the purpose of having cattle present on the farm for as long as possible and also to allow for a green manure incorporation in an annual pasture system prior to potatoes. Annual pasture seed blend included fast growing species such as black forage pea, berseem clover, pearl millet, Japanese millet, oats, conventional seed corn, groundbreaker radish, kale, purple top turnip, buckwheat, and sunflowers and planted on June 9, 2021. Perennial pastures included arsenal meadow bromegrass, meadow fescue, orchard grass, birdfoot trefoil and half a rate of red clover. Red clover rate was reduced to half to prevent cattle bloating as this field was previously planted with alfalfa. No fertilizer was applied in these fields.

CROP PERFORMANCE

Potatoes

Total yields at harvest of Russet Burbank, Caribou Russet and Innovator were estimated at 394 cwt/acre (44 t/ha), 440 cwt/acre (49.4 t/ha) and 412 cwt/acre (46 t/ha), respectively. These yields are in line with the estimated New Brunswick's average yields of 411 cwt/acre (46.1 t/ha) for Russet Burbank, 386 cwt/acre (43 t/ha) for Caribou Russet, and 394 cwt/ acre (44 t/ha) for Innovator. Farm of the Future Canada's final payable yields and full quality assessment along with crop economics will be reported in next year's report, as all potatoes have not been delivered to the factory. The partial delivery data is showing the crop has good color, gravity and acceptable tuber size.

Fertilizer use in all three varieties at the Farm of the Future Canada was slightly lower than average fertility rate in the area. This reduction was mainly in the amount of Phosphorous and Nitrogen used. Fertilizer for Russet Burbank was banded at a rate of N185-P90-K120 pounds per acre at planting. Additionally, 105 pounds per acre of potassium was broadcasted as a variable rate in fall 2020, based on SoilOptix® analysis (cost $25/acre). Innovator was banded with N200-P81-K130 pounds per acre at planting and Caribou Russet was with N175- P85-K114 pounds per acre at planting. Additionally, potassium was broadcasted in fall 2020. Optimizing fertilizers rates can lower cost and reduce greenhouse gas emissions.

Barley and Oats

Barley crop yield was good, averaging 1.4 metric tonnes/acre. However, high winds and heavy rains at crop maturity induced heavy lodging in oats and only about half of the acreage was harvested. Oat fields were fertilized with N44-P16-K47 pounds per acre and barley with N65-P24-K68 pounds per acre. Both oats and barley were underseeded with four perennial species (perennial rye grass, alfalfa, clover and timothy). Seed cost per acre for underseeded plant species was $38.22. Underseeding the grain crops with perennial multispecies provides excellent soil coverage following the cash crop, contributes to soil biology and should provide high quality green manure prior to potatoes.

ADDITIONAL PROJECTS IN CROP YEAR 2022

Farm of the Future team will implement number of new projects in 2022, including:

- Implementation of best in-class on-farm employee safety program.
- Installation of drip irrigation powered by solar renewable energy.
- On-farm composting using Johnson-Su bioreactor.
- Seed pollinator to enhance biodiversity: The pollinator seed mixes to be planted along the field borders in the spring of 2022 include timothy, alsike clover, red clover, birdsfoot trefoil, phacelia and crimson clover (Picture 8).

Picture 8. Photo of pollinator seed mix