Factsheet #1

Date: February 2023

" In this project, we want to harvest data that we can share with other farmers."
Les Willms
Rose Prairie, BC

Factsheet available on:

www.bcgrain.com
www.peaceforage.bc.ca
www.peaceforageseed.ca

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COVER CROPPING AT FARM SCALES

Context For This Factsheet

This factsheet is part of a project for demonstrating cover cropping at farm scales. It summarizes the results of the first season of learning. The Willms are committed to continue this innovative work so this is #1 of a potential series of factsheets.

Les & Hannah's Goals

Les & Hannah's main goal for their farm land is to:

⇒ Improve the soil with the use of plants.

The 4 main objectives of this project are:

⇒ Break up compaction to increase water infiltration and water holding capacity.
⇒ Grow a mix of plants that will contribute nitrogen (N) to the soil and not deplete it.
⇒ Grow 4 different blends to assess which cover crop plants grow best in the region.
⇒ Grow these blends field scale to assess how they grow in different landscape positions in a field.

The goal of growing radish is two fold:

⇒ To physically break up the compacted clay soil.
⇒ To increase water infiltration so that the soil dries quicker & compaction from equipment is less.

Les showing the growth of the tillage radish *(left photo)* & diversity of plant types *(right photo).*

Background & Farm History

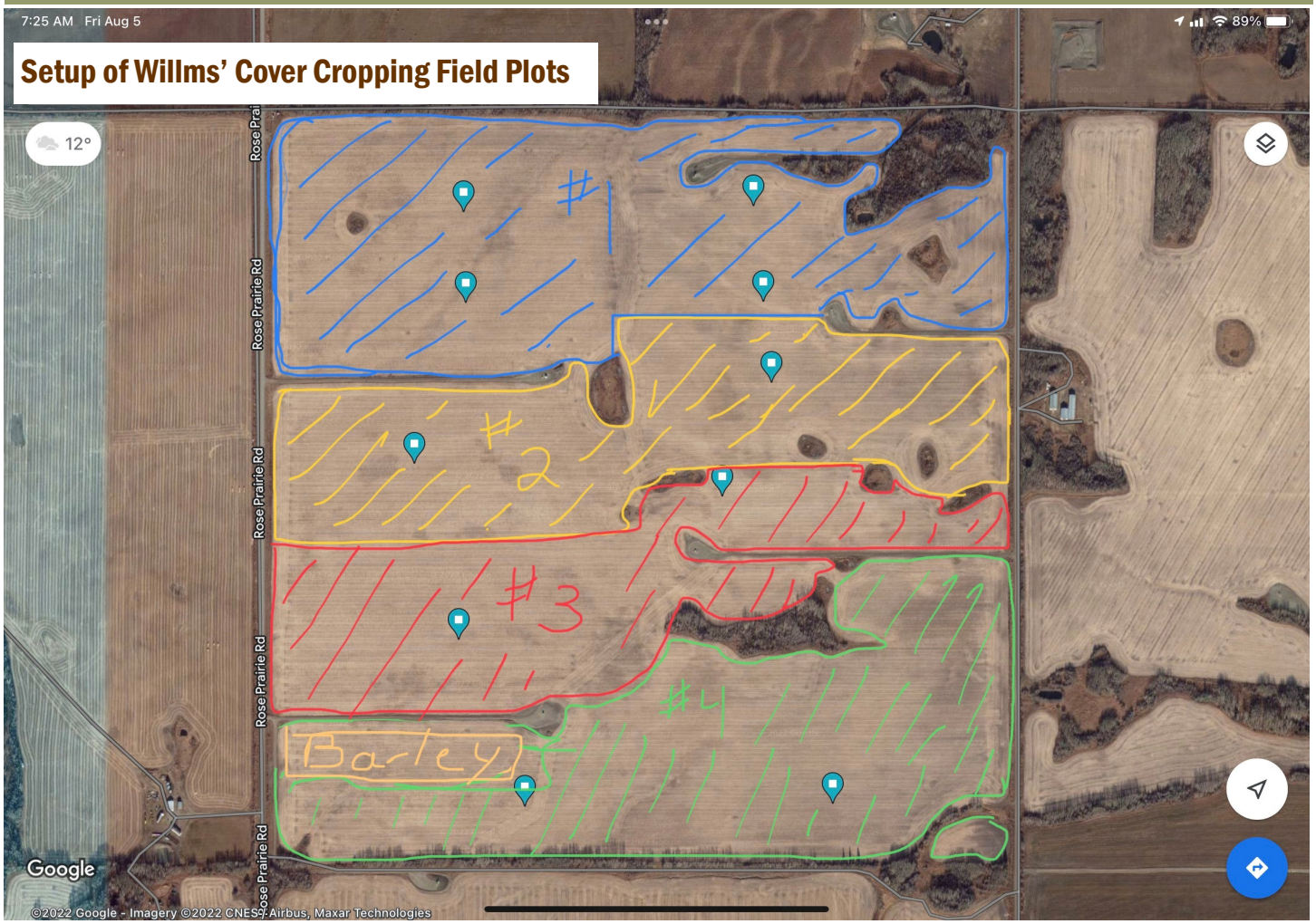
Les grew up farming in Rose Prairie and has seen the benefits a **diverse crop rotation,** to maintain organic matter in their heavy clay soils.

In the 80's and 90's their farm grew a lot of **fescue.** It was a profitable crop and added lots of organic matter to the soil. However it was hard to terminate the large root mass that drew large amounts of nitrogen from the soil.

In recent years **legumes** were added to the rotation to build up organic matter and also add natural nitrogen to the soil. These are great soil builders. However it's a 2-3 year crop with low returns as a cash crop. These legumes often deliver a 10% increase in the next few years cash crops.

The **water infiltration** story: after a large rain event (2-3 inches in a few days) the clay soils become saturated and the lack of porosity and oxygen in the soil leads to poor stunted crops. On their farm they have lost more crops to excess moisture than to lack of moisture or nutrients. The move to zero / minimum till in the 2000's has increased their organic matter from traditional cereal and oilseed croppng. However, the soil compaction from wet conditions has been an issue. There is compaction from tractors, air drill tanks, sprayers and combines that is multiplied when conditions are wet.

Setup of Willms' Cover Cropping Field Plots



Blends & Management

Blend # 1:
Fosters Custom Blend
seeded at 8 lbs/ acre
- 50% radish
- 50% red clover

Blend # 2:
Fosters Custom Blend
seeded at 14 lbs/ acre
- 40% radish
- 20% Crimson clover
- 20% annual ryegrass
- 20% turnip

Blend # 3:
Imperial Seed Pollinator Blend
seeded at 10 lbs/ acre
- 21% Crimson clover
- 15.5% Siberian millet
- 15.5% black oil sunflower
- 10.5% Phacelia
- 10.5% Persian clover
- 10.5% Berseem clover
- 10.5 % radish
- 3% teff grass
- 3% purple top turnip

Blend # 4:
Imperial Seed TG Soil Enhancer Blend
seeded at 9 lbs/acre
- 70% Daikon radish
- 15% Crimson clover
- 15% Berseem clover

Seeding: The cover crops were seeded 1/2 " deep on June 6-8, 2022 with 4 different blends *(see air photo above & blends to the left)*. They were seeded with a New Holland SD 440 Seeder with paired rows & Adam jet openers.

Controlling Weeds: To give the cover crops a fair test weed free:
Sept, 2021: after barley harvest Roundup (1l/ac)
Jun 10, 2022: Conquer II (1 jug/ 80 ac) + Roundup (0.33l/ac)
Jun 16: 540 Glyphosate (0.5l/ac) for volunteer canola
Jun 28: 2,4 D (spot sprayed) for horsetail

Incorporating: The cover crops were incorporated into the soil with vertical tillage on Oct 20, 2022. *(photo to left).*

The Soil Landscape Starting Point

The study area is dominantly Esher soils. These soils are loamy to clayey developed on lacustrotill materials transported by ice & deposited in glacial lakes. On a macro scale, they tend to dominate lower elevations and have a humid water regime. They are moderately well drained and moderately to slowly pervious. They have strongly developed subsurface horizons (Bnt) & can be slightly calcareous & slightly saline at depth.

Les Willms & Richard Kabzems sampling initial soil properties on June 14, 2022.

Soil Quality Properties Selected

To get a quick measure of soil quality, before & after the cover cropping, 9 soil properties were selected to focus on:
Physical: structure, infiltration & soil moisture.
Chemical: organic matter, pH & cation exchange capacity.
Biological: soil respiration, topsoil & rooting depth.

Structure is the arrangement of particles. It affects how roots penetrate & how water flows in the soil. Loose, friable & porous aggregates are the optimal for seed germination & root growth. Soil structure provides many clues about the processes that developed it, such as wetting & drying, freezing & thawing, rooting behaviour & soil animal activities.

Infiltration is the ease & speed that water enters the soil. It is dependent on soil type, moisture content, structure & amount of aggregation. Tillage will often increase infiltration, while compaction & surface crusting will slow infiltration. Initial moisture content of the soil influences the rate that water enters the soil, so often infiltration is repeated to bring the compared soils to the same water %. Measuring the soil moisture helps interpret results.

Soil Moisture is the amount of water present in the soil at a particular time. Given the complex dynamics of water & air in the soil pore space, it is a snapshot in time. It is measured as a volume or weight of water in a given volume or weight of soil.

Organic Matter is the source of available plant nutrients, which are released by decomposition by micro organisms. Soil organic matter plays a very important role in retaining nutrients and water in the rooting zone, rather than being leaching through the soil profile. A general approximation of the organic matter can be estimated in the field using a soil color munsell chart.

pH is the measure of the acidity or alkalinity of the soil. It effects the activities of the microbes in the soil that convert plant nutrients into forms available for the plant. Acid soils occur in the Peace where rainfall and moisture have moved the bases down through the soil profiles.

Cation Exchange Capacity is the indicator of the capacity of soil to retain nutrients in plant available forms eg. calcium, magnesium, potassium, sodium & ammonium.

Soil Respiration is an indicator of soil biological activity. It measures the production of carbon dioxide or CO_2 from biological activity by micro organisms, live roots, earthworms, nematods & insects in the soil. Biological activity in the soil is considered positive so high readings of CO_2 indicate a lively healthy system.

Topsoil depth indicates nutrient supply & water storage capacity for plant growth. Less topsoil or removal of topsoil causes soil fertility loss, decreasing water holding capacity and productivity. An earthy smell is healthy, while a sour or anaerobic smell is not.

Rooting depth is an indicator of the healthy functioning of the soil. Rooting depth can be influenced by compacted layers, solonetzic columnar structures, subsoil salinity, stoney or bedrock layer, hard pan or frozen layers. Impeded roots indicate their stress by stunting, thickening & irregular shapes.

The soil property that Les & Hannah were most interested in learning more about was infiltration *(see comments on page 1).* Measuring infiltration on June 14 *(benchmarks 1a, 1b, 2a, 2b)* & on June 26 *(benchmarks 3a, 3b, 4a, 4b)* is shown in the photos to the right. The amount of water used represents 1 " of rain.

Soil Quality Indicators at Benchmark Pair #1

Cooperator: Les & Hannah Willms

Date: June 14 2022

Cocktail Cover Crops Field 1

Description/ Innovation: GPS:		West side Blue Plot 2022 1a	East side On Map 2022 1b	Ratings for Values			Key Soil Quality Messages & Management Implications
Quality	Indicator	Test Value	Test Value	Poor	Mid Way	Good	
Physical Traits	Structure Index	63	50	0 - 30	30 - 60	60	Soil structure was more granular & healthy at the west or lower landscape benchmark.
	Infiltration (in/hr, 1st rate) (in/ hr for 2nd rate)	120.0 20.7	15.0 5.0	0 - 0.6	0.6 - 6	6 - 20 +	1st Infiltration is most important (soil moisture measured at field capacity, typical of Esher soil).
	Soil Moisture inches per top foot of soil	3.6	3.2	< 1 > 3	1 - 2	2 - 3	Soil moisture was at field capacity, 29% (0.9 in) for 1a cp 27% (0.8 in) for 1b for top 3 inches of soil.
Chemical Traits	Organic Matter (OM) %	5.8	6.2	< 4 > 29	4 - 8 17 - 29	8.0 - 17	Improving organic matter would have ripple effects of improving other properties.
	pH in surface layer in lower layers	6.0	5.5	< 5 > 8	5 - 6 7.5 - 8	6 - 7.5	Improving pH would improve nutrient availability & biological activity.
	Cation Exchange Capacity (CEC) meq/100g	19.9	19.2	< 4	4 - 26	> 26	CEC reflects %OM & %clay. The values here are typical for Esher soil surfaces.
Biological Traits	Respiration lb CO2-C/ acre/ day	6.7	7.0	< 9.5	9.5 - 32	32 - 64+	Soil respiration & activity could be improved at both upper (east) & lower (west) benchmarks.
	Topsoil depth inches	8	7	0 - 4	4 - 8	8 - 12 +	Depth of topsoil can be improved.
	Rooting depth inches	8	7	0 - 4	4 - 8	8 - 12 +	Rooting depth is moderately good until roots reach lower horizon, but needs improvement.

This benchmark pair equals 2 of the 8 sites sampled for the **starting points of soil quality** in June, 2022. Benchmark 1a represents better soil properties & the Willms's goal for the rest of field. Benchmark 1b is the knoll or upper landscape positions with several challenges, for example poorer structure.

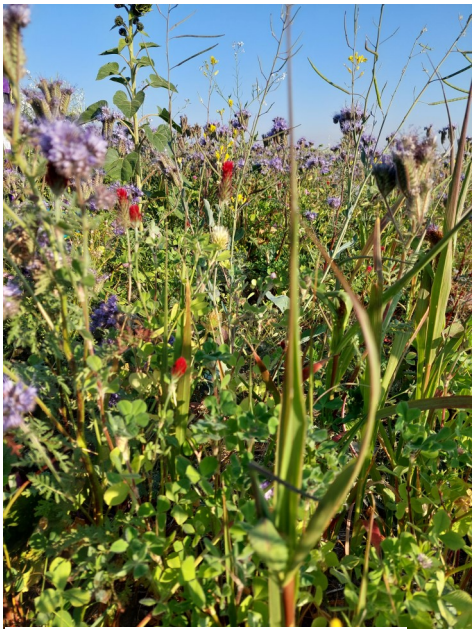
Most of the ratings for interpreting the measured soil values (i.e. good, midway, poor *in middle of the table*) were developed & tested by McGill & Burton 2015 to 2020. The ratings proposed for interpreting cation exchange capacity were developed by Burton & Kabzems in 2023.

Plant Growth & Observations

The Daikon radish blend in full bloom on September 9, 2022.

Erin Maxfield, of Blackbird Environmental flew the site with one of their drones.

Incorporating the luxurious growth & biomass into the soil with tillage in October.



The Crimson clover grew well in Montney conditions & will be part of 2023 cover crop mixes.

Crimson clover performed well in both the Foster & Imperial Seed mixes.

Daikon Radish
⇒excellent growth, large biomass on top, stayed green late into the fall.
⇒robust root to a depth of 12”+.
⇒able to withstand minor frosts.
⇒a host for flea beetles feeding.

Crimson Clover
⇒was quick to develop plant & flower.
⇒fixing N to feed other plants around it.
⇒low biomass plant.

Red Clover
⇒good establishment.
⇒surface germinator.
⇒produced less biomass than expected, due to dry conditions.

Turnip
⇒good growth, developed into a mature plant, with a lot of biomass.
⇒large root at the soil surface with a small tap root.

Annual Ryegrass
⇒good early growth, but doesn’t always persist in the Peace Region.
⇒needed more moisture & nutrients to develop.

Millet
⇒good establishment, but often low biomass in our region.

Phacelia
⇒good establishment & flowered well.
⇒a good host for pollinators.
⇒low biomass plant without a lot of root mass.

Sunflower
⇒good establishment, robust tap root.
⇒flowered well.
⇒a good host for pollinators.
⇒a fairly heavy feeder of nutrients.

Tailgate comparison of the Daikon radish & turnip roots.

The roots grew even in the adverse conditions of compacted headlands.

Key Messages

1. There is definitely a good fit for cover cropping within grain & oilseed rotations in the Peace Region.
2. Selecting the right species adapted for our regional soil conditions & weather is critical for success.
3. Compaction is created by heavy loads in wet conditions, slippage from tractor tires under load and tillage in wet soils. Reducing compaction by waiting for soils to dry is the best option, however it's easier said than done. Cover crops with large deep roots like turnip & radish can be part of the solution. It may take several years with an integrated approach.

Key Resources for Cover Cropping:

Imperial Seeds
Winnipeg, MB
204 786 8457
https://www.imperialseed.com/

Fosters Feed & Seed
Beaverlodge, AB
780 354 2107
800 379 4804
https://www.fosterscanada.com/

Union Seeds
Calgary, AB
800 COW CHOW
https://www.unionforage.com/

USDA Cover Crops Chart
https://www.ars.usda.gov/plains-area/mandan-nd/ngprl/docs/

Management Considerations

The 2022 season was full of climatic contrasts. Spring was wetter than usual, so the later seeding of cover crops worked out well for some initial germination. Then came 4 weeks with no rain or moisture, so plant growth suffered and the field had lots of poorer areas and bare spots. This was followed by a recovery period with $^{3}/_{4}$ inch rain, in early August, so there was lush growth in most of the field plots by the fall.

The field was vertical tilled on October 20 to break down the above ground biomass and leave plant roots in place. This leaves maximum organic matter to naturally decay and keeps the benefits of improved soil structure in place. Increasing organic matter & improved soil structure should lead to better infiltration of moisture.

Ungulates including deer and moose found the top growth very attractive from October, 2022 until January, 2023.

Species for Next Season

The combination of Daikon Radish and Crimson Clover seemed to have the best biomass both under the surface and above ground. The radish penetrated though compaction layers on headlands, potentially leaving a passageway for water to infiltrate. Areas where the radishes were a lush dark green with good biomass, the Crimson Clover was present and fixing nitrogen as the demand for this nutrient increased.

Selecting Species

When Les was asked to be part of a Cover Crop Farmers Panel for Farm Folk City Folk recently, we learned of a very cool reference. The USDA researchers tell us they are currently in the process of making this site more interactive for decision making. See the link to this informative chart *(link at the lower left at the bottom of the sidebar).*

The essence of this project is to improve the health of the soil & enhance the interactions between plant roots & soil aggregates.

The Economics of Adding Cover Crops Into the Rotation

Costs:
The desired goal is to move towards having 20% of their acres in cover crops each year. Currently the Willms' grow wheat, barley and canola in a 3 year rotation as cash crops. Growing cover crops at farm scales is difficult to start, as there will be 20% drop in cash crop income.

Benefits:
However, the vision is that after cover crops are grown, subsequent crops will show 10% yield increases. Other benefits will include:

⇒Reduction in fertilizer use,
⇒Increased water infiltration for crop use & to manage excess moisture,
⇒Better water holding capacity for drought situations,
⇒More resilient soil & crops for weather extremes.

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Thank You to Our Partners & Contributors
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