SWAT CERTIFIED

Farm Sustainability Report

CARLSON FARMS

2024

Sustainability Report

SWAT CERTIFIED

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NATURAL CAPITAL

Overview	
Total land area	3760 acres
Total cultivated area	3365 acres
Ecoregion	Central Parkland
Watershed	Battle River & Bittern Lake
Dominant soil types	Dominantly black chernozems with some dark gray chernozems
Mean Annual precipitation	492 mm
Mean Annual Temperature	3.2 deg C
Location	53.05599, -113.17103

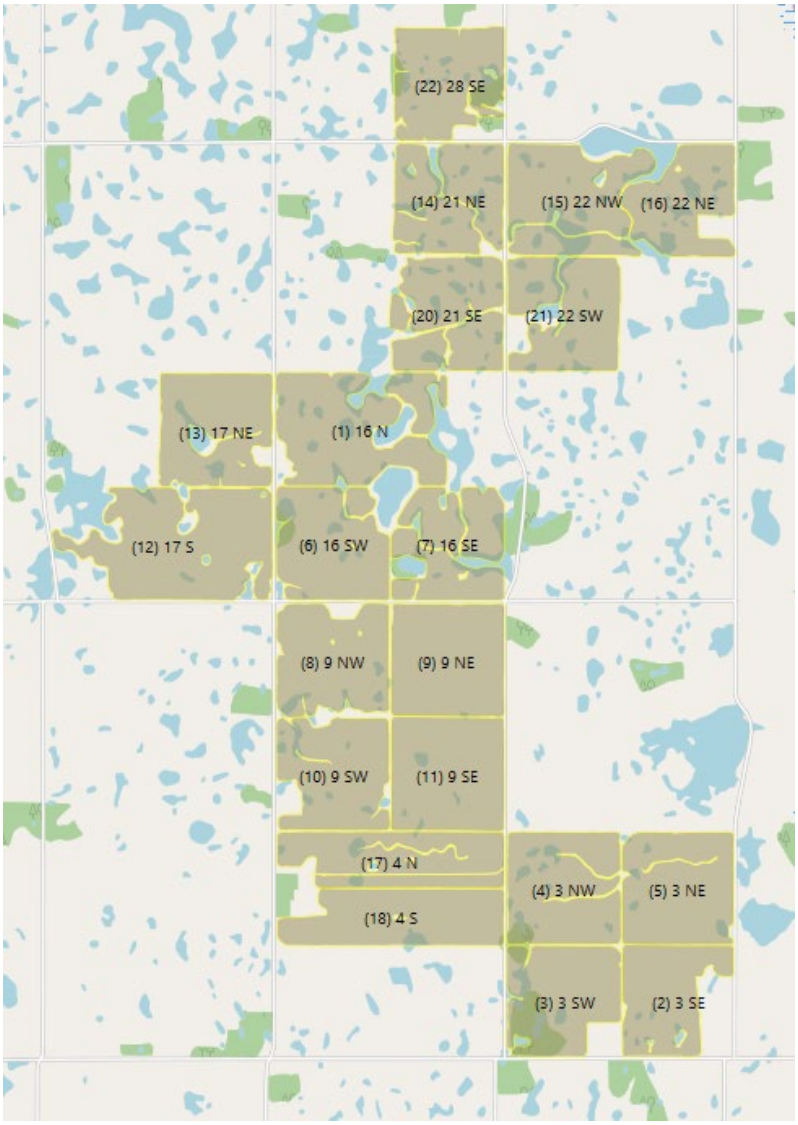
Carlson Farms is a family owned, 3365 acre dryland grain farm located in the central Alberta black soil zone. The farm is focused on annual grain production including canola, high quality CWRS wheat, malt barley, feed barley, and field peas. The farm converted from minimum tillage to a zero-till direct seeding system in 2011 to reduce erosion, improve soil health, build organic carbon, and maximize water use efficiency. Significant topography and some steep slopes make parts of the landscape susceptible to erosion, which are steadily being improved with retained crop residues and low disturbance seeding. The landscape is mostly hummocky with many internal depressions that don't drain to external waterways. Many of these depressional areas contain ephemeral water habitat for waterfowl such as ducks and migrating geese, while an equally significant area of natural forest and grasses provide habitat for other birds, mammals, and insects native to the parkland region of Alberta.

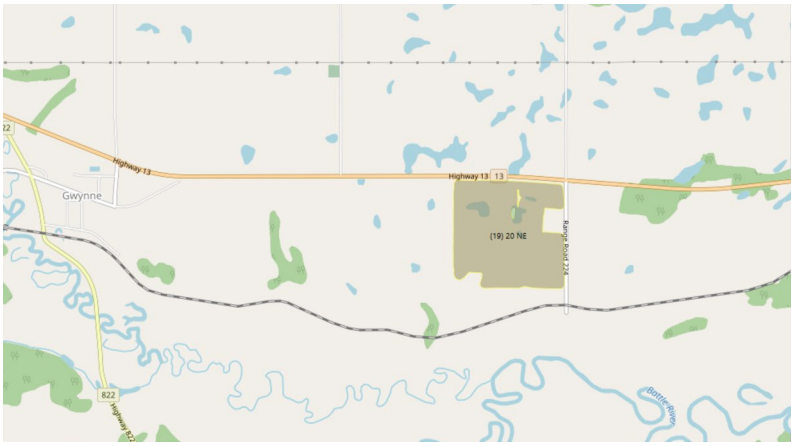
Current focus areas of improvement for the farm include:

- Improving grain production output per tonne of synthetic fertilizer used.
- Reduce nutrients applied in areas of excess soil fertility to minimize crop lodging, improve harvestability, grain quality, and yield, & reduce risk of nutrient runoff into nearby ponds and lakes.
- Use of targeted, multiple mode of action herbicides and increased seeding rates to manage weed populations and prevent herbicide resistance.
- Managing nutritional limitations to yield to improve water use efficiency.

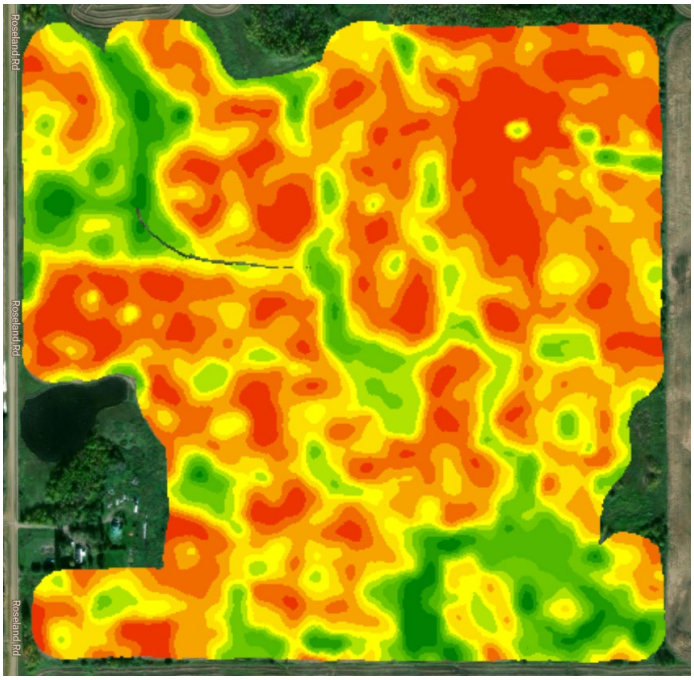
2024 Crop Summary		
	Acres	**Tonnes**
Canola	1255	1435
Wheat	1335	2265
Barley	490	901
Peas	285	407

FARM MAP


(22) 28 SE
(14) 21 NE
(15) 22 NW
(16) 22 NE
(20) 21 SE
(21) 22 SW
(13) 17 NE
(1) 16 N
(12) 17 S
(6) 16 SW
(7) 16 SE
(8) 9 NW
(9) 9 NE
(10) 9 SW
(11) 9 SE
(17) 4 N
(18) 4 S
(4) 3 NW
(5) 3 NE
(3) 3 SW
(2) 3 SE


Highway 13
Gwynne
Highway 13
(19) 20 NE
822

Land Use Classification (example) **SWAT MAP**



Land Use Summary		
	Estimated Area (ac)	**Estimated Area (%)**
Perennial vegetation - Managed	15	0.4
Native vegetation – Trees & shrubs	175	4.7
Native vegetation - Grassland	20	0.5
Wetlands	150	4.0
Waterways	5	0.1
Buildings, roadways, & developed areas	30	0.8
Annual cropland	3365	89.5
Total titled land area	3760	

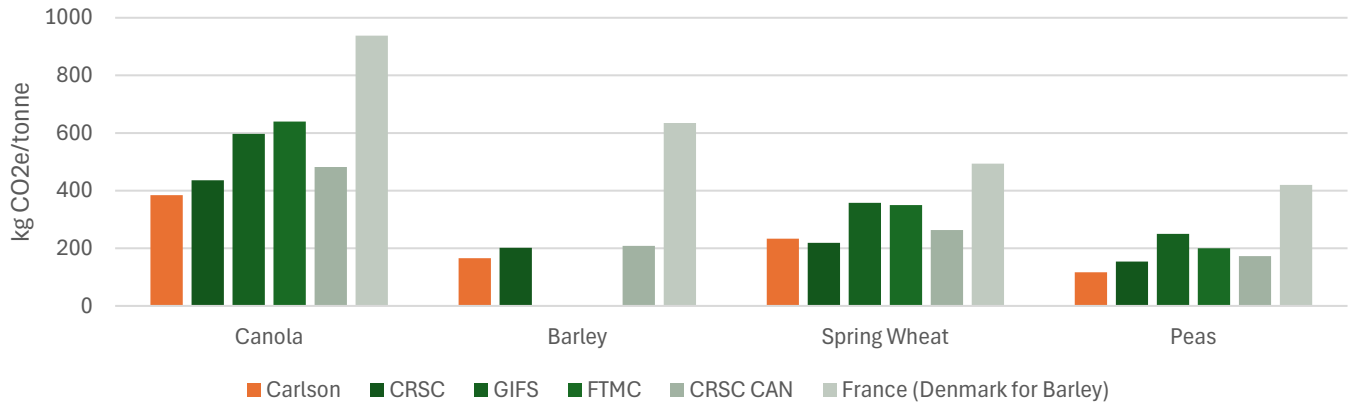
Most recent date of deforestation >1 ha (2.47 ac): Nil since 2008.
Minimum riparian area surrounding wetlands: 5 m

AIR

Farm GHG Absolute Emission		
	2024 (including SOC)	**2024 (no SOC)**
Mean Farm GHG emissions (cultivated area):	256 kg CO_2e / ac	379 kg CO_2e / ac
GHG emissions by commodity:		
Canola	316 kg CO_2e / ac	439 kg CO_2e / ac
Wheat	273 kg CO_2e / ac	396 kg CO_2e / ac
Barley	182 kg CO_2e / ac	305 kg CO_2e / ac
Peas	44 kg CO_2e / ac	166 kg CO_2e / ac

Farm GHG Emissions Intensity		
	2024 (including SOC)	**2024 (no SOC)**
Mean Farm GHG emissions (cultivated area):	172 kg CO_2e / t	255 kg CO_2e / t
GHG emissions by commodity:		
Canola	277 kg CO_2e / t	384 kg CO_2e / t
Wheat	161 kg CO_2e / t	233 kg CO_2e / t
Barley	99 kg CO_2e / t	166 kg CO_2e / t
Peas	31 kg CO_2e / t	117 kg CO_2e / t

Commodity Benchmarks (no SOC)



Benchmark References		
Name	**Region**	**Reference**
CRSC	Alberta Ecoregion 35	Canadian Roundtable for Sustainable Crops (CRSC), 2022 Crop Lifecycle Assessments
GIFS	Saskatchewan	Global Institute for Food Security (GIFS) Carbon Life Cycle Analysis
FTMC	Prairie Provinces	Field to Market Canada (FTMC), 2023 Emissions Report
CRSC CAN	Canadian Weighted Avg	Canadian Roundtable for Sustainable Crops (CRSC), 2022 Crop Lifecycle Assessments
Europe	France (Denmark for Barley)	GIFS Carbon LCA (see ref above); Barley: Sørensen, C. G., Halberg, N., Oudshoorn, F. W., Petersen, B. M., & Dalgaard, R. (2014). Energy inputs and GHG emissions of tillage systems. Biosystems Engineering, 120, 2–14.

Energy Use	
	2024
Fuel (diesel, petrol, oil)	61,145 L
Gas (methane, propane)	842 GJ
Electricity (grid)	37,574 kWh
Electricity (on-site renewables)	0 kWh

N_2O Mitigation	
	2024
% of synthetic nitrogen applied with a nitrification inhibitor or controlled release source (EEF):	17%
Total synthetic N fertilizer use per unit of production:	55 lbs N/t grain

Comments:

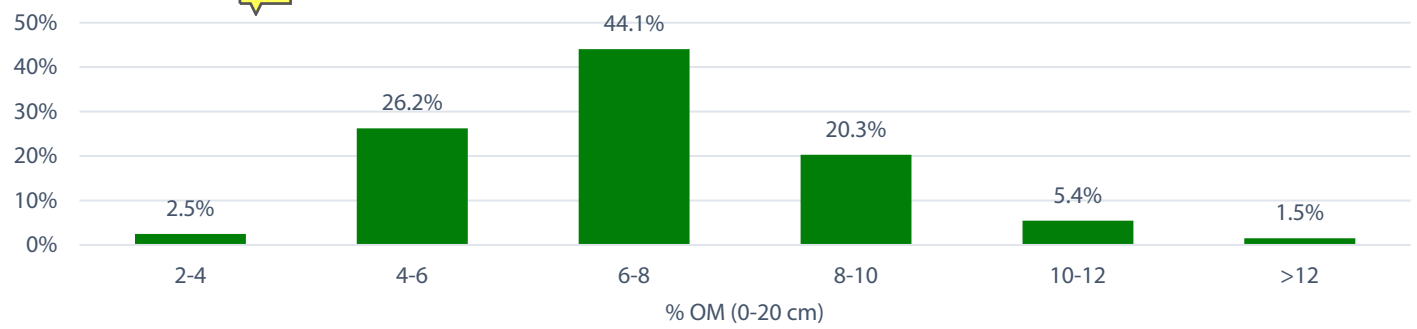
- The farm uses SWAT MAPS to apply variable rate nutrients based on zone soil tests, soil nutrient supply, and expected crop demand. On many fields this involves reducing applied nitrogen in high organic matter soils in lower landscape positions that would otherwise contribute a disproportionally high amount of nitrous oxide emissions if rates were not reduced.
- Variable rate seed is also used to apply higher seed rates in areas with high mortality, ensuring better crop establishment to use nitrogen applied, contributing to high NUE and less emissions.
- Field Peas are included in rotation as a nitrogen-fixing legume to reduce reliance on synthetic N sources and provide rotational diversity.
- ESN (polymer coated urea) is used as a portion of synthetic N source to reduce losses and N_2O emissions.

SOIL

Soil Disturbance & Tillage	
	2024
Farm weighted mean:	7.5%
By commodity:	
Canola	7.5%
Barley	7.5%
Wheat	7.5%
Peas	7.5%

Soil Health History	
	2024
Organic matter % (0-8")	6.1%
pH (0-8")	6.6
% salt affected area	13%
Cover crop area sown	0%

Organic Matter % Distribution



Comments:

- Long-term use of zero till continues to benefit soil health and organic matter levels with many soils exceeding 8% organic matter (4.6% SOC).
- Cover crops are not used due to the very short growing season in this region and lack of frost-free days.
- Crop residue is retained on the field to provide ground cover, reduce erosion, and cycle carbon in the soil.

WATER

Water Use Efficiency	
	2024
Grain yield per unit of growing season rainfall + irrigation:	kg/ac/mm GSR*
• Canola	4.5
• Wheat	6.7
• Barley	7.2
• Peas	5.6
Irrigation scheduling based on one or more of following:	☐ None
• Soil moisture probes	☐ One
• Daily ET rates	☐ Two or more
• Portable soil moisture sensors	☒ Not applicable
Remote sensing (ie. canopy temp, crop stress models)	

*254 mm of GSR (growing season rainfall)

Pollution Prevention	
	2024
% of cultivated area with high P runoff risk:	7%
Minimum riparian area surrounding wetlands:	☐ < 5 m ☒ 5 – 30 m ☐ > 30 m
Do fuel and/or liquid fertilizer storage have suitable containment areas in event of a spill or leak?	☒ Yes ☐ No
Is sprayer cleanout solution sprayed out on a bio-bed or dilute solution on suitable land area?	☒ Yes ☐ No

Comments:

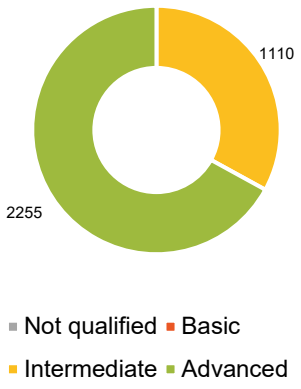
- High P soils are primarily limited to lower landscape positions and depressions and applied P is significantly reduced in these areas to draw down soil P and limit P runoff in waterways that would contribute to eutrophication of local waterbodies.
- All fields have a minimum riparian area of 5 m typically consisting of tall native grasses that restrict soil, nutrient, or pesticide movement into surface waters.

4R INPUT

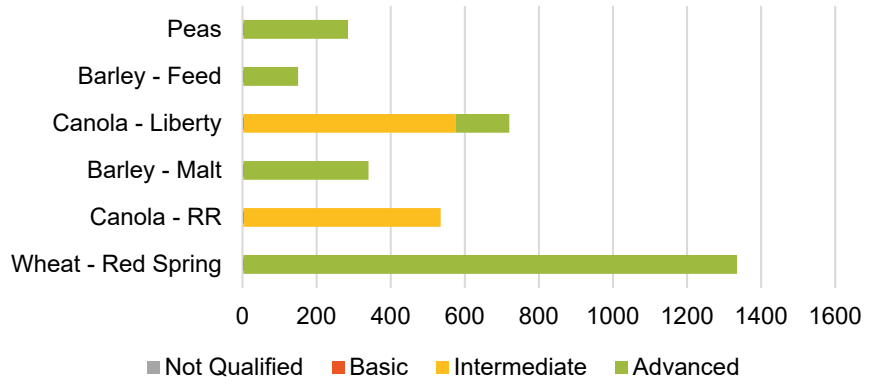
4R Fertilizer

Crop	Total Acres	4R Nitrogen Management				4R Phosphate Management			
		Not Qualified	Basic	Intermediate	Advanced	Not Qualified	Basic	Intermediate	Advanced
Wheat - Red Spring	1335	0	0	0	1335	0	0	0	1335
Canola - RR	535	0	0	535	0	0	0	0	535
Barley - Malt	340	0	0	0	340	0	0	0	340
Canola - Liberty	720	0	0	575	145	0	0	0	720
Barley - Feed	150	0	0	0	150	0	0	0	150
Peas	285	0	0	0	285	0	0	0	285

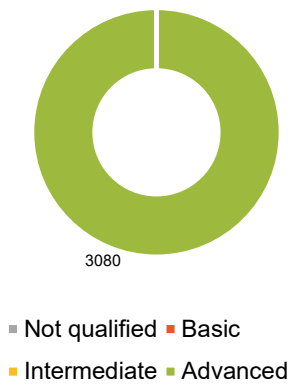
4R – N Level – Farm



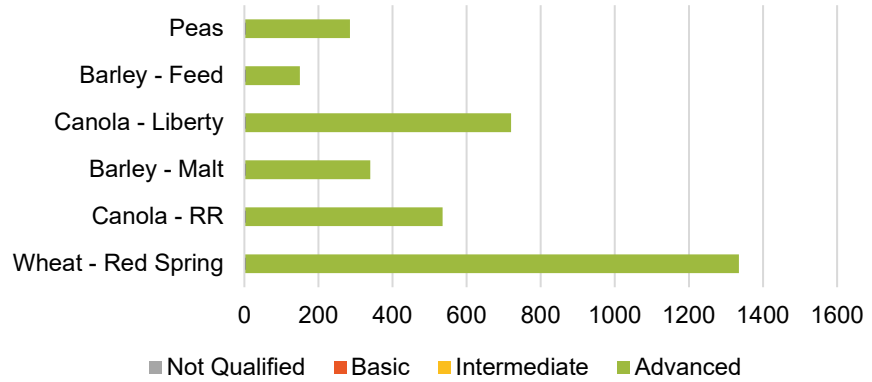
4R – N Level – Crop



4R – P Level – Farm



4R – P Level – Farm



4R Soil Amendments (Lime & Gypsum)	
Not applicable	☐
Not qualified	☐
Basic	☐
Advanced	☒

4R Manure & Compost	
Not applicable	☒
Not qualified	☐
Basic	☐
Advanced	☐

4R Pesticides	
Not applicable	☐
Not qualified	☐
Basic	☐
Advanced	☒

Nutrient Use Efficiency (Partial Balance)	
NUE_{PB} = R/(F+M+B+D)	**2024**
N	101%
P	92%
K	149%
S	49%

Comments:

- Soil pH continues to be monitored closely and managed when necessary, using variable rate applications of pH amendments such as cement kiln dust – a biproduct of the cement industry.
- Overall weighted farm average of 101% nitrogen use efficiency demonstrates exceptional efficiency, indicating a balance of exports vs. N applied to maintain soil carbon stocks.
- Phosphorus use efficiency is also near balanced to avoid unnecessary accumulation of soil P that would increase runoff into surface waterways.
- K use efficiency indicates a net soil mining of this nutrient.
- S use efficiency is relatively low. While not an environmental risk, it presents an opportunity for improvement. Reasonable targets for S are 70-90% to account for some leaching losses.
- In 2024 the farm has utilized SWAT CAMS on the sprayer and satellite imagery to identify ways to target pesticide use using variable rate applications. For example, fungicide use was reduced approximately 6% on 500 acres in 2024.