ON-FARM SOIL HEALTH IN THE GREATER GOLDEN HORSESHOE

PROGRAM OVERVIEW

Long-term adoption of soil health management systems can reduce production costs, build resilience, and improve yield — but to set appropriate goals, growers must understand their farm's soil potential.

To meet this need, in spring 2023 and 2024, the Greenbelt Foundation and Soil Health Institute (SHI) sampled soils at 264 fields representing common soil textures in the Greater Golden Horseshoe.

This program evaluates three management systems: typical **BASELINE** management, regenerative **SOIL HEALTH PRACTICES**, and minimally disturbed **REFERENCE** sites. These systems are compared by soil types to show management practices' impacts on soil health.

This pilot project used two soil health protocols: SHI's essential suite of indicators and the Ontario Ministry of Agriculture, Food and Agribusiness (OMAFA's) Soil Health Assessment and Plan.

Results show that growers in the Greater Golden Horseshoe improved soil health by adopting beneficial management practices that reduced soil disturbance and maximized living roots.

PRINCIPLES OF SOIL HEALTH

Minimizing disturbance improves soil aggregation, infiltration, and water holding capacity.

Maintaining living roots throughout the year promotes nutrient cycling and increases organic carbon stocks.

Keeping the soil covered reduces erosion, regulates soil temperature and soil moisture, and increases organic carbon stocks.

Diversifying crops enhances nutrient cycling, improves weed suppression, and increases yield.

Building soil organic matter improves soil structure, maintains aggregate stability, and feeds soil ecosystems.

BASELINE

Corn, soybean, with field cultivator in spring and vertical disk in spring or fall

80 fields

SOIL HEALTH PRACTICES

Corn, soybean, wheat, red clover or oats, with field cultivator before corn or no-till

82 fields

REFERENCE

Long-term pasture, hayfield, orchard, fencerow

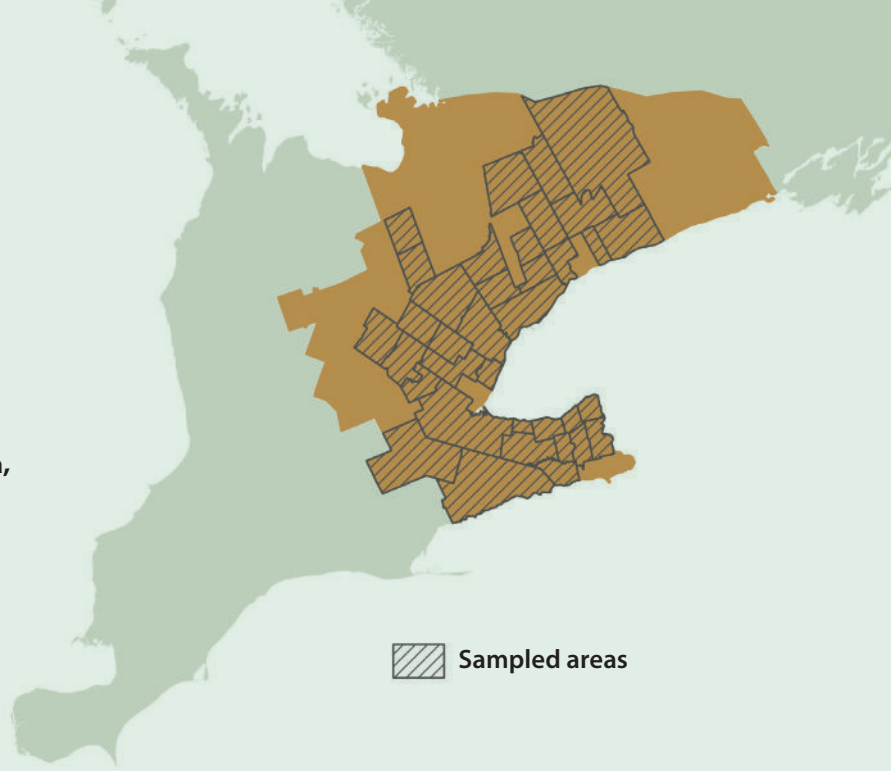
102 fields

GREENBELT FOUNDATION SOIL HEALTH

SOIL HEALTH INSTITUTE
Enriching Soil, Enhancing Life

ABOUT THE REGION

- **31% of the Greater Golden Horseshoe (2.1 million acres) is planted in field crops, primarily soybeans, corn, and winter wheat.**
- **Approximately 65% of cropland is managed with reduced tillage methods, including nearly 30% that is planted no-till.**
- **Roughly 35% of farms use cover crops regularly.**
- **60% of cropland is on loamy soils, except in Niagara, where 77% of cropland is on silty clay loams and clay loams.**
- **Crop production challenges include:**
  - **Increased frequency of extreme weather events**
  - **Delayed field access in spring and fall due to wet soil conditions**



WHAT WE MEASURED

Soil health is a multifaceted quality that includes biological, chemical, and physical aspects. At each location, we measured or calculated these indicators of soil health:

Soil Organic Carbon (0 to 15 cm depth) measures the carbon contained in soil organic matter, and promotes soil structure, microbial activity, plant-available water, and plant-available nutrients.

Soil Organic Matter (0 to 15 cm depth) represents all materials associated with living and dead organisms, and it promotes soil structure, microbial activity, available water, and available nutrients (calculated from soil organic carbon). It's composed of carbon, hydrogen, oxygen, nitrogen, and various other elements.

Soil Organic Carbon Stock (0 to 30 cm depth) represents the amount of carbon stored in the soil, and is calculated using both soil organic carbon concentrations and bulk density measurements.

Active Carbon (0 to 15 cm depth) represents a fraction of soil organic carbon that is not the most microbially available, but rather moderately stable and slightly processed. Greater active carbon is related to the benefits that come with healthy soil biology.

Potentially Mineralizable Nitrogen (0 to 15 cm depth) measures how much of the nitrogen in organic matter is converted, or mineralized, into plant-available form (ammonium nitrogen) under controlled temperature and moisture conditions.

Respiration (0 to 15 cm depth) refers to the carbon dioxide released from soil due to biological activity of soil organisms. Increases in respiration indicate a greater biological capacity to cycle nutrients and plant residues. Respiration is measured as the amount of CO_2 produced by soil microbes after rewetting the soil.

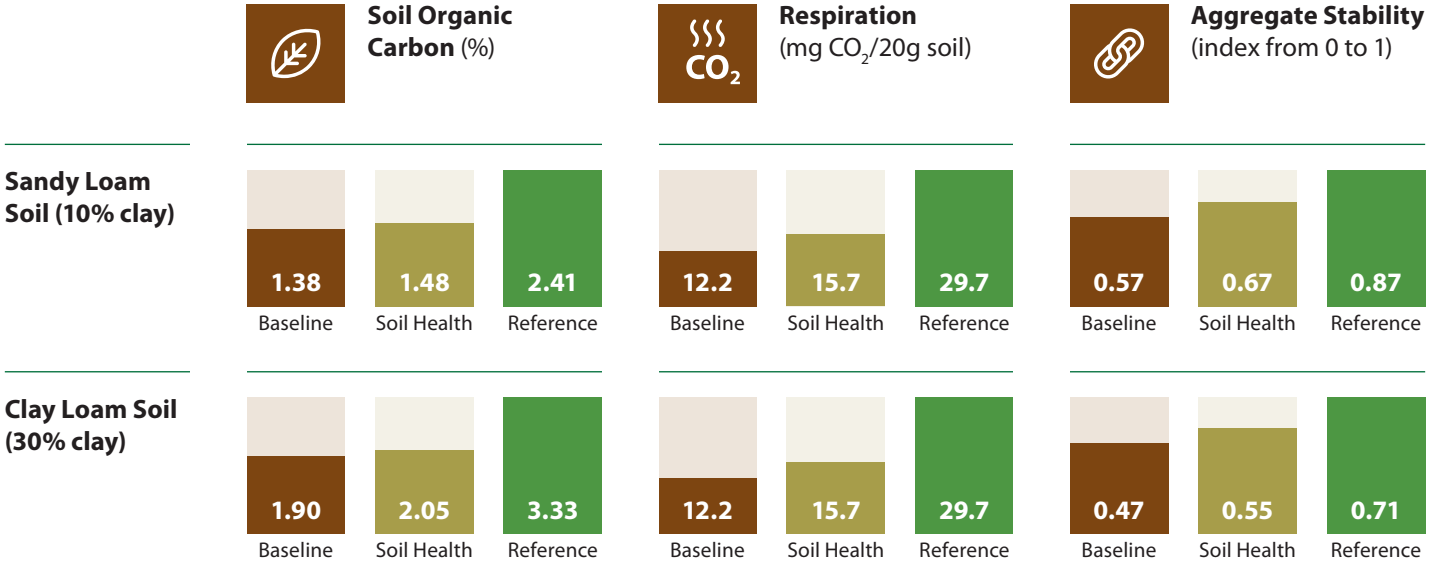
Aggregate Stability (0 to 6 cm depth) measures soil structure and resistance to disturbance. Soils with greater aggregate stability are more resistant to erosion and have improved aeration, water infiltration, and water storage.

Available Water Holding Capacity (0 to 15 cm depth) is the amount of water the soil can store and provide to plants, and is predicted from texture and soil organic carbon. Greater AWHC improves resilience to drought and flooding.

WHAT WE FOUND

In addition to management practices, soil properties (including texture) influence the soil health indicators. The chart below shows the average values of three soil health indicators for two typical soil textures and three systems. Similar trends were observed for the other indicators. All indicators increased in value from fields using **BASELINE** management to fields implementing **SOIL HEALTH PRACTICES** and were highest in the **REFERENCE** sites.

SOIL HEALTH INDICATORS



Results were calculated using models to adjust for differences in soil texture across sampled locations.
Respiration was not significantly influenced by texture and so the values are repeated for the two soil types.

WHAT'S WORKING?

Compared to **BASELINE** fields, samples from fields with **SOIL HEALTH PRACTICES** had on average:

6% greater soil organic carbon concentration and organic matter

16% greater aggregate stability*

28% greater respiration*

39% greater potentially mineralizable nitrogen

7% greater active carbon

12% greater available water-holding capacity

2% greater soil organic carbon stocks

WHAT'S POSSIBLE?

Compared to **BASELINE** fields, samples from **REFERENCE** fields indicated that the region's soils can achieve:

74% greater soil organic carbon concentration and organic matter*

51% greater aggregate stability*

143% greater respiration*

323% greater potentially mineralizable nitrogen*

44% greater active carbon*

30% greater available water-holding capacity*

37% greater soil organic carbon stocks*

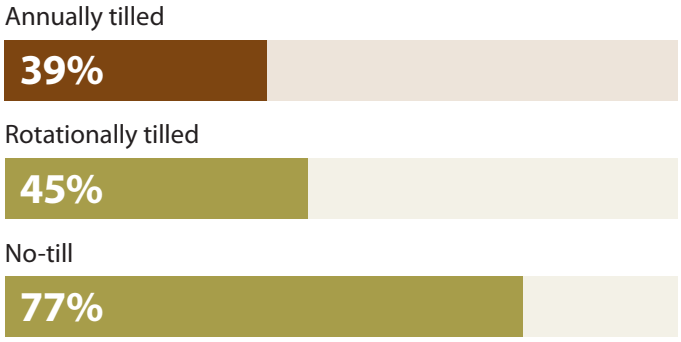
These increases demonstrate the effects of beneficial management practices.
Farms implementing BMPs see higher soil health indicator values across all indicators.

* This increase was statistically significant.

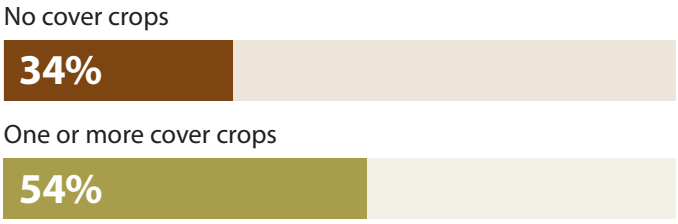
PRACTICES THAT GET RESULTS

In addition, many growers using **SOIL HEALTH PRACTICES** were able to achieve 50% or even 75% of soil health values seen in minimally disturbed **REFERENCE** sites.

Percentage of fields reaching a selected soil aggregate stability value (75% of reference) by tillage practice



Percentage of fields reaching a selected respiration value (50% of reference) based on cover crop use



These results show that **reducing tillage, adding cover crops, and implementing other beneficial management practices are improving soil health** in the Greater Golden Horseshoe region of Ontario.

Soil health tests can help farmers understand the current state of their soil and its future potential. The results from this report show which practices can help improve soil structure, water holding capacity, and nutrient cycling and storage.

"Soil health means to us that our soil is a total package, in terms of its structure, its organisms and earthworms, and in terms of its productivity, fertility, and drainage."

BARB PARKER
Cove Valley Farms

More information on the program can be found at www.greenbelt.ca/greenbelt_soil_health

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