# Ground Truthing SHAP Project - Report

In 2023, the Ontario Ministry of Agriculture, Food and Agri-Business (OMAFA) launched the Soil Health Assessment and Plan (SHAP), an approach to soil health testing based on five analytical indicators:

- Soil Organic Matter (SOM)
- Active Carbon
- Respiration
- Potentially Mineralizable Nitrogen (PMN)
- Aggregate Stability

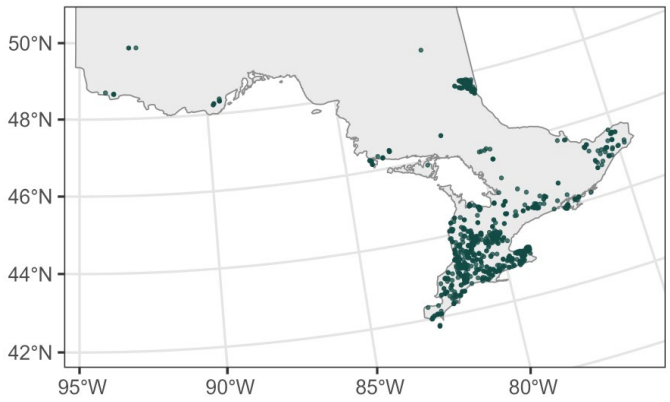
From 2023 to 2025, Soils at Guelph collaborated with Ontario farmers, advisors, laboratories, and other project partners in the Ground Truthing SHAP project to pilot and validate this approach.

**Soil Care Management Practices** included:

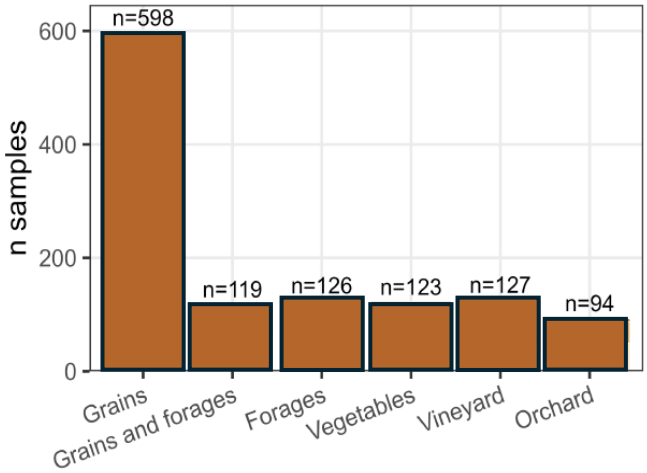
- Compaction Reduction Strategies.
- Good Crop Rotation.
- Use of Cover Crops.
- Use of Organic Amendments.
- Reduced Tillage Intensity.
- Use of Perennials and Pasture.
- Minimal Residue Removal.

## Who participated and what was the soil and cropping management?

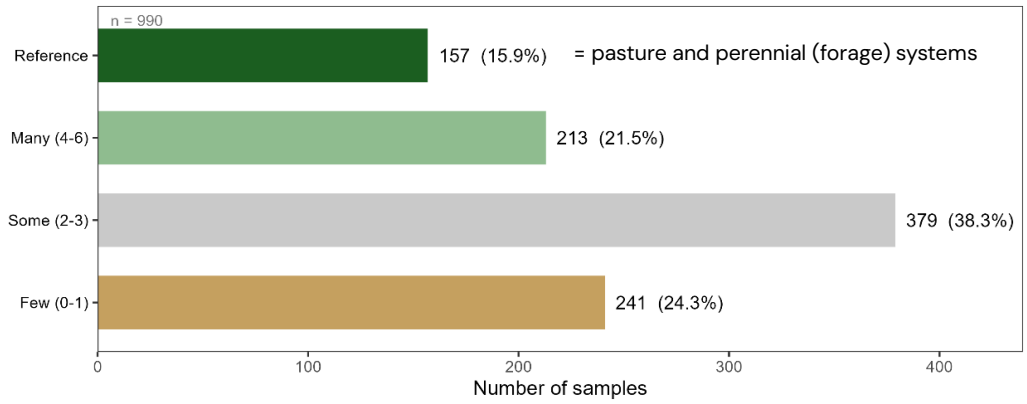
### Geo-referenced sample locations, 1033 in total




### Number and type of production systems



### Number of soil care management practices x number of samples



# How did management impact soil health indicators?

**SOIL ORGANIC MATTER**

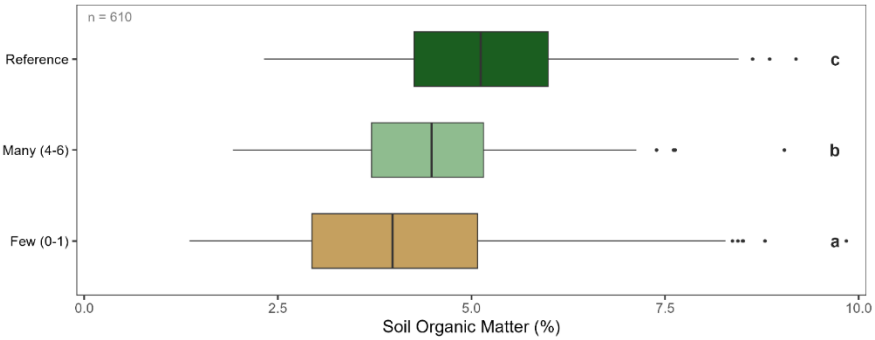
THE HEART OF HEALTHY SOIL

- Made up of living and dead plant and animal materials.
- Feeds soil life and helps soil store nutrients, store water, and resist erosion.
- Levels can **take several years** to change in response to management practices.

**Typical range in Ontario farmland: 1% to >8% organic matter.** (impacts soil physical, biological, and chemical functions)

Loss on ignition @425°C

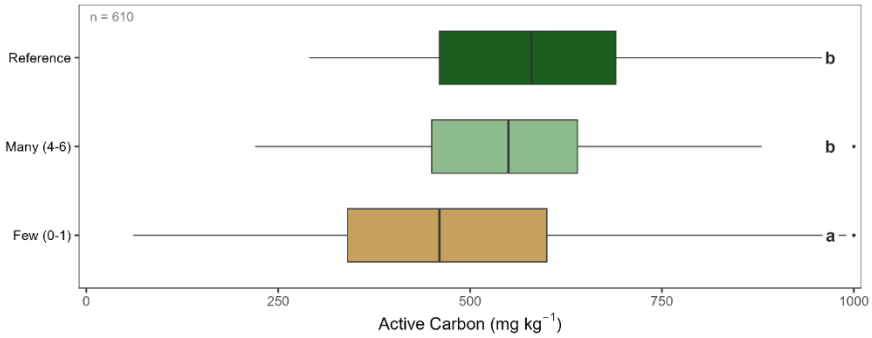
## Soil Organic Matter




*Graph showing how **soil management practices impact soil organic matter** levels. Levels are statistically different between categories*.*

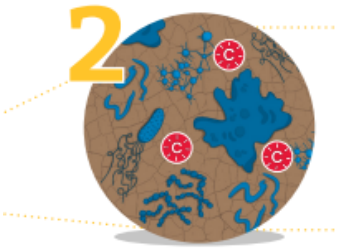
Key Finding: Stacking soil care practices increases soil organic matter levels.

## Active Carbon




*Graph showing how **soil management practices impact active carbon** levels. Reference and sites with many soil care practices are statistically different than sites with few soil care practices*.*

Key Finding: Active carbon levels are lower when soil care practices are not implemented. However, when multiple soil care practices are used, levels are statistically indistinguishable from those in pasture and perennial systems (reference).




**ACTIVE CARBON**

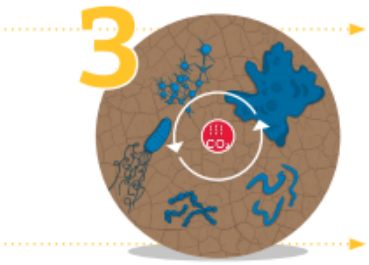
FAST LANE OF SOIL CARBON

- The portion of soil organic carbon that's most available to microbes.
- Levels **respond quickly** to management changes, signaling future soil health trends.

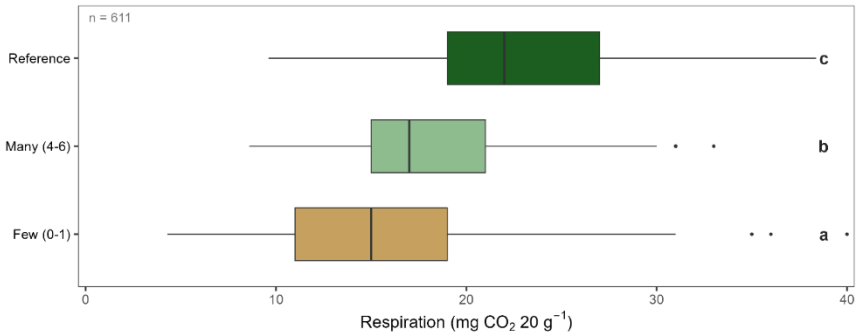
**Typical range in Ontario farmland: between 120 to 1000 mg kg$^{-1}$ of soil.** (measures soil biological function)

Potassium permanganate reaction absorbance @550 nm

** Sites with 2-3 soil care practices were omitted because their values generally fell between those of the few (0-1 practices) and many (4-6 practices) categories. Reference = pasture and perennial (forage) systems*




## Soil Respiration




*Graph showing how **soil management practices impact soil respiration** levels. Levels are statistically different between sites with few and many soil care practices, with the relatively undisturbed sites having the highest levels*.*

Key Finding: Stacking soil care management practices increases soil respiration levels.

**RESPIRATION**

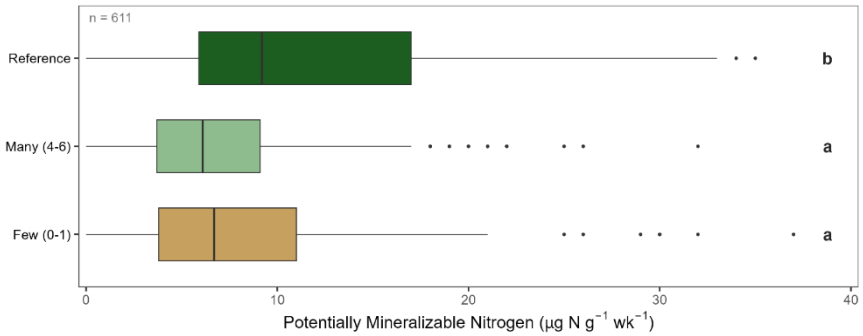
WINDOW INTO SOIL MICROBIAL ACTIVITY

- Many soil microbes 'breathe' as they work, releasing carbon dioxide. Measuring this helps us understand how active and healthy soil life is.
- Active microbes cycle nutrients and boost soil structure.

**Typical range in Ontario farmland: soil respiration levels between 0.254 to 2 mg $CO_2$-C $kg^{-1}$ of soil.** (measures soil biological function)

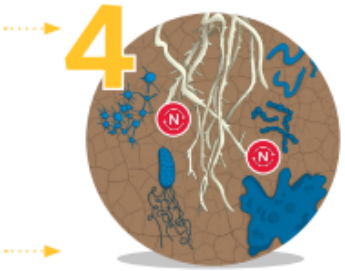
4-day rewetted alkaline trap

## Potentially Mineralizable Nitrogen (PMN)




*Graph showing how **soil management practices impact potentially mineralizable nitrogen** (PMN). Reference sites are higher than sites with few and many soil care practices, which were not different from each other*.*

Key Finding: There is a high degree of variability in the reference sites, which are pastures and perennials and no differences between management. Further research is needed to better understand why.



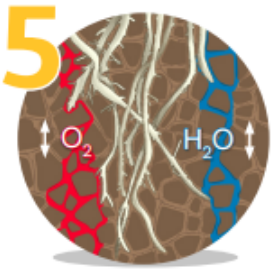

**POTENTIALLY MINERALIZABLE NITROGEN (PMN)**

SOIL'S NUTRIENT POWER

- Measure of how much organic nitrogen soil microbes can release for plant use.
- Understanding the soil's PMN can help optimize nitrogen fertilizer applications.

**Typical range in Ontario farmland: PMN levels between 0.1 to 35 *ug* N $g^{-1}$ of soil.** (measure of soil biology driving soil chemistry)

7 day anerobic @37°C, KCl extraction $NH_4$-N




**AGGREGATE STABILITY**

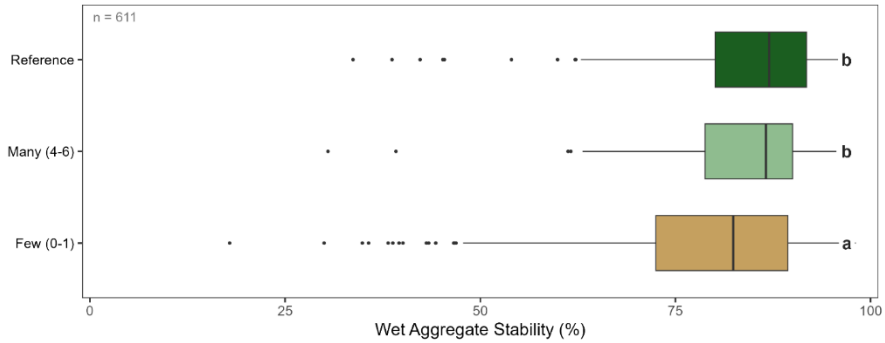
THE FOUNDATION OF SOIL STRUCTURE

- A soil aggregate is a clump of soil particles bound together. Aggregates form the building blocks of soil structure.
- Stable soil structure resists erosion, crusting, and compaction while supporting roots and reducing water stress.

**Typical range in Ontario farmland: aggregate stability between 65 to 98%.** (measures soil physical structure)

Modified Yoder sieving, 30 strokes/min (4cm stroke)

## Aggregate Stability




*Graph showing how soil management practices impact soil management practices and **aggregate stability**. Lower aggregate stability when soil care practices are not used, but stacking practices gives values similar to the reference*

Key Finding: The Modified Yoder Method gave aggregate stability values that were unexpectedly high – most had values greater than 75% - which limits meaningful insights into the effects of soil management practices. Other methods are available to measure aggregate stability.

**Summary of findings:**

- Soil health indicator values were influenced by soil texture; greater values in fine (clay) soils and least in coarse (sandy) soils. See detailed report for details.
- Despite these texture differences, stacking soil care management practices gave greater soil health values compared to sites where no or only a few practices were being used.
- Reference sites (pastures + perennials) had higher soil health scores than other crop production systems, confirming that sites with plant growth, year-round living roots, less disturbance and integration with livestock support healthier soils.
- Involving end users (farmers, advisors, laboratory, OMAFA staff) throughout the piloting process helped make the reports and recommendations more accessible, interpretable, and actionable for farmers and other decision-makers.

**Next steps include:**

- More analysis linking the effects of climate, topography, texture, and other soil properties (fertility, pH, CEC) on indicator values.
- Identify and prioritize soil management practices that build soil health most effectively.
- Anonymized data will be added to the provincial soil database.
- Continue to build capacity within the province and country around soil health testing.

*Citing this report:*
*White, H., Chahal, I., Bower, J., and Van Eerd, L. 2026. Ground Truthing SHAP Report. Soils at Guelph, September 2026.*