

Soil Organic Carbon

Soil organic carbon (SOC) is the carbon that is left in the soil after living organisms (such as plants, roots, fungi, etc.) are partially decomposed; it makes up the largest component of soil organic matter (more than 50%), and therefore, soils that are rich in soil organic matter are also rich in SOC.

Soil Health Benefits of SOC

Improved soil structure and reduced erosion

SOC helps soil particles (clay, silt, sand) bind together to form soil aggregates. Aggregates protect SOC from microbial breakdown by surrounding SOC with soil particles. Aggregates also protect the soil from both wind and water erosion due to their strong binding characteristics.

Improved water infiltration, retention, and aeration

SOC and soil aggregates create macropores between soil aggregates and micropores within soil aggregates. Macropores are larger pores in the soil that allow for greater water infiltration and soil aeration, while micropores are smaller pores that increase the soil's ability to retain water.

Decreased nutrient leaching and increased nutrient availability

SOC has a high cation exchange capacity, meaning it can hold a large amount of positively charged cations. Many essential plant nutrients (ex. magnesium, calcium, potassium, etc.) are positively charged. Therefore, soils that can hold more cations will experience less nutrient loss due to leaching and will provide more accessible nutrients to plant roots.

Greater soil biodiversity

Carbon is the main food source for many microbes in the soil, so increasing SOC increases the diversity of beneficial microbes in the soil as well as the overall biodiversity of the soil.

Other Benefits of SOC

Crop Production

Improved crop productivity, and potentially higher yields and crop quality over time.

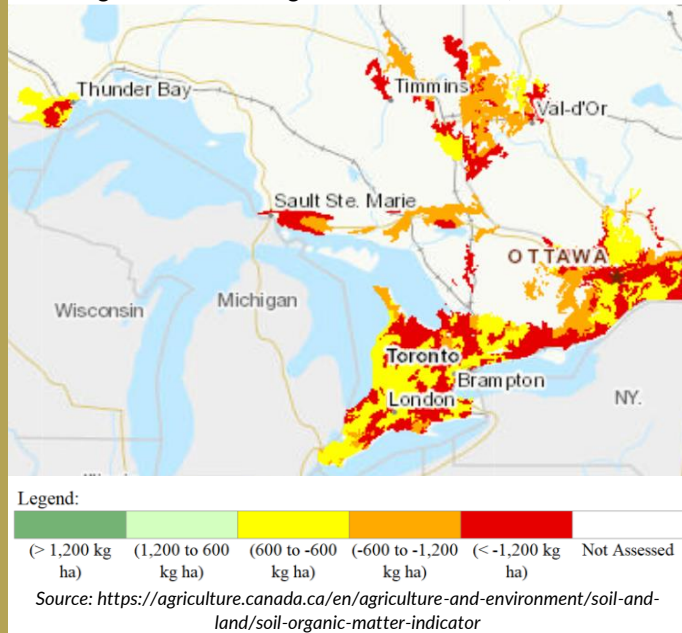
Ecosystem Health

Lower levels of carbon dioxide released into the air (less greenhouse gas emissions), and healthier ecosystems with higher biodiversity.

Community Health

Increased food security due to greater resiliency to extreme weather events (such as drought), improved fertility, and higher yields.

Soil organic carbon change in Eastern Canada, 1981 to 2011



SOC in Ontario

While SOC may take years or even decades to build up, poor farm management practices cause SOC to breakdown and decrease over time, leading to poorer quality soil. In Ontario, a large proportion of farmland has experienced decreases in SOC over the last 30 years.

One of the major reasons for these decreases in SOC is a change in land-use – pastures and forages are being replaced by cereal crops and oilseeds, usually grown in annual, monocropped (only one crop grown at a time) rotations. However, there are many ways to increase SOC levels in all types of farming systems (including gardens, animal production, and fruit and vegetable production).

Ways to Increase SOC

Conservation Tillage

Conservation tillage is any tillage practice that leaves more than 30% of plant residues on the soil surface after harvest. Conservation tillage decreases the amount of carbon that is lost to the atmosphere as CO₂. It also decreases soil erosion, and helps improve water infiltration and retention, soil structure, and overall soil health. Reduced tillage, strip tillage, ridge tillage, and no-till (zero tillage) are all types of conservation tillage practices used in Ontario.

Cover Crops

Cover crops are plants that are grown specifically to protect the soil; they are key to increasing SOC, especially when growing annual plants. Cover crops increase SOC by adding living plants to the soil during the fall and winter when the soil is usually bare. Common cover crops include rye and clovers. Additionally, using nitrogen “catch crops” (such as rye) can be a beneficial addition to perennial fruit production of grapes and fruit trees to prevent winter injury.

(More info at: http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm)



Figure 3. Fall Rye Cover Crop

Source: <https://soilsatguelph.ca/new-resources-for-ontario-from-the-midwest-cover-crop-council/>

Plant Selection

SOC can be increased by introducing perennial crops to your farming system. Perennials are plants that live for more than two years and keep living roots and above-ground plant material in the ground year-round; therefore, perennials are an excellent way to add carbon to the soil. Annual farming systems can also build SOC if a diverse mixture of plants is used. For example, introducing winter wheat and a cover crop into a soybean-corn rotation can increase SOC over time.

Residue Management

Leave as much plant residue on the soil as possible! Residue not only helps maintain SOC, but also helps to prevent soil erosion and maintain soil health.

Manure and Compost

Adding manure or compost to the soil can increase SOC over time—especially in low residue-producing systems such as vegetable production.

Resources:

Government of Canada. 2021. Soil Organic Matter Indicator. <https://agriculture.canada.ca/en/agriculture-and-environment/soil-and-land/soil-organic-matter-indicator>

Eli Corning, Amir Sadeghpour, Quirine Ketterings, and Karl Czymmek. 2016. The Carbon Cycle and Soil Organic Carbon. <http://nmsp.cals.cornell.edu/publications/factsheets/factsheet91.pdf>