Bioeconomy Science Institute™

Te Uru Kahika Regional and Unitary Councils Aotearoa

Soil organic matter

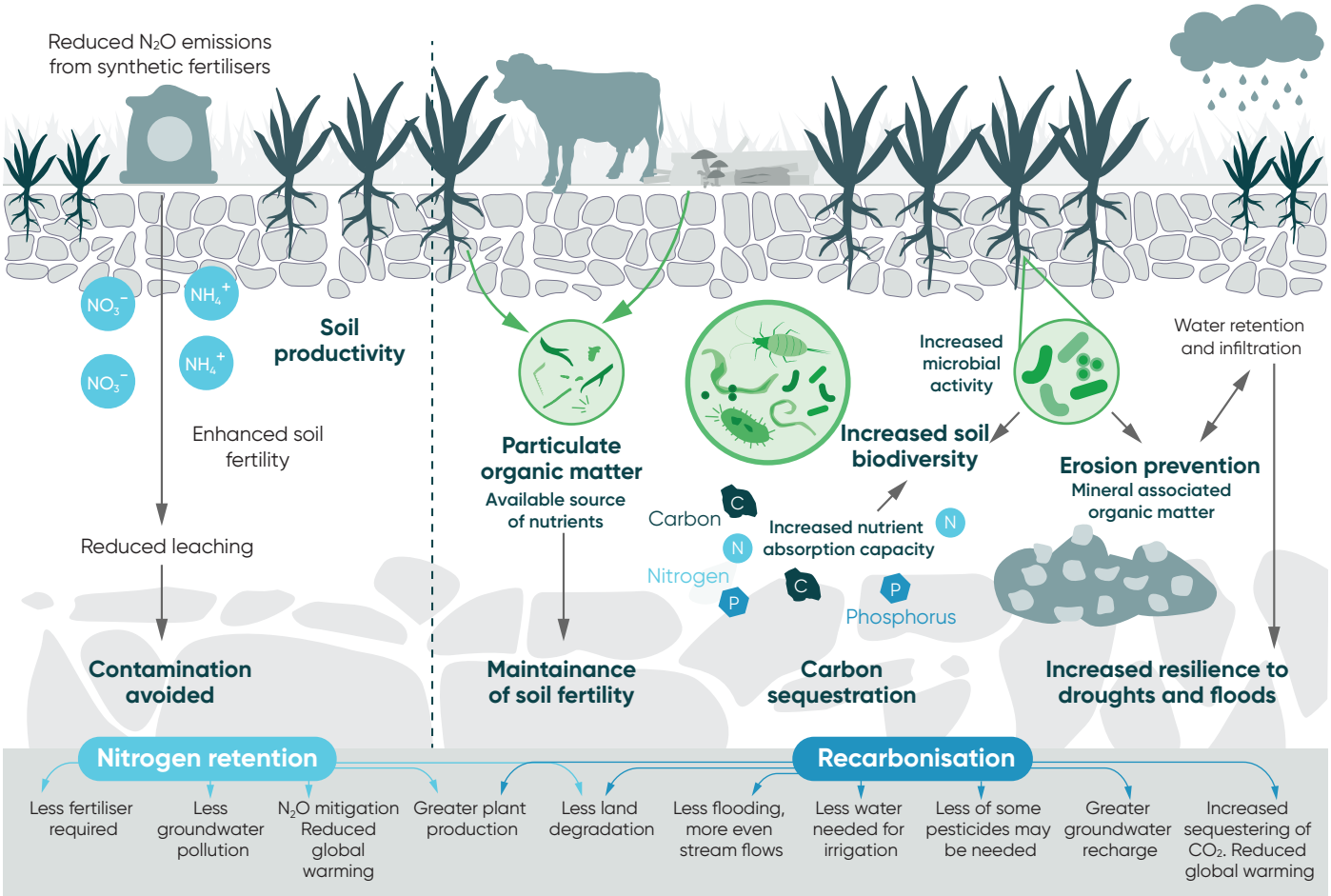
This factsheet contains information on indicators related to organic matter used for *State of the Environment (SOE) soil quality monitoring and reporting*, for local policy-makers such as councils, land managers, and the general public.

Soil organic matter is made from living or once-living material, in various stages of decomposition. Compost, plant and animal residues, roots, and microorganisms all make up organic matter.

Organic matter is the 'engine room' of the soil. It provides a source of plant nutrients, it contributes to soil structure, the formation of soil aggregates and the water-holding capacity of soil, and it provides habitat and food for soil flora and fauna.

Soil organic matter can store significant amounts of carbon, so it plays a critical role in climate regulation.

Most soil organic matter is found in the **topsoil** - a vital limited resource. Within the organic matter, some is used up within months to years (the 'active pool'), some within decades (the 'slow pool'), and the remainder can be present for hundreds to thousands of years (the 'recalcitrant pool'). Organic matter fractions may also be described as particulate organic matter - formed from pieces of decaying plants and animals, and is more active – or mineral-associated organic matter (MAOM). MAOM is primarily adsorbed (adhering to their surface) to clay minerals and undergoes much slower cycling.



The benefits of increasing soil organic matter.

New Zealand soils are naturally high in organic matter, although this varies across soil types and land uses. Management practices can determine whether organic matter accumulates, is maintained, or is used up.

For SOE soil quality monitoring, total carbon and total nitrogen are used to assess the amount and quality of organic matter. Hot-water extractable carbon provides a measure of active carbon. Anaerobically mineralisable nitrogen is a measure of the capacity of the soil microbial community to convert (mineralise) nitrogen tied up in organic matter into plant-available nitrogen.

Total carbon

Total carbon is a test that includes all organic and inorganic carbon (although most New Zealand soils contain very little inorganic carbon), expressed as a percentage of soil weight. Organic matter is assumed to be 58% carbon. Total carbon is converted to organic matter using a factor of 1.72 (i.e. total C x 1.72 = estimated organic matter).

Reference ranges used for SOE reporting vary depending on land use and soil type. In general, more carbon (hence more organic matter) is considered better. Mineral soils under cropping tend to have the lowest carbon contents, whereas pastoral soils tend to have more. Organic Soils (commonly referred to as peat) have the highest carbon contents, whereas Allophanic Soils have the highest carbon content of mineral soils.

Total N

Total N (TN) is a measure of the total amount of all forms of nitrogen in soil, including organic N (e.g. N in soil organic matter and crop residues) in addition to inorganic N (e.g. ammonium and nitrate). Organic N makes up the largest fraction of TN, and often is not readily plant-available, whereas inorganic N makes up a small amount of TN but is immediately plant-available.

Total N is typically measured alongside total C to provide an indication of the organic matter N content, and the ratio of total C to total N (the soil C:N ratio).

C:N ratio

The soil C:N ratio gives an indication of the quality of the organic matter to supply N. A widening of the C:N ratio over time reflects declining N fertility, whereas a narrowing of the ratio may indicate enrichment of N in the soil.

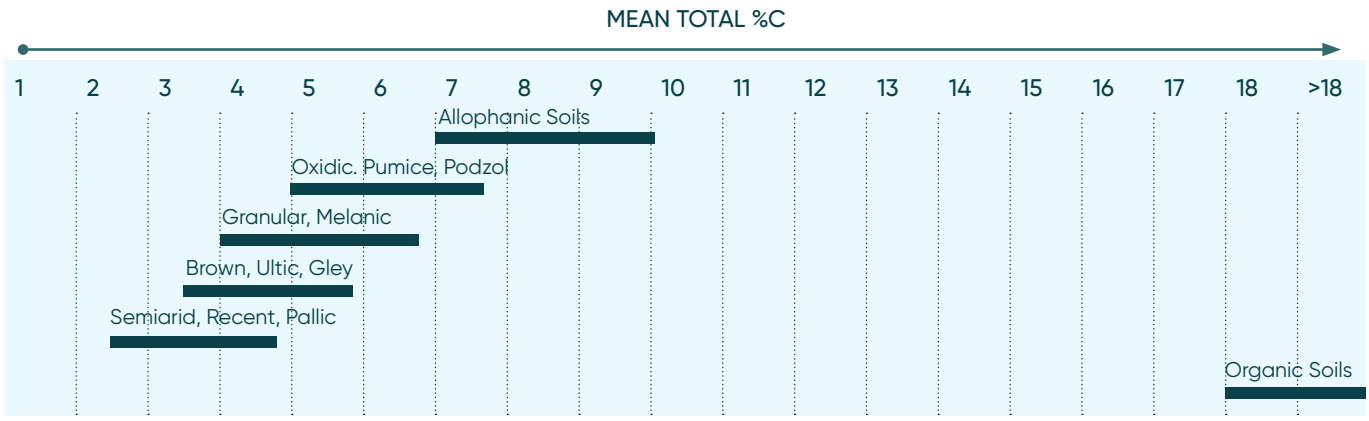
Managing organic matter levels

Soil organic matter tends to be depleted over time, particularly with intensive cropping. It can be difficult to increase organic matter in soil, so the **first priority for management should be to avoid losing organic matter**.

In general, organic matter levels can be improved by:

1. Adding more organic inputs (i.e. cover crops, retaining crop residues, and including legumes in pasture), and/or
2. Reducing the losses of organic matter from soil (such as reducing the depth and extent of cultivation).

However, organic matter takes years to replace naturally. Most organic inputs decompose rapidly, so it can take large and frequent applications to increase soil carbon over the long term.



Approximate soil order differences in mean total C determined from statistical modelling, controlling for the effect of land use.

This factsheet is part of a series produced in 2025 by the Bioeconomy Science Institute, for the Regional Council Land Monitoring Forum.