

SOIL CARBON STEWARDSHIP AND NATURE-BASED SOLUTIONS: MANAGING SOIL ORGANIC CARBON



Summary

The impact of nature-based solutions (NBS) on soil organic matter (SOM) and soil organic carbon (SOC) is a hot topic. Healthier soils make farms more resilient and efficient. However, there is a knowledge gap on how farmers can benefit from better management of their SOM and SOC.

The need

Carbon represents 50% of SOM, the rest comes from nutrients (N,P,S,O,H). As microbes, these nutrients provide crops with energy. The microbial activity improves soil structure, water filtration and retention, aeration, and root growth. SOM is an important reservoir of nutrients through microbial activity.

Most carbon is found in soil, meaning SOC is important for regulating the climate. However, SOC is easily lost through conventional farming. Destructure of soil functionality and structure inhibits carbon replacement. Land needs to be managed for soils to be substantial carbon sinks.

However, knowledge gaps mean it isn't clear which sustainable practices or combinations are best to maximize SOC or SOM.

Possible management practices on farmland include a) reducing soil disturbance by switching to low-till or no-till practices or planting perennial crops; b) changing planting schedules or rotations, such as planting cover crops; c) managed grazing of livestock or applying manures; d) applying compost or retaining crop residues to fields.

The effect of any one NBS will depend on whether it is combined with other options. Rothamsted Research's Large-Scale Rotation Experiment (LSRE) is testing all possible combinations of compost, reduced tillage, cover crops and perennial crops in different 'system.'



The benefits

Even small increases in SOM and SOC have been found to be beneficial to soil health and function. Improving SOM and SOC can create efficient use of water and nutrient management and wider ecosystems, including increasing worm populations.

Broad global context also needs to be considered. The global north has organic rich carbon soils which require a responsible approach to managing these carbon stocks. It has been estimated that soils - mostly agricultural ones - could sequester over a billion additional tons of carbon each year.

NBS interventions, such as the ones being used on the LSRE, help to manage SOC and SOM through retaining crop residues, adding organic matter through manures, compost, reducing tillage and soil disruption/compaction and including leys in arable rotations.

Thus, implementing NBS systems may allow SOC to be managed more effectively for long-term health of the soil and has wider beneficial implications for planetary health. NBS systems may therefore provide environments for microbial activity that maintains a flow of nutrient and minerals through the soil and improves soil structure and healthy functions.

SOM can be measured by Loss on Ignition testing, essentially the organic matter is burnt off. However if SOC is being measured through dry combustion the amount of carbon measured can be converted into an estimate of SOM (and vice versa), SOC is reliably measured by carrying out a Dumas test (dry combustion). This analyses the carbon from gasses released by heating up the soil samples in oxygen rich air until it starts to burn, and the amount of carbon dioxide produced is measured.



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trans4num solution

The Rothamsted Research Large-Scale Rotation Experiment (LSRE) is testing multiple NBS interventions (crop rotations, diversified cropping, min/zero till, organic amendments) deployed in different combinations to assess the impact on different properties of soil, with SOC and SOM being a key element.

The interventions on the LSRE are being monitored to study the synergies and trade-offs of each approach and to also assess the effects on crop yield and efficiency of fertilizer use.

Soil organic carbon dynamics need to be assessed over the long-term. Because of seasonal effects of weather, short term reductions in SOC were observed in all treatments but, over the longer term, we are seeing consistent benefits of NbS interventions; emphasizing the need for a long term experiment.

SOC increases in the phase of a rotation where the NBS (for example, carbon) is applied but may decrease in the other phase of the rotation. The benefits of an NBS, therefore, were assessed by quantifying the soil carbon across the whole rotation at the level of the 'system'.

After six years, the top five cropping systems in terms of increases in SOC, all had a combination of compost and reduced tillage indicating an additive benefit of these two NBS. These results were from a site with sandy soil meaning the potential for additional carbon storage is limited. We expect to see larger effects from the LSRE site on a heavy clay soil which has a greater capacity for carbon storage.

The management of SOC resources can only be achieved through the monitoring of levels and implementation of strategies to maintain already developed stocks and management of interventions to improve them in the case of degraded soils/

Management interventions include reduced tillage, cover crops, rotational and diversified cropping, direct drilling, application and inclusion of livestock, manures and compost, as well as retaining crop residues and reducing fallow land. All these NBS interventions are linked with enhancements in soil structure, soil organic matter and soil carbon. Improved soil structures provide ecosystem services which include water retention, reducing soil loss, decreasing the need for inputs such as mineral fertilizers and therefore run-off of such inputs into watercourses.

What were the challenges / limitations in the implementation process?

- LSRE does not include livestock integration, so not representative of a mixed system.
- Challenges in removing cover crops and perennial lays without tillage. Over-reliance on glyphosate.
- Extreme weather and establishing cover crops in time for growing season.

What kind of resources do you need to implement the proposed solution?

- Direct drilling machinery appropriate to soil type.
- Access to livestock manure and/or livestock plus livestock infrastructure.
- Access to green compost.
- Appropriate varieties for diversified cropping rotations.

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More information

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- [trans4num British NBS site](#)

