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Soil Organic Carbon Sequestration in Climate Change

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Introduction

Soil carbon sequestration, also known as "carbon farming" or "regenerative agriculture," includes various ways of managing land, especially farmland, so that soils absorb and hold more carbon. Increasing soil carbon is accomplished in various ways,

(1) Reducing soil disturbance by switching to low-till or no-till practices or planting perennial crops.

(2) Changing planting schedules or rotations, such as by planting cover crops or double crops instead of leaving fields fallow.

(3) Managed grazing of livestock

(4) Applying compost or crop residues to fields. In addition to providing local environmental and economic benefits, these practices can capture carbon dioxide (CO2) from the atmosphere and store it in soils, making them a form of carbon removal.

Soil organic carbon (SOC) is a "Process of transferring CO_2 from the atmosphere into the soil through plants, plant residues, and other organic solids, which are stored or retained as part of the soil organic matter (humus). Soils and the plants that grow in them absorb about a third of the carbon emissions that drive the climate crisis, partly limiting the impact of fossil-fuel burning. Rising carbon dioxide levels in the atmosphere can increase plant growth and, until now, it was assumed carbon storage in soils would increase too.

Carbon sequestration is the long-term storage of carbon in oceans, soils, vegetation (especially forests), and geologic formations. Although oceans store most of the Earth's carbon, soils contain approximately 75% of the carbon pool on land - three times more than the amount stored in living plants and animals. Soils play a key role in the carbon cycle by soaking up carbon from dead plant matter. Plants absorb CO_2 from the atmosphere through photosynthesis and this is passed to the ground when dead roots and leaves decompose.

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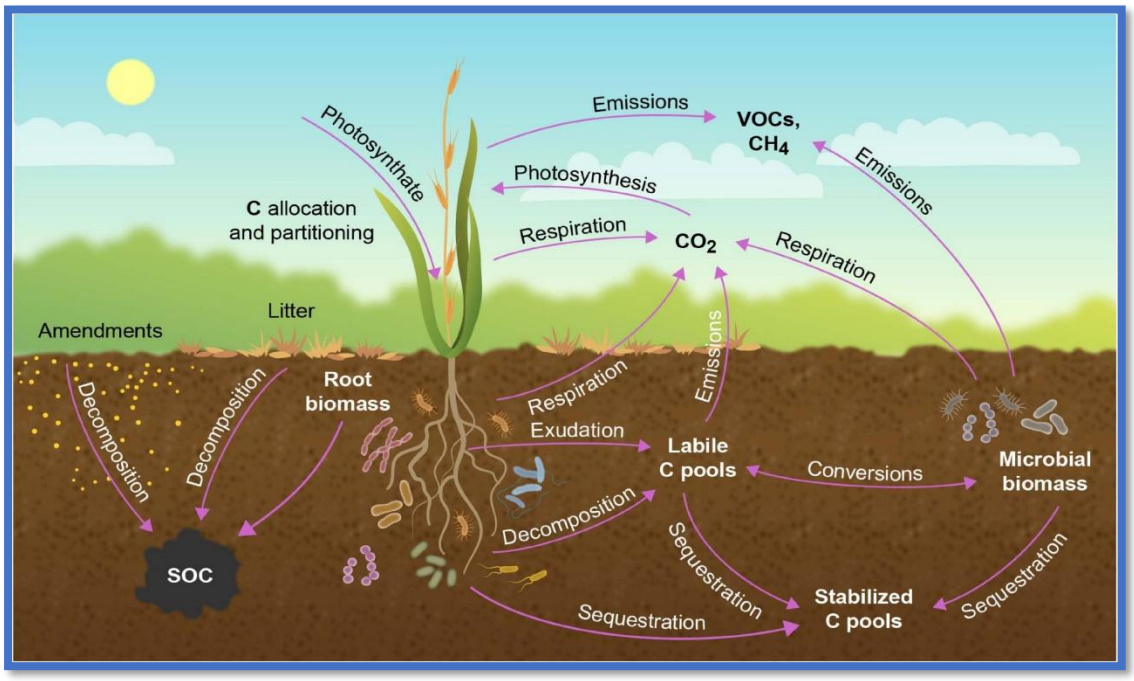
Carbon is sequestered in soil by plants through photosynthesis and can be stored as soil organic carbon (SOC). Agroecosystems can degrade and deplete the SOC levels but this carbon deficit opens up the opportunity to store carbon through new land management practices. Soil can also store carbon as carbonates.

In addition to enhancing soil carbon sequestration, soil amendments may provide co-benefits to growers such as increased crop and forage yields and improved soil health. Carbon farming is the use of specific on-farm practices designed to take carbon out of the air and store it in soils and plant material. Carbon farming practices include the application of soil amendments like compost or biochar, conservation tillage, agroforestry, whole orchard recycling, cover crops that maximize living roots, and many others.



Building soil organic matter on croplands and rangelands sequesters carbon in soils, which helps mitigate the effects of climate change while potentially providing co-benefits for soil health and increased adaptive capacity. Soil amendments may increase the amount of carbon held in soil organic matter, leading to greater carbon sequestration.

Soil amendments are products added to soils to improve soil qualities like soil fertility. Many of the soil amendments that can improve soil health, also sequester carbon. Amendments that increase soil organic matter may improve the water holding capacity and infiltration in soils, which promotes

resilience to climate-related impacts such as drought, heatwaves, or heavy rains. Amendments can promote biological activity and supply vital nutrients, resulting in healthier plants that are less vulnerable to pests and disease.

Benefits and Concerns

1. **Improved soil health:** soil carbon sequestration helps restore degraded soils, which can improve agricultural productivity.
2. **Increased climate resilience:** healthier soils make farms more resilient against both droughts and heavy rainfall.
3. **Reduced fertilizer use:** healthier soils require less fertilizer, saving farmers money and reducing environmental impacts
4. **Saturation:** soils can only hold a finite amount of carbon; once they are saturated, societies will no longer be able to capture more carbon using soil carbon sequestration.
5. **Reversibility:** the carbon captured via soil carbon sequestration can be released if the soils are disturbed; societies would need to maintain appropriate soil management practices indefinitely.
6. **Difficulty of measurement:** monitoring and verifying carbon removal via soil carbon sequestration is currently difficult and costly.