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Soil Carbon is a Key component for Soil quality and Farm Sustainability

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Soil carbon

In addition to advancing food security, soil resources need to be managed in sustainable ways to meet multiple global needs, including mitigating and adapting to climate change, improving the quality and quantity of water resources, promoting biodiversity, preserving human heritage, preventing desertification, alleviating poverty, and being an engine of new industries and economic growth (Lal, 2007). Soil carbon provides nutrients to plants through mineralization, helps aggregate soil particles (structure) to provide resilience to physical degradation, increases microbial activity, increases water storage and availability to plants, and protects soil from erosion.

Soil organic carbon (SOC) is a critical natural resource and contributes significantly to achieving all these goals, such as by directly storing more C in soils, while improving soil health and ecosystem functions. SOC is considered a key indicator because of its contributions to food production, mitigation and adaptation to climate change, and role in water storage and purification. The SOC content is almost 50% to 58% of soil organic matter (SOM) (Pribyl, 2010). With an optimal amount of SOC, the filtration capacity of soils that supports for clean water.

Turnover of SOC in terrestrial ecosystems is always dynamic, and human activities can turn SOC into either a net sink or a net source of greenhouse gases (GHG) in the atmosphere. Although the climate change have impact on SOC stocks, it is highly variable according to the region and soil type. Climate vagaries like rising temperatures and increased frequency of extreme drought events may to lead to increased loss of SOC. The dynamics of these processes highlight the importance of quantifying global C fluctuations to ensure maximum benefits of SOC to soil health, food production, and water and climate change mitigation. However, the protection and monitoring of SOC stocks still face complicated challenges at national and global levels in impeding effective on-the-ground policy designs and regionally adapted implementation.

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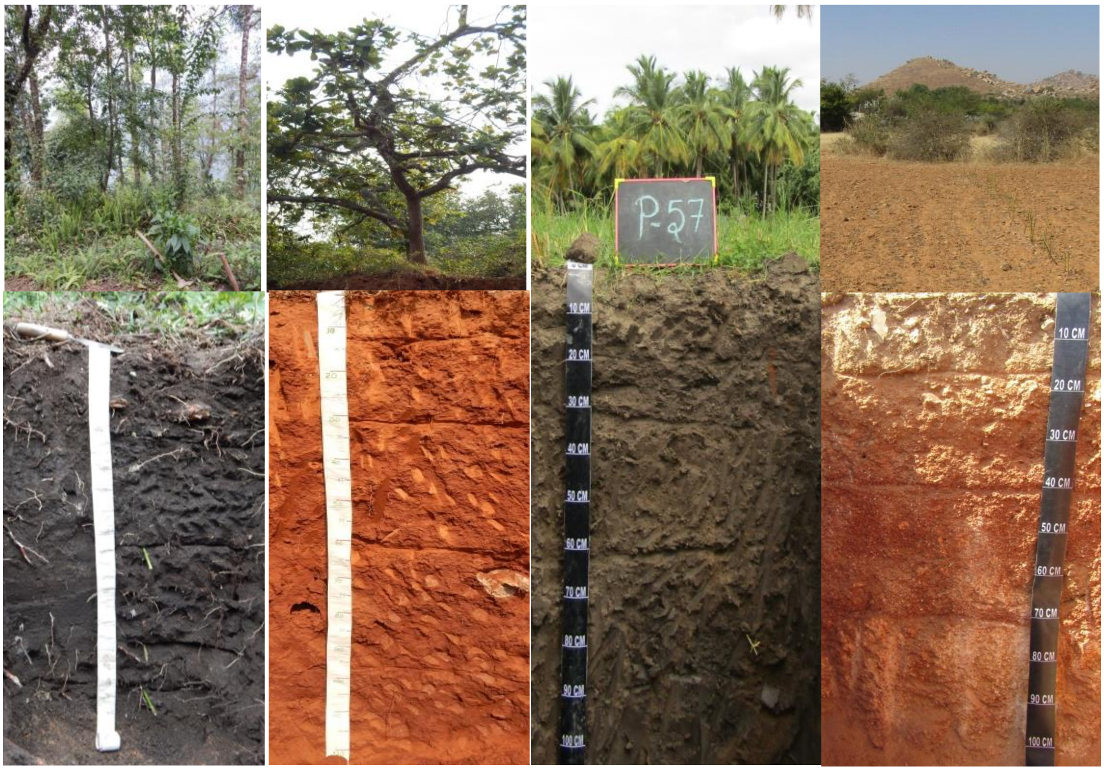
Soil quality can be defined as the fitness of soil to function within its capacity and within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Karlen et al., 1997).



Forestry | Plantation | Wet region | Dry region

Fig. 1 Soils of different ecosystems of India

The amount of soil carbon varies depending on the land use system and the depth at which the carbon is measured. Forest soils have the highest TOC, followed by horticultural systems, while degraded and agricultural systems have the least (Fig.1). Soil organic carbon (SOC) is a key determinant of soil quality and significantly impacts the environment, agriculture, and human health. SOC decreases with increasing depth of the soils.

Types of soil carbon

Soil carbon is the solid carbon stored in global soils. This includes both soil organic matter and inorganic carbon as carbonate minerals.

1. **Organic carbon**: Comes from decaying plant matter, microbes, and soil organisms, as well as carbon compounds like proteins, sugars, and starches.
2. **Inorganic carbon:** Made from minerals, with calcium carbonate being the most common form.

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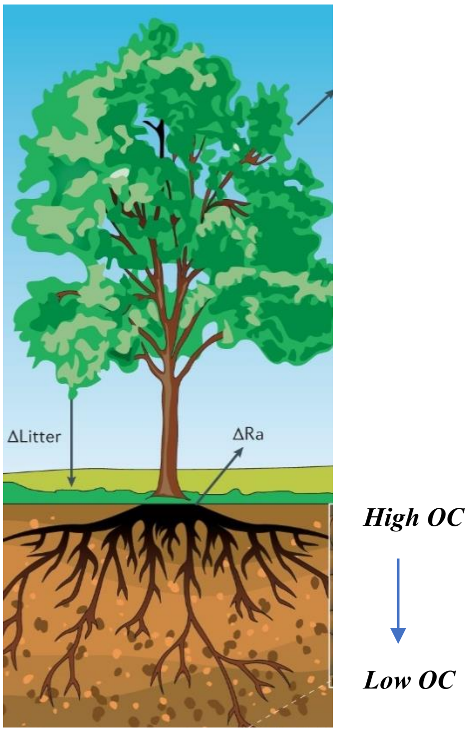

Carbon Cycle in Soil

various transformations and exchanges.

Carbon Inputs: Plants capture CO_2 from the atmosphere through photosynthesis.

Carbon Allocation: Some carbon is used for plant growth, while some is transferred to the soil via roots and plant residues.

Decomposition: The organic matter in soil are break down by soil organisms and releasing some carbon as CO_2 and incorporating some into their biomass.

Stabilization: Some carbon becomes stabilized in soil aggregates or bound to minerals

Carbon Loss: Spome amount of carbon from soil can be lost through erosion, leaching, or CO_2 emissions

Factors Affecting SOC

Climate: Temperature and precipitation affect carbon inputs and decomposition rates

Soil Type: Clay soils tend to store more carbon than sandy soils

Land Use: Agricultural practices, forestry, and urbanization impact soil carbon levels

Vegetation: Different plant types contribute varying amounts of carbon to the soil

Management Practices: Tillage, crop rotation, and fertilization influence soil carbon dynamics

Strategies for Managing Soil Carbon

Conservation Tillage: Reducing soil disturbance helps preserve soil carbon.

Cover Cropping: Planting cover crops adds organic matter to the soil.

Crop Rotation: Diversifying crops can enhance carbon inputs and soil health.

Organic Amendments: Adding compost or manure increases soil carbon content.

Agroforestry: Integrating trees into agricultural landscapes can boost carbon sequestration.

Precision Agriculture: Using technology to optimize resource use and minimize soil disturbance.

Conclusions

Soil carbon plays a vital role in soil health, crop productivity, and climate change mitigation. Understanding and managing carbon in soil is crucial for sustainable agriculture and the environment. By leveraging modern agricultural practices and technologies, they can effectively monitor and manage soil carbon levels, leading to healthier soils, better crops, and a more sustainable future.

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