SUNSHINE AGRICULTURE
e-Newsletter

ISSN (E): 2583 – 0821

Sun. Agri.:e- Newsletter, (2024) *4*(11), 7-9

Article ID: 344

Role of Soil in Achieving Carbon Neutrality Goals

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Open Access

Available online at
http://sunshineagriculture.vitalbiotech.org/

Article History
Received: 10. 11.2024
Revised: 17. 11.2024
Accepted: 21. 11.2024

INTRODUCTION

The global shift towards carbon neutrality is one of the biggest challenges of the 21st century, aiming at the reduction of greenhouse gas emissions and mitigation of climate change. Soils, as one of the biggest carbon reservoirs on Earth, play a pivotal role in achieving carbon neutrality. The same agriculture can not only reduce its carbon footprint but enhance carbon storage capacity as a significant contributor to the global carbon cycle. The paper explores the role of soil in carbon neutrality with focus on soil carbon sequestration, its potential for mitigating climate change, and practices that could improve soil's role in carbon neutrality goals.

3.Carbon Sequestration in Soils

Soil carbon sequestration is the process by which carbon dioxide from the atmosphere is absorbed by soils and stored as soil organic carbon. Soil, forests, and oceans are the largest carbon sinks. There are about 2,500 gigatons of carbon stored in soils, which is more than three times the carbon stored in the atmosphere and vegetation combined. Carbon sequestration in soil is through the addition of plant residues, decomposing organic matter, and the creation of stable organic compounds in the soil matrix.

4.Soil Carbon and Climate Change Mitigation

Soils are a double-edged sword in the context of climate change. On the one hand, poor management of soils such as overgrazing, deforestation, or intensive farming leads to the emission of stored carbon into the atmosphere, which worsens global warming. On the other hand, healthy soils can be a buffer to absorb atmospheric CO2 and store it in the form of organic matter. So, carbon sequestration in soils is a significant strategy in mitigating climate change through offsetting emissions from industries, transportation, and agriculture.

The potential for soils to sequester carbon is enormous. The Intergovernmental Panel on Climate Change (IPCC) estimates that globally, soils have the potential to sequester up to 10 billion tons of CO2 annually if managed sustainably. This can contribute significantly to achieving carbon neutrality goals set by governments and international climate agreements like the Paris Agreement.

5.Soil Management Practices for Carbon Sequestration

Some of the soil management practices can really improve sequestration levels in the soils. Several of such practices revolve around or build on their SOM's conservation and promotion, something critical to achieving good quality of the carbon in those soils. Essential practices entail;

Conservation Tillage: Soil organic carbon from being oxidized can be prevented by reducing tillage or adopting no-till farming practices. Conservation tillage minimizes soil disturbance through leaving crop residues on the soil surface, thus enhancing the formation and preservation of organic matter.

Cover Cropping: Growing cover crops like legumes, grasses or clover during fallowing periods improves soil structure while increasing the organic matter component and microbial activity. Furthermore, these crops reduce the rate of soil erosion; hence, soil fertility can be enhanced.

Agroforestry and Tree Planting: Agroforestry practices integrate the trees into agricultural systems whereby several benefits are realized that include increasing soil carbon. The trees sequester carbon in their biomass apart from contributing to soil fertility through leaf litter and their root systems.

Organic Fertilization: Adding organic amendments, such as compost, manure, or biochar, to the soil will greatly increase soil organic matter. Organic amendments increase the microbial activity in the soil and increase its health, which leads to better carbon retention.

Managed Grazing Systems: Introducing rotational grazing and varying grazing intensity in pastures can be effective in enhancing soil organic carbon levels. The practice improves vegetation cover, decreases soil compaction, and promotes carbon storage in soils.

Restoring Degraded Soils: Loss of soil organic carbon in degraded areas through erosion, deforestation, or excessive exploitation calls for the regeneration of that carbon storage potential through restored lands, preferably through afforestation, reforestation, and optimal soil care.

Application of Biochar: Biochar is a stable form of charcoal produced from biomass through pyrolysis. It can be added to soils to enhance carbon sequestration. It increases the carbon content in the soil and improves soil fertility and water retention.

6.Challenges in Soil Carbon Sequestration

Soils offer significant potential for carbon sequestration, but several challenges hinder their full potential:

Climate Variability; The impacts of climate conditions including temperature, precipitation, and drought condition affect soil carbon sequestration. Thus, high carbon sequestration may be lost as a result of extreme events in such regions.

Land Use and Soil Management Change: Change in land use, like converting forests into agricultural lands or draining of wetland,

releases lots of carbon stored in soil. Improper soil management also degrades carbon stored in soils.

Measurement and Monitoring: The accurate measurement and monitoring of soil carbon sequestration are technically challenging. Differences in soil types, land use, and climate conditions complicate the assessment of carbon stocks and make it difficult to track progress towards carbon neutrality.

Economic and Policy Barriers: Although carbon sequestration has huge potential, most farmers and landowners lack the incentives or policies to adopt sustainable soil management practices. The government, through subsidies and carbon credit markets, needs to encourage soil-friendly practices.

7. Soil and Carbon Neutrality in Agriculture

Agriculture is both a cause and a solution to climate change. While agricultural activities contribute significantly to GHG emissions, soil management practices can provide an opportunity for the sector to become part of the solution. With the inclusion of soil carbon sequestration into farming practices, agriculture can instead become a net carbon sink rather than a net emitter.

The agricultural sector can contribute to carbon neutrality goals through:

- Carbon farming practice integration, which incentivizes farmers to adopt carbon sequestration techniques.
- Carbon credit market participation, where the farmers are compensated for their efforts on carbon sequestration.
- Promotion of soil carbon offset programs, which will bring extra revenue to farmers.

CONCLUSION

Soils have a central role in reaching carbon neutrality through carbon sequestration. Agriculture can contribute considerably to mitigating climate change and reducing atmospheric CO2 levels by adopting sustainable soil management practices. However, the full potential of soil carbon sequestration depends on overcoming challenges related to measurement, policy, and land management. Governments, industries, and farmers have to collaborate and develop strategies that improve soil health and carbon storage to ensure soils continue to play a central role in the fight against climate change. In this way, soils can be part of building a resilient, carbon-neutral future for all.

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