The Impact of Soil Health on Carbon Sequestration: Boosting Climate Change Mitigation through Sustainable Practices

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Abstract

Soil health plays a pivotal role in carbon sequestration, a critical process for mitigating climate change by capturing and storing atmospheric carbon dioxide in soil systems. This paper explores how enhancing soil health through sustainable agricultural practices can significantly improve carbon sequestration capacity, thereby contributing to global climate mitigation efforts. Healthy soils, rich in organic matter and microbial diversity, act as effective carbon sinks, reducing the amount of carbon released into the atmosphere. Key practices such as cover cropping, no-till farming, and organic amendments not only improve soil structure and fertility but also increase the soil's ability to sequester carbon long-term. Conversely, soil degradation, driven by unsustainable farming and land-use practices, diminishes this capacity, accelerating greenhouse gas emissions. This study underscores the importance of adopting regenerative agricultural practices to restore soil health, boost carbon storage, and support climate resilience. The findings highlight the need for policies and incentives that promote sustainable soil management as a crucial component of climate change strategies.

Introduction

Climate change due to increased greenhouse gas emissions (GHG) in the atmosphere has been consistently observed since the mid-20th century (Bhatti et.al., 2024). Also, it has become one of the most pressing challenges of the 21st century, driven largely by the excessive accumulation of greenhouse gases (GHGs), especially carbon dioxide (CO2), in the atmosphere. Among the strategies to mitigate the effects of climate change, carbon sequestration, capturing and storing atmospheric CO2 in long-term reservoirs is recognized as a vital process, (Bhavsar et.al., 2023). Soils, in particular, hold immense potential as carbon sinks, capable of storing more carbon than the atmosphere and all plant biomass combined (Sharma et.al., 2023). However, the effectiveness of soils in carbon sequestration is heavily influenced by their health. Healthy soils, rich in organic matter, microbial activity, and optimal structure, have a much higher capacity to store carbon than degraded soils. Soil health refers to the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans (Lehmann et.al., 2020). When soil is healthy, it supports robust plant growth, enhances water retention, and promotes biodiversity all of which contribute to carbon storage. However, unsustainable agricultural practices, such as over-tillage, monoculture, and the overuse of chemical fertilizers, can degrade soil, leading to erosion, loss of organic matter, and the release of stored carbon back into the atmosphere (Bisht and Chuhan, 2020). This not only reduces the soil's ability to sequester carbon but also exacerbates climate change.

Sustainable farming techniques, including cover cropping, no-till farming, agroforestry, and the use of organic amendments, have been shown to improve soil health and enhance its carbon sequestration potential (Jat et.al., 2022). Cover crops, for instance, help maintain soil cover year-round, preventing erosion and adding organic matter to the soil. No-till farming reduces soil disturbance, preserving soil structure and microbial activity, which are critical for long-term carbon storage. Similarly, incorporating organic amendments, such as compost or manure, can boost soil organic carbon levels, further enhancing its role as a carbon sink (Li et.al., 2021). This article explores the link between soil health and carbon sequestration and highlights the importance of adopting sustainable agricultural practices to maximize this potential. By improving soil health, we can not only enhance carbon storage but also make agricultural systems more resilient to the impacts of climate change. Furthermore, this article argues for the integration of soil health into climate change mitigation strategies, as well as the implementation of policies and incentives to encourage farmers to adopt practices that promote both carbon sequestration and long-term soil sustainability.

By addressing the relationship between soil health and carbon sequestration, we can better understand the critical role that soils play in mitigating climate change and how sustainable management of this natural resource can lead to long-term environmental benefits.

Conclusion

The connection between soil health and carbon sequestration is a critical component in the fight against climate change. Healthy soils, enriched with organic matter and robust microbial communities, act as efficient carbon sinks, helping to reduce atmospheric CO2 levels. Conversely, soil degradation through unsustainable agricultural practices leads to the release of stored carbon, worsening climate change. Furthermore, it highlights the importance of

adopting sustainable farming methods, such as cover cropping, no-till farming, and organic amendments, to restore and maintain soil health. By improving soil structure and enhancing its carbon storage capacity, these practices contribute to climate mitigation and promote resilience in agricultural systems.

To maximize the role of soils in carbon sequestration, it is crucial to integrate soil health into broader climate change mitigation strategies. Policies and incentives that encourage sustainable soil management are needed to ensure long-term carbon storage and soil sustainability. Ultimately, prioritizing soil health not only supports carbon sequestration but also fosters a more sustainable and climate-resilient future for ecosystems and agriculture alike.

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