



Soil Carbon Sequestration: A Solution to Climate Change

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ABSTRACT

Soil carbon sequestration can be used as a solution in reducing atmospheric carbon dioxide. In this process, the carbon is stored in the form of soil organic carbon by using plants to capture carbon dioxide in air through photosynthesis. There are many advantages in increasing soil carbon such as betterment of soil structure, soil health, capturing of carbon dioxide from air. Maintaining soil residue, using cover crops, and practicing various crops and agroforestry, as well as using all of the other typical and less typical practices like biochar and rock dust, help to increase soil carbon. With new advances in soil science, new methods of soil carbon management will develop. Because soil carbon storage is reversible and influenced by management, soil carbon sequestration should be implemented in conjunction with other climate strategies to reduce carbon emissions.

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1. INTRODUCTION

Soil carbon comprises about 70-75% of all organic carbon in soils. Soil organic carbon (SOC) encompasses plant and animal biomass and the microbial carbon. SOC plays crucial function in retaining soil moisture for plant use. Agricultural activities such as the continuous removal of plant residues will cause loss of soil organic carbon, accelerate problem of soil erosion which will further lead to an increase in atmospheric carbon. Soil carbon sequestration is the practice of increasing the amount of soil carbon. Plants absorb atmospheric carbon dioxide and release some of it to the soil as their residues decompose. When carbon dioxide is released during soil respiration, some of it can be incorporated into both soil organic matter and other soil aggregates

where it can be retained for many years. The FAO (2025) reports the importance of soil carbon extends beyond the mitigation of climate change (Ramalakshmi *et al.*, 2025). Carbon-rich soils have a better water holding capacity and improved nutrient availability. Thus the management of soil carbon can provide sustainable climate-mitigation practices.

2. SOIL CARBON SEQUESTRATION AS A CLIMATE STRATEGY

Soil carbon sequestration is the process of adding carbon to the soil through plants and roots and optimum management practices. These practices include retaining crop residue, using cover crops, reduced tillage, and the application of compost. Soil carbon sequestration generally improves soil structure,

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increases water holding capacity (WHC) and enhances nutrient cycling. Each soil type, climate and management practice will impact soil carbon sequestration potential. Long term storage of soil carbon depends on management practices as well as site conditions. Therefore, carbon sequestration in soil should be incremental.

3. AGRICULTURAL TECHNIQUES FOR INCREASING SOIL CARBON

Some agriculture techniques enhance soil carbon with fewer losses by increasing organic matter inputs. This includes cover crops, placing crop residue on the field, crop diversification and rotation. These practices add carbon inputs from the plant root mass and the stored carbon present in the plants. Some techniques reduce the amounts of soil disturbance and protect stored soil carbon, including reduced tillage and conservation agriculture. Although, the effectiveness of both techniques depends heavily on soil and climate conditions. Agroforestry increases soil carbon by the carbon contained in the litter and root biomass. Techniques like compost and manure application also increase soil carbon. Lastly, implementing a variety of complementary techniques specific to the local climate and soil is greatly more effective than relying on a single technique.

4. BIOCHAR FOR SOIL CARBON SEQUESTRATION

Biochar is a carbon-rich material formed by heating biomass under limited oxygen and is attracting interest as a potential long term carbon storage option. Part of the carbon in biochar is resistant to decomposition (Thornbush *et al.*, 2026; Pragnya *et al.*, 2026a). One global meta-analysis based on 75 studies and 250 observations concluded that biochar increases soil carbon sequestration. The ability of biochar to increase the sequestration of carbon in soil depends on the feedstock, pyrolysis conditions and application rate. Several studies were focused on engineered biochar in order to enhance carbon stability, availability of nutrients and water retention (Bekchanova *et al.*, 2024). These methods outcome depends on the characteristics of biochar, production method, rate of application and the conditions of the soil.

5. ENHANCED ROCK WEATHERING: TURNING MINERALS INTO A CARBON SINK

Enhanced rock weathering (ERW) involves use of finely ground silicate-rich rocks to speed up the process of natural weathering and enhance release of carbon dioxide (CO₂). Xu *et al.* (2025) conducted an

analysis and found that this technique had positive effect on soil organic carbon. This technique has potential to increase the availability of nutrients in soil (Cong *et al.*, 2024; Pragnya *et al.*, 2026). Above all, there is still a need for long term evaluation to ensure effective adoption.

6. CHALLENGES AND FUTURE PROSPECTS

Soil carbon sequestration has some potential, but challenges include slow accumulation of soil carbon which is influenced by factors such as soil type, climate and soil management practices. This limitation may be overcome by monitoring soil carbon stored in deeper layers. It would be useful for future studies to carry out long-term field studies where the impact of carbon storage in soil is evaluated along with crop production, soil health, and emissions of greenhouse gases. It was proposed that the combination of biochar, agroforestry, digital soil monitoring, and the application of other management practices along with the use of enhanced rock weathering and organic amendments, would allow for significant improvement. All practices should be adapted to the local conditions, with equal emphasis placed on maintaining existing carbon-rich soils and preventing further carbon losses.

7. CONCLUSION

Soil carbon sequestration, as a means to mitigate climate change, has several benefits along with the improvement of soil health, and crop production. Some practices (e.g., cover cropping, retaining crop residue, including crop rotations, and the use of agroforestry) increase soil carbon. Additional methods, such as biochar, enhanced rock weathering, digital soil mapping, and more sophisticated carbon monitoring, may also serve to support carbon storage. Carbon storage practices, along with other climate change mitigation strategies, should be the goal, as management practices that are not continued may lead to a loss of sequestered carbon.

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