

# Carbon Farming for Sustainable Agriculture

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## ABSTRACT

Climate change is increasingly affecting agriculture, ecosystems, and human livelihoods across the world. Rising temperatures, increasing atmospheric carbon dioxide levels, and frequent extreme weather events highlight the urgent need for sustainable solutions. Agriculture contributes significantly to greenhouse gas emissions, yet it also holds immense potential to mitigate climate change through carbon sequestration. Carbon farming is an approach that focuses on capturing atmospheric carbon dioxide and storing it in soil and plant systems. This paper discusses the concept, scientific basis, major practices, benefits and challenges of carbon farming. It highlights how sustainable agricultural practices can transform farming systems into carbon sinks while enhancing soil health, productivity and farmer livelihoods.

## INTRODUCTION

Climate change has become one of the most serious environmental challenges of the present time. Rising global temperatures and increasing atmospheric carbon dioxide concentrations are leading to extreme weather events such as droughts, floods, and heatwaves. These changes are

directly affecting agricultural productivity and food security worldwide.

Agriculture plays a dual role in this context. It contributes significantly to greenhouse gas emissions, but it also has the potential to act as a carbon sink through proper land management practices. Sustainable agricultural approaches

are therefore essential to reduce emissions and enhance carbon storage. Carbon farming has emerged as a promising strategy to address this issue by integrating climate mitigation with improved agricultural practices.

### Concept of Carbon Farming

Carbon farming refers to a set of agricultural practices aimed at removing carbon dioxide from the atmosphere and storing it in soil organic carbon (SOC) and plant biomass. The main objective is to improve the carbon balance of agricultural systems so that carbon storage exceeds carbon emissions.

In conventional agriculture, soil disturbance and excessive input use often lead to carbon loss. Carbon farming, on the other hand, focuses on practices that enhance carbon storage and reduce emissions, thereby converting agricultural land into a carbon sink.

### Scientific Basis of Carbon Sequestration

Carbon sequestration is based on natural processes such as photosynthesis and the carbon cycle. Plants absorb carbon dioxide from the atmosphere and convert it into biomass, which eventually becomes part of the soil organic matter through decomposition.

Soil is one of the largest carbon reservoirs on Earth, and improving soil organic carbon is critical for climate change mitigation. Enhancing soil carbon not only reduces atmospheric CO<sub>2</sub> but also improves soil fertility and productivity (Smith *et al.*, 2020).

### Role of Soil and Plants

Soil organic carbon plays a vital role in maintaining soil health and agricultural sustainability. It improves soil structure, water retention, and nutrient availability, making soils more resilient to climate stress. Declining soil carbon levels are a major concern in many agricultural regions, including India.

Plants act as the primary pathway for carbon entry into the soil. Through photosynthesis, they capture atmospheric CO<sub>2</sub> and transfer it into the soil through roots and plant residues. This process forms the foundation of carbon farming.

### Major Carbon Farming Practices

**Conservation Tillage:** Conservation tillage reduces soil disturbance, thereby minimizing carbon loss and enhancing soil carbon storage. It has been shown to improve soil carbon dynamics and reduce greenhouse gas emissions.

**Cover Cropping:** Cover crops play an important role in improving soil organic matter and protecting soil from erosion. They also contribute to carbon sequestration and enhance soil fertility.

**Crop Rotation:** Crop rotation improves soil health by increasing biodiversity and enhancing soil carbon content. Rotational systems have been found to significantly improve soil organic carbon compared to monocropping (Meena *et al.*, 2015).

**Agroforestry:** Agroforestry integrates trees with crops and livestock, increasing carbon storage both above and below ground. It is particularly effective in regions like the Himalayas, where it enhances both carbon sequestration and livelihood security (Zahoor *et al.*, 2021).

### Greenhouse Gas Emissions from Agriculture

Agriculture emits three major greenhouse gases: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). These gases contribute significantly to global warming, with nitrous oxide having a particularly high global warming potential.

Carbon farming practices help reduce these emissions by improving soil management, optimizing input use and enhancing carbon storage (Smith *et al.*, 2020).

### Benefits of Carbon Farming

**Environmental Benefits:** Carbon farming helps reduce atmospheric CO<sub>2</sub> levels and contributes to climate change mitigation. It also supports biodiversity and ecosystem stability (Smith *et al.*, 2020).

**Soil Health Benefits:** Improved soil organic carbon enhances soil structure, water-holding capacity, and nutrient availability, leading to better crop productivity.

**Economic Benefits:** Carbon farming can provide economic benefits to farmers through reduced input costs and potential income from carbon credit systems.

**Social Benefits:** It supports sustainable livelihoods, improves food security, and promotes environmentally friendly agricultural practices.

### Challenges in Adoption

Despite its advantages, carbon farming faces several challenges. Measuring soil carbon is technically complex and costly. Farmers often face high initial investment and delayed returns. In addition, lack of awareness and policy support limits large-scale adoption.

Small landholdings and limited access to carbon markets further restrict the participation of farmers in carbon farming initiatives.

### CONCLUSION

Carbon farming offers a practical and sustainable solution to address climate change while improving agricultural productivity. By enhancing soil carbon storage and reducing greenhouse gas emissions, it has the potential to transform agriculture into a carbon sink. However, its success depends on strong policy support, technological advancements, and increased awareness among farmers. With proper implementation, carbon farming can play a crucial role in achieving sustainable and climate-resilient agriculture.

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