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CARBON FARMING - THE HEALING LUNGS OF FUTURE AGRICULTURE: A REVIEW

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ABSTRACT

Carbon farming is an innovative agricultural practice with the principal aim of removing excess carbon from the atmosphere and using it as an input agricultural practice. Soil carbon sequestration in agricultural lands through soil amendments and management strategies regarded as a relatively well-tested and cost-effective method of removing CO_2 from the atmosphere. Carbon farming has beneficial effects on soil health, biomass production, and crop productivity in a sustainable manner. Carbon dioxide from the atmosphere is used by plants to prepare their food. They also convert the gas to a stable, solid form of carbon, which they store in the soil via direct or indirect fixation. Unlike carbon farming practices, which emphasize keeping carbon in the ground for long periods of time, several conventional agriculture practices, such as unscientific ploughing and tractors, tilling, overgrazing and so on, result in the release of carbon into the atmosphere rather than capturing it. Carbon benefits from conservation and/or land management practices need to exceed carbon losses for carbon farming to be effective. Therefore, the purpose of this review was to clarify carbon farming, the need for carbon farming in the present agricultural scenario and the pros and cons associated with soil carbon sequestration.

KEY WORDS: Organic carbon, Carbon farming, Soil and environmental health, sustainable agriculture.

INTRODUCTION

Novel farming systems and soil management approaches are being developed to deal with the excess of CO_2 in the atmosphere while also enhancing water usage efficiency and soil quality. Different management approaches have an impact on the amount of organic matter in the soil, its composition and its ability to retain water. However, satisfying growing demands while also safeguarding environmental resources is critical to effective planning strategies. Soil quality study seeks to comprehend soil management in order to capitalize on its natural qualities. As a result, it is required to know the elements influencing soil health, of which organic matter is crucial. Organic matter is prevalent in most agricultural contexts and is easily modified by land management operations. Organic matter improves agricultural output by increasing water retention capacity and strengthening soil structure as well as reducing drought and disease occurrences. Furthermore, agricultural operations that deposit organic matter into the soil are required to decrease CO_2 emissions in the environment. It has also been established that soil management practices are critical for conserving and rebuilding soil carbon. Many farming fields, but not all, have significant carbon deficits due to soil loss and breakdown (Sharma *et al.*, 2021). It is well acknowledged that various governments use

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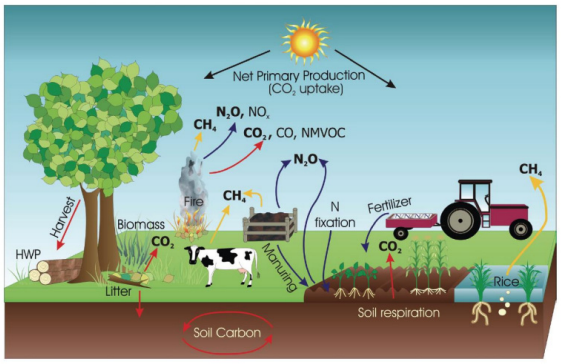
potential measures to incentivize environmentally sustainable farming methods in order to conserve soil carbon. Therefore, carbon farming is a conceivable way to reduce the carbon index in the atmosphere. In turn, it can boost crop output and assist farmers in maintaining soil quality in low-input environments.

NEED FOR CARBON FARMING

One of the structural elements needed for plant growth and development is carbon. By limiting the emission of greenhouse gases into the atmosphere, carbon farming or carbon sequestration is a collection of farming techniques that aid in the storage of carbon in the soil and in crop biomass. It is a complex and emerging economic practice. Implementing these practices that are known to increase the rate at which CO_2 is taken from the atmosphere and transformed into plant material or soil organic matter is known as carbon farming. Significant carbon sequestration can assist in restoring a livable climate to the planet (Becker and Lawrence, 2014). Many natural and artificial processes are involved in removing the carbon from the earth's atmosphere and storing them either in soil or liquid form for decades or centuries. Agronomists' solution to combat climate change is "carbon farming", which satisfies both human needs and the idea of sustainable agriculture, when carbon gains from better land management and/or conservation practices overcome carbon losses, carbon farming is effective (IPCC, 2007). The term "carbon farming" refers to a group of environmentally beneficial practices that have the potential to promote soil carbon storage. Increasing the C sink in the soil will aid in reducing the environmental emissions of CO_2, CH_4, and N_2O (Das *et al.*, 2015). According to studies, using compost in place of chemical fertilizers and turning manure and other organic wastes into high-quality compost prevents methane from being released into the atmosphere and aids in the restoration of carbon in cropland and grassland soils. It also enhances soil properties such as water-holdingcapacity, soil porosity and water use efficiency etc. (Scotti *et al.*, 2015). Organic matter is created from fossil fuels and dead plant biomass, which also stores a significant quantity of carbon in the soil. Although mitigation techniques have been determined to be technically possible, they must be widely adopted and require government efforts (policy and incentives). Additionally, it would assist India in achieving its goals for food security while lowering overall greenhouse gas emissions (Kumari *et al.*, 2020). Carbon farming has the potential to mitigate the effects of climate change and reduce the misery created by CO_2 emissions in the coming days.

Carbon Sequestration Practices

1. Rather than burning the leftover biomass after harvest, use it as organic soil cover.
2. Replacing conventional tillage with conservation tillagesuch as reduced/no-tillage (Blanco *et al.*, 2008).
3. Cultivating cover crops throughout the off-season rather than leaving croplands fallow or without any crops.
4. Replacing monocultures with diverse crop rotations and integrated agricultural techniques including Hi-Tech agricultural practices (Pretty *et al.*, 2015).
5. Replacing extensive chemical fertilizer application with integrated nutrient management and precision farming.
6. Integrating trees into agriculture through cropland agroforestry.

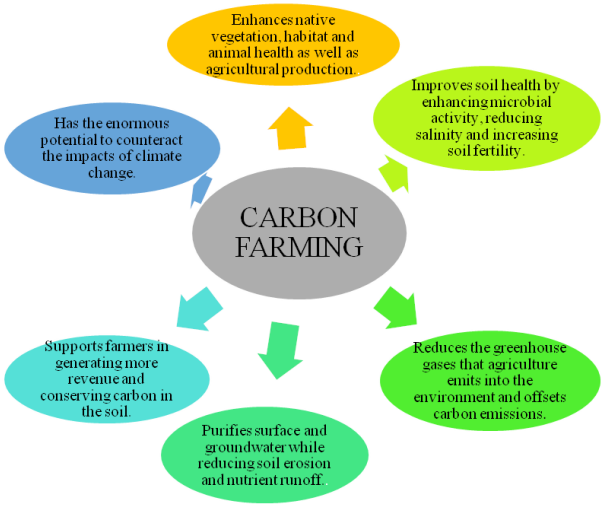


Source: IPCC, 2006.

Source: Photograph Courtesy of Allie Rowe and Land smart

7. Reintroduce livestock into agricultural cultivation to improve nutrient cycling.
8. Protecting carbon-rich soils, which serve as natural carbon sinks.
9. Using compost to restore soil fertility and increase grassland carbon storage and crop productivity.
10. Conversion of degraded and marginal areas to forests, as well as perennial land use, can increase the organic carbon pool in the soil (Nath *et al.*, 2015).

BENEFITS OF CARBON FARMING

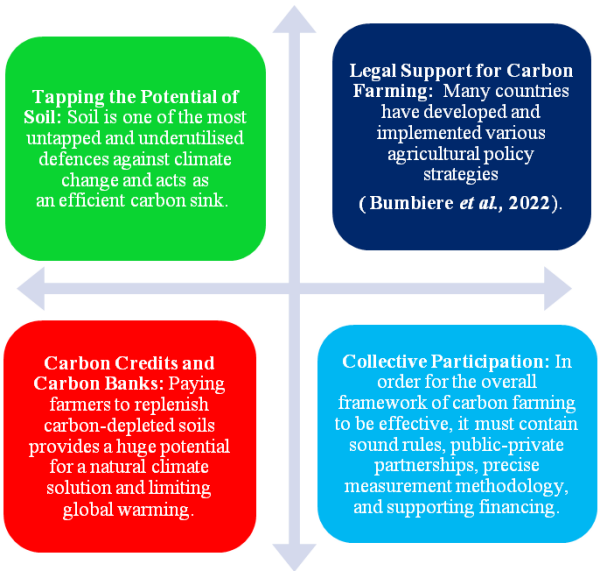


Challenges Associated with Carbon Farming

Due to a lack of proper knowledge, farmers are typically hesitant to engage in such programs, owing to the complexity of scheme design and execution of farming objectives (Salas *et al.*, 2017). The adoption of new methods frequently results in financial losses for farmers during the early years of transition. So, farmers are hesitant to embrace the risk (Tang *et al.*, 2016). Carbon farming could make riparian forest restoration more cost-effective and fire-prone areas may enhance the danger of conflagration because of carbon burdens on vegetation and soil (Kumari *et al.*, 2020). The key limitation is that no exact technology exists to handle it even after soil carbon content has increased over time, it can be readily reversed and it can be released into the atmosphere when farming operations are discontinued.

Strategies to Implement Carbon Farming

The development of irrigation facilities, the provision of incentives for water conservation, the mitigation of carbon emissions, subsidies and other incentives for the installation of resource-conserving infrastructure, skill development training, public awareness campaigns, the creation of low-cost, environmentally friendly herbicides, accurate weather forecasting, the development of post-harvest facilities, and the advancement of technologies for In order to solve the issue of small farm size, cooperatives, self-help groups (SHGs), joint government initiatives, or even major private corporations could be formed (Pathak and Aggarwal, 2012). The adoption of low-carbon technological solutions by other farmers might surely be influenced by the establishment of carbon credits and the investigation of local carbon markets.



CONCLUSION

In view of growing human requirements and their effects on the environment, sustainable agricultural production methods are being promoted. The susceptibility of agricultural output to climate change can be stabilized by employing less intensive and intelligently organized farming systems. It is crucial to thoroughly assess the agro-environmental characteristics in order to identify farming practices that can manage the delicate balance between climatic change and agricultural production.

An all-encompassing and environmentally friendly method of managing land usage that benefits society and the environment is carbon farming. The combination of crop cultivation, livestock raising, and forest vegetation, known as

agroforestry, boosts net agricultural production and food security. In addition, it is recognized for having lower greenhouse gas (GHG) emissions and carbon absorption, which mostly depend on the climate, soil characteristics, vegetation, and land-use patterns. To reduce carbon sequestration and greenhouse gas emissions, the silvopastoral system outperforms the agroforestry system. Furthermore, carbon farming methods can accumulate more soil organic carbon (SOC) than mono-cropping, which improves soil quality. These methods are particularly successful in preserving soil organic carbon stocks. Carbon farming is undervalued by farmers for a variety of reasons, despite the fact that it has several advantages. In order to persuade farmers to use CFI for agricultural production and soil management and to minimize unsustainable agricultural methods, knowledgeable advisory services are required.

The agricultural output's reliance on climate change can be reduced by adopting less-intensive and more well-planned farming methods. Agro-environmental characteristics must be thoroughly considered in order to develop farming systems capable of controlling the delicate balance between climatic change and agricultural production. In this context, carbon farming provides an all-encompassing and sustainable land-use management strategy that benefits both the environment and society.

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