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Carbon Farming: Improving Soil Health While Earning Carbon Credits

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INTRODUCTION

Carbon farming is a climate-smart agriculture that emphasizes on altering farm management practices to enhance the sequestration of carbon in soil and biomass and to minimize greenhouse-gas emissions when feasible. Plants sequester atmospheric carbon dioxide (CO_2) via photosynthesis into biomass. Some of this carbon is deposited in the soil via roots, root exudates and crop residues, and some portion may be converted into soil organic matter. By adopting appropriate soil, water, crop, nutrient and pest management to cover cropping, residue retention, reduced tillage, crop rotation, agroforestry, and improved nutrient and water management, farmers can increase carbon inputs to the soil and enhance the soil.

Soil organic carbon (SOC) is a core constituent of soil organic matter (SOM) and has a strong influence on soil quality. It promotes soil aggregation, water holding, nutrient cycling, and microbial metabolism. Enhancing soil carbon can also bring returns beyond climate mitigation. Good soil can increase the productivity of crops, slow down erosion, increase water-use efficiency, and promote resilience to drought and other weather-related stresses. Carbon farming thus provides an opportunity to link soil-health improvement, climate action and potentially additional farm income.

2. What is Carbon Farming?

Carbon farming includes those agricultural methods that increase the storage of carbon in soils and plants, or decrease emission of greenhouse gases from farming operations. The basic principle is simple: increase carbon entering the farm ecosystem, improve its retention and minimize avoidable carbon losses. Crops and trees take in CO_2 from the air as they photosynthesize. Carbon is then stored in the leaves, stems, and roots, as well as in the soil organic matter. Farmers can sequester more carbon in Soils and Biomass by retaining crop residues, planting cover crops, enhancing root biomass, adding appropriate organic amendments, or implementing agroforestry practices. Simultaneously, nutrient input, water management, and soil disturbance can be optimized to mitigate losses of these resources and, where appropriate, greenhouse-gas emissions.

Soil test should be done before the planting time to assess soil pH, organic carbon, nutrients, electrical conductivity and other properties of the soil. Based on soil test result, appropriate organic materials and nutrients management practices can be planned. Organic matter is very important in maintaining soil fertility and increasing the water holding capacity of the soil.

3. Major Carbon Farming Practices

Conservation and Reduced Tillage

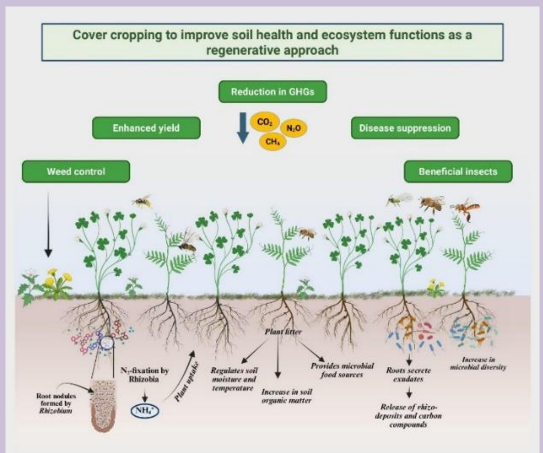
Reduced tillage minimizes unnecessary soil disturbance and can help protect soil aggregates and organic matter. When combined with residue retention and suitable crop rotations, conservation tillage can contribute to improved soil structure, reduced erosion and better soil-water management.

Crop Residue Management: - Crop residues are a source of valuable carbon and nutrients. Conservation of residues or their application as mulch allows for the return of organic matter to the soil and protects the soil surface. Prevention of open burning also avoids release of carbon and other air pollutants in large amounts.

Organic Amendments: - Compost, farmyard manure and other appropriate organic materials add carbon to soil and enhance microbial activity. They should be applied according to quality, nutrient content, crop needs and soil conditions.

Crop Rotation and Diversification: - Crop rotations and diversified cropping systems have different types of roots and residues which can enhance nutrient cycling and biological activity. They may also play a role in better pest control and greater resilience of the production system.

Cover Cropping: - Cover crops are planted to serve as a protective cover and supply extra biomass when the cash crop is not in the field. Roots of these plants contribute carbon below the soil level while above ground biomass shields the soil from erosion and raindrop impact. Leguminous cover crops can also add nitrogen via biological nitrogen fixation.



Agroforestry: - Combining trees with crops or animals can enhance carbon sequestration in tree biomass, roots and soils. Agroforestry systems can also supply fruits, fodder, fuelwood, timber, shade and various other products, delivering extra profits for farmers.

Efficient Nutrient and Water Management

Fertilizer applications based on crop demand and soil-test results have the potential to enhance nutrient use efficiency and minimize unintended nutrient losses. Proper irrigation scheduling and management practices can save water and produce better crops.

4. Benefits of Carbon Farming

4.1 Improves Soil Health

Increasing soil organic carbon content positively influences soil aggregation, structure, porosity, and biological activity. Organic carbon serves as a source of energy and substrate for soil organisms involved in decomposition and nutrient cycling.

4.2 Improves Water-Holding Capacity

The structure and organic matter content of the soil can affect rates of infiltration and water holding capacity. This could enable crops to make better use of rain or irrigation water on hand, and possibly increase resilience in times of water strain.

4.3 Enhances Nutrient Cycling

Organic matter supports microbial processes involved in nutrient transformation and cycling. Improved nutrient availability and retention can contribute to better nutrient-use efficiency when combined with balanced fertilization.

4.4 Reduces Soil Erosion

Cover crops, crop residues, mulching and agroforestry can protect the soil surface from wind and water erosion. Maintaining soil cover also reduces the direct impact of intense rainfall on exposed soil.

4.5 Supports Biodiversity: -Carbon-rich soils can provide a better habitat and food source for microorganisms and soil fauna. Diversified cropping and agroforestry can further increase biological diversity within agricultural landscapes.

4.6 Improves Climate Resilience: - Healthy soils can help crops withstand environmental stresses by improving water availability, root development and soil biological activity. Carbon farming can therefore contribute to both climate-change mitigation and adaptation.

4.7 Potential Additional Farm Income: - Where farmers participate in eligible and properly designed carbon projects, verified greenhouse-gas reductions or removals may generate carbon credits. These credits can potentially provide an additional income stream alongside crop and livestock production.

5. Carbon Credits: How Do They Work?

A carbon credit is a quantified and verified unit of climate benefit under a specific carbon standard or programme. In farming projects, the advantage may come from either boosted carbon sequestration or diminished greenhouse-gas emissions. But that doesn't mean a farmer doing a sustainable farming method will receive carbon credits. It usually starts with definition of a baseline representing what would have happened in absence of the project. According to the plan, farmers use approved methods and monitor the changes in carbon storage or greenhouse gas emissions as the result. Typically, measurements entail soil sampling, laboratory testing, farm records, remote sensing, modelling, and other approved methods. The climate benefit is then estimated, and may be subjected to independent verification. If the project fulfils the criteria of the relevant programme or standard, carbon credits can be generated. They can then be sold for potential profit to buyers in the relevant carbon market.

6. Soil Carbon Measurement and Monitoring

Robust quantification is the cornerstone of credible carbon farming. Soil carbon is known to vary naturally with depth, and by soil texture, land management history, climate, and location of sampling. Thus, when evaluating change over time, it is critical that the soil sampling be representative and the monitoring be consistent. Soil testing, field records, remote sensing, crop growth information and modelling may need to be combined in carbon projects in accordance with the methodology specified. Farmers can also help by keeping track of the crops they plant, tillage practices, how they manage their residue, what fertilizers they apply, if they irrigate, whether they add organic matter and any other changes in management. Routine monitoring also offers agronomic insights. Even if a farmer is not part of a carbon credit program, observing soil organic carbon, soil fertility, crop yield and input use can provide guidance on whether management changes are resulting in benefits for the farm.

7. Carbon Farming in India:-The varied agricultural systems of India offer a huge potential for carbon-smart agriculture. Residue management, conservation agriculture, integrated nutrient management, agroforestry, diversified cropping, efficient irrigation and judicious use of organic amendments can improve soil health and climate up-resiliency. However, smallholder farmers might have challenges accessing carbon markets on their own because soil testing, monitoring, and verification can be costly in relation to the carbon revenues an individual farm generates. Farmer Producer Organizations (FPOs), cooperatives, and aggregated carbon projects may be able to address some of these challenges as they pool multiple farmers together within a common monitoring and management system. Agricultural universities, ICAR institutes, Krishi Vigyan Kendras and state department of agriculture can also help farmers through demonstrations, soil testing, training and location specific recommendations. Carbon farming should be encouraged as part of overall soil-health management and climate-smart agriculture not as an isolated carbon-credit activity.

8. Challenges and Considerations: - While carbon farming has a lot of promise, there are a few challenges that must be addressed. Soil-carbon dynamics are challenging to measure accurately, and measurements are often costly, due to spatial heterogeneity and the slow pace of change. It also adds up initial cost's farmers may incur as they bring in new practices, buy equipment, plant cover crops or change existing management plans. Carbon-credit projects may be subject to monitoring, reporting and verification requirements, contractual obligations and transaction costs. Carbon prices fluctuate, and not all sustainable activities produce the same quantity of credits. There is also the need to ensure that the carbon claims are underpinned by scientifically robust methodologies and that the farmers get a fair share of the benefits.

9. Role of Farmers in Carbon Farming: - Farmers are the pivotal agents of change for carbon farming, as they are the ones who directly influence how carbon flows in agriculture systems. Farmers can start with testing their soil to get an understanding of its current health. Suitable practices can then be chosen from residue retention, cover crops, crop rotation, minimum tillage, organic amendments, agroforestry and efficient nutrient and water management. Keeping farm records is just as important. The records of cropping history, fertilization, irrigation, residue management, and soil-test results may be useful supporting documentation in conservation of farm performance and, where potential exists, in supporting carbon credit projects. The best carbon-farming practice will be one that enhances soil health, sustains or increases productivity, lowers unnecessary resource use, and delivers financial profit for the farmer.

CONCLUSION

Carbon farming is a way to link healthy soil and productive farming with climate solutions. Increasing organic carbon inputs, protecting the soil, diversifying crop sequences, retaining residues, integrating trees and implementing better nutrient and water management allows farmers to enhance soil structure, water holding capacity, nutrient cycling, and activity of the biota while mitigating greenhouse gases. Carbon credits could at best bring in some additional economic incentive to practice, but that should not be counted on as income. Generation of credible carbon credits requires appropriate methodologies, measurement, monitoring, reporting and verification. In the case of farmers, transparency agreements and fair distributions of the revenues are more important. So, the long-term aim for carbon farming should be more than just earning carbon credits. It ought to be about building healthy, productive, climate-resilient farms, too. When farmers build soil, they are investing not only in this year's crop but in the productivity and sustainability of future generations.