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Soil Carbon Credit Bank and Its Benefits for Indian Farmers

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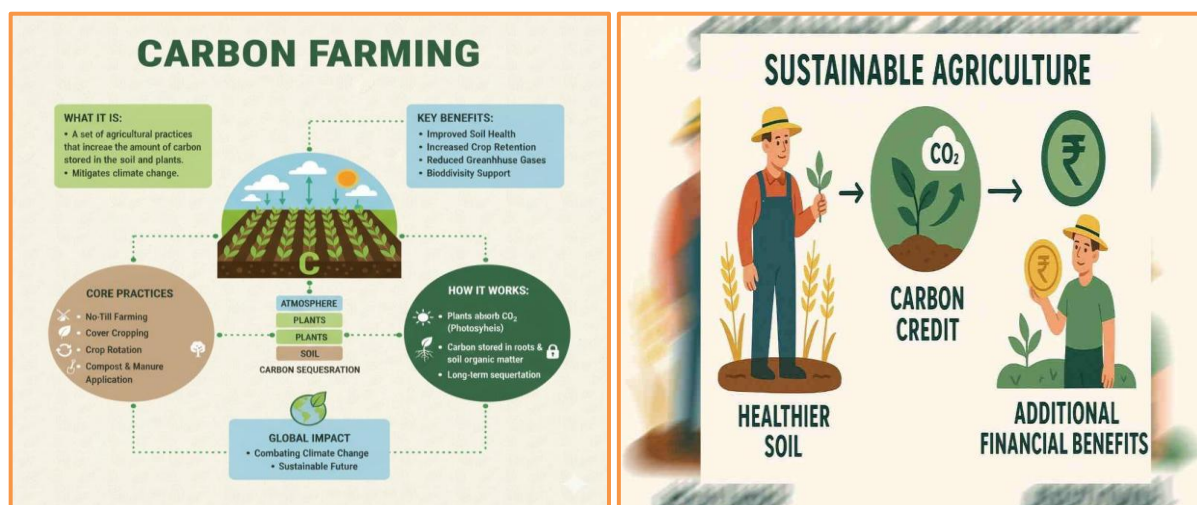
Soil is not only essential for agriculture but also an important carbon storage area. Some farming practices such as continuous tillage, excessive tillage of soil layers, burning of crops and use of fertilizer affect soil organic carbon levels and soil condition adversely. However, there is also a range of agricultural practices such as no-tillage, returning the residues of plants to the soil, use of green manure and cover crops, agroforestry, addition of compost and crop rotation that can improve soil organic matter content and allow for carbon sequestration. Emergence of the new carbon market provides an opportunity for the farmers to get paid for their ecological services. A Soil Carbon Credit Bank functions as a producer-focused framework for documenting, collecting, validating, and potentially trading quantifiable gains in soil carbon along with related decreases in greenhouse gases. This model is especially significant for small-scale and marginal growers, as single plots typically produce limited credit volumes. By grouping these holdings through Farmer Producer Organisations (FPOs), cooperatives, or similar agricultural groups, the expenses related to monitoring and transactions can be lowered. India has established a structure to encourage the Voluntary Carbon Market within the farming sector. The upcoming challenges will include reliable measurement of quantities, fair sharing of output, educating farmers, and durability of soil carbon captured.

Keywords: Soil Carbon, Fertilizers, Carbon Credit, Carbon Farming, Soil Health, Indian Farmers, Voluntary Carbon Market, FPO, Regenerative Agriculture

Introduction

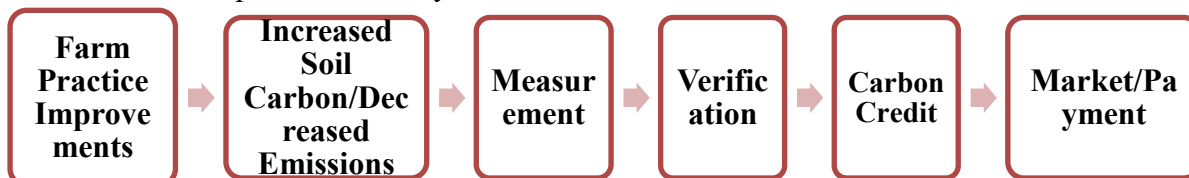
The global cycle of carbon is importantly dependent on farming activities. The soils of earth are considered an important pool of organic carbon stock and changes in organic matter content can have implications for soil quality, soil's capacity to retain water, microorganisms and polluting emissions. The Indian Council of Agriculture Research (ICAR) points out that the implementation of soil organic carbon increase is a vital step in carbon farming as soil often loses the above-mentioned parameter due to land cultivation and lack of management. Carbon farming includes the application of environmentally friendly climate-smart practices in the agricultural sphere. These scientifically proven practices can either sequester carbon or reduce the emissions of the greenhouse gases, providing a financial benefit to farmers. In January 2024, the structure of the Voluntary Carbon Market was formed by the Ministry of Agriculture & Farmers Welfare of India which aims to promote the involvement of small farmers into carbon transactions.

Therefore, the **Soil Carbon Credit Bank** model can serve as an organized method for connecting individual farmers, tracking soil carbon data and providing access to carbon credit markets.



What is a Soil Carbon Credit Bank?

A Soil Carbon Credit Bank is a proposed or institutional mechanism through which information about soil-carbon improvements generated by participating farms can be systematically recorded, aggregated and managed. It should not be confused with a conventional bank. A system that would track verified data regarding carbon-related practices of individual farms instead of tracking the amount of money earned by those farms. Farmers could participate in this system through Farmers Producer Organizations (FPOs), Cooperatives, Government Supported Programs, or Carbon Project Development Companies. The fundamental process of the system is shown below:



One small farm will typically produce very few credits. When aggregated with hundreds or thousands of other farms, however, the ability to measure, report, verify and engage in a market becomes much more efficient.

Why Soil Carbon Matters?

The amount of organic carbon in a soil directly affects its overall quality. An increased concentration of organic material in the soil will promote aggregate formation, increase microbial activity, improve nutrient cycling within the system and ultimately result in improved water retention. In addition, the use of carbon farming methods for increasing the amount of organic carbon present in the soil does not only help to address the issue of climate change; it can also lead to an improvement in the productivity and sustainability of a farmer's agricultural system.

Table 1. Agricultural Practices and Their Contributions

Farm Practices	Potential Carbon/Soil Benefit	Other Benefits to the Farm
Conservation/minimum tillage	Reduces soil disruption	Reduces energy and labour costs
Crop residue recycling	Returns carbon to soil	Enhances nutrient cycling
Green manuring	Adds organic biomass to soil	Improves nutrient cycling
Cover crops	Safeguards and adds organic biomass to soil	Enhances nutrient cycling

Farm Practices	Potential Carbon/Soil Benefit	Other Benefits to the Farm
Compost/FYM	Provides organic carbon to the soil	Improves structure of the soil
Agroforestry	Uses biomass for carbon storage	Generates new outputs for the farm
Crop diversity	Stimulates microbial life	Minimizes production risks
Avoiding burning of plant residues	Lowers direct emissions from farming	Improves nutrient conservation
Improved nutrient management	Might help to cut excess emissions	Consumer & stakeholder engagement

ICAR has been developing programs throughout Bihar that include practices such as residue recycling, green manuring, conservation agriculture, balanced fertilizer application, and other soil health practices as part of climate resilient agriculture.

How a Soil Carbon Credit Bank Works

A farmer-centered carbon program can have multiple steps.

Step 1: Farmer Registration

Farmers can register individually or through an FPO/cooperative. At registration, basic information about each farm, including location, previous crops grown and current management techniques will be recorded.

Step 2: Establishment of Baseline

Before calculating how much additional carbon will be produced by adopting improved practices, it is necessary to record the existing soil conditions and current management methods. Information that supports the development of a baseline includes soil samples analyzed in a laboratory, field records and satellite imagery.

Step 3: Adoption of Improved Practices

Once the baseline is set up, farmers will move towards the adoption of improved practices such as reduced tillage, incorporation of residues, green manuring, cover cropping, or diversification of rotations.

Step 4: Monitoring

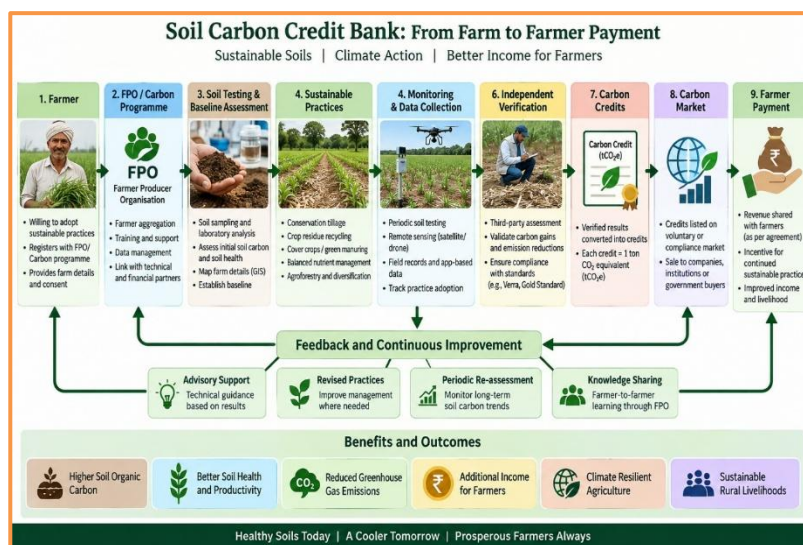
Soil carbon and emissions will be monitored over time. Monitoring should be done according to accepted scientific protocols.

Step 5: Verification

Unique verification is needed to confirm the validity, quantification, and attribution of the carbon benefits reported.

Step 6: Generation of Credit and Payment

After successful verification, eligible carbon benefits may be transformed into credits using the relevant carbon market methodology. The revenue generated by selling credits can then be distributed according to transparent agreements.

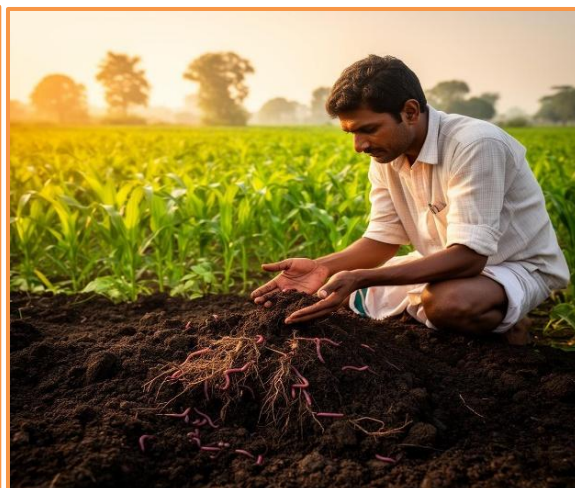


Proposed Conceptual Diagram

Benefits for Indian Farmers

Potential for Additional Income

The most obvious benefit for Indian farmers participating in a soil carbon credit bank is the potential for additional income from verified carbon benefits. However, carbon income should be considered supplemental income rather than replacement for agricultural income. India's agricultural carbon market is slowly moving toward implementing farmer-level carbon crediting. In September 2026, the Government announced that more than 2,500 farmers in Punjab and Haryana were scheduled to receive more than INR 2.9 crore as part of the first reported soil-carbon payments under a regenerative farming program.



Enhancement of Soil Health

Practices that increase soil carbon can enhance organic matter and improve various physical, chemical and biological aspects of soil.

Lowering Production Expenses

Agriculturalists can decrease expenditures on fuel, watering, and various supplies by adopting numerous carbon-neutral techniques.

Increased Climate Resilience

Soils that are rich in organic matter are more effective in optimally retaining water than soils low in organic matter. Organic matter increases the soil's capability of supporting healthy plants even in varying environmental conditions, making it significant for both irrigation and rain-fed systems.

Collective Benefits through FPOs

Small farmers often struggle to meet the technical and financial requirements of carbon projects individually. Collective participation through FPOs can assist small farmers with soil sampling, record keeping, training, verification and marketing.

Table 2. Possible Benefits of a Soil Carbon Credit Bank

Benefit	Possible impact on farmers
Carbon income	Additional source of revenue
Better soil organic matter	Improved soil quality
Residue management	Less burning and nutrient loss
Conservation tillage	Lower field-operation costs
Green manuring	Improved soil fertility
FPO participation	Collective bargaining and lower transaction costs

Role of FPOs in Soil Carbon Banking

FPOs can serve as an important link between individual farmers and carbon markets. FPOs can aggregate farms, keep records and coordinate technical assistance. For example, an FPO with 1,000 farmers can create a shared carbon program. Instead of each farmer organizing soil sampling, training and verification separately, the FPO can do so collectively. The use of

FPOs can also increase transparency because all farmers involved in the program can collectively monitor the terms of carbon projects and payment arrangements. Recently, ICAR has emphasized the role of FPOs, researchers and progressive farmers in promoting soil health, climate resilient agriculture and sustainable farming systems.

Challenges and Limitations

Although there are many potential benefits associated with soil carbon banking, there are also many scientific and institutional challenges.

Measurement: The level of carbon in a soil can vary depending upon its composition (i.e., whether it is sandy, clayey or loamy), how deep it goes into the ground, what kind of climate exists there and what type of farming practices were used.

Permanence: Once carbon is stored in soil it can be lost if management techniques are changed. Therefore, long-term monitoring is crucial.

Additionality: A carbon project must show that any additional carbon benefits are due to interventions made by participants in the project and not due to existing conditions.

Costs of Transactions: The expenses of performing soil sample testing, managing data, conducting audits, and finalizing results can cost small enterprises excessive amounts of money.

Awareness of Farming: A significant portion of farmers is unaware of the operation of carbon markets and contracts.

Market Uncertainty: One of the characteristics of carbon credits is their price uncertainty; because of this the amount of money that farmers will earn will be affected by the project specification, verification expenses, and revenue-sharing arrangements.

Table 3: Major Challenges and Possible Approaches

Challenge	Possible approach
High monitoring cost	Farmer aggregation through FPOs
Difficult soil-carbon measurement	Standardised sampling and laboratory protocols
Lack of Awareness among farmers	Providing more training and Extension Programmes
Unclear contracts	Simple and transparent farmer agreements
Carbon permanence	Long-term monitoring
Market-price uncertainty	Transparent revenue-sharing mechanisms
Data management	Digital farm and soil-carbon records

Opportunities for Bihar and Other Smallholder Regions

Soil Carbon Credit Banks may be particularly relevant to regions characterized by numerous small and fragmented landholdings. For example, Bihar has a large number of smallholder farmers and extensive acreage devoted to rice-based and diversified cropping systems. Practices such as residue management, green manuring, crop diversification, conservation agriculture, composting and agroforestry could be incorporated into carbon farming programs based on local circumstances. Recently, ICAR-MGIFRI in Motihari conducted programs across East Champaran District, West Champaran District and other districts promoting soil health management practices such as green manuring, residue recycling, conservation agriculture and climate resilient farming. These programs could form a basis for future farmer-centered carbon initiatives.

Future Outlook

The future of soil carbon banking will depend on combining soil science with digital agriculture technologies such as remote sensing and laboratory analysis along with carbon market structures. A digital Soil Carbon Credit Bank could record individual farm-level data regarding soil carbon levels, past crops grown, current management techniques and verified carbon outputs. A digital database could provide greater transparency and avoid duplication of data collection efforts. Scientific credibility must continue to serve as the guiding principle. Farmers should not be encouraged to implement practices solely because they are marketed as "carbon-positive." Carbon benefits must be verified independently when credits

are claimed. Recent national workshops and farmer programs conducted by ICAR indicate increasing interest among institutions in agricultural voluntary carbon markets and scientifically sound, farmer-centered carbon projects.

Conclusion

A Soil Carbon Credit Bank can create a link between healthy soils, climate change mitigation efforts and farmer income. By aggregating farmers and maintaining credible records of increases in soil carbon levels, a Soil Carbon Credit Bank can facilitate access for smallholders to participate in carbon markets. However, its ultimate success will depend on transparent contracts, reliable measurements of soil carbon levels, independent verification of claimed increases in soil carbon levels, fair distribution of revenues generated by selling carbon credits and long-term technical assistance. Carbon credits should supplement — not replace — good agricultural practices and profitable crop production. The highest possibility for Indian agriculture is in building up a system where improving soil health is environmental investment as well as an opportunity for farmers to earn. If there is an effective collaboration among farmer organizations, research institutions, government agencies, and stakeholders in carbon markets, then soil carbon programs could prove to be important means of developing climate-resilient, sustainable agriculture.

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