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Carbon Farming: Turning Climate-Smart Agriculture into a New Opportunity for Indian Farmers

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INTRODUCTION

India's farmers achieved one of the great transformations of modern history. From a nation once confronted with food shortages, India has emerged as one of the world's major agricultural producers. The next transformation, however, cannot be measured by tonnes of grain alone. It must answer a more difficult question: can we produce enough food, improve farm incomes and simultaneously use less water, waste fewer nutrients, restore soils and reduce agriculture's climate footprint?

Agriculture occupies a distinctive place in the climate equation. Farming can release greenhouse gases, yet well-managed soils, trees and biomass can also store carbon. This dual role creates an opportunity: practices that improve resource-use efficiency can strengthen farm resilience and, where they satisfy an approved carbon-market methodology and are properly measured and verified, may also create tradable environmental value.

PROBLEM AT A GLANCE | WHERE DOES A FARM'S CLIMATE FOOTPRINT COME FROM?

Paddy fields — prolonged flooding can favour methane formation.
Livestock — digestion and poorly managed manure release methane.
Nitrogen fertilizers — inefficient nitrogen use can increase nitrous oxide losses.
Crop residues — burning wastes biomass, nutrients and contributes to air pollution.
Depleted soils — declining organic matter weakens soil health and carbon storage.
Farm energy — diesel, pumping and other fossil-energy uses add emissions.

"The same farm can emit carbon, conserve carbon and store carbon. The difference lies in how we manage it."

Decarbonisation Does Not Mean Producing Less

For farmers, decarbonisation should not mean sacrificing productivity. It means producing more intelligently from every drop of water, every kilogram of nutrient, every unit of energy and every tonne of biomass. Saving irrigation water reduces pumping needs. Matching nitrogen supply to crop demand improves nutrient-use efficiency. Recycling residues keeps valuable biological material within the farm economy. Scientific manure management can turn a pollution liability into energy and organic manure.

"Produce efficiently—not less. The climate-smart farm converts resource efficiency into resilience."

Eight Technological Shifts for the Farm of Tomorrow

MOVE AWAY FROM	MOVE TOWARDS	FARM BENEFIT
Unnecessary continuous flooding	Scientific irrigation/AWD where suitable	Water saving; lower methane potential
Blanket fertilizer application	Soil-test and precision nutrient management	Better nutrient-use efficiency
Crop-residue burning	Mulching, incorporation, composting, bioenergy	Waste becomes a resource
Unmanaged livestock manure	Biogas and scientific manure management	Energy plus organic manure
Declining soil organic matter	Residue recycling, compost, legumes, cover crops	Improved soil health and carbon
Resource-intensive monocropping	Appropriate crop diversification	Greater resilience
Low perennial/tree component	Suitable agroforestry and orchard systems	Biomass and carbon storage
Waste-disposal mindset	Circular bioeconomy	Additional products and value

Rice: A Change in Water Management Can Change the Emission Profile

Continuously flooded paddy soils become oxygen-deficient, creating conditions favourable for methane-producing microorganisms. Alternate Wetting and Drying (AWD) periodically allows the water level to decline before re-irrigation. When properly adapted to local soils, climate and crop management, AWD can save irrigation water and reduce methane emissions without necessarily sacrificing yield.

A crucial distinction must be maintained: an environmentally beneficial practice does not automatically generate a carbon credit. To become creditable, an emission reduction must meet the rules of an applicable methodology, including baseline setting, additionality, monitoring, reporting and verification.

"A carbon credit should be the bonus—not the only reason—for adopting climate-smart farming."

From Waste to Wealth—and Carbon Savings

Straw, stalks, livestock dung, orchard prunings and processing residues are often treated as wastes. In a circular farm economy they are reservoirs of carbon, nutrients and energy. Paddy straw can be incorporated, mulched or channelled to suitable bioenergy and industrial uses. Dung can produce biogas and nutrient-rich digestate. Orchard residues can become compost, mulch, energy feedstock or other useful products.

"There is no agricultural 'waste' until we waste it."

THE FARM CARBON PANCHSUTRA

- जलबचाओ — SAVE WATER: Irrigate scientifically and avoid unnecessary flooding.

- मिट्टीमेंकार्बनबढ़ाओ — BUILD SOIL CARBON: Recycle biomass, use organic amendments judiciously, integrate legumes and protect soil biological activity.
- पोषकतत्वबचाओ — USE NUTRIENTS PRECISELY: Right source, right dose, right time and right place.
- अवशेषमतजलाओ — TURN RESIDUES INTO RESOURCES: Mulch, compost, incorporate or productively utilize biomass.
- कार्बनकोमापो — MEASURE BEFORE YOU MONETISE: Keep records, establish credible baselines and participate through scientifically verified programmes.

Ancient Ethos, Modern Science

Indian cultural thought has long emphasized interconnectedness among earth, water, air, energy, living organisms and human society. Modern agricultural science uses terms such as circular economy, resource-use efficiency, ecosystem services, carbon sequestration and sustainability. The terminology is new; the ethic of using natural resources responsibly and maintaining ecological balance has deep cultural resonance.

This connection should be understood as philosophical rather than as a claim that ancient texts described modern carbon markets. The useful bridge is the ethic: take responsibly from nature, minimize waste, regenerate productive resources and safeguard them for succeeding generations.

"Carbon farming can become a meeting point between modern science and India's enduring ethos of living responsibly with nature."

And Now Comes the Carbon Market

India's Carbon Credit Trading Scheme (CCTS), developed under the Energy Conservation framework, provides an institutional architecture for the Indian Carbon Market through compliance and offset mechanisms. The framework is evolving as the Bureau of Energy Efficiency publishes procedures, methodologies and verification requirements. Farmers and project developers must therefore distinguish between a practice that is climate-smart and an activity that is currently eligible to generate credits under an approved methodology.

In general carbon accounting, one carbon credit represents one tonne of carbon-dioxide equivalent (CO_2e) reduced or removed, subject to the rules of the applicable programme.

HOW AN ELIGIBLE EMISSION REDUCTION CAN BECOME A CARBON CREDIT

- Adopt an eligible practice or project activity.
- Establish the baseline: what would have happened without the project?
- Monitor the emission reduction or carbon removal.
- Report data under the applicable methodology.
- Obtain independent validation/verification where required.
- Register and seek issuance under the applicable carbon-market system.
- Trade or transfer issued credits according to market rules.
- Distribute benefits according to the farmer/FPO/project agreement.

The Three-Income Logic of Carbon-Smart Farming

SAVE FIRST → VALUE SECOND → CREDIT THIRD

FIRST VALUE — SAVE: Reduce avoidable expenditure on water, energy and nutrients.

SECOND VALUE — UTILISE: Convert residues, dung and biomass into useful products, energy or soil amendments.

THIRD POTENTIAL VALUE — CARBON: Where eligibility, verification and issuance requirements are met, environmental performance may create additional carbon revenue.

Why FPOs Can Become a Gateway

India's small and fragmented holdings make individual carbon-project development expensive. Farmer Producer Organizations

(FPOs), cooperatives and credible aggregators can pool many farms into a common project, standardize records and spread monitoring and verification costs. Digital farm records, remote sensing and validated field-monitoring technologies may progressively make such aggregation more practical.

"One small farm may create a small carbon benefit. Thousands of farms acting together can create a carbon landscape."

BEFORE SIGNING A CARBON-FARMING AGREEMENT, ASK

- Which recognized methodology covers the proposed activity?
- Who legally owns the carbon credit?
- Who establishes and pays for the baseline, monitoring and verification?
- What is the agreement period and what obligations continuing over time?
- How will farm data be collected, stored and used?
- What share of gross and net carbon revenue reaches farmers?
- What happens if credits are not issued or prices decline?
- Can the farmer withdraw, and under what conditions?
- Who bears reversal, non-performance or verification risk?
- Is the revenue-sharing formula written clearly in the contract?

"Do not sell tomorrow's carbon without understanding today's contract."

Jammu & Kashmir: A Mountain Carbon Opportunity

Jammu & Kashmir offers a distinctive combination of orchards, forests, livestock, paddy systems, mountain pastures and horticultural biomass. These systems create opportunities for climate-smart management, although any claim for tradable carbon credits must be linked to an applicable methodology and verified project design.

J&K | FIVE PRACTICAL OPPORTUNITY AREAS

ORCHARDS — soil organic matter, cover vegetation, efficient nutrient use and pruning-biomass management.

PADDY — water-efficient rice production and methane-mitigation research.

LIVESTOCK — better feeding, manure management, biogas and nutrient recycling.

AGROFORESTRY & PASTURES — suitable perennial systems and scientific grazing/pasture management.

HORTICULTURAL BIOMASS — apple pomace and pruning residues for compost, energy and value-added utilization.

A Role for Agricultural Universities

Carbon farming cannot be built by carbon traders alone. It needs agronomists, soil scientists, agricultural economists, livestock specialists, engineers, remote-sensing experts, extension professionals and farmers. SKUAST-Jammu and similar institutions can contribute through locally validated technologies, long-term carbon and soil-health research, farmer education, FPO capacity building and development of cost-effective Monitoring, Reporting and Verification (MRV) approaches suited to local production environments.

A future cadre of trained village-level 'Carbon Entrepreneurs' could help connect science, farmers, FPOs, credible data and verified climate action.

WHAT CAN A FARMER START DOING TOMORROW?

- Test the soil before deciding fertilizer requirements.
- Irrigate according to crop need rather than habit.
- Avoid crop-residue burning wherever viable alternatives exist.
- Recycle biomass through suitable mulching, composting, incorporation or productive use.
- Integrate legumes and crop diversification where agronomically appropriate.
- Improve livestock feeding and manure management.
- Maintain or introduce suitable trees in compatible farming systems.
- Record irrigation, fertilizers, residues, yields and livestock-management practices.

- Explore collective participation through FPOs/cooperatives and scrutinize contracts.
- Verify eligibility and methodology before believing promises of carbon income.

THE FOUR-STEP RULE: REDUCE → RECORD → VERIFY → MONETISE

Carbon Literacy Must Come Before Carbon Trading

The greatest early-stage risk is unrealistic expectation. Every tree planted, kilogram of compost applied or irrigation saved does not automatically create a tradable carbon credit. Crediting depends on an applicable methodology, additionality, credible measurement, documentation, verification, permanence where relevant and safeguards against double counting. India therefore needs not only potential carbon-credit sellers, but carbon-literate farmers and institutions.

From Annadata to Carbon Steward

India's first great agricultural transformation answered the question: how do we produce enough food? The transformation before us must answer a more complex one: how do we produce enough food, improve farm incomes, conserve natural resources and leave a healthier environment for the next generation?

Carbon farming offers part of that answer, but carbon credits should not be mistaken for its only reward. A farmer who saves irrigation water, uses nitrogen more efficiently, rebuilds soil organic matter, converts crop and livestock residues into useful resources and creates a more resilient farming system is already producing economic and ecological value.

Where these improvements also create measurable, verifiable and eligible greenhouse-gas reductions or removals, carbon markets may provide an additional incentive. The farm of tomorrow can therefore produce more than grain, fruit, vegetables, milk and fibre: it can conserve water, regenerate soil, recycle nutrients and provide environmental services to society.

"The Indian farmer has always been our Annadata. The opportunity now is to empower the Annadata to become a Jal Rakshak, Mrida Sanrakshak and Carbon Steward as well."

PRODUCE • CONSERVE • REGENERATE • PROSPER

Further Reading & Authoritative Sources

- Bureau of Energy Efficiency (BEE), Government of India. Indian Carbon Market / Carbon Credit Trading Scheme: official framework, procedures and approved methodologies. https://beeindia.gov.in/
- Forest Survey of India. India State of Forest Report 2023. Ministry of Environment, Forest and Climate Change, Government of India.
- National Academy of Agricultural Sciences. Policy and technical literature on soil carbon, sustainable agriculture and carbon markets in Indian agriculture.
- Scientific literature on Alternate Wetting and Drying, agricultural methane mitigation, soil organic carbon, crop-residue management and circular bioeconomy should be cited in the magazine's preferred reference style after final source verification.

EDITORIAL / ORIGINALITY NOTE

This article draws upon over three decades of experience in agricultural research, extension and farming-systems approaches aimed at enhancing productivity, sustainability and farmers' income. It presents a forward-looking vision for Indian agriculture—empowering farmers to move beyond food production towards resource stewardship, value creation and agri-entrepreneurship. By integrating climate-smart technologies, carbon farming and innovation with India's agricultural ethos, the authors envision a resilient, profitable and environmentally responsible farming sector supported by a strong agri-startup ecosystem.