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Carbon Credits from Mulberry Plantations: Scientific Evidence, Carbon-Sequestration Potential and Opportunities for Sustainable Sericulture

*Sangeeta Dash[1], Gangubai S Managuli[2], Kenchappa N. M.[3] and S. Ranjith Kumar[1]
[1]CSB-Reginal Sericultural Research Station, Koraput, Odisha-764021
[2]CSB- Central Sericultural Research and Training Institute, Berhampore, Murshidabad, West Bengal-742101
[3]CSB- Central Tasar Silkworm Seed Station, Kargi Road, Kota, Chattisgarh-495113
*Corresponding Author's email: sangeetadash031@gmail.com

Mulberry (*Morus* spp.) plantations offer an opportunity to integrate sericulture with climate change mitigation through carbon sequestration in plant biomass and soil. This article explores the carbon-farming potential of mulberry cultivation, highlighting the influence of plantation management, ground cover, organic matter recycling and soil conservation on carbon storage. Published research from West Bengal reported carbon-sequestration-potential estimates of 6.54–6.90 tonnes per hectare per year under different mulberry management practices, demonstrating the importance of scientific cultivation methods. The article also examines the distinction between carbon sequestration and tradable carbon credits, emphasising the need for additionality, reliable carbon accounting, independent verification and compliance with eligible carbon-crediting methodologies. A phased approach involving baseline assessment, improved management practices and carbon-market feasibility analysis is proposed for Odisha. Integrating carbon farming with mulberry sericulture could potentially diversify farmers' income while promoting sustainable land management. However, carbon-credit generation must be scientifically validated and economically viable before commercial benefits can be assured.

Introduction

Mulberry (Morus spp.), the principal food plant of the domesticated silkworm, *Bombyx mori*, has ecological significance beyond silk production through its potential to sequester atmospheric carbon and enhance soil carbon storage. Carbon farming integrates agricultural productivity with climate mitigation, while eligible carbon-crediting programmes may offer farmers additional income. However, carbon sequestration does not automatically qualify for carbon credits; credit generation requires demonstrable additionality, reliable measurement and independent verification of climate benefits.

Mulberry plantations as biological carbon sinks

The carbon-storage potential of a mulberry plantation can be understood through three major components.

- Above-ground biomass: Mulberry stems, branches and leaves store carbon, although stocks vary with plant age, pruning and harvesting practices.
- Below-ground biomass: Roots store carbon directly and contribute organic matter to the soil through root growth and decomposition.
- Soil organic carbon: Decomposing roots, leaves and pruning residues enrich soil organic matter, with carbon retention influenced by soil properties and management practices.

Thus, mulberry plantations function as dynamic carbon-storage systems. Their net climate benefit depends not only on carbon accumulation but also on harvesting, residue management and cultivation-related emissions. Accurate assessment must distinguish existing carbon stocks, annual stock changes and net greenhouse gas removals.

What does research tell us about carbon sequestration in mulberry cultivation?

One of the most relevant studies for Indian sericulture was published by Kar, Vijay and Trivedy in 2018 examining mulberry cultivation practices under irrigated Gangetic alluvial soil conditions. The study compared intensive tillage without grass cover against moderate tillage with grass cover. The reported results are particularly relevant because they connect carbon-related measurements with the management of a commercially cultivated mulberry garden.

Table 1. Findings from the three-year mulberry field study

Parameter	Intensive tillage, without grass cover	Moderate tillage, with grass cover
Annual mulberry leaf productivity	38.16 t/ha/year	38.72 t/ha/year
Reported carbon-sequestration potential	6.54 t/ha/year	6.90 t/ha/year
Soil organic carbon stock after three years	35.25 Mg C/ha	40.16 Mg C/ha

Mulberry management practices influence carbon sequestration and soil carbon storage. A West Bengal study reported sequestration-potential estimates of 6.54 and 6.90 t/ha/year under different management systems, with a 4.91 t C/ha difference in soil carbon stocks after three years. A 2021 study in Pakistan reported varietal differences in above-ground biomass carbon, ranging from 25.56 ± 0.66 to 66.93 ± 1.99 t/ha. These findings highlight the importance of appropriate management, varietal selection and region-specific assessment. However, biomass carbon stocks and sequestration estimates cannot be equated directly with annual carbon credits, underscoring the need for standardised measurement and verification.

Improving carbon storage through scientific mulberry management

Carbon farming does not require sericulture farmers to abandon established cultivation systems. Rather, it encourages them to adopt practices that support soil health, maintain productive vegetation and improve the retention of organic carbon, wherever these practices are agronomically suitable.

1. Moderate tillage and suitable ground cover
2. Organic matter recycling
3. Efficient water and nutrient management
4. Responsible management of pruning biomass
5. Integration with suitable agroforestry systems

From carbon sequestration to carbon credits: Understanding the difference

The transition from biological carbon storage to a tradable carbon credit is not automatic. Carbon sequestration describes the removal of carbon dioxide from the atmosphere and its storage in vegetation, soil or other carbon pools. A carbon credit is a formally issued unit under a carbon-crediting programme, representing a quantified climate benefit in accordance with that programme's rules. India's Carbon Credit Trading Scheme (CCTS) provides a framework for carbon-credit trading, including an offset mechanism for eligible projects. The Bureau of Energy Efficiency (BEE) publishes the relevant procedures and methodologies. The approved methodology for afforestation and reforestation on lands other than wetlands is one potential avenue to examine for suitable tree-based projects. However, the existence of a forestry methodology does not mean that every mulberry garden automatically qualifies. The eligibility of an existing plantation or a newly established mulberry project must be checked against the

exact requirements of the applicable methodology. In particular, land-use history, baseline conditions, additionality and project design can determine whether a proposed activity is eligible.The following distinctions are essential:

- Carbon stock: The quantity of carbon held in plant biomass or soil at a particular time.
- Annual carbon-stock change: The increase or decrease in carbon stocks over a defined period.
- Net greenhouse gas removal: The climate benefit remaining after relevant project emissions, baseline conditions, leakage and other prescribed adjustments are accounted for.
- Issued carbon credits: The units formally issued after the project meets the applicable programme requirements and verification procedures.

A carbon-stock estimate cannot simply be converted into the same number of carbon credits. Nor can the gross amount of carbon dioxide absorbed by a mulberry plant be assumed to represent the net climate benefit of an entire farming operation.

How can a mulberry plantation project generate carbon credits?

A credible mulberry carbon-farming project would need to progress through a structured process.

1. Identify the project and confirm eligibility
2. Establish a baseline
3. Measure biomass and soil carbon
4. Demonstrate additionality and account for emissions
5. Register, monitor and verify
6. Obtain and sell issued credits

What could the research figures mean for a farmer?

The West Bengal field study offers a useful quantitative starting point. Its reported carbon-sequestration-potential estimates were 6.54 and 6.90 tonnes per hectare per year under the two respective management treatments. The difference was 0.36 tonnes per hectare per year. The study's soil organic carbon results provide another perspective. The reported difference of 4.91 tonnes of carbon per hectare between treatments after three years represents a difference in measured soil carbon stocks. It is not equivalent to 4.91 tonnes of carbon dioxide removed every year. For farmers, these distinctions matter because the economic feasibility of a carbon project depends on the net quantity of eligible credits issued, rather than on the gross carbon-stock estimate.

Why farmer aggregation could make mulberry carbon farming more viable

Small and marginal farmers may find it difficult to finance carbon-project development, baseline measurements, repeated monitoring and independent verification individually. A cluster-based approach could offer a more practical way to assess the commercial feasibility of mulberry carbon farming. Under a cluster-based model, several farmers could participate through a farmer producer organisation (FPO), cooperative, sericulture association or eligible project developer. A coordinating organisation could help maintain plantation records, organise soil sampling, standardise field measurements and manage the administrative requirements of the carbon-crediting programme.

Such a model could offer several advantages:

- Shared project costs: Monitoring, technical documentation and verification expenses could be distributed across participating farms.
- Consistent scientific measurements: Common protocols could improve the quality and comparability of biomass and soil-carbon data.
- Improved farmer access: Farmers could obtain technical assistance and access potential buyers without having to develop an individual carbon project.
- Integration with sericulture extension: Existing farmer training, plantation management and demonstration activities could support the collection of relevant agronomic information.

- Transparent revenue distribution: Agreements could specify project expenses, ownership of credits, payment arrangements and the share payable to each farmer.

Nevertheless, aggregation does not automatically guarantee project eligibility or profitability. The programme must permit the proposed project structure, and the expected volume and value of credits must be sufficient to justify the associated costs.

Opportunities for Odisha and the wider sericulture sector

Odisha can explore mulberry-based carbon farming through a scientifically designed pilot project integrating sericulture with climate-smart agriculture. The initiative should involve three phases: (1) Baseline assessment of plantation characteristics, biomass and soil carbon; (2) Improved management trials to evaluate changes in carbon stocks, leaf productivity and greenhouse gas emissions; and (3) Carbon-market feasibility assessment to determine eligibility, potential credit generation and project costs. This phased approach would establish region-specific scientific evidence and assess whether mulberry-based carbon farming can deliver measurable climate benefits and economically viable supplementary income for farmers.

Major challenges and considerations

Despite its promise, mulberry-based carbon farming faces important scientific and commercial limitations.

- Eligibility: Existing mulberry plantations may not qualify for carbon credits because of land-use history and additionality requirements.
- Measurement costs: Biomass and soil-carbon assessment, monitoring and verification can be expensive, particularly for smallholders.
- Permanence: Fire, erosion, plantation removal and management changes may reverse carbon storage.
- Regional variability: Carbon sequestration varies with soil, climate, plantation age, varieties and cultivation practices.
- Market uncertainty: Carbon prices fluctuate, and credit sales or revenue are not guaranteed.
- Long-term monitoring: Sustained data collection and verification are essential, potentially delaying credit issuance and income generation.

These constraints reinforce the need for careful project design and realistic financial planning. Carbon-credit income should be treated as a potential supplementary benefit rather than a guaranteed source of farm revenue.

Conclusion: Building a scientific foundation for carbon-positive sericulture

Mulberry plantations can support climate change mitigation through carbon storage in plant biomass and soil. Studies in West Bengal reported carbon-sequestration-potential estimates of 6.54–6.90 tonnes per hectare per year under different management practices, while research in Pakistan demonstrated varietal differences in biomass carbon. These findings highlight the potential of integrating mulberry sericulture with carbon farming. However, carbon sequestration does not automatically translate into tradable carbon credits. Region-specific assessments, scientific monitoring and compliance with eligible carbon-crediting methodologies are essential. Pilot projects in Odisha could evaluate the additional climate benefits and economic feasibility of mulberry-based carbon farming, potentially linking sustainable sericulture with supplementary farmer income and environmental conservation.

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