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Sericulture As A Nature-Based Solution: Combating Desertification And Climate Change Through Mulberry-Silkworm Agro Ecosystems

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"In every silken thread lies the quiet work of nature—restoring the soil, cooling the air, and weaving resilience into the fabric of our planet."

Abstract

Driven by unsustainable land use, deforestation, and anthropogenic emissions, threaten food security, biodiversity, and the livelihoods of millions. In this perspective, sustainable land management practices and nature-based solutions have gained prominence. Among them, sericulture is one promisingbiodiversity and microclimate creation by mulberry plantations supporting various organisms including pollinators, soil fauna, and microbes. They also create shade, reduce soil surface temperatures, and increase local humidity levels, promoting ecological stability.Mulberry as a Pioneer Species is drought-tolerant and can thrive on marginal, degraded lands. Their fibrous root systems prevent soil erosion, improve water retention, and contribute to organic matter through leaf litter.One hectare of mulberry approximately can sequester up to 8 tons of CO2 annually. Under intensive cultivation, it can provide Sustainable Development and Rural Employment. The FAO and UNCCD endorse it as a component of sustainable agriculture and ecosystem restoration under the SDG framework.

Key words: sericulture, biodiversity, sustainable development, SDG, soil temperature.

Introduction

Climate change and arid desert (Desertification) are two deeply interlinked andthe most pressing environmental challenges of the 21st century. **According to the** IPCC Sixth Assessment Report (2021)**,** rising global temperatures, erratic rainfall, soil degradation, **releasing stored soil carbon** and declining

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vegetation are collectively threatening ecosystems, agriculture, and rural livelihoods in arid and semi-arid regions. The United Nations Convention to Combat Desertification (UNCCD)**estimates that** over 24 billion tons of fertile soil are lost every year, nearly 2 billion peopleand**nearly** 52% of agricultural land is moderately or severely affected by land degradation globally **in tropical and subtropical regions.** Addressing these issues requires sustainable land use practices that are economically viable, ecologically restorative, and socially inclusive.

The urgency to restore degraded land and sequester atmospheric carbon has spurred interest in nature-based solutions**,** including agroforestry**,** sustainable agriculture, and silvopastoral systems. One such eco-friendly nature-based practice is sericulture which offers the dual benefit of ecological restoration and livelihood which is increasingly recognized for its environmental benefits. Its reliance on mulberry plantations, organic land management, and low-carbon processing methods makes it a valuable tool in the fight against both desertification and climate change. Silkworms (*Bombyx mori*) do not directly combat desertification or climate change. However, sericulture when integrated into sustainable land use practice can indirectly contribute to addressing both challenges.As noted by Dandin (2005),Sericulture is not simply an agro-based economic activity, but a holistic system that integrates ecological conservation with rural development.Trees ofmulberry have been effectivelyreared to retrievedegraded and marginal lands due to their drought resistance, deep root systems, and firm growth. These features help in soil conservation, improvement of microclimate, restoration of vegetativeand contribute to carbon sequestration, a critical process for climate change mitigation. Studies of Prakash and Nataraju (2011) shows that a hectare of mulberry plantation can absorb 7 to 9 tons of CO_2 annually, depending on variety and soil conditions. Sericultureaffords a justifiableoccupation to number of rural families in countries like India, China, Bangladesh, and parts of Africa and Latin America. It promotes inclusive economic development, especially empowering women and landless farmers. By integrating income generation with ecological stewardship, sericulture fits squarely into the framework of a green economy and contributes to several UN Sustainable Development Goals (SDGs), including SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 1 (No Poverty). Reclaims degraded land, prevents erosion, and increases vegetation cover. Sequesters carbon, promotes sustainable textiles, and lowers emissions. Creates eco-friendly jobs, supports green livelihoods. 1. Combating Desertification through Sericulture. In addition, the silk industry has a significantly lower environmental impact compared to synthetic fiber production, which relies heavily on fossil fuels and contributes to microplastic pollution. Natural silk is biodegradable, and its production requires minimal chemical inputs, particularly when organic sericulture methods are used.

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a. Mulberry Plantation:

- These deep-rooted mulberry trees prevent soil erosion and stabilize the soil.
- Rehabilitation of degraded land is done by mulberry plantation in marginal and degraded lands.
- Enhances green shield in arid and semi-arid regions, slowing down desertification. In arid regions of India (like Karnataka and Andhra Pradesh), mulberry farming has been used in wasteland development turning barren areas into green belts.

According to Sudhakar (2009) Cultivation of mulberry and its maintenance help improve soil fertility and conserve moisture in dry lands, thus helping in reversing land degradation. Improves green area and helps reclaim desert-prone or barren lands. Mulberry is a hardy plant that can be cultivated on marginal lands, making it a suitable crop for afforestation and wasteland reclamation was noticed by Ramesha and Babu (2014).

b. **Water Retention and Microclimate Improvement**

1. Mulberry plants improve:

- Soil moisture through leaf litter and canopy over.
- Microclimate by reducing surface temperatures and increasing humidity, creating more favourable conditions for biodiversity.

2. Prevents Soil Erosion:

Mulberry plantations act as windbreaks and help prevent wind and water erosion in arid and semi-arid regions was observed by Meena et al. (2015).Mulberry plantations create ground shelter and canopy that:

- Reduces wind erosion in dry areas.
- Improves water retention.
- Promotes soil microbial activity, enriching the soil.

c. **Agroforestry Integration**

- Sericulture is often integrated with agroforestry or intercropping systems.
- It promotes biodiversity, enhances productivity, and reduces pressure on forests.

2. **Addressing Climate Change:** a. **Carbon Sequestration**

According to Prakash et al. (2011) mature mulberry plantation can sequester significant amounts of carbon annually, contributing to climate change mitigation.Dandin (2005) stated that sericulture offers an eco-friendly model where carbon sequestration is enhanced through mulberry biomass, without compromising income generation.

Mulberry trees act as carbon sinks, absorbing CO_2 from the atmosphere.

Silkworm rearing doesn't emit significant greenhouse gases compared to industrial sectors.

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b. **Low Carbon Footprint of Sericulture**

- Sericulture is a low-energy, non-polluting cottage industry.
- It does not rely on fossil fuels extensively.
- Encourages organic farming practices and minimal pesticide use.

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c. **Alternative to Synthetic Fibers**

- Natural silk is biodegradable, unlike synthetic fibers that release microplastics and are made from petrochemicals.
- Promotes sustainable textile production that reduces the ecological footprint of the fashion industry.

Studies of Ratnaand Deshpande (2014) showed that silk production through sericulture is a low-carbon industry compared to synthetic fiber production, making it a sustainable textile alternative. Natural silk decomposes easily, unlike synthetic fibers that persist in the environment, contributing to pollution and global warming has been noticed by Li et al. (2020).

3. **Socio-Economic and Environmental Co-benefits**

a. **Livelihood Generation in Rural Areas:** According to Mallikarjuna et al. (2016) sericulture offers stable income in arid regions with limited cropping potential, enhancing the climate resilience of rural households

- Sericulture provides employment to millions, especially women in rural India, China, and Africa.
- Diversifies income sources for farmers, encouraging them for land steward ship for reducing land abandonment to develop climate-resilient.

b. **Agroforestry and Sustainable Land Use**

- Sericulture integrates well with agroforestry systems, combining tree planting, mulberry farming, and silkworm rearing.
- Promotes multi-layer cropping and soil fertility improvement.

4. **Integration with Green Economy and Climate Resilience Strategies**

Sericulture is part of green economy frameworks because it:

- Encourages renewable biological resources.
- Supports climate-smart agriculture.
- Aligns with Sustainable Development Goals (SDGs) like:
    - SDG 13 (Climate Action)
    - SDG 15 (Life on Land)

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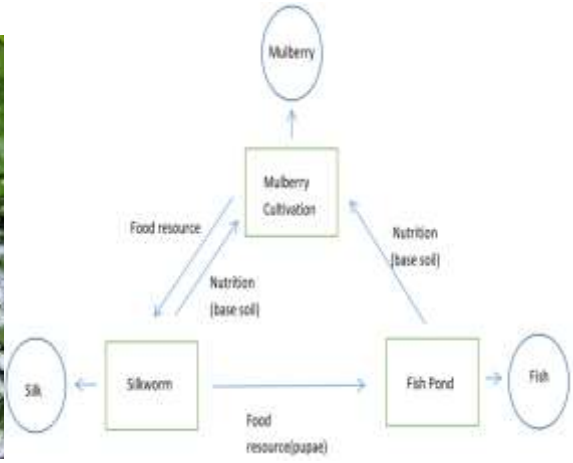
- SDG 12 (Responsible Consumption and Production)

As per FAO (2013) sericulture can play a key role in green economy models by promoting sustainable land use and rural employment."



Illustratingsericulture contribute to combating desertification and addressing climate change.

Challenges and Future Research Directions

While sericulture holds significant potential, challenges remains:

- Environmental stress sensitivity of silkworms
- Need for water-efficient mulberry genotypes
- Limited awareness of its ecological benefits

Future research must focus on:

- Developing climate-resilient silkworm breeds and mulberry varieties
- Promoting organic and regenerative sericulture
- Leveraging GIS and remote sensing for monitoring impacts on land degradation

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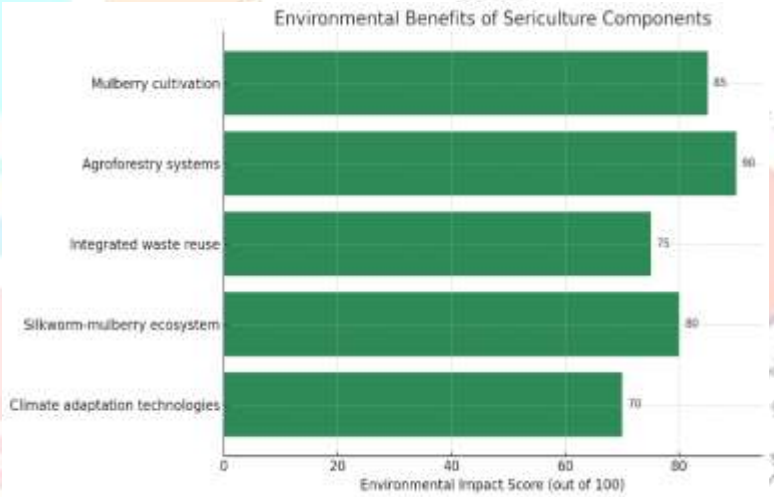
Summary Table

Contribution	Impact on Environment	Source
Mulberry Cultivation	Reclaims degraded land, prevents erosion	Ramesha & Babu (2014)
Soil Restoration	Improves fertility and moisture	Sudhakar (2009)
Carbon Sequestration	Mulberry acts as carbon sink	Prakash & Nataraju (2011)
Eco-Friendly Silk Production	Low emissions compared to synthetic industries	Ratna & Deshpande (2014)
Biodegradability	Silk is sustainable alternative to synthetic fibers	Li et al. (2020)
Climate-Resilient Livelihoods	Income diversification in dry lands	Mallikarjuna et al. (2016)



Conclusion

Thus, sericulture represents a multi-functional land-use system that supports both environmental restoration and climate resilience, making it a promising strategy in global efforts to combat desertification and climate change.Sericulture presents a compelling case for its inclusion in national and global strategies to combat desertification and climate change. It's ecological, economic, and social benefits align well with the principles of sustainability and resilience. By transforming drylands into productive landscapes and supporting rural livelihoods, sericulture weaves a future where silk threads not just cloth, but hope. Agroforestry and Land Use Efficiency Sericulture fits well within agroforestry systems, allowing for intercropping with legumes, vegetables, or medicinal plants. This diversified land use reduces the risk of monoculture, supports food security, and maximizes ecological benefits per unit of land.

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