Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 06, Issue: 02 (MAR-APR, 2026)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

From Waste to Wealth: Value Addition of Sericulture By-products

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Sericulture, traditionally focused on silk production, generates substantial by-products such as mulberry pruning, silkworm pupae, rearing bed waste, and reeling residues. Historically treated as waste, these materials are now recognized for their potential in value addition, enabling a transition from "waste to wealth." This article reviews the diverse applications of sericulture by-products, including their use as organic fertilizers, animal feed, bioactive compounds, handicrafts, textile materials, and bioenergy sources. By valorizing these by-products, the industry not only enhances economic returns for rural communities but also promotes environmental sustainability and circular economy practices. Emerging technologies, coupled with entrepreneurial and policy support, are expanding opportunities for innovative, eco-friendly utilization. This review emphasizes the economic, social, and ecological significance of sericulture by-products, highlighting their potential to transform the industry into a sustainable, diversified sector.

Keywords: Sericulture, Silkworm, By-products, Value Addition, Sustainability, Circular Economy

Introduction

Sericulture the cultivation of silkworms for silk has been an important agro-based industry for centuries, especially in countries like India, China, and Brazil. Although the production of silk is the main goal of sericulture, the sector also produces a significant amount of trash and byproducts at every stage, from mulberry farming to cocoon processing. Many of these byproducts were thrown away as waste for a long time, which led to problems with disposal and missed business opportunities. However, by viewing these byproducts as useful resources rather than waste, new research and entrepreneurial endeavours are changing this paradigm. As a result, there is a growing "waste to wealth" shift that boosts revenue, encourages sustainability, and enhances the principles of the circular economy while also empowering rural communities. This article explores the nature of sericulture by-products, their potential uses, value-added products emerging from them, and the broader implications for sustainable rural development.

Sericulture By-products

The sericulture process consists of three major stages:

1. Mulberry cultivation,
2. Silkworm rearing, and
3. Cocoon processing and silk reeling.

Each stage generates useful by-products that can be valorised (converted to value-added products) rather than discarded:

- Mulberry biomass -leaves, twigs, branches, and fallen fruits.
- Silkworm by-products - pupae, larval excreta, rearing bed waste, and pupal litter.

- Reeling waste - floss silk, Noil, short fibres, and perforated cocoons.
- Sericin and fibroin residues - proteins obtained during silk degumming.

These by-products, once considered waste, are now acknowledged for their functional properties nutritional, organic, biochemical, and structural that make them suitable for industrial, agricultural, health, and artisan applications.

Value Addition Pathways

Sustainable Agriculture and Organic Inputs

Crop production and soil health are two of the most significant applications of sericulture's byproducts. Silkworm litter and mulberry pruning are high in organic matter and can be vermicompost or composted to create biofertilizers and organic manure. Healthier crops and lower agricultural expenses result from these organic inputs' improved soil structure, increased nutrient availability, and decreased dependency on chemical fertilisers. The mulberry plant, which is frequently grown for silkworm feed, yields biomass that is useful for purposes other than feeding silkworms. Mulberry leaves and twigs can be processed to produce extracts with therapeutic qualities, brewed into nutraceutical teas, or fed to animals.

Animal Feed and Nutrition Enhancement

The larvae that remain after silk filament extraction are called silkworm pupae, and they are high in protein and nutrients. According to recent research, processed silkworm pupae can be used as an alternate source of protein in animal feed, partially substituting traditional components like soybean meal in the diets of ruminants. This lowers feed costs, enhances sustainable livestock nutrition, and encourages waste valorisation. These developments are a part of more recent bioconversion techniques that incorporate proteins produced from insects into feed formulations, making sericulture byproducts economically important for animal husbandry.

Textile and Material Innovations

Spun yarn, nonwoven materials, and composite fabrics are now made from short fibres, noil, and floss from silk reeling, which were formerly difficult to dispose of. These can improve the material value chain beyond conventional silk fabrics by being utilised in upholstery, insulation, and environmentally friendly textiles. The quality of spun goods has increased, their market potential has grown, and waste formation has decreased thanks to industrial developments in mechanical and biological processing.

Handicrafts and Rural Entrepreneurship

The use of damaged or cut cocoons in handicrafts is one of the most obvious and culturally significant value addition paths. These are turned into cocoon flowers, ornamental garlands, vases, wall hangings, dream catchers, and bird swings by artisans, producing eye-catching, environmentally responsible goods that appeal to both traditional and contemporary markets. Many of these products have larger profit margins than raw cocoons alone, according to economic evaluations, and they require less in the way of materials and skill development, making them appropriate for women's self-help organisations and rural entrepreneurship.

Bioactive Compounds: Sericin and Fibroin

Sericin, a naturally occurring protein, is isolated from fibroin during the manufacturing of silk. Sericin has antioxidant qualities and is biodegradable and biocompatible. These qualities make it appropriate for use in cosmetics, packaging materials, tissue engineering scaffolds, and biomedical applications (such as wound healing and drug delivery). Sericin extraction and commercialisation creates opportunities for biorefinery models, which transform biomass into high-value biochemical products that support the objectives of the circular bioeconomy.

Bioenergy and Industrial Uses

New technological approaches investigate the production of bioenergy from sericulture waste. For instance, a thermal process called torrefaction turns the waste from silkworm pupae into bio coal, which can be used as a renewable energy source for decentralised applications. In addition to replacing fossil fuels in rural areas, these energy products can create new value chains for agricultural and industrial byproducts. Similarly, mulberry prunings and silkworm litter can be converted into biogas, enhancing sericulture clusters' sustainable energy portfolios.

The Bigger Picture: Sustainability and Rural Livelihoods

Environmental Benefits

Efficient utilization of sericulture by-products supports environmental sustainability by

- Reducing organic waste disposal burdens.
- Minimizing greenhouse gas emissions from decomposing biomass.
- Lowering chemical fertilizer use through organic alternatives.
- Promoting soil conservation and biodiversity.
- Such practices align with global circular economy principles where products and materials are reused, recycled, and kept in productive use for as long as possible.

Economic and Social Impacts

For smallholder farmers and rural communities, value addition of by-products means diversified income streams. Instead of depending solely on cocoon sales, farmers can earn from:

- Organic inputs.
- Animal feed sales.
- Handicraft production.
- Bioactive compound extraction.
- Energy products.

This diversification reduces vulnerability to market fluctuations and creates entrepreneurial opportunities, particularly for women and youth in rural areas contributing to inclusive economic growth.

Challenges and Opportunities

Despite the promising potential, several challenges remain:

- Technological barriers in processing and product standardization.
- Limited market access for value-added products.
- Lack of awareness among farmers and artisans about new opportunities.
- Insufficient policy support and training for scaling value-addition practices.

Addressing these challenges requires coordinated efforts involving government initiatives, research institutions, industry partnerships, and community engagement programs. Enhanced training, access to credit, and market linkages can accelerate the transition from traditional sericulture to a bio-circular industry model.

Conclusion

The sericulture industry holds far greater economic and environmental potential than merely producing silk. As research and innovation expand the frontiers of value addition for sericulture by-products, an exciting shift is underway from treating these outputs as waste to recognizing them as wealth-generating resources. Integration of these strategies not only enhances economic viability but also fosters environmental sustainability and rural prosperity. By embracing value-addition pathways from organic fertilizers and animal nutrition to handicrafts and biomedical applications sericulture can transition into a robust, diversified sector that benefits communities and ecosystems alike. With the right mix of technology, policy support, and market development, the sericulture value chain can become a model of sustainable, rural-centric industrial growth for the 21st century.

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