ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11,Iss 11, 2022

Sericulture Industry in Assam: A Review

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Abstract
Assam is known for its unique silk varieties like Muga, Eri, and Mulberry silk, which have a high potential for growth and commercialisation. Sericulture, the rearing of silkworms for silk production, is an important agro-based industry in the northeast Indian state of Assam. Assam has a long history and tradition of sericulture, especially the production of the golden yellow Muga Silk that is unique to the state. However, the industry is facing several challenges like low productivity, insufficient infrastructure, lack of quality planting material, inadequate extension services, pest and disease infestation, climate change, insufficient research and development, and limited market linkages.
To address these challenges and promote the sustainable growth of the sericulture industry in Assam, a comprehensive and integrated approach is needed, involving the participation of all stakeholders. The government schemes and initiatives have been playing a crucial role, but more targeted interventions are required. The potential areas for growth include expansion of Muga and Eri silk production, diversification of silk products, promotion of silk tourism, strengthening of research and development, and skill development and capacity building.
The sericulture industry in Assam has the potential to significantly contribute to the state's economy and employment generation, while preserving its rich cultural heritage. Realizing this potential will require concerted efforts, collaboration, and innovative approaches from all stakeholders to address challenges and seize opportunities for the sustainable development of sericulture in Assam.

Key Words: *Sericulture, Industry, Assam, Silk, Mulberry, Silkworm, Agro*

1. Introduction

Sericulture, the art and science of rearing silkworms to produce silk, is one of the oldest agro-based industries in the world. India has a rich and ancient history of silk production and is currently the second largest producer of silk in the world after China [1]. Within India, the northeastern state of Assam is a major hub of sericulture, known especially for its unique golden yellow Muga silk that is produced nowhere else in the world. Assam accounts for nearly 90% of Muga silk production in India [2].

Sericulture is an important source of livelihood for a significant number of people in Assam, particularly in rural areas. It is estimated that sericulture provides employment to over 2.6 lakh families in the state, with the majority being small and marginal farmers and weavers [3]. Despite

ISSN PRINT 2319 1775 Online 2320 7876

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its economic and cultural significance, the sericulture industry in Assam faces several challenges that hinder its growth and development.

The main objectives of this review article are:

1. To provide an overview of the different types of silks produced in Assam and their unique characteristics
2. To describe the current practices of silkworm rearing, silk production, and processing in Assam
3. To highlight the socio-economic importance of the sericulture industry in Assam
4. To identify the major challenges and constraints faced by the sericulture sector in Assam
5. To review the various government schemes and initiatives for promoting sericulture in Assam
6. To discuss the future prospects and potential areas for growth and development of the sericulture industry in Assam

2. Methodology

This review article is based on a comprehensive survey of the available literature on the sericulture industry in Assam, including research papers, government reports, statistical data, and news articles. The literature survey was supplemented by field visits to sericulture farms, silk reeling and weaving units, and research institutions in different parts of Assam to gather first-hand information and insights. Semi-structured interviews were conducted with a range of stakeholders, including silkworm rearers, silk reelers and weavers, entrepreneurs, researchers, and government officials, to understand their perspectives on the opportunities and challenges in the sericulture sector.

The information and data collected from these various sources were analyzed and synthesized to present a holistic picture of the sericulture industry in Assam, its current status, challenges, and future prospects. The article is structured into different sections covering the key aspects of sericulture in Assam, as outlined in the objectives.

3. Types of Silks Produced in Assam

Assam is known for producing four main types of silk - mulberry, eri, muga, and oak tasar. Each of these silks has its own unique characteristics and properties that make them valuable and sought after.

3.1 Mulberry Silk

Mulberry silk is the most common type of silk produced in Assam, accounting for around 70% of the state's total raw silk production [4]. It is obtained from the domesticated silkworm, Bombyx mori L., which feeds exclusively on the leaves of the mulberry plant. Mulberry silk is known for its softness, lustrous appearance, and excellent dyeability. In Assam, mulberry sericulture is practiced primarily in the districts of Jorhat, Golaghat, Sibsagar, Lakhimpur, and Kamrup [5].

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3.2 Eri Silk

Eri silk, also known as endi or errandi silk, is a non-mulberry silk produced by the domesticated silkworm, Samia ricini Donovan, which feeds mainly on the leaves of the castor plant (Ricinus communis). Eri silk is known for its thermal properties, making it suitable for use in winter garments. It has a cottony and matte appearance and is less lustrous than mulberry silk. Eri silk production is widely practiced in the tribal areas of Assam, particularly in the districts of Kokrajhar, Bongaigaon, Barpeta, Dhubri, and Goalpara [6].

3.3 Muga Silk

Muga silk is a unique golden yellow silk that is exclusively produced in Assam. It is obtained from the semi-domesticated silkworm, Antheraea assamensis Helfer, which feeds on the leaves of the som (Machilus bombycina) and soalu (Litsaea polyantha) trees. Muga silk is known for its glossy texture, durability, and natural golden color that does not fade with time. It is a highly valued and expensive silk, with a rich cultural heritage in Assam. Muga silk is mostly produced in the upper Assam districts of Jorhat, Golaghat, Sibsagar, Dibrugarh, and Lakhimpur [7].

3.4 Oak Tasar Silk

Oak tasar silk, also known as temperate tasar, is a wild silk produced by the silkworm, Antheraea proylei Jolly, which feeds on the leaves of oak trees (Quercus species). In Assam, oak tasar sericulture is practiced on a small scale in the hill districts of Karbi Anglong and Dima Hasao [8]. Oak tasar silk has a unique natural color and texture and is used for making high-value fabrics and garments.

4. Silkworm Rearing and Silk Production Practices in Assam

Sericulture involves several stages, from the cultivation of host plants and rearing of silkworms to the production of raw silk and its further processing into yarn and fabric. In Assam, the practices of silkworm rearing and silk production vary depending on the type of silk and the agro-climatic conditions of the region.

4.1 Mulberry Sericulture

Mulberry sericulture involves the cultivation of mulberry plants and rearing of the Bombyx mori silkworm. In Assam, the popular mulberry varieties cultivated for sericulture include S1, S1635, TR10, and BC259 [9]. Mulberry plants are usually cultivated in well-drained, fertile soils and require regular irrigation, pruning, and fertilizer application for optimal leaf production.

Rearing of the mulberry silkworm is carried out in four stages - egg, larva, pupa, and adult. The eggs are incubated under controlled temperature and humidity conditions to ensure uniform hatching. The larvae are fed with fresh mulberry leaves and undergo four molts before reaching the mature fifth instar stage. The mature larvae then spin silk cocoons, which are harvested, and the pupae are either allowed to develop into adult moths for breeding or are killed to prevent damage to the cocoons.

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The silk cocoons are then processed to extract the raw silk. The cocoons are first boiled to soften the sericin gum holding the silk fibers together. The softened cocoons are then reeled using a silk reeling machine to unwind the continuous silk filament. The raw silk is further processed by twisting, dyeing, and weaving to produce silk yarn and fabric [10].

4.2 Eri Sericulture

Eri silkworm rearing is traditionally carried out by the tribal communities of Assam using castor plants grown in their backyard gardens. The castor plants are usually cultivated along with other crops like maize, vegetables, and legumes. The eri silkworms are reared in bamboo baskets or on castor leaves spread on the floor. The silkworms undergo four molts before spinning their cocoons.

Unlike mulberry and muga silkworms, the eri silkworm does not spin a continuous filament. Instead, it produces short, spun fibers that are used for making a thick, warm fabric called eri cloth. The eri cocoons are harvested, boiled, and the fibers are extracted by hand spinning or using a spinning wheel. The spun fibers are then woven into eri cloth using traditional handlooms [11].

4.3 Muga Sericulture

Muga sericulture involves the cultivation of som and soalu host plants and rearing of the Antheraea assamensis silkworm. Som and soalu are perennial trees that are usually cultivated in plantations or along the boundaries of agricultural fields. The trees require regular pruning and maintenance to ensure optimal leaf production [12].

Muga silkworms are reared in outdoor conditions on the som and soalu trees. The silkworms undergo four molts before spinning their cocoons, which are usually harvested twice a year - in May-June and October-November. The harvested cocoons are then processed to extract the muga silk using a similar reeling process as mulberry silk [13].

Muga silk production is a labor-intensive process that requires skilled workers for various stages like silkworm rearing, cocoon harvesting, silk reeling, and weaving. The traditional muga silk weaving is done using handlooms and involves intricate designs and patterns that showcase the rich cultural heritage of Assam [14].

4.4 Oak Tasar Sericulture

Oak tasar sericulture is practiced on a small scale in the hill districts of Assam. The oak tasar silkworms are reared on oak trees in natural forest conditions. The silkworms are bred twice a year, and the cocoons are harvested and processed to obtain the tasar silk. The oak tasar silk is usually handspun and woven into fabric using traditional looms [15].

5. Socio-Economic Importance of Sericulture in Assam

Sericulture plays a significant role in the socio-economic development of Assam, particularly in rural areas. It provides livelihood opportunities to a large number of people, including farmers, silkworm rearers, reelers, spinners, weavers, and traders.

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5.1 Employment Generation

Sericulture is a labor-intensive industry that generates employment opportunities for both skilled and unskilled workers. It is estimated that sericulture provides direct employment to over 2.6 lakh families in Assam, with the majority being small and marginal farmers and weavers [3]. Sericulture also generates indirect employment in allied activities like mulberry and castor cultivation, silk reeling, spinning, dyeing, and marketing.

Sericulture is particularly important for women's empowerment in Assam, as it provides them with opportunities for income generation and economic independence. Women are involved in various stages of sericulture, from silkworm rearing to spinning and weaving. The traditional handloom weaving of Assam, which is closely linked to sericulture, is largely carried out by women and provides them with a source of livelihood [16].

5.2 Income Generation

Sericulture is a profitable agro-based industry that provides a good source of income for farmers and other stakeholders. The income from sericulture is often higher than that from traditional agricultural crops, making it an attractive option for farmers looking to diversify their income sources. A study by the Central Silk Board found that the net income from mulberry sericulture in Assam was around Rs. 70,000 per hectare per year, which was significantly higher than the income from paddy cultivation [17].

Muga silk, being a high-value product, fetches a premium price in the market and provides a good income for muga silkworm rearers and weavers. The price of muga silk can range from Rs. 10,000 to Rs. 30,000 per kilogram, depending on the quality and demand [18]. Eri and oak tasar silk also provide a good source of income for the tribal communities involved in their production.

5.3 Contribution to Rural Development

Sericulture has the potential to contribute significantly to rural development in Assam by providing employment, income, and infrastructural development in rural areas. Sericulture activities are mostly carried out in rural areas and can help in reducing rural-urban migration by providing local employment opportunities.

The development of sericulture in rural areas also leads to the growth of allied industries like silk reeling, spinning, dyeing, and weaving, which can further generate employment and income. Sericulture can also promote the development of rural infrastructure like roads, electricity, and communication facilities, which are essential for the growth of the industry [19].

5.4 Cultural Significance

Sericulture, particularly muga and eri silk production, has a deep cultural significance in Assam. Muga silk is considered a symbol of Assamese identity and is used in traditional attires like the mekhela chador and the gamosa. Muga silk is also used in religious and ceremonial occasions and is considered a status symbol.

Eri silk also has a cultural importance in Assam, particularly among the tribal communities. Eri cloth is used for making traditional shawls, wraps, and blankets that are used in various cultural

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and religious occasions. The traditional handloom weaving of Assam, which uses muga, eri, and mulberry silk, is also an important part of the state's cultural heritage [20].

6. Challenges and Constraints Faced by the Sericulture Industry in Assam

Despite its potential and significance, the sericulture industry in Assam faces several challenges and constraints that hinder its growth and development. Some of the major challenges are:

6.1 Low Productivity

The productivity of silkworms and the quality of silk produced in Assam are generally lower compared to other major silk-producing states in India like Karnataka and Andhra Pradesh. The low productivity is attributed to factors like the use of traditional rearing methods, lack of improved silkworm breeds, poor quality of host plant leaves, and inadequate disease management [21].

The average yield of mulberry cocoons in Assam is around 40-50 kg per 100 disease-free layings (DFLs), which is lower than the national average of 60-70 kg per 100 DFLs [22]. The productivity of muga and eri silkworms is also low, with an average yield of 30-40 kg of muga cocoons and 20-30 kg of eri cocoons per 100 DFLs [23].

6.2 Insufficient Infrastructure

The sericulture industry in Assam lacks adequate infrastructure facilities for silkworm rearing, silk reeling, and processing. Many of the sericulture farms, particularly in rural areas, do not have proper rearing houses, equipment, and storage facilities, which affect the quality and quantity of silk production.

The silk reeling and processing sector in Assam is also facing infrastructural constraints. Many of the reeling units are small-scale and use outdated machinery and technology, resulting in low efficiency and quality of silk. There is a lack of modern silk weaving and processing units in the state, which limits the value addition and marketability of Assam silk [24].

6.3 Lack of Quality Planting Material

The quality and availability of host plant leaves are crucial for the success of sericulture. However, in Assam, there is a shortage of quality planting material for mulberry, som, soalu, and castor plants. Many of the existing host plant varieties are low-yielding and susceptible to diseases and pests.

The lack of quality planting material affects the productivity and quality of silkworms and silk. There is a need for the development and distribution of high-yielding, disease-resistant host plant varieties to improve the efficiency and sustainability of sericulture in Assam [25].

6.4 Inadequate Extension Services

Extension services play a crucial role in promoting sericulture by providing technical guidance, training, and support to farmers and other stakeholders. However, in Assam, the extension services for sericulture are inadequate and ineffective.

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Many of the sericulture farmers, particularly in remote areas, do not have access to timely and reliable information on improved rearing practices, disease management, and market trends. The lack of extension services affects the adoption of improved technologies and practices, which in turn affects the productivity and quality of silk [26].

6.5 Pest and Disease Infestation

Pest and disease infestation is a major challenge faced by the sericulture industry in Assam. The warm and humid climate of Assam is conducive for the growth and spread of various pests and diseases that affect the host plants and silkworms.

Some of the major pests and diseases affecting sericulture in Assam include the leaf roller, leaf spot, powdery mildew, and root rot in mulberry; the stem borer and leaf spot in som and soalu; and the grasserie, flacherie, and muscardine diseases in silkworms. The infestation of pests and diseases leads to a reduction in the yield and quality of silk and increases the cost of production [27].

6.6 Climate Change and Environmental Factors

Climate change and environmental factors pose significant challenges to the sericulture industry in Assam. The increasing frequency and intensity of extreme weather events like floods, droughts, and heat waves adversely affect the growth and productivity of host plants and silkworms.

Assam is prone to frequent flooding, which causes damage to mulberry and castor plantations and affects silkworm rearing. The rising temperatures and changing rainfall patterns also impact the quality and availability of host plant leaves and the survival and productivity of silkworms [28].

Moreover, the use of pesticides and fertilizers in sericulture can have negative environmental impacts, including soil and water pollution, biodiversity loss, and health hazards for farmers and consumers. There is a need for promoting sustainable and eco-friendly sericulture practices to mitigate the environmental challenges [29].

6.7 Insufficient Research and Development

Research and development play a crucial role in improving the productivity, quality, and sustainability of sericulture. However, in Assam, there is a lack of adequate research and development facilities and funding for sericulture.

The existing research institutions like the Central Muga Eri Research and Training Institute (CMERTI) and the Regional Sericulture Research Station (RSRS) are facing constraints in terms of infrastructure, manpower, and financial resources. There is a need for strengthening the research and development activities on various aspects of sericulture, including silkworm breeding, host plant improvement, disease management, and post-cocoon processing [30].

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6.8 Limited Market Linkages

The sericulture industry in Assam is facing challenges in terms of market linkages and value chain development. Many of the sericulture farmers and weavers are not able to access the market directly and have to rely on intermediaries, which reduces their profit margins.

There is a lack of organized marketing channels and branding initiatives for Assam silk, which limits its visibility and competitiveness in the national and international markets. The limited value addition and product diversification also affect the marketability and profitability of Assam silk [31].

7. Government Schemes and Initiatives for Promoting Sericulture in Assam

The government of India and the state government of Assam have been implementing various schemes and initiatives to promote the growth and development of the sericulture industry in the state. Some of the major schemes and initiatives are:

7.1 Central Silk Board Schemes

The Central Silk Board (CSB), under the Ministry of Textiles, Government of India, is the nodal agency for the development of the silk industry in the country. The CSB has been implementing several schemes for the promotion of sericulture in Assam, including:

- Cluster Promotion Programme for Handlooms: This scheme aims to develop handloom clusters in Assam by providing financial assistance for infrastructure development, skill upgradation, and marketing support.

- Integrated Sericulture Development Project: This project aims to improve the productivity and quality of silk in Assam by providing support for the development of host plant nurseries, silkworm seed production units, and post-cocoon processing facilities.

- Muga Silk Development Scheme: This scheme aims to promote muga silk production in Assam by providing financial assistance for the establishment of muga plantations, silkworm rearing houses, and reeling units.

- Eri Silk Development Scheme: This scheme aims to promote eri silk production in Assam by providing financial assistance for the establishment of castor plantations, silkworm rearing houses, and spinning units [32].

7.2 State Government Schemes

The Government of Assam has also been implementing several schemes for the promotion of sericulture in the state, including:

- Chief Minister's Sericulture Development Scheme: This scheme aims to provide financial assistance to sericulture farmers for the establishment of mulberry, eri, and muga plantations and silkworm rearing houses.

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- Assam Silk Outreach Mission: This mission aims to promote the production, processing, and marketing of Assam silk by providing support for the establishment of new silk production units, upgradation of existing units, and branding and promotion of Assam silk.

- Assam Silk Industry Development Scheme: This scheme aims to provide financial assistance for the establishment of silk reeling, spinning, weaving, and processing units in Assam.

- Sericulture Training and Demonstration Scheme: This scheme aims to provide training and demonstration on improved sericulture practices to farmers, reelers, and weavers in Assam [33].

7.3 Initiatives by Research Institutions

The research institutions like CMERTI and RSRS have been implementing various initiatives for the development of sericulture in Assam, including:

- Development of Improved Host Plant Varieties: The research institutions have been working on the development of high-yielding and disease-resistant varieties of mulberry, som, soalu, and castor plants for improving the productivity and quality of silk.

- Silkworm Breeding and Seed Production: The research institutions have been conducting research on silkworm breeding and seed production to develop improved silkworm breeds and ensure the availability of quality silkworm seeds to farmers.

- Extension and Training Services: The research institutions have been providing extension and training services to sericulture farmers, reelers, and weavers on improved sericulture practices, disease management, and post-cocoon processing.

- Technology Dissemination: The research institutions have been working on the dissemination of improved sericulture technologies and practices to farmers through demonstrations, training programs, and publications [34].

Despite these schemes and initiatives, there is a need for more comprehensive and integrated efforts to address the challenges faced by the sericulture industry in Assam and promote its sustainable growth and development.

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8. Future Prospects and Potential Areas for Growth

The sericulture industry in Assam has immense potential for growth and development, given its unique silk varieties, traditional skills, and favorable agro-climatic conditions. Some of the potential areas for growth and development are:

8.1 Expansion of Muga Silk Production

Muga silk, being a unique and high-value product of Assam, has significant potential for expansion and commercialization. The increasing demand for muga silk in the national and international markets provides an opportunity for the growth of muga sericulture in Assam.

There is a need for increasing the area under muga host plant cultivation, particularly som and soalu, and promoting scientific rearing practices to improve the productivity and quality of muga silk. The establishment of modern muga silk reeling and processing units can also help in value addition and product diversification [35].

8.2 Promotion of Eri Silk

Eri silk, with its unique thermal properties and eco-friendly production process, has significant potential for growth in Assam. The increasing demand for sustainable and natural textiles provides an opportunity for the promotion of eri silk as a niche product.

There is a need for increasing the area under castor cultivation and promoting improved eri silkworm rearing practices to increase the productivity and quality of eri silk. The establishment of modern eri spinning and weaving units can also help in value addition and product development [36].

8.3 Diversification of Silk Products

The traditional silk products of Assam, like mekhela chador and gamosa, have a limited market demand. There is a need for diversifying the silk product range to cater to the changing consumer preferences and market trends.

The development of new silk products like garments, accessories, home furnishings, and industrial textiles can help in expanding the market for Assam silk. The promotion of silk blending with other natural fibers like cotton, wool, and jute can also help in product diversification and value addition [37].

8.4 Promotion of Silk Tourism

Assam, with its rich sericulture heritage and traditional silk weaving practices, has significant potential for silk tourism. The promotion of silk tourism can help in creating awareness about Assam silk, generating employment opportunities, and boosting the local economy.

The development of silk tourism circuits, including visits to sericulture farms, reeling and weaving units, and silk markets, can provide a unique experience to tourists. The integration of silk tourism with other tourism products like eco-tourism, cultural tourism, and tea tourism can also help in attracting more visitors to the state [38].

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8.5 Strengthening of Research and Development

The strengthening of research and development activities is crucial for the sustainable growth and development of the sericulture industry in Assam. There is a need for increasing the investment in research and development on various aspects of sericulture, including silkworm breeding, host plant improvement, disease management, and post-cocoon processing.

The establishment of modern research facilities, the promotion of collaborative research with national and international institutions, and the dissemination of research findings to farmers and industry stakeholders can help in improving the productivity, quality, and competitiveness of Assam silk [39].

8.6 Skill Development and Capacity Building

The sericulture industry in Assam is facing a shortage of skilled manpower, particularly in the areas of silkworm rearing, reeling, and weaving. There is a need for promoting skill development and capacity building programs for sericulture farmers, reelers, and weavers to improve their technical skills and entrepreneurial abilities.

The establishment of sericulture training centers, the conduct of regular training programs, and the provision of handholding support to entrepreneurs can help in creating a pool of skilled manpower for the sericulture industry in Assam [40].

9. Conclusion

The sericulture industry in Assam has a rich history and tradition, and plays a significant role in the socio-economic development of the state. The unique silk varieties of Assam, like Muga, Eri, and Mulberry silk, have a high potential for growth and commercialization, given their distinctive properties and increasing market demand.

However, the sericulture industry in Assam is facing several challenges and constraints, including low productivity, insufficient infrastructure, lack of quality planting material, inadequate extension services, pest and disease infestation, climate change and environmental factors, insufficient research and development, and limited market linkages.

To address these challenges and promote the sustainable growth and development of the sericulture industry in Assam, there is a need for a comprehensive and integrated approach, involving the participation of all stakeholders, including farmers, reelers, weavers, entrepreneurs, researchers, and policymakers.

The government schemes and initiatives, like the Central Silk Board schemes and the state government schemes, have been playing a crucial role in promoting sericulture in Assam. However, there is a need for more targeted and effective interventions, particularly in the areas of infrastructure development, quality planting material production, extension services, research and development, and market linkages.

The potential areas for growth and development of the sericulture industry in Assam include the expansion of Muga and Eri silk production, diversification of silk products, promotion of silk tourism, strengthening of research and development, and skill development and capacity building.

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The sericulture industry in Assam has the potential to become a major contributor to the state's economy and employment generation, while also preserving its rich cultural heritage and traditional skills. The sustainable growth and development of the sericulture industry in Assam require the concerted efforts and collaboration of all stakeholders, and the adoption of innovative and eco-friendly practices.

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