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TASAR SERICULTURE: A SUSTAINABLE ECONOMICAL BOOSTER

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ABSTRACT

The current review explores the multifaceted significance of Tasar silk production as a catalyst for sustainable economic development. This study delves into the intricate interplay between sericulture practices focused on the Tasar silkworm and its pivotal role in fostering economic growth, particularly in regions where this silk industry thrives. This review also investigates the sustainable aspects of Tasar sericulture, emphasizing its socio-economic impact on local communities and regional economies. It examines the lifecycle of the Tasar silkworm, the unique ecological dependencies, and the cultivation practices integral to its sustainable production. Additionally, the study analyzes the value chain of Tasar silk production, from raw silk extraction to weaving, and assesses its economic contributions at various stages. Furthermore, the environmental sustainability of Tasar sericulture, considering its potential as an eco-friendly alternative to synthetic fibers and its positive influence on biodiversity and ecological conservation in the regions where it is practiced is also discussed. We aim to shed light on the potential of Tasar sericulture as a sustainable economic booster. The findings and insights derived from this study aim to provide guidance for policymakers, sericulture practitioners, and stakeholders in leveraging Tasar silk production as a means to achieve sustainable economic growth, while also promoting ecological preservation and community development.

Key words: Sericulture, Tasar silk moth, *Anthaerea mylitta*, Tasar culture, sustainable development

INTRODUCTION

Sericulture is both the art and science of raising silkworms for silk production. It serves as a profitable agro-based employment system that engages a significant portion of rural populations. Beyond generating employment, sericulture has the potential to uplift the economic development and status of rural communities. However, successful silkworm rearing necessitates intensive on-site technical guidance. The practice of sericulture relies on creating and maintaining specific environmental conditions, with temperature and humidity being of utmost importance. These factors significantly impact the growth and development of silkworms, as well as their ability to produce quality silk. To ensure optimal outcomes, sericulturists require expertise and support to effectively manage and control these environmental parameters. By providing intensive technical guidance, sericulturists can enhance their understanding of silkworm rearing techniques and improve their overall productivity. This includes knowledge of creating suitable rearing environments and employing appropriate temperature and humidity controls. Such guidance empowers sericulturists to optimize silk production and contribute to their economic well-being. The economic benefits derived from sericulture extend beyond individual employment, as it contributes to the overall development of rural areas. By engaging in sericulture, rural communities can increase their income and improve their socio-economic status. This, in turn, helps to uplift the overall quality of life in these regions. Sericulture combines both art and science and offers a promising avenue for employment and economic development in rural areas. With the provision of intensive technical guidance and the management of specific environmental conditions, sericulturists can thrive in this industry and contribute to the prosperity of their communities (Dewangan *et al.*, 2011; Jolly *et al*, 1974).

Silk, a highly prized fabric, was discovered as a weavable fiber by the Chinese empress Xi Lan Shi in 2,640 B.C. The Chinese kept the knowledge of silk culture and weaving a secret for over 2,500 years. Silk became a profitable trade commodity in China, with traders from ancient Persia undertaking perilous journeys through challenging terrains to acquire coloured and fine-textured silks from Chinese merchants. Along with silk, other commodities like amber, glass, spices, and tea were traded, and the trade route came to be known as the "silk route." Even today, silk remains highly desirable and a fabric of high fashion (Jolly *et al*, 1974).

Sericulture, the production and weaving of silk, is predominantly carried out by economically disadvantaged sections of society, making it popular and sustainable in countries like China and India. The origins of sericulture can be traced back approximately five thousand years to China. Its reputation as an excellent raw material attracted the interest of other countries in Asia and Europe, leading to the development of sericulture in Korea, Japan, and various European nations. Uni- and bi-voltine sericulture thrived in the temperate regions, while multi-voltine sericulture flourished in tropical countries such as India, Thailand, and Vietnam (Jolly *et al*, 1974; FAO, 2023).

According to statistics from the Food and Agriculture Organization (FAO, 2023), approximately 35-40 countries have been involved in the global development of the sericulture industry. The top five silk-producing countries, including China, India, Uzbekistan, Brazil, and Thailand, account for more than 85 percent of raw silk/silk yarn production. However, FAO investigations and feasibility studies indicate that there is untapped potential for sericulture development in regions such as Eastern Europe, Central Asia, Latin America, and Africa, considering their socio-economic and agro-climatic conditions.

Despite the desire of many countries to promote sericulture as a viable agro-industry that provides job opportunities and income resources for small farmers, some have faced challenges in successfully developing their sericulture industry, especially in the case of bi-voltine sericulture. It is important to explore the reasons behind these difficulties and discuss techniques for successful sericulture industry development. International organizations have played a role in promoting sericulture and supporting its growth (Jolly *et al*, 1974).

Sericulture, a thriving industry, provides employment opportunities to around 6 million individuals across various sectors. This includes both on-farm and off-farm activities, with an estimated 11 individuals involved in producing one kilogram of cocoon per day. The significant employment value generated by sericulture greatly benefits rural communities (Pateriya, 2021). Recognized globally as the "Queen of Textiles," silk is renowned for its unparalleled beauty, natural affinity for dyes, excellent absorbency, lightweight nature, soft texture, and remarkable durability (Bukhari & Kaur, 2019).

Sericulture is practiced in more than 40 countries worldwide. Among them, India holds the second position in raw silk production, following China. However, India stands out as a unique producer of five distinct types of silk: Mulberry, Tropical Tasar, Temperate Tasar, Eri, and Muga. This makes India exceptional in the global silk production landscape. Mulberry silk accounts for the majority share of 86.5% in the overall silk production, while the remaining 13.5% is attributed to the production of non-mulberry silk (Singh & Chakravorty, 2006; Ray & Mohapatra, 2021).

Sericulture has been a significant and recurring practice in India, serving as a traditional occupation that offers extensive employment opportunities, particularly in rural areas. It has emerged as a highly profitable cash crop with low investment requirements but substantial returns. The sericulture industry has played a crucial role in transforming the country's economy and fostering economic stability in India. It has effectively contributed to reducing unemployment and supporting the livelihoods of the economically disadvantaged, including those belonging to scheduled castes (SC) and scheduled tribes (ST). Presently, sericulture serves as the primary source of income, either directly or indirectly, for a considerable number of individuals, with a significant proportion hailing from marginalized sections of society (Savithri *et al.*, 2013).

Sericulture provides employment opportunities across various stages, including food plant farming, rearing, reeling or spinning, weaving, and garment production. This has a significant impact on enhancing the rural economy through self-employment. The sericulture industry is a crucial source of work and employment in numerous developing countries with abundant labour resources. It is a versatile product that caters to the needs of the poorest individuals while also being used by the

affluent. China holds the distinction of being the world's largest silk-producing country, engaging approximately 20 million people in sericulture production. India ranks second, offering employment to around 5.5 million individuals. As silk continues to play a transformative role in the global textile consumption, it remains a prominent fiber known for its exceptional elegance. However, its position as the "queen of textiles" may face challenges due to the emergence of other stylish alternatives. Non-mulberry silks, such as Tasar, Eri, Muga, Anaphe, and limited-production varieties like Fargana, Coan, Mussel, and Spider, also contribute to the industry (FAO, 2023).

Spider silk is obtained from wild silk moths belonging to the family Saturniidae, which is part of the superfamily Bombycoidea. The Saturniidae family, the largest in the Bombycoidea superfamily, comprises approximately 1,861 species across 162 genera and 9 subfamilies. Globally, there are around 1,100 species of non-mulberry silk moths (Narang & Gupta, 1981). The Saturniidae family, encompassing about 1,200 to 1,500 species worldwide, includes 50 species that are found in the Indian subcontinent, spreading from the Himalayas to Sri Lanka (Lemaire *et al.,* 1998).

According to reports, there are approximately 80 species of wild silk moths found in Asia and Africa (Jolly *et al.,* 1975). In North East India, the family Saturniidae alone includes 24 enlisted species (Singh & Chakravorty, 2006). India itself is home to 40 species of wild silk moths, and nearly 95% of the global production of non-mulberry silks is attributed to Tasar silk. Developing countries like India make significant contributions to the world's raw silk production, primarily due to the relatively lower production costs associated with non-mulberry silks (Jolly *et al*, 1974; FAO, 2023).

While the production of mulberry silk has reached a saturation point in leading countries, the potential of non-mulberry silk, particularly Tasar silk, remains untapped. These silks, although not commercially utilized to a large extent, are consumed within the countries that produce them. The availability of labour and the untapped potential of non-mulberry silk, such as Tasar silk, have garnered attention from breeders, workers, and biologists, as it presents a promising opportunity (Arora, 1979).

Silk production relies on two key elements: food plants and manpower. In the case of mulberry sericulture, a significant portion (over 60%) of the production value is dedicated to raising and maintaining the food plants. Additionally, substantial initial investments are required for rearing houses, equipment, and other necessary infrastructure. Non-mulberry silk varieties have a higher production cost due to their reliance on domesticated silk insects. Muga silk, unique to the Assam region of India, is difficult to cultivate in other parts of the country. However, Tasar silk, with its immense potential, has been naturally bestowed. Tasar cultivation presents a promising opportunity as an additional activity in the world's forests. On one hand, it helps to mitigate deforestation, while on the other, it enables the profitable utilization of this abundant natural resource. For centuries, the significance of Tasar culture and other challenging non-mulberry silk varieties remained obscure, mainly under the purview of tribal communities. The sericulture sector received little attention, as the annual profits per family from Tasar rearing in India were traditionally low. However, through discontinuous and unsystematic research, Tasar rearing has been transformed into a viable and lucrative industry of great importance (Mohanty, 1998).

The toughness of silk is attributed to the semi-crystalline structure of the silk fibroin protein, which is the main component of silk. Sericin protein, on the other hand, is an amorphous protein polymer that acts as a glue, helping to maintain the integrity of the cocoon fibers (Ude *et al.,* 2014). The rate of silk spinning is faster at higher temperatures compared to lower temperatures, and very low temperatures can prevent silkworms from spinning cocoons altogether (Offord *et al.,* 2016).

Indeed, the silk industry utilizes various species of silk moths, but only a subset of these species is used for silk production. Silk can be classified into different types based on the species of silk worms that produce them. The most common types of silk are mulberry silk and non-mulberry or wild silk. Mulberry silk is derived from domesticated moths, whereas non-mulberry silk comes from wild or semi-domesticated moths. Non-mulberry silk can be further categorized as insect and non-insect types (Mohanty, 1998).

India has the unique distinction of producing all these commercially viable silk varieties. These varieties are classified as univoltine, bivoltine, and

multivoltine based on the number of generations produced each year. Each of these varieties has its own characteristics and uses in the silk industry, contributing to the diversity and richness of India's silk production (Gautam *et al.*, 2022).

Tasar silk is known for its copperish colour and is primarily used in furnishing centers. Tasar silkworms are plant-feeders and rely on specific primary and secondary food plants for their sustenance. The genus *Antheraea*, which includes Tasar silkworms, comprises more species of sericigenous insects than any other genus (Mohanty, 1998).

Tasar silk is produced by different eco-races of Tasar silkworms, which are primarily influenced by natural environmental conditions. There are two main types of Tasar silkworms: tropical and temperate. The species *Antheraea mylitta* feeds on various host plants such as *Terminalia tomentosa* (Asan), *Terminalia arjuna* (Arjun tree), *Ziziphus mauritiana* (Ber), *Terminalia catappa* L. (Badam tree), *Quercus spp*. (Oak), *Terminalia tomentosa* (Indian laurel), and *Shorea robusta* (Sal) (Bambhaniya *et al.*, 2017).

The major Tasar silk-producing states in India include Jharkhand, Odisha, Chhattisgarh, West Bengal, and Andhra Pradesh. Tasar silk rearing plays a vital role in the livelihoods of many tribal communities in these regions (Gautam *et al.*, 2022).

In conclusion, the history of silk and sericulture spans thousands of years, with China being its birthplace. The trade and production of silk have had a significant impact on the economies of various countries. While certain regions have excelled in sericulture, there is potential for further development in untapped areas. By understanding the challenges and implementing effective strategies, countries can successfully harness the economic and social benefits of the sericulture industry (Bukhari *et al.*, 2019).

Historical aspects of Sericulture

The sericulture industry is a significant source of employment for rural populations. The history of silk has both mysterious and romantic elements. While silk is mentioned in ancient Sanskrit literature, the most well-known myth regarding the discovery of silk originates from China. According to the myth, the 14-year-old Chinese emperor Xi Ling Shi observed a shining thread unravelling from a cocoon into a warm tea pot in 2640 B.C. (Mohanty, 1998). For a long time, the Chinese government kept sericulture as a national secret, and it remained unknown to other countries as an industry (Ravikumar, 2011).

The Chinese were creating intricate designs as early as 1300 B.C., which were more advanced than anything produced in subsequent years. The oldest silk found in the Summer Palace in Hang Zhou is estimated to be 4,500 years old (Periasamy, 1986). It is also known that during the reign of the Chaui Emperor in Japan, a Chinese individual brought silkworm eggs to India. While sericulture has records dating back to 2600 B.C. in China, silk insect eggs were first imported to Japan in 195 A.D. (Tazima, 1958). Korea was the first country outside of China to discover the secret of silk production. Chinese migrants established sericulture in Korea around 1200 B.C., and during the 300 B.C. period, the industry spread to Japan. General Semiramus, a military commander under the rule of Singu-Kongo, attacked and occupied Korea, taking some sericulturists as prisoners and bringing them to Japan. Later, this trade expanded to India via Tibet when a Chinese princess, carrying silk insect eggs and mulberry tree seeds in her headdress, married the king of Khotan in Tibet around 1400 B.C. (Devasurappa, 1986).

Information about silkworms and silk production reached Japan through Korea in the 3rd century AD and later spread to Europe (Bukhari & Kaur, 2019). According to reports, sericulture was introduced to India about 400 years ago, and until 1857, it thrived as an agro-industry with an annual production of two million pounds of silk fiber. Between 1857 and 1895, the industry faced challenges due to the outbreak of Pebrine disease. After 1928, intense competition from progressive sericulture countries like China, Japan, and European nations led to a decline in the industry. However, after independence, sericulture experienced resurgence as an agro-industry, providing employment to over 7 million people across the country. Sericulture has proven to be beneficial for the economy, particularly for marginalized communities such as scheduled tribes and scheduled castes. Wild silk sericulture is primarily practiced by tribal communities, and sericulture is well-suited for small and marginal farmers (Kumar & Sneha, 2022, Kumar *et al* 2022).

For a long time, wild sericulture remained a mysterious craft practiced by tribal and hill communities in Central and Northeastern India. Recently, there has been a renewed interest in the involvement of these communities in the industry, attracting attention on a national scale. The abundant production potential within the country has created a

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demand for wild silk products internationally. The eco-friendly nature of wild silk production, along with the involvement of women in various processing activities, has facilitated the commercial exploitation of this traditional craft, transforming it into an industry with vast potential. Wild silks have been profitable and exploited since the 17th century, especially when an uncontrolled silkworm disease devastated the sericulture industry in Europe, leading to the development of alternative silks. When Asian nations could not meet the demand for mulberry silk from Europe and North America, it created a market for wild silks (Bukhari *et al.*, 2019).

Sericulture is an agro-based industry that involves the rearing of silkworms for the production of raw silk. This includes activities such as cultivating host plants to feed the silkworms, spinning silk cocoons, and unwinding the silk filament for value-added processes like weaving and processing (Pateriya, 2021).

Global status of Sericulture:

The belt of sericulture in the world generally follows the Tropic of Cancer, up to approximately 50°N latitude. The major silk-producing countries in the world include China, India, Brazil, Japan, Vietnam, Uzbekistan, North Korea, Thailand, South Korea, Iran, and others. There are also some countries that are involved in the production of cocoons and raw silk on a smaller scale, such as Kenya, Botswana, Nigeria, Zambia, Zimbabwe, Bangladesh, Colombia, Egypt, Nepal, Malaysia, Turkey, Bulgaria, Uganda, Romania, and Bolivia (Thiripura Sundari & Rama Laxmi, 2015).

Silk is one of the oldest and most precious fibers in the world, accounting for only 0.18% of total cloth and fiber production. Despite its rarity, silk production remains active and has even seen significant growth. However, countries like France, Italy, Spain, and Portugal are no longer major producers of silk. Japan, which was once the top producer, has declined in its ranking, while China has emerged as the leading producer, accounting for 60% of the world's total silk production. Currently, there are 50 countries worldwide involved in raw silk production, some of which have longstanding traditions in sericulture, such as Thailand and Zimbabwe. India, known for its traditional silk production, aims to increase its silk production and currently holds the second position globally as a raw silk producer. The sericulture industry has become more industrialized in silk-producing countries, but it has also faced challenges and decline due to competition from other profitable activities in agriculture or industry, as well as competition from low-wage producing countries (Ronald, 1988).

The main markets for silk products are the USA, Europe, Japan, and India. The demand for silk materials is growing in industrialized countries and is expected to increase in developing countries as well. The overall silk production is gradually increasing, and more countries are getting involved in sericulture training, which indicates positive signs for the development of the sericulture industry (Mohanty, 1998).

Sericulture in India:

Non-mulberry silk, also known as forest or wild sericulture, is a distinct category of silk production apart from mulberry silk. Currently, China and India are the two largest silk-producing countries, accounting for more than 60% of the world's silk production. India holds the second position globally and contributes 18% to the total raw silk production. In India, there are five main types of silk varieties: Mulberry, Eri, Tropical Tasar, Temperate Tasar, and Muga (Singh *et al.*, 2017).

Mulberry sericulture is primarily concentrated in states such as Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu, Odisha, Maharashtra, Gujarat, Bihar, Uttar Pradesh, Kerala, and Jammu and Kashmir. Of the total silk production, 96% is from multivoltine (many generations in a year) silk variety, and 3% is from bivoltine (two generations in a year) silk variety. Tropical Tasar is mainly found in Bihar, Jharkhand, Odisha, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, West Bengal, and Maharashtra, while Temperate Tasar is predominant in Manipur, Nagaland, Mizoram, Meghalaya, and Arunachal Pradesh. Eri silk is produced in Assam, Meghalaya, Bihar, Arunachal Pradesh, Manipur, Mizoram, Nagaland, and Odisha. Muga silk is primarily limited to Assam and to a lesser extent in Mizoram. Sericulture is a labour-intensive agro-industry that provides significant employment opportunities for rural residents, particularly those from Scheduled Castes (SC) and Scheduled Tribes (ST). It is a highly profitable cash

crop with minimal labour investment (Mohanty, 1998).

The sericulture industry encompasses various sectors, including seed production, silk rearing, weaving, reeling, and the utilization of by-products, providing extensive employment opportunities for rural and tribal communities (Gregory, 1994; Srivastava *et. al*., 2003). Mulberry silk is the most prevalent variety, accounting for approximately 79% of the country's silk production. In 2017-18, the production of the five silk varieties was 31,931 metric tons, with Mulberry silk accounting for 69.09% (22,062 metric tons), Tasar silk for 9.45% (3,018 metric tons), Eri silk for 20.86% (6,661 metric tons), and Muga silk for 0.60% (190 metric tons). There is also a growing awareness of sericulture in non-traditional regions (Bhattacharjya *et al.,* 2020). India has immense untapped potential for silk development, and with increasing awareness and efforts, its development is within reach (Dewangan *et al.,* 2011).

Tasar culture in India:

Tasar silk, also known as Vanya silk, is a significant tribal culture in India (Alam *et al.,* 2018). India holds the second rank in silk production globally, contributing over 18% of the total raw silk production (Singh, 2020). Tropical Tasar silk is produced by the silkworm species *Antheraea mylitta*, while temperate Tasar silk is produced by *Antheraea proyeli*. These silkworms feed on plants such as *Terminalia arjuna* (Arjun), *Terminalia tomentosa* (Asan), and *Quercus* sp. (Oak). Tasar silk production is closely associated with forest-based fauna diversity and is a source of revenue for tribal inhabitants (Jolly *et al*., 1974).

Tasar silk, also known as "Tussah," is characterized by its copperish colour and coarse texture, which gives it a unique feel and appeal. It is primarily used for weaving silk clothes and furnishing materials. The adaptability of Indian Tasar silk is unmatched, and it is considered a special gift to the world. The sericulture industry of Tasar silk is primarily practiced by tribal populations in forest areas. It provides a great source of income for rural communities, especially tribal people. Tasar sericulture has significant potential for sustainable development, creating employment opportunities for approximately 250,000 rural individuals (Vishaka *et al.,* 2020).

Temperate Tasar silk is mainly found in the sub-Himalayan belt of India, covering regions such as Jammu & Kashmir, eastern Manipur, Himachal Pradesh, Assam, Arunachal Pradesh, Mizoram, Nagaland, and Meghalaya. It yields it silk in three cycles annually, with harvest periods in June to July and January to February, providing better earnings (Jolly *et al.,* 1974). However, Tasar silk larvae face challenges such as pest attacks, predators, and climatic threats, leading to significant mortality (Samitha & Purushotham, 2005).

The Tasar silkworm, *Antheraea mylitta* Drury, exists in 44 ecological ecoraces in various geographical zones in India, depending on different host plants and ecological conditions. Tasar silk was once widely distributed in Asia and European countries during the 19th century (Srivastava *et al.,* 2016). In India, tropical Tasar silkworm is extensively distributed due to the abundance of suitable host plants, although only 5% of them are utilized for Tasar culture. States such as Jharkhand, Bihar, Chhattisgarh, Odisha, Madhya Pradesh, Sikkim, Meghalaya, West Bengal, Tamil Nadu, and Himachal Pradesh, as well as some areas in Uttar Pradesh, engage in Tasar silk production (Sinha & Prasad, 2011).

Tasar silk production involves the family Saturniidae in the order Lepidoptera, which includes various eco-races influenced by environmental conditions. In India, *Antheraea mylitta* Drury is profitably used for Vanya silk production, providing income for numerous underprivileged families. Tasar silk exhibits higher air permeability compared to mulberry silk. Curtains made from Tasar silk fabric outperform those made from mulberry silk fabric (Bamhaniya *et al.,* 2017). *Shorea robusta* accounts for 80% of the host plant range for Tasar silk in India, while *Terminalia* species and other host plants make up the remaining percentage (Singh & Mishra, 2003). The choice of food plants significantly impacts Tasar silk cocoon quality (Jadhav *et al.,* 2014). *Antheraea mylitta* feeds on primary and secondary food plants such as *Terminalia arjuna*, *Shorea robusta* (Sal), *Terminalia tomentosa*, *Ziziphus mauritiana*, *Anogeissus latifolia*, *Syzygium cumini*, *Hardwickia*, and *Lareya arborea* (Reddy *et al.,* 2010). Large-scale production of Tasar silk is challenging due to the wild nature of *Antheraea mylitta*. However, if the species is reared under systematic and scientific conditions outdoors, it can yield higher quality cocoons. Understanding the feeding habits of Tasar silk larvae and selecting appropriate food plants based on

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specific environmental conditions are critical for successful rearing (Jolly et al., 1974).

Tasar culture in Uttar Pradesh:

Tasar silkworm rearing in Uttar Pradesh follows a bivoltine cycle, with two crops produced each year. The first crop is reared during the rainy season from July to August, while the second crop is reared during autumn in September to October (Deka, 2016). In Uttar Pradesh, Tasar silk production is not as familiar as mulberry silk production. The environmental conditions for Tasar silk rearing are less favourable compared to mulberry rearing in Uttar Pradesh. However, certain districts in Uttar Pradesh, such as Hardoi, Jhansi, Mirzapur, Sonbhadra, Lalitpur, Sultanpur, Varanasi, Chandauli, and Banda, may have more suitable climatic conditions for Tasar rearing (Sathe & Jadhav, 2001, Bhargava, 2023).

The Mirzapur area in eastern and southern Uttar Pradesh is known for its high floral and faunal diversity and is considered a biodiversity hotspot. This region provides primary and secondary host plants for Tasar silk worms. *Antheraea mylitta*, the Tasar silkworm, is naturally bred in these regions. With improved conditions, human efforts, social awareness, and the adoption of advanced techniques, the growth of Tasar silk production in eastern Uttar Pradesh could be further enhanced. Tasar culture contributes to biodiversity conservation and improves the economic conditions of tribal communities (Bhargava, 2023).

Sonbhadra district, which covers an area of 6,788 km2 in Uttar Pradesh, is characterized by protected forests, including semitropical evergreen and dry deciduous forests. The rearing conditions for *Antheraea mylitta* in the Sonbhadra region are favorable due to its diverse flora and fauna. The temperature in this region can reach up to 41.4°C in April-May and drops to 9.1°C during the winter season in December-January. The rainy season in Sonbhadra lasts from June to September, with the majority of rainfall occurring during the southwest monsoon. The district receives an average rainfall of 136.6 mm, and the average humidity is around 65% (Indian Climate) (Bhargava, 2023).

Significance of Tasar culture:

Tasar silk, produced by wild silk moths or massive silk moths, has emerged as an important trade and practice in India. Previously, it was primarily known among tribal, hill societies, and indigenous communities residing in isolated forest areas of the Central Plateau and Northeastern regions. However, in recent times, the significance of this tribal practice has gained recognition throughout the country. The abundant production capabilities within the nation, coupled with steady demand for Tasar silk products in international markets, have led to the transformation of this age-old tradition into an industry with immense potential (Jolly *et al*, 1974; Mohanty, 1998).

The Tasar silk region not only fosters tribal development but also contributes to environmental protection, regeneration, and serves as an effective poverty alleviation measure. It plays a crucial role in creating rural employment opportunities and curbing rural migration. By embracing Tasar rearing, tribal communities contribute to environmental conservation by eliminating the need to cut trees, as Tasar culture becomes an integral part of their way of life. The simplicity of the Tasar rearing process, which requires no fees or expertise, aligns well with the lifestyle of tribal people. In a world where artificial fiber manufacturing harms the environment, sericulture, including Tasar culture, stands out as an eco-friendly practice that meets the demand for special textiles. Tasar rearing provides significant benefits to tribal communities, ensuring their sustenance through food, shelter, and other basic requirements (Jolly *et al*, 1974; Mohanty, 1998; Pateriya, 2021).

The Tasar culture also plays a vital role in the conservation of bioresources. It offers substantial financial returns, employment opportunities for both genders, and serves as a strong foundation for Tasar silk-based rural cottage industries. Studies worldwide emphasize the recommendation and promotion of sericulture to restore environmental stability, safeguard endangered silk insects, and preserve related flora and fauna for future generations (Jolly *et al*, 1974; Mohanty, 1998; Ravikumar, 2011; Pateriya, 2021).

Sericulture, known for its labour-intensive nature across all stages of production, provides year-round income and continues to contribute to rural development. It serves as a significant source of employment, with approximately eleven people, including six women, employed for the production of one kilogram of raw silk. In the production chain, about 6 million permanent workers, including 3.5-4

million women, are employed. Tasar culture plays a crucial role in bridging the income gap between urban and rural areas. The growing trend of the Tasar silk industry in various states contributes to poverty reduction planning. To enhance marketing and attract high-end buyers, it is necessary to progressively increase working capital funds and improve the transportation and native marketing systems. Given the substantial tribal population in the country, the sericulture industry holds particular importance in ensuring the financial stability of tribal communities (Jolly *et al*, 1974; Mohanty, 1998; Ravikumar, 2011; Ray et al, 2012; Pateriya, 2021).

The vast availability of Tasar food plants in both tropical and temperate regions, spanning approximately 11.16 million hectares and 1.26 million hectares, respectively, presents significant potential. However, currently, only 5% of the temperate Tasar food plants are being utilized. The Tasar silk industry has the potential to generate extensive employment opportunities and contribute to foreign exchange earnings (FAO, 2023).

In conclusion, Tasar culture in India has evolved from a traditional practice to a thriving industry with immense potential. It fosters tribal development, environmental protection, and poverty eradication. Tasar silk production not only provides economic benefits but also empowers rural communities, particularly tribal populations, through year-round income, employment, and opportunities for sustainable livelihoods (Bhargaca, 2023).

The Role of Sericulture in National Economy:

The abundant natural resources in our country have highlighted the potential for accelerating economic development through appropriate measures. Economic growth has become a significant focus, both in India and globally. To transform a low-income agrarian society into a prosperous industrial nation, two key factors must be addressed. Firstly, agriculture needs to be sufficiently productive so that only a small portion of total income is required for fiber and food production. Secondly, there should be opportunities for resource transfer from the agricultural sector to the non-farm sector, promoting greater efficiency (Dewangan, 2018).

In India, this process has been ongoing for a considerable time. Agriculture is not merely a means of livelihood; it is a way of life that has shaped the thoughts and circumstances of numerous individuals for centuries, as recognized by the Indian Financial Commission (Bhttarcharjya *et al.,* 2020). However, rural areas in India face various forms of poverty and complex challenges such as scarcity and underemployment. Effective interventions and appropriate technological choices are essential to alleviate poverty, promote production, and improve the overall income levels without adversely affecting productivity (Dewangan *et al.*, 2011).

The sericulture industry, encompassing both farm and non-farm activities, plays a significant role in India's rural economy by generating approximately sixty lakh jobs per year (Roy *et al.*, 2012). It holds a prominent position in the rural budget of the nation and serves as a tool for rural development, providing additional income and employment opportunities. Silk production has become an attractive rural activity due to its low initial investment, extended growth period, significant employment opportunities, and rapid return on investment (Kasi, 2011).

Silk, being a trade-oriented product, is exported to around 50 countries, including the United Kingdom, United States of America, United Arab Emirates, Italy, and Saudi Arabia. Several Asian and European countries are the major consumers of Indian silk. The role of export and import in the progress of both a nation and a state's economy cannot be understated. International trade offers advantages such as foreign exchange earnings, industrial growth, utilization of available resources, and the creation of large-scale employment opportunities. In the early stages of development, exports and imports serve as the engine of economic growth for a country or state (Bhttarcharjya *et al.*, 2020).

Women role in Sericulture:

Women make significant contributions to rural economies across various sectors worldwide. However, evaluating their specific contributions in terms of magnitude and diversity can be challenging, as it varies between countries and regions. Their roles and activities differ within and between areas, especially in regions experiencing economic and social transformations in the agricultural sector. In rural villages, women often manage family affairs and pursue multiple sources of income (Bhttarcharjya *et al.*, 2020; Geetha *et al.*, 2020).

Their activities typically involve cultivating crops, tending to animals, preparing food, engaging in wage labour in agriculture and other rural activities, collecting water and fuel, seeking livelihood opportunities, participating in marketing activities, maintaining households, and caring for family members. Although these diverse activities may not

be classified as "economically active employment" in national economic reports, they play a significant role in the well-being of rural families. In India, the favourable agro-climatic conditions (temperature and humidity), along with existing skills and market infrastructure, have led to silk production being concentrated in states such as Karnataka, Andhra Pradesh, Chhattisgarh, Jharkhand, Uttar Pradesh, Jammu and Kashmir, and Orissa. A large number of workers in the sericulture industry belong to economically disadvantaged sections of society (Best & Maier, 2007; Bhatta & Rao, 2003; Geetha & Indira, 2011; Geetha *et al*., 2020).

Women have a substantial presence in the sericulture industry, with a large number of people involved in sericulture activities relying on family members, particularly older individuals and women. Women actively participate in various agricultural activities, including sericulture, dairy farming, poultry farming, beekeeping, mushroom cultivation, fish cultivation, and social forestry (Prasad & Chandra, 1991). The labour contributions of women in sericulture are well documented in the context of rural development (Chowdhuri *et al.,* 2011). It has been observed that the collaboration between men and women can yield tremendous results in the sericulture industry (Usha Rani, 2007; Geetha *et al*., 2020).

Conservation of Tasar Biodiversity and Sustainable Development:

The development of agriculture and rapid urbanization, coupled with deforestation, has led to a decline in forest areas and the destruction of biodiversity, including tropical Tasar silk. The loss of habitat due to environmental degradation and other related factors poses a threat to the biodiversity of Tasar silk in India. The decline in the natural population of Tasar silkworms is alarming, as their habitats are being lost due to desertification and habitat fragmentation (Nayak *et al.,* 2000; Hansda *et al.,* 2008). The decline in naturally growing Tasar cocoons, which used to contribute significantly to Tasar silk production, is a cause for concern. Without conservation efforts, there is a risk of losing these valuable genetic resources. Therefore, it is crucial for environmentalists to prioritize the conservation of these diverse Tasar fauna through genetic variation, allowing them to adapt to different environmental conditions (Conner *et al.,* 2002; Kakati & Chutia, 2009).

The investigation of food plants for Tasar silk production is important not only for the sustainable exploitation of wild silk insects but also for the conservation of wild biodiversity. Conservation efforts aimed at preserving Vanya silk entomofauna indirectly contribute to the preservation of overall biodiversity (Novotny *et al.,* 2002). Biodiversity conservation has become a matter of livelihood and sustenance for humanity, making it essential to preserve sericulture biodiversity, especially the endangered Tasar silkworm germplasm and its food plants. Initiating conservation awareness programs for rural communities and promoting silk worm rearing can provide economic benefits to tribal communities while supporting forest and biodiversity conservation (Alam *et al.,* 2018).

Biodiversity is crucial for sustaining human life as it provides food, fuel, shelter, fiber, medicines, and other daily necessities. Therefore, it is important to increase understanding, preserve, and sustainably utilize biodiversity with appropriate human intervention. Breed conservation is essential not only for establishing new breeding programs but also for saving species that are at risk of extinction. Preserving the hereditary traits and exploring them is essential for the progress and development of the silk industry in the country (Ghosh *et al.,* 2019).

Conservation of forests is of utmost importance as they provide valuable natural resources, protect land and water resources, prevent wind erosion, control floods, store nutrients, and provide habitat for wildlife. Forests also hold significant hereditary properties and are a part of the collective heritage of society. The utilization of these resources should be regulated in a way that ensures the sustainability of renewable resources and the nourishment of mankind. Biodiversity protection should be planned with the involvement of the people within and around protected areas (Mohanty, 1998).

As an emerging agrarian country, India has multiple pathways for development within the agricultural sector. Preserving the biodiversity of Tasar silk is crucial to support various sectors of the population. Tasar and tropical forests are not only the "green lungs" of biodiversity but also vital for maintaining a healthy environment. The richness of nature has sustained and delighted people throughout

history, providing them with sustenance through the use of plants and animals for clothing, food, shelter, and medicine. However, unsustainable human practices are threatening this biodiversity. Therefore, the concept of "sustainable utilization," which entails orderly, appropriate, and strategic use of natural resources, becomes imperative (Mohanty, 1998).

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