Golden Threads of Tradition: The Endurance And Evolution of Muga Culture And Silk Weaving in Assam

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Abstract
Muga culture is an age old traditional practice sustaining amidst the rural folk of Assam since time immemorial. It involves lot of traditional practices and beliefs over the time and many of the time these traditional practices have proved to be successful and sustainable. Muga silk is a product of the silkworm, *Antheraea assamensis* Helfer is endemic to Assam province. Assam is known for creating intricate designs in handlooms and holds first position in the country with 11,11,577 number of handlooms and has 16,43,453 handloom weavers. Sualkuchi is the textile centre of Assam. At present, this golden yellow thread has evolved from a tradition to a trend. The muga silk holds monopoly in the world and has been a sector of research and development recently due to its immense potentiality to provide opportunities for national and international revenue.

Keywords: muga silk, *Antheraea assamensis*, ITK, silk weaving, handloom, motifs

Introduction:

Muga culture is an age old traditional practice sustaining amidst the rural folk of Assam since time immemorial. It involves lot of traditional practices and beliefs over the time and many of the time, these traditional practices have proved to be successful and sustainable (Mech and Vijay, 2022)**.** Silk industry in Assam is significant from the early period of Ramayana where the Assam was known as a country of cocoon rearer. Rearing, reeling of silkworm and weaving were a daily routine in ancient Assam. Throughout ages, Assam is also called the **'Land of Golden silk'** (Mahan, 2012)**.** The silk industry of Assam flourished and progressed during the Ahom regime (1228- 1828 A.D.) due to the care and keen interest taken by the ruling kings. The Tai-Ahoms had invaded Assam in 1228 A.D. and since then sericulture was an integral part of their culture. Silk from Brahmaputra valley was marketed to Magadh, Aung, Mithila and Brahmadesh during 1340 B.C. (Phukan, 2012). Kamrup, Sibsagar, Jorhat, Golaghat, Lakhimpur, Dhemaji, Goalpara, Udalguri, Kokrajhar, Tinsukia, Dibrugarh are the major muga silk producing districts of Assam (Borpuzari, 2022).

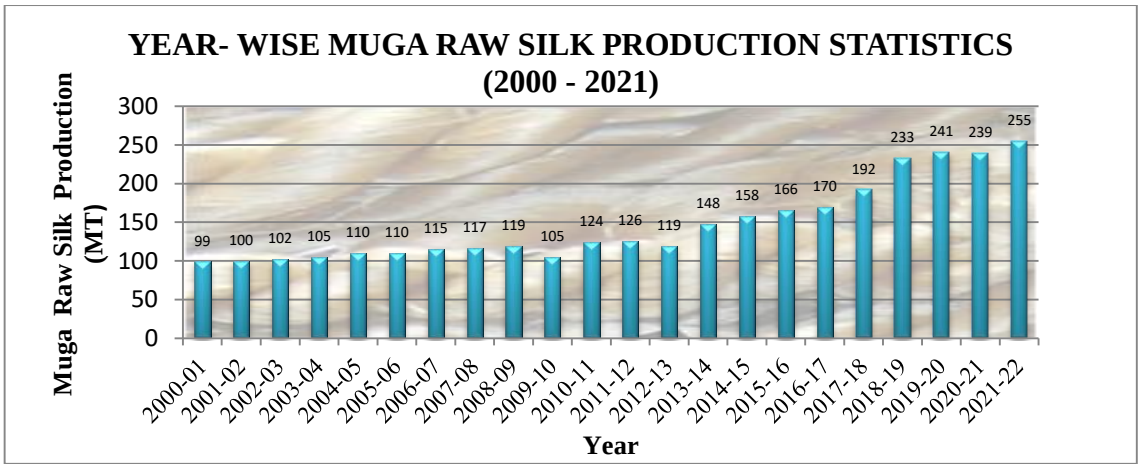
Muga culture is a traditional practice in Assam and adjoining states of North East India and it involves lot of indigenous technical knowledge (ITK) based on long experience of the farmers over the time. Indigenous knowledge has enormous importance in different fields of agriculture including sericulture. Buresh and Cooper (1999) defined indigenous technical knowledge as consisting of facts, experiences, practices, resource management strategies and production systems developed through trial-and-error during several millennia in a given community, nation or region. Atte (1989) enlightened that indigenous technical knowledge is the knowledge of a given population that reflects the experiences based on their tradition. The traditional muga farmers commonly used ITK in selection of healthy brood, silkworm rearing and seed production, pests and diseases management of silkworm, stifling of cocoons, reeling, *etc* (Mech *et al.*, 2015).

Assam is a uniquely suitable place for muga culture due to its favourable climatic conditions and is renowned for its golden-coloured muga silk yarn (Unni *et al*., 2009; Saikia, 2012). Cloths made out of muga silk are UV protective, colour stable and comfortable to wear in both the summer and winter seasons. The threads of silk are used in surgical sutures as well as in regular clothing and muga yarns are incorporated into aircraft tyres, bulletproof jackets and parachute ropes (Nath, 2013). Muga silk is therefore of considerable socio-economic value as it contributes significantly to the economy of the country.

Muga silk is a product of the silkworm *Antherea assamensis* Helfer endemic to Assam province. It is a semi domesticated multivoltine insect belongs to order Lepidoptera and family Saturniidae. The larva of these silkworms feed primarily on som (*Persea bombycina*) and soalu (*Litsaea monopetala*) leaves (Neog, 2011). The natural golden color silk produced is known for its glossy fine texture and durability (Baruah, 2023). Muga possesses unique characteristics such as unique method of cultivation and

Plate. 1 Muga silkworm (*Antheraea assamensis* Helfer)

production, color stability, golden colour increases with each wash, tensile strength (4.53g/D), strongest amongst all silks, UV absorption capacity (>80%), durability (over 50 years), acid resistant and thermal properties (Akhtar, 2022). The muga silk has received the Geographical Indication Tag (GI Tag) in the year 2007 and the Trademark logo in the year 2014 (Hnamte, 2022).



***Source*:** Annual report, 2021-22, CSB, Bangalore

Fig.1: **Year- wise muga raw silk production statistics (2000 - 2021)**

TABLE. 1: STATEWISE MUGA RAW SILK PRODUCTION 2021-22

State	Muga silk (MT)	State	Muga silk (MT)
Andhra Pradesh	-	Manipur	1
Arunachal Pradesh	2	Meghalaya	39
Assam & BTC	211	Mizoram	2
Bihar	-	Nagaland	0.24
Chhattishgarh	-	Odisha	-
Haryana	-	Punjab	-
Himachal Pradesh	-	Sikkim	-
Jammu & Kashmir	-	Tamil Nadu	-
Jharkhand	-	Telangana	-
Karnataka	-	Tripura	-
Kerala	-	Uttar Pradesh	-
Madhya Pradesh	-	Uttarakhand	-
Maharashtra	-	West Bengal	0.01
Total			**255**

***Source*:** Annual report, 2021-22, CSB, Bangalore

Prices:

Muga cocoons ('000 nos) = Rs. 3000 (min), Rs. 4000 (max.)

Muga raw silk = Rs. Rs. 28000 (min.), Rs. 34000 (max.)

Plate. 2 Muga raw silk

R&D in Muga Industry:

Central Muga Eri Research and Training Institute (CMER&TI), Lahdoigarh

Central Muga Eri Research and Training Institute (CMER&TI), Lahdoigarh, Jorhat provides R&D support for the development of muga and eri industries especially in Eastern and North-eastern regions of the country.

Highlights in brief of the research works carried out during 2021-22 are as follows:

- One promising muga silkworm line with improved characteristics, such as above 500 meter filament length, compact cocoons and fecundity of above 250 was shortlisted and test verified under limited trials.
- A quick and efficient cocoon pre-treatment method to achieve uniform cocoon cooking in muga cocoons with improved reelability and raw silk recovery was developed.
- Cold reeling technique in muga was standardized for improving seed availability during unfavorable seasons (pre-seed & seed crops).

Government schemes

- Muga Eri Silkworm seed Organization (MESSO) is having two P4 units and five P3 units for production of muga basic silkworm seed and one Muga Silkworm Seed Production Centre for the production of commercial muga silkworm seed.
- Besides, under North Eastern Region Textile Promotion Scheme (NERTPS), three muga P3 Basic Seed Stations and one SSPC have also been established. These units have produced and supplied 6.20 lakh muga DFLs (3.68 lakh basic DFLs & 2.52 lakh commercial DFLs) during 2021-22.

Integrated Sericulture Development Project (ISDP):

1. Eighteen projects were approved with a total cost of Rs.31.97 crore with Government of India share of Rs.525.11 crore under ISDP in Assam including BTC, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura states. The projects will cover 29,910 acres of mulberry, eri & muga plantation to support around 41,068 beneficiaries belonging to all NE States.
2. Presently, 33,920 hectares of land is covered under silkworm food plantation in the state by involving around 3,53,000 families from 20, 333 villages and 17,916 reelers.
3. Government of India has supported Assam for implementation of Catalytic Development Programme (CDP), a centrally sponsored scheme from IX Plan to first 3 years of XII Plan. The CDP envisaged development of host plantations, post-cocoon infrastructure, up-gradation of silk reeling and processing facilities, extension, capacity building, enterprise development, and publicity etc.
4. With a view to restructure centrally sponsored scheme, the Government of India discontinued the CDP during 2015-16, and introduced Silk Samagra (Compendium on Seri-States, 2019).

Marketing

'Khon' is the counting unit of muga cocoon (1,000 cocoons = 1 khon). There is no organised marketing system in the state of Assam. However, the state government facilitates the farmers to market the cocoons produced by them at identified locations in the state and invite reelers and other consumers to participate in open auctions. This marketing system is not on a daily basis due to the reason that the sericulture activity in Assam is seasonal. The state has established cocoon banks at Boko (Kamrup), Golaghat and Lakhimpur (Compendium on Seri-States, 2019).

Table. 2: Goods and Service Tax for Silk Sector (GST)

Items	Description	GST
Silkworm cocoons	Suitable Reeling	0%
Raw silk	Not Thrown (Untwisted/ Not thrown)	
Silk waste	Reeling/Spinning/Weaving waste including waste cocoons	
Silk Yarn	Spun silk, twisted (Mulberry/Tasar/ Muga) silk, Noil, Silk embroidery Yarn	5%
Silk Fabrics	Sarees, Handloom/power loom woven fabrics, other silk fabrics, Ready made garments, etc • Garment value is < Rs. 1000/- = 5% • Garment value is > Rs. 1000/- = 12%	5% & 12%
Silk Machinery	All types of reeling, Twisting, Spinning, Weaving, Testing Machinery	18%
Silk handloom Machinery	All types of Handloom (weaving machinery)	0%
Silk Testing Services	Silk Testing & Analysis Services	18%
Silk Expos	Events, Exhibitions, Conventions and Trade show Organisations and Assistance Services	18%

***Source*:** Central Silk Board, Bangalore

Traditional Muga culture Practices of Assam

Muga culture is an outdoor practice, which is strongly affected by climatic and other environmental conditions. Yet, Muga culture remains an activity in the rural landscape because traditional methods developed by local culturists have been capable to hold back the losses of Muga silkworms at low stage. These methods, passed down from generation to generation only by word of mouth, may or may not have a scientific background, but they represent indigenous knowledge that may be crucial for muga sericulture and thus has to be worth recording.

Traditional rearers believe that muga silkworms are holy and that the rearing depends on the blessings of the Gods. With regard to sericulture in Upper Assam, a number of proverbs exist, of which this may serve as an example: "*Ahu kheti ahu kal muga kheti kopal val, hali kheti korilei pai*". In English this means that 'cultivation of rice depends on the season, but the rearing of muga depends on the fate of the rearer". Therefore, even today, muga rearers in the rural areas implement traditional knowledge at each and every step of the entire rearing and spinning processes.

Steps involved in Muga culture

I. Selection of host plant

Traditional rearers usually prefer the Som tree for the production of good quality silk yarn, but the sualo tree is favoured for seed cocoon production due to the resultant variation in colour and compactness of silk yarn.

Muga farmers apply their traditional knowledge to identify suitable host plant for muga silkworm rearing. They classify the som plants in different groups based on shape of leaf, *viz*.,

a) Naharpotia-leaf shape resembling leaf of Indian iron wood (*Mesua ferrea* L.)
b) Belpotia - resembling wood apple (*Aegle marmelos* Correa) leaf
c) Jampotia-resembling blackberry (*Syzygium cumini* (L) Skeels) leaf
d) Kathalpotia-resembling jack fruit (*Artocarpus heterophyllus*) leaf
e) Aampotia-resembling mango (*Mangifera indica*) leaf

Based on farmers' traditional knowledge, **Naharpotia** is the most preferred variety for muga silkworm rearing. Experienced muga farmers use to identify the preferred variety of som plants by chewing the leaves. According to the farmers, taste of the suitable leaves is sweet (Sarmah, 2010).

II. **Selection of seed cocoon**

In Assamese, there is a proverb, ***"Namonir sonch ujanir goch"*** that means, seed cocoon from lower Brahmaputra valley reared in upper Brahmaputra valley always ensures successful harvest of cocoons. The traditional rearers usually select seeds by seeing the larval colour, movement, number of ridges on the silkworm litter (preferred 6 ridges) and by touching the tubercles of the larvae. Feeding behaviour of silkworm is a criterion for seed cocoon selection, since feeding of leaves from top to bottom is a sign of healthy worms. (Sarmah, 2010).

III. Rearing techniques

Selection of breeds for rearing: If high quality silk production is the main aim, this favours May-June and October-November harvests, *i.e.* Jethua and Kotia breeds, but if the production of seed cocoons for the rearing of muga silkworms is the priority, then the other four breeds, *i.e.* "Jarua" (December-January), "Chotua" (March- April), "Aherua" (June-July), and "Bhodia" (August-September) can also be used.

Seeds in the "chokori pera": The rearers generally keep the seed cocoons in the chokori pera (a box made of bamboo), spreading out the cocoons in it evenly for easy emergence of moths from the cocoons and is a precaution against microbial contamination. The box with the seed cocoons is kept in the kitchen close to the wood fire at a certain height so that the cocoons can receive optimal heat for their metamorphosis. Traditional rearers usually spread tulsi or holy basil (*Oscimum sanctum*) and kochu (*Alocasia indica*) twigs over the cocoons to prevent infections or to avoid "the evil eye" (*i.e.*, mukhloga). The rearers also spray the aqueous extract of tulsi leaves on the floor of the room where the cage with the seed cocoons is kept.

After emergence, the female moth is tied with cotton threads onto a kharika. The kharikas consist of thatch grass of about 30 cm in length and 1 cm in diameter, bent into the shape of a hook at one end. The rearers hang the kharikas on a jori (*i.e.*, a long rope made from strips of bamboo) inside a separate room of the house and allow the female to mate with a male. Copulation or aar-joa is permitted for about one day, after which the moths normally decouple, which is known as Aar-bhonga. Thereafter the rearer uses smoke out of burning rice straw, a process known as jumuthi, in the house for providing a mild heat to the decoupled female moth.

Hatching of eggs: About one hour after copulation the female moth may start to lay her eggs. The rearers will take only the eggs which are laid on between one to two days after copula tion, believing that these eggs are best for rearing. Thereafter the kharikas, bearing the eggs, are very carefully hung on the chak (*i.e.*, equipment made out of bamboo.

Traditional rearers dip the egg-bearing kharikas in a dilute extract of *Oscimum sanctum* leaves to stimulate fast and uniform hatching of the eggs.

Transfer of newly hatched larvae to host plant: On the first day of hatching the muga rearers transfer the kharikas from their home to the host plant on the farm, the Somoni. This process is known as "khorika logua" (= putting the khorikas on the tree). The khorikas are kept on the host plant for a week so that all the larvae can creep onto the host plant and start feeding on its leaves more or less simultaneously.

After stripping a tree bare due to their feeding activity, the larvae crawl down the trunk of this tree, but to prevent them from crawling down onto the soil and thereafter be difficult to locate, rearers surround the trunk at about 1.0-1.2 m above ground with a girdle or jori bandh, which the larvae will not crawl over. The girdles are made of either thatched grass (Imperata *cylindrica*) or a variety of dry leaves and fresh pseudo-stems of banana plants (*e.g., Musa balbisiana, Colla sp.*) , or sometimes with fresh leaves of kapau dhekia (*Microsorium punctatum*) and tora (*Alpinia allughas*).The muga larvae never cross or even touch the girdle, which may be due to the presence of the chemicals in the plant material used in the girdle. Thereafter the rearers can pick up the larvae by hand and place them on the chaloni, the triangular bamboo support, and put them on another tree that still carries green leaves.

Rules to be followed during rearing process

During the rearing process rearers abide by the following customs: In order to avoid mukhloga disease (the "evil eye"), other than the rearer no outsider is allowed to be near the culture. Recently, Sarmah *et al.* (2010) described "mukhloga" disease as flacherie, a bacterial or viral disease of muga and other silkworms, e.g. *Bombyx mori* (Yokoyama, 1973). Women, not even those belonging to the rearer's family, are allowed near the culture during their menstrual periods. People who are taking care of the rearing process in the farm are not allowed to use any cosmetics (body oil, hair shampoo, soap, powder or scented substances), trim their hair, shave their beards or cut their nails during the rearing period.

To protect the larvae from predatory birds and other animals in the somoni the rearers stay in the Somoni for the entire rearing period. They construct a temporary hut or shelter with bamboo and thatch grass and call it somoni ghar (= farm house). In it they keep essential tools and equipment and also prepare the "batolu guti" by drying them over a fire or keeping in strong sunshine. They keep the jalies (= cocoon forming cages) in the house, where they also cook their food and from where they control every step of the rearing process.

Collection of Ripe silkworms:

The mature or ripe larvae can be identified by behavioural changes like ceasing to feed, becoming sluggish and unwilling to crawl (locally known as jholom dhora) and starting to release copious amounts of excreta. At night they crawl down the tree and this mass exodus of larvae crawling down the tree is known as bhor pok. The bhor pok varies with the season, *e.g.*, during the summer it lasts for 5-6 days but in winter for 8-9 days. At night the rearers collect the mature, ripe muga larvae by hand and put them into the khurung (a basket made of bamboo).

Cocooning in Jalies

For cocoon formation, the rearers keep the mature muga silkworms in jalies, (leaf mesh) which are bundles of dry leaves of various plant species like Nahor (*Mesua ferrea* sp.), Singori (*Castanopsis sp.*), Azar (*Lagerstroemia speciosa*), Bhomlati (*Celastrus monospermus*) and Mango (*Mangifera indica*). Among these leaves, Singori leaves are the most favored one. Before the leaves and twigs are used, they are properly dried in the sunlight and ants and other harmful invertebrates are carefully taken out. However, in winter before preparing jalies the dry leaves are kept above the fire at certain height on a bamboo plate for a while for warming it up. They test the temperature of the jali by putting in the hand in the jalies and due to this warming the larvae at once enters into the jalies for cocooning. While in summer the fresh leaves are likewise employed for setting up jalies. The moisture in the fresh leaves believed to let down the temperature of jalies in summer thereby leads to easy cocooning.

IV. Post-rearing techniques

Drying of cocoons

The muga rearers collect the cocoons of the silkworms from the jalies one week after cocoon forming has occurred but damaged cocoons are sorted out within 4-5 days to avoid further infections. Out of the population of suitable cocoons, the rearers select the very best, keeping them aside as seed for their next breed. The remaining cocoons are dried under strong sunshine or by keeping them above the fire at certain height on a bamboo plate for 3 to 4 days. This procedure not only dries the cocoon, but also kills the pupa inside it without damaging the cocoon. Apparently smoke dried cocoons give a better shine to the muga yarn than sun-dried ones do.

Boiling or cooking of cocoons

Before reeling can commence the cocoons are cleaned by removing their outer most cover, known as floss, which is loosely bonded to muga yarns and cannot be reeled off. Once the cleaning has been done, the cocoons are boiled. During boiling various traditional degumming and other facilitatory reeling reagents are used. These include the kolakhar (aqueous extract of dried banana peel or pseudostem of *Musa balbisiana* (Musaceae) charred and steaped overnight in water) and dhankhar('alkali' derived from an extract of rice straw ashes) and for easy reeling of the thread, slippery substances like owtenga (*Dilenia indica* Linn.), simalu (*Bombax malabaricum*), joba pat (*Rosa chinensis* leaves), kukurhuta leaves are used depending upon their availability.

Reeling of silk yarn from muga cocoons

After cooking, the cocoons are kept in warm water devoid of the alkali additions and reeled onto bhanguri, bhowri or bhir (spinners) made of wood. Two persons are required for this process, one for spinning out the thread from the boiled cocoons and the other for reeling it on the bhanguri and subsequently yarns are rolled out from spinner and dried in sun to give a final Muga thread.

Indigenous Traditional Knowledge

Dighloti as ITK against disease incidence

The plant ***Litsea salicifolia*** is locally named as **Dighloti** in Assam and known as secondary host plants of muga silkworm. Traditionally, the plants are used for brushing of newly hatched muga silkworms and it is believed that muga silkworm fed on Dighloti leaves at the early stages (1st to 3rd instars), cocoon yield is enhanced. Nath *et al*. (2013) revealed that the extent of disease incidence of muga silkworm was only 6.4 percent in ITK hybridized improved technology against 14.4 percent in existing improved technology package. Average yield of 70 cocoon per dfl and ERR 62.2 percent was significantly higher in ITK hybridized improved technology as compared to the yield of 56 cocoons per dfl and ERR 51.7 percent in improved technology package.

De-pairing of moths using smoke

One of the most common indigenous technical knowledge is 'de-pairing of moths using smoke' and it is strictly followed by the muga farmers in Upper Brahmaputra Valley of Assam. Usually, the muga moths have tendency for pairing more than 20 hours in undistressed condition. Unless, the moths do not depair either naturally or mechanically, female moths do not start egg laying. Hence, the paired moths after allowing to pair at least for 4-6 hours need to be depaired for facilitating egg laying. In this process, paired moths kept in dark room are exposed to light and smoke generated through firing of thatch grass or leaf and twigs of plant at least for a period of 5-10 minutes normally in the afternoon, which helps to decouple of moths naturally (Borthakur 2003 and Thangavelu *et al.* 1988). The farmers believe that the practice is highly effective for enhancement of fecundity as well as self de-pairing of moths.

Plate. 3 Khora

Plate. 4 Chak

Plate. 5 Egg laying on Kharika by female moth

Plate. 6 Chokoripera

Plate. 7 Chaloni

Silk weaving in Assam

Assam is known for creating intricate designs in handlooms and holds 1st position in the country with 11,11,577 number of handlooms and has 16,43,453 handloom weavers. Assam is the third largest silk producing state in India. The state produces around 85% of global muga silk (Annual report, 2021-22, CSB, Bangalore).

Sualkuchi - The silk village of Assam

Sualkuchi is the textile centre of Assam. This village is known as the **"Manchester of Assam"** and was established by Momai Tamuli Barbaruah, a great administrator of the Ahom kingdom. Muga silk and Pat (mulberry) silk cloth from this region is famous for its quality. The pride village Sualkuchi is situated under Kamrup (Rural) district of Assam. The weaving tradition in this area started in the 11th century when King Dharma Pal, of the Pala dynasty sponsored the craft and brought 25 weaving families from Tantikuchi to Sualkuchi. Fly shuttle handlooms and hook jacquards are benignly used in the Assam for silk weaving. The village became a weaving village when the Shams occupied Sualkuchi

defeating the Mughals in the mid 17th century. Presently 73.78% of the households of the village are being engaged in commercial weaving and hand-loom. 90% of household of Sualkuchi have looms. It is found that 79% families have traditional looms at their home, 17% of them have modern looms for commercial silk weaving (CSB, Assam). Sualkuchi produce Sarees, Mekhela-Chadar, Salwar-Kameez, Kurta, Scarf, Gamosa and Dupatta, *etc*. In Kamrup (rural) district there are approximately 6,000 handlooms. Out of which 4,478 handlooms are situated in Sualkuchi. Total numbers of weavers in this village are 12,056 out of which 57% are female weaver (Phukan, 2012).

Critical Gaps in Muga Silk Industry

1. High mortality of muga silkworm/pupae during young and spinning stages which is basically due to pests and predators as well as climatic vagaries.
2. Poor realized fecundity (120-150) in Muga silkworm against potential fecundity of 250-280 numbers.
3. Silk recovery in Muga is very low (40-45%), which accounts almost 50% reduction in production (reelability).
4. Large scale proliferation of small scale tea growers in Upper Assam. It is estimated that 70,000 small tea growers are in Assam and most of the traditional muga plantations are occupied by tea growers.
5. Lack of appropriate system for cocoon and silk marketing in muga sector.

Conclusion

The changes that were adopted by modern sericulturists, albeit at the expense of traditional practices, have undoubtedly led to a greater efficiency in silk production and consequently the quantity of silk reaching the market is likely to increase. However, there is much more to be done in this sector, at research level as well as at the government level so as to take Muga culture and hence the Muga silk production to greater heights.

References

1. Ahmed, S. A., Singh, N. I. and Sarkar, C. R. (2015). Role of forest biodiversity in conservation of non-mulberry (vanya) silk in India. *Munis Entomology & Zoology*, *10*(1), 342-357.
2. Akhtar, N. (2022). Environmental Influences on the Muga Silk Industry of Assam: Globalization Perspectives. *Contemporary Social Sciences*, 85.
3. Anonymous. (2019). *Compendium on Seri-States, 2019*, Central Silk Board, Bangalore.
4. Anonymous. (2021). *Annual Report 2021-22*, Central Silk Board, Bangalore.
5. Babu, K.M. (2012) Silk fibres. In Handbook of natural fibres, Vol. I: Types, properties and factors affecting breeding and cultivation (Kozłowski, R.M. ed.), pp.146-170. Woodhead Publ. Ltd. Cambridge.
6. Baruah, M. B., and Kalita, P. (2023). Muga silk: Sustainable materials for emerging technology. In *Advanced Materials from Recycled Waste* (pp. 295-316). Elsevier.
7. Borpuzari, S. P., Das, M. R., and Rahman, A. (2022). Comparative study on the Rearing performance of muga silkworm (*Antheraea assamensis* Helfer) on two primary host plants Som (*Persea bombycina* Kost) and Soalu (*Litsea monopetala* Roxb) in different rearing seasons. Eco. *Env. & Cons*, *28*(1), 568-573.
8. Borthakur, S.K. (2003) Ethnobiological wisdom behind the traditional muga silk industry in Assam. *Indian Journal of Traditional Knowledge*, 2, 230-235.
9. Chakravartty, P. and Basumatary, K (2018). Sualkuchi Village of Assam: The Country of Golden Thread. *IOSR Journal of Business and Management*, 20 (3), 12-16.
10. Chakravorty, R., Dutta, P. and Ghose, J. (2010) Sericulture and traditional craft of silk weaving in Assam. *Indian Journal of Traditional Knowledge*, 9, 378-385.
11. Cloudsley-Thompson, J.L. (1976) Insects and history. 1ed., Weidenfeld and Nicolson Publishers, London.
12. Erren, T.C., Koch, M.S. and Meyer-Rochow, V.B. (2013). Common sense: Folk wisdom that ethnobiological and ethnomedical research cannot afford to Ignore. *Journal of Ethnobiology and Etnomedicine*, 9, 1-12.
13. Hani, U., and Das, A. (2017). Design intervention in the handloom industry of Assam: In the context of a debate between traditional and contemporary practice. In *Research into Design for Communities, Volume 1: Proceedings of ICoRD 2017* (pp. 999-1006). Springer Singapore.
14. Hnamte, I. L. (2022). Geographical Indications Act and Cultural Appropriation in Northeast India: Scope and Analysis. *Issue 2 Int'l JL Mgmt. & Human.*, *5*, 137.
15. Jolly, M.S. (1986) Pebrine and its Control, In Bulletin No.5, pp.1-34. Central Sericultural Rresearch and Training Insti tute, Mysore.
16. Mahan, B. (2012). Silk industry among the Tai-Ahom of Assam, India as an attraction of tourist. *International Journal of Scientific and Research Publications*, *2*(12), 1-4.
17. Mech, D. and Vijay, N. (2022). Indigenous technical knowledge for higher fecundity of muga silkworm seeds. *Plant Archives*,Vol. 22, pp.88-91.
18. Mech, D., Ahmed, M. and Kumar, R. (2015). Indigenous technical knowledge associated in muga culture. In *Biological Forum*, 7(1), 1-6.
19. Meyer-Rochow, V.B. (2005). Traditional food insects and spiders in several ethnic groups of Northeast India, Papua New Guinea, Australia and New Zealand. In Ecological implications of mini-livestock: rodents, frogs, snails, and insects for sustainable development (Paoletti, M.G. ed.), pp.385-409. Science Publ., Inc., Enfield.

20. Meyer-Rochow, V.B. and Changkija, S. (1997) Uses of insects as human food in Papua, New Guinea, Australia, and NorthEast India: Cross-cultural considerations and cautious conclusions. *Ecology of Food and Nutrition*, 36, 159-185.
21. Nath, R., Haloi, K., Talukdar, B., and Devi, D. (2013). Comparative study on tensile properties of different colour morphs and wild counterpart of muga silkworm (*Antheraea assamensis* Helfer) of North-Eastern India. *International Journal of Research in Biological Sciences*, *3*, 141-144.
22. Neog, K., Unni, B., and Ahmed, G. (2011). Studies on the influence of host plants and effect of chemical stimulants on the feeding behavior in the muga silkworm, *Antheraea assamensis* Helfer. *Journal of Insect Science*, *11*(1).
23. Nunome, J. (1988) Archaeology of silk and cloth. 1ed., Yuzankaku Publishers, Tokyo.
24. Phukan, R. (2012) Muga silk industry of Assam in historical perspective. *Global Journal of Human Social Science History and Anthropology*, 12, 5-8.
25. Phukan, R., and S.N. Chowdhury (2006) Traditional knowledge and practices involved in muga culture of Assam. *Indian Journal of Traditional Knowledge*. 5, 450-453.
26. Saikia, S. (2012) Muga silk: the golden silk of Assam. Lambert Academic Publishers, Saarbrücken.
27. Sarmah, M. C., Rahman, S. A. S., and Barah, A. (2010). Traditional practices and terminologies in Muga and Eri culture. *Indian Journal of Traditional Knowledge* Vol. 9 (3), 448-452.
28. Thangavelu, K.; Chakroborty, A.K.; Bhagowati, A.K. and Isa, M.D. (1988). Handbook of muga culture, Central Silk Board, Bangalore, 68.
29. Unni, B.G., Goswami, M., Kakoty, Y., Bhattacarjee, M., Wann, S.B., Rajkhowa, G., Das, S., Devi, B.R. and Chutia, A.D. (2009) Indigenous knowledge of silk worm cultivation and its utilization in North Eastern region of India. *Indian Journal of Traditional Knowledge*, 8, 70-74.
30. Yokoyama, T. (1963). Sericulture. Annual Review of Entomology, 8, 287-306.
31. Yokoyama, T. (1973) The history of sericultural science in relation to industry. *In History of Entomology*, 1ed (Smith, R.F., Mittler, T.E. and Smith, C.N. eds.), pp.267-284. Annual Reviews Ltd. Publications, Palo Alto.