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Research Article

MUGA SILK (*ANTHERAEA ASSAMENSIS*) AS MEANS OF SUSTAINING LIVELIHOOD IN RURAL AREAS-A CASE IN BRAHMAPUTRA VALLEY OF ASSAM-INDIA

***Niranjan Das**

Department of Business Administration, Tezpur University, Napaam, Sonitpur-Assam, India

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Abstract

Assam is literally a 'Silk country' where silk culture is rooted in the rural life and culture of Assamese people. This is the only state in India and the world where Muga silk *(Antheraea assamensis)* is grown. Geographical isolation of Muga silkworm is indicative of its special requirements for geo-climatic conditions that prevail in this region i.e. high humid temperate climate and forest vegetation of primary and secondary host plants. Thus, this species is phylogenetically less adaptive reaching its ecological isolation that is indicative of being on verse of extinction. The declines of Som (*Machilus bombycina*), Soalu (*Litsaea ppolyantha*) plantation areas in rearing and sericulture farms have pushed Muga silk towards the verge of extinction. Encroachment in government Som plantation (host plant) areas is one of the prime causes of decreasing food availability of Muga silk worm. If measures are not taken the Muga (*Antheria assamensis*) heritage of Assam may face extinction in the near future. In this paper the researcher emphasizes the possibility of sustaining livelihood and conserving environment among the rural folks of the Brahmaputra valley in Assam, India.

Keywords: Muga, Natural silk, environment conservation, sustainability and livelihood.

INTRODUCTION

The Muga silk rearing is confined to the North-East India, particularly, the Brahmaputra valley of Assam. This is perhaps, due to pleasant climatic conditions and distribution of wide range of muga host plants in this region (Tikader and Thangavelu, 2006). In Assam 'Som' tree provides the principal food for muga silkworms which produce the golden coloured silk that is very specific and prestigious to Assam particularly in the Brahmaputra valley of India and found nowhere else on the globe (Das *et al.,* 1970). The state of Assam is a center of diversity for som tree with rich source of genetic diversity and it is reservoir of valuable gene pool (Thangavelu *et al.,* 2005). The cultivation of som tree under diverse agro-ecological conditions for a continuous period under various biotic and abiotic stresses, specific adaptation through natural selection and farmers discretion over years have resulted, introduction of different types of som cultivars into the region leading to further diversification of the som genetic stock (Saikia *et al.,* 2016). Traditionally, the farmers of Assam had classified the som plants into four types on the basis of leaf shape locally known as Naharpatia, Ampatia, Jamupatia and Kathalpatia of which Naharpatia is considered as the best (Barah *et al.,* 1992). The land races are genetically diverse and heterogeneous population. The land races are genetic resources for the development and improvement of modern varieties. These land races are reported by several workers (Sengupta *et al.,* 1993).

Geographical Distribution of Muga Silk

Fossil's evidence indicates that the genus *Persea* originated in West Africa during the Paleocene era (geologic period from 65.5 ± 0.3 to 55.8 ± 0.2 million years ago) and spread to Asia, Europe, South America and then to North America. It is thought that the gradual drying of Africa, West Asia and the Mediterranean from Oligocene era (geologic period from about 33.7 to 23.8 million years ago) to the Pleistocene era (from 1.8 to 11,550 million years ago) and the glaciations of Europe during the Pleistocene caused extinction of the genus across these regions, resulting in present disjunctive distribution. The genus *Persea* belonging to family Lauraceae has about 70 Neotropic species, ranging from Brazil and Chile in South America to Mexico, West Indies and South-Eastern United States in North America. A single species *Persea indica* is endemic to the Macaronesian Island including Madeira and the Canary Islands; nearly 80 species in East and South-East Asia (Bhattacharya *et al.,* 1993) ranging from outer Himalayan ranges in Pakistan and India to Sikkim, Burma, Java, Sumatra, China and to Ceylon. In India, *Persea* is found up to an elevation of 8000 feet above mean sea level along the lower Himalaya from Garhwal and Kumaon Hills to Sikkim, Khasi and Jaintia Hills, Assam and to tropical wet evergreen forest of Arunachal Pradesh (Tikader and Kamble, 2018a). The best known *Persea* species is the *Persea Americana* (Avacado) widely cultivated in subtropical regions for its large, edible fruit. Whereas, in India especially in North-Eastern region *Persea bombycina* (King ex Hook f.) Kosterm. (Som) as the host plant of muga silkworms (*Antherea assamensis*, Helfer) is economically most important (Tikader *et al.,* 2011a). It grows throughout Assam both in natural and cultivated form, ascending to an elevation of about 1500 ft in the Khasi and Jaintia Hills of Meghalaya and along with pine and oak forest of Garhwal and Kumaun hills region up to the altitude of 1500 meter above mean sea level (Phukan, 2012). It also grows along the lower Himalaya as far as west Nepal.

Muga Host Plants and Their Distribution

Muga silkworms' food plants grow well in high rain fall, humid and warm climatic conditions in Assam. Most of the muga food plants belong to the family Lauraceae (order-Laurales). The species occur in natural condition in sub-Himalayan hill range particularly in the north-astern India

Corresponding Author:** ***Niranjan Das,
Department of Business Administration, Tezpur University, Napaam, Sonitpur-Assam, India.

(Hazarika *et al.,* 1996). The food plant of western and sub-Himalayan belts is variable and show different morph metric characters with those of Assam, Arunachal Pradesh, Meghalaya and Mizoram (Paliwal and Das, 1989). Among the different food plants, som *Persea bombycina* (King ex Hook.f) Kostern is principal food plant of muga silkworms (*Antheraea assamensis* Helfer). Thangavalu *et al.*, 1988 have reported 11 species as food of muga silkworms. Tikader (2010) reported 19 species as food plants of muga silkworms, among which *Zizyphus jujube*, *Zizyphus maririana, Gmelina arboraea, Michelia champaca, Michelin oblonga, Symplocos paniculata, Symplocos grandiflora, Symplocos ramosissima, Zanthoxylum armarum* and *Zanthoxylum limonella* are the most common species. These species are broadly classified into primary, secondary and tertiary food plants on basis of feeding preference of silkworms (Phukan, 2012).

and conducting grainage for dfls (Disease Free Laying's) production (De and Das, 2007). Traditionally, the seed cocoons intended for preparation of eggs are kept in a single layer in trays or *'Khang' (basket)* to facilitate the emergence of the moths. Moths emerge from the cocoons in the evening and pair in the bamboo tray or '*Khang*' itself mating is allowed during the night. Next morning, the mated females are separated and tied with a piece of cotton threaded to a *'Kharika'* (a roll of straw with a hook) on which they lay eggs about 150-250 eggs on the '*kharika'*. The eggs are brown. The reare's take the '*khorikas'* with hatched worms and hang them on the host plant. Lose eggs are prepared also and packed into paper or cloth bags for distribution. Muga silkworm culture is a traditional outdoor rearing practice and adopted by people of Assam states particularly Brahmaputr valley (Chakraborty *et al.,* 2010). It is polyphagias, multivoltine reared in six different seasons throughout the year.

Table 1. Geographical Distribution of Muga Silkworms Host Plant Species

Botanical name		Vernacular name	Geographical distribution
1.	A. Primary food plants: *'Machilus bumbycina'* King ex Hook. f. (Syn. *Persea bornbycina* (Kingex Hook J.) Kosterm (Lauraceae)	Som	Prevalent throughout northeast India up to an altitude of l832° meter above sea level and lower Himalayas extending from Garhwal to Nepal.
2.	*'Litsaea monopetala'* (Roxb.) Pers. (Syn. *Litsaea polyantha* Blume) (Lauraceae)	Hanalu	Extending northward from Punjab up to salt range along the foothills of Himalayas ascending to 3000 meter above mean sea level, eastward to northeast India and southward to Satpura hill range. Prevalent throughout Assam, Meghalaya, Mizoram and Nagaland. Common in plains of northeast India.
1	B. Secondary food plants *'Litsaea salicifolia'* Hook. F. (Lauraceae)	Digloti	Distributed throughout northeast India, Sikkim, and Nepal ascending up to an altitude 3000 meter above sea level.
2	*'Litsaea cubeba'* Pers. Syn, L. citrata Blume (Lauraceae)	Mezankari	Eastern Himalayas covering Sikkim to Arunachal Pradesh, Assam, Meghalaya, Mizoram, Manipur and Naga hills up to 2000 meter above sea level.
1	C. Tertiary food plants *'Actinodaphnae anquistifolia'* Nees. Syn.*A. hookeri Meissn.* (Lauraceae)	Petarichawa	Distributed throughout northeast India
2	*'Cinnamomumglanduliferu'* Meissn. (Lauraceae)	Gondhsaroi	Distributed throughout northeast India
3	*'Cinnamomum obtusifolium'* Nees., Syn. *Actinodaphnea obovate* Blume (Luraceae)	Patihanda	Common tree in northeast India. Found in Sikkim and Bangladesh
4	*'Litsaea nitida* Hook' f. (Lauraceae)	Kothalua	Prevalent throughout northeast India
5	*'Gmelina arborea'*Roxb (Verbanaceae)	Gamari	Prevalent throughout northeast India
6	*'Magnolia pterocarpa'* Roxb Syn. *M. sphenocarpa* Roxb (Magnoliacae)	Panchampa	Tropical Himalayan forest from Nepal to Assam, Meghalaya, Bangladesh and Burma
7	*'Michelia odoratissima'* Nees (Lauraceae)	Som	Prevalent in Assam and Meghalaya
8	*'Zizyphus jujube'* Mill. Syn. *Z. sativa* Gaertn. Z. *vulgaris* Lam. (Rhamnaceae)	Bogori	Common throughout India, Afghanistan, Malaya, China and Australia

Source: Present status and constraints of muga silkworm host plant germplasm conservation: Neog K, Gogoi SN, Chakravorty R (2015)

The distribution pattern of muga silkworm's food plants is given in the following table. Muga silkworm's host plants grow in natural habitats and enrich the genetic resources and diversity of species. Eri silkworm is polyphagous in nature and feeds on number of food plants. These host plant species are '*Ricinus communis'* L. (Castor), Family: Euphorbiaceae, '*Manihot esculanta'* Crantz. (Cassava/Tapioca), Family: Euphorbiaceae, '*Sapium eugeniifolium'* Buch- Ham (Korha), Family: Euphorbiaceae, '*Evodia fraxinifolia'* Hook (Payam), Family: Rutaceae, '*Alianthus grandis'* Prain (Barpat), Family: Simaroubaceae, '*Ailanthus excels'* Roxb. (Barkesseru), Family: Simaroubaceae, '*Plumeria acutifolia'* Poir (Gulanch), Family: Apocynaceae, '*Heteropanax fragrans'* (Roxb.) Seem (Kesseru), Family: Araliaceae, '*Jetropa curacus'* L. (Bhotera), Family: Euphorbiaceae and '*Gmelina arborea'* (Gamari), Family: Verbanacae grow natural habitats in this region.

Som (*Machilus bombycina)* as Principal Host Plant of Muga Silkworms

Som is the principal host plant of Muga silk worms, '*Antheraea assamensis* Helfer' and widely distributed in northeast India. Muga is a golden yellow silk produced by silk moth a semi-domesticated sericigenous insect species endemic to Brahmaputra valley of Assam. It is semi-domesticated owing to the fact that the larval stage is spent in the open and ripening worms are brought indoor for spinning the cocoons

Out of these six seasons two seasons namely, May-June and October-November are commercial crop seasons, whereas, other seasons are seed crop seasons. Again, the seed crops during December-January and June-July are called pre-seed crop. Thus, each commercial crop is preceded by one pre-seed crop and one seed crop. Since, this pattern of muga silkworm's cultivation has been an age-old practice, it is obviously environment controlled and the rearing performance is quite different in each season Nodal and. Hence, effecting rate of rearing in each season shows wide variation in different seasons due to lack of improved breeds in muga. Muga silkworms belong to the Lepidoptera of Saturniidae family and, geographically are located only to northeastern region of India. Geographical isolation of this silkworm is indicative of its special requirements for geo-climatic conditions that prevail in this region, that is, high humid temperate climate and forest vegetation of primary and secondary host plants (Choudhury, 1981). Thus, this species is phylogenetically less adaptive reaching its ecological isolation that is indicative of being on verse of extinction and urgent required *in-situ* conservation (Ahmed *et al.,* 1998). Although, Muga silkworm since time immemorial has been reared for muga silk still it is purely an outdoor culture on host plant under natural conditions. Only cultural specificity is being managed and took care by muga rearer. Being exposed to natural environment muga culture practices encounter lots of problems right from brushing of

worms to spinning of cocoons. Outdoor silkworm's larvae are invariably expose 'to nature's vagaries such as seasonal climate change, rainfall and strong wind, solar temperature, besides pests, predators and pathogens inflecting heavy loss particularly in early three instars (Raja Ram, 1998). Prophylactic measures adopted for pest and diseases in outdoor rearing became fruitless due to cross infestation by both pests and pathogens are common in open conditions. Sengupta reported that more than 50 per cent worms was lost during summer due to abiotic factors and 80 per cent of total loss of muga silkworms occurred in second and third instars only (Siddiqui *et al.,* 2000). Although, a number of farmers' friendly new technologies have been innovated (Srivastava *et al.,* 2000) for the development of muga industry to enhance the muga silk production, still production of cocoon per dfl in different season is far away to meet demands of consumers, in the region. It is very essential to develop new technologies especially new improved host plant varieties to increase the raw silk production in the muga growing states.

Som and In-situ conservation of Muga Silk (*Antheraea assamensis Helfer*)

Muga silkworms show diversity within the species which indicate the possibility of isolation of new inbreed lines and development hybrid in the species. Although, the species shows heterozygous nature, there is no any improved muga silkworms breeds for commercial exploitation (Tikader and Kamble, 2008a). Nodal. As old aged traditional practices of Ahom Kings, seeds were collected preferably from forests of Garo Hills through rearing in jungle in *In-situ* habitats which was further multiplied as commercial crop in valley during *Kotia* (October-November) and further multiplied through selection breeding in pre seed crop (December-January) and seed crops (February-March) till *Jethewa* (April-May) commercial crop where, bumper cocoons were harvested. The historic muga crop management practices of Ahom kings indicated the needs of *In-situ* conservation of muga silkworms and improvement of breeding strategies. The breeding of muga silkworms from P4 stock to Pl stock is directly correlated with dfl (Disease Free Layings) production systems which need details investigation and standardization of breeding technologies of species. Thangavalu (1988) reported muga management system from P-4 stock (seed rearing) to P-l stock (commercial rearing), it indicates the modification due to changes of global climates and rapid deforestation in northeastern states of India (Tikader and Kamble, 2008s). Muga silkworm's shows heterozygous natures in wild conditions and after 5-6 successive generations develop homozygous nature and lose the vigor and heterosis due to genetic drift and inbreeding depression. The cultivated lines of '*Antheraea assamensis'* cannot be utilized as parents' materials in P-4 stock for multiplication in P-3, P-2 and P-l stock for seed production and commercial cocoon production. Presently, the silkworms breeding technologies in seed production system of muga silkworms, P-4 parent resources are collected from the farmers' field due to lack of germplasm or improved breeds in the species. Muga silkworm's loss their heterozygous character in *Ex-situ* conditions which indicate the necessity of conservation of muga in natural habitats to continue heterozygous nature. Som can play significant role in conservation of muga silkworms in natural habitats for evergreen nature (Tikader *et al.,* 2011a). The species should be extensively planted in the forest, national parks, and reserve forest hence standard model for plantation is essential for the species.

Economics of Muga Silk Rearing

Sericulture is one of the most important crops where minimum investment is required with maximum return. Rupees 58,552/- can be generated from 1 acre of som plantation through silkworms rearing using paid labours. On the other hand, Rs 83,392/- can be earned using labours from 1-acre som plantation within a year. Details of economics of som plantation and silkworms rearing are discussed below.

An expenditure of Rs. 15,416 has to be incurred per year from 2-4th year growth of plantation to conduct 1000 dfls per year in 5th year growth of plantation. Hence, Rs. l5,416.00 is considered for calculation of economics.

Impact of Muga Rearing on Livelihood

The Handloom Textile and Sericulture Department, Govt. of Assam has launched Integrated Sericulture Development Project (ISDP) to popularize Muga rearing in the state particularly in the Brahmaputra valley of Assam. North-East Region Textile Promotion scheme has contributed to livelihood opportunities and natural resource management initiative to the local community in the Brahmaputra valley in different way. The community has been benefitting from Muga rearing a fee that is paid by govt. under the scheme for the lease of land. About 1 hectare of land from each household have been leased at a fee of Rs. 94,000 per year. Over and above the community individually receives amounts ranging between Rs. 2000-Rs.3000 per year as bed charges (local accommodation) paid by the tourist/researcher who visits the area to explore Muga rearing culture. The community uses these earnings to support different community livelihood initiatives such as the provide money to self-help group, construction of schools, community houses, roads and expanses for community festivals. Eco-friendly accommodation that has been developed in the region pays monthly salaries to local community who serve in the muga farm. Individual households benefit from the sale of muga cocoon, muga cloth and the different organic food stuff that are sold to individual and tourists. Earnings received from muga rearing are used in various ways, including purchase of livestock; land as well other necessary item, initiatives that are contributing towards livelihood in general and local food security in specific. The community reside in the Brahmaputra valley benefitting from improved infrastructural systems. These include better road network and other facilities such as drinking water, cleanness, school, medical facilities and so on. The all-weather road has improved community accesses to outside markets. To increase som plantation for the muga rearing the community constructed eleven small barrages on the different tributaries and planted som (*Machilus bombycina)*. Community contact to the outside world has improved following access to electricity and telephone line provided by the govt. More benefits to the local community come in a form of contribution from the department of Sericulture, Government of Assam. The sericulture department has been involved in the establishment of som plantaion and also facilitated negotiations between the community and govt. through workshops and exposure tours, helped to build trust for the initiative among the members of the community.

Table 2. Initial Establishment Cost of 1 (One) Acre of Som Plantation

Sl No	Particulars	Input	Man days	Rate (Rs.)	Amount (Rs.)	Remarks
1.	Land preparation by Tiller	-	3	500	1500	
2.	Uprooting of trees, Removing roots and leveling plot	-	15	300	4500	
3.	Pit digging @50/man day	-	10	300	3000	
4.	FYM application/ Manuring of pit		8	300	2400	
5.	Seedling cost	800		3	2400	
6.	Seedlings Transplantation	-	8	300	2400	
7.	Cost of FYM	4t		1550	6200	
8.	Aldrin (5%) dust	4 kg		120	480	
9.	Cultural operation	-	22	300	6600	
10	Urea (Kg)	70 kg		22	1540	After 6
11.	SSP (Kg)	90 kg		15	1350	months
12.	MOP (kg)	50 kg		25	1250	of growth
13.	Fungicide/insecticides	10 kg		500	5000	
14.	Bamboo fencing	30		120	3600	
15.	Miscellaneous			-	1000	-
Total =			66		Rs. 43,220	

Source: Collected and computed by researcher from field, 2019

Table 3. Annual Expenditure for 1 Acre of Som plot per year from 2-4 year of growth

Sl	Item	Input	Man days	Rate (Rs.)	Amount (Rs.)	Amount (Rs.)
1.	Part of initial cost				-	-
2.	Repayment of bank interest			8 % pa	2200	
3.	Digging & weeding		12	300	3600	
4.	Cost of cow dung	4 t		3000	12000	
5.	Cost of urea	150kg		22	3300	
6.	Cost of SSP	170kg		18	3060	
7.	Cost of MOP	60kg		25	1500	
8.	Application of items at 3 to 7		15	300	4500	
9.	Insecticide & pesticide				1000	
10.	Miscellaneous				1000	
	Total =		27		Rs. 32,160	

Source: Collected and computed by researcher from field, 2019

Table 4. Initial Investment on Silk Worm Rearing Based on 1 Acre of Som Land

Sl	Item	Quantity	Amount (Rs.)	Longevity (years)	Depreciation/ Year (Rs.)
.	Jali house for silkworms	1 No.	25000	5	5000
2.	Worms transfer chalani	50 Nos.	17500	5	1750
3.	Jali stands	10 Nos.	2000	5	100
4.	Knife	1 No	100	10	10
5.	Hygrometer	1 No.	400	10	40
6.	Bamboo pachi/plastic container	10 Nos.	1500	10	150
7.	Sprayer machine	1 No.	1500	10	150
8.	Rearing net	10	15000	10	1500
9.	Bambii	20	2000	5	100
10.	Miscellaneous		500		
	Total		65,500		8800

Source: Collected and computed by researcher from field, 2019

Table 5. Annual Expenditure on Silk Worm Rearing from 1 Acre of Som Land

Sl No	Particulars	Input	Man days	Rate (Rs.)	Amount (Rs.)	Remarks
1.	Depreciation (initial investment)				8800	
2.	Interest on initial Investment			8% pa	1752	
3.	Production of som leaf			Table 2	15416	
4.	Bleaching powder	12 kg		20	240	
5.	Lime	20 kg		7	140	
6.	DFL for 2 seasons	1000		6.5	6500	
7.	Labour for silkworm Rearing		120	180	21600	
8.	Miscellaneous				1000	
	Total =		120		55,448	

Source: Collected and computed by researcher from field, 2019

1. Profit with labour = Rs. 58,552/-; 2. Profit with family labour = Rs. 83,392/-; 3. Cost benefit ratio with labour = 1: 1.95; 4. Cost benefit ratio without labour: 1: 37

Table 6. Annual Profit from 1 Acre of Som Land

Sl	Item	Quantity	Rate (Rs.)	Amount (Rs.)	Remarks
1.	Cocoon harvest at 60 nos./dfl	60,000			
2.	Sale of cocoon	57,000	2	1,14,000	
3.	5% damage cocoon			500	
4.	Total gross income			114,500	
5.	Total expenditure			55,448	
6.	Net profit			58,552	

Source: Collected from the field, 2019

The major investment of muga earnings is used for livelihood because there is no other foremost means of income generation in brahmaputra valley. Following exposure tours and consultative meetings local members have identified various forums for sharing information on technological innovations of muga rearing and possible funding. Despite the different gains, reports from consultative meetings point to negative effects of muga rearing on livelihood. It is clear, for instance, that only a few members and/or institutions benefit. While the 'empowered few' help to mobilize locally available resources and create awareness among the rest of the members to participate in muga farming initiatives, the same members marginalize the rest of the community in benefiting from muga related gains.

Impacts on Environment Conservation

Impacts on natural resource management on muga rearing initiatives has made positive impact on natural resource management and environment conservation. This is primarily because of national policy to integrate the initiatives with resource management and conservation. Conservation is still being influenced by the premise that any lifeform needs to be protected to avoid overutilization and/or through competition with nature. Despite this orthodox practice, there is evidence that the numbers of plants and animal species have either remained stable or increased due to som plantation. Massive plantation of som tree under the scheme has contributed to retaining congenial environment that improves the biodiversity in the area. The number of White Winged Wood Duck (*cairina scutulata*) a critically endangered bird species found in Brahmaputra valley stands at 424 numbers having risen from almost few at the time of conservation efforts. Following exposure tours, the community has expressed interest to introduce sustainable tourism practices and organic farming to reduce more threat to environment.

Conclusion

This paper has established how pilot North East Region Textile Promotion scheme have changed local practices and attitudes towards muga rearing and marketing of finished product. The impacts that include accumulation of savings by individuals are leading to social differentiation beyond traditional realms further marginalizing the already impoverished groups/individuals at the expense of the elite. Young well-to-do local who are increasingly controlling power in the community following their exposure to the outside world and the wealth they have accumulated, are eroding long-established settings. This new form of marginalization has to be addressed, especially through empowerment of individuals and are motivated to actively participate in emerging livelihood options.

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