Chapter I
INTRODUCTION

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Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen and inherent affinity for dyes, high absorbance, light weight, soft touch and high durability and known as the "Queen of Textiles" the world over. On the other hand, it stands for livelihood opportunity for millions owing to high employment oriented, low capital intensive and remunerative nature of its production. The very nature of this industry with its rural based on-farm and off-farm activities and enormous employment generation potential has attracted the attention of the planners and policy makers to recognize the industry among one of the most appropriate avenues for socio-economic development of a largely agrarian economy like India.

Silk has been intermingled with the life and culture of the Indians. India has a rich and complex history in silk production and its silk trade dates back to 15th century. Sericulture industry provides employment to approximately 7.65 million persons in rural and semi-urban areas in India. Of these, a sizeable number of workers belong to the economically weaker sections of society, including women. India's traditional and culture bound domestic market and an amazing diversity of silk garments that reflect geographic specificity has helped the country to achieve a leading position in silk industry. India has the unique distinction of being the only country producing all the five known commercial silks, namely, mulberry, tropical tasar, oak tasar, eri and muga, of which muga with its golden yellow glitter is unique and prerogative of India.

As may be seen from Table-1, world raw silk production was 1,52,868 MT in 2012. China leads the world with silk production of 1,26,000 MT or 82.41% of the total production. India is the second largest producer of silk in the world and

has 15.49 % share in global raw silk production. All the countries except China and India have been witnessing a declining trend in raw silk production in the last two decades.

Table 1. World Raw Silk Production:

Silk Production in MT

Country/Year	2008	2009	2010	2011	2012
China	98620	84000	115000	104000	126000
India	18370	19690	20410	23060	23679
Brazil	1177	811	770	558	614
Indonesia	37	19	20	20	20
Iran	180	82	75	120	123
Japan	96	72	54	42	30
North Korea				300	300
Thailand	1100	665	655	655	655
Turkey	15	20	18	22	22
Uzbekistan	770.5	780	940	940	940
Vietnam			550	500	450
Others	30.5	30	31	47	57
Total	**120396**	**106169**	**138505**	**129684**	**152868**

Note: Figure of India is for financial year April to March. *Source: www. inserco.org*

Man is always inquisitive of silk products. Silk- the queen of textiles spells luxury, elegance, class and comfort. Mankind has always loved this sparkling fibre of unparallel magnificence from the moment Chinese Empress Xi Ling Shi discovered it in her cup of tea in 2697 B.C. The unique exquisite qualities of this natural fiber have made silk a fascination for all class of people of the world.

Sericulture refers to the conscious mass scale rearing of silk producing organisms in order to obtain silk from them (Ganga and Chetty, 1997). Sericulture

plays an eminent role in the rural economy of India. It is a viable agro-based industry, which was first introduced into India about 400 years back. Since then the industry is flourishing as an agro-based industry. Among the five commercially exploited silk varieties produced in the country, Mulberry silk is produced throughout the country, Tropical Tasar, temperate/Oak Tasar are produced by tribal inhabiting in Central India and Sub-Himalayan Region, Eri Silk (spun silk produced mainly in N. E. Region, now practiced in many other states) and Muga – Golden silk is produced only in Brahmaputra valley of Assam province in NE Region. The non-mulberry silks (Tasar, Muga & Eri) are now being popularized as *Vanya* silk (Ahmed and Rajan, 2011).

North Eastern Region (Longitude 77 to 99^0 E and Latitude 22 to 28^0 N) of India comprising Assam, Meghalaya, Manipur, Tripura, Mizoram, Arunachal Pradesh and Nagaland, popularly known as 'Seven Sisters', occupies an important position in sericulture map of India on account of its unique faunal and floral wealth. Congenial climatic condition has made the region natural home for enormous varieties of insects, moth and butter flies and particularly certain sericigenous insects as well as their corresponding host plants.

The present species diversity of the world is though described as 1.75 million out of the possible 12 to 100 million species (Hawksworth and Kalin-Arroyo, 1995). The insect group comprises the largest diversity among all living organisms with 9.50 lakh species out of 13.2 lakh animalia species. The species richness of most groups of organisms' peaks in the tropics, with rainforests is being particularly diverse. The maximum richness of plant species is mostly found near to the equator.

Biodiversity forms a still largely explored treasure that is severely endangered due to a huge amount of destructive human actions. The current rate of species extinctions due to anthropogenic actions will result in the irreversible loss

of genetic diversity, and likewise of metabolic construction plans. It can be easily predicted that the losses for agriculture, pharmaceuticals, and many other fields of basic and applied sciences like sericulture will be severe and losses will hamper the development of future research strategies and technological innovations (Barthlott *et al.*, 2005). Changes in land use, habitat reduction and fragmentation, nutrient enrichment and environmental stress caused by human beings in the form of pollutants, lead to reduced biological diversity on all levels (genes, species, and communities) and all functional roles. These accelerate the widespread extinction of bulk quantity of flora and fauna during last five centuries which are popularly known as 'the era of extinction', during which the earth has lost 200 known animal species and 400 unknown plant species each year (Koopowitz and Kaye, 1990). It is evident from reports that since 1980, the extinction rate was extraordinarily high with an annual extinction rate of 27,000 species, i.e. one species in every twenty minutes (Wilson, 1992). At this rate in 2000 AD, the number of plant species lost from the earth estimated as 40,000. The extinction of one plant species leads to extinction of several dependant animal species, which threaten the existence of human beings (Hazarika and Bhuyan, 2006). The anthropogenic actions lead to the erosion of natural forest specially the tropical forest. Till 1974, Norman Myer, a leading ecologist, estimated the loss of tropical forest ecosystem at 243200 km^2 per year. This might have increased manifold till date resulting in loss of habitats for many animals at the rate of 0.8 % to 2 % per year (May *et al.*, 1995), resulting in extinction of 16 million population per year or one individual in every two second (Hughes *et al.*, 1997). The Food and Agriculture Organization of the United Nations (FAO, 2006) estimated that about 13 million hectares –an area roughly equivalent to the size of Greece- of the world's forests are cut down and converted to other land uses every year. Forest fragmentation can jeopardize the long term health and vitality of forest ecosystem. Forest fragmentation can also result in species loss as the size of a forest become too small to support a viable population of a certain plant or animal species, which is more prominent in South East Asian Countries including India.

The North Eastern Region of India has got unique place in the silk map of the country producing all the four commercially exploited silk varieties namely, muga, eri, tasar and mulberry silk. India is considered as hot spot of seri-biodiversity particularly in case of non-mulberry (*vanya*) silk sector and the region has emerged as its epicenter. The production and sustenance of different *vanya* silk varieties depend directly as well as indirectly on forest trees, which otherwise act as food plants for these silkworms. Hence, the productivity of *vanya* silk depends on the health of the natural as well as artificial (cultivated) forest ecosystem. North East India including the Himalayan region is included in the 'Indo-Burma hot spot' (Myers *et al.*, 2000), which reflects that the region is vulnerable to high rate of depletion of bio-resources. One of the important decisive factors to declare a particular region as the hotspot is the degree of threat to endemic species through habitat loss that is alarming very high in North East India (Hazarika and Bhuyan, 2006). The original extent of primary vegetation of Indo-Burma region was 2,060,000 Km^2, which has reduced to 100,000 Km^2 in recent days, estimated at 4.90 % of the original vegetation (Myers *et al.*, 2000). The data reflects that we have lost more than 95 % of our primary vegetation which includes host plants of silkworms mainly non-mulberry germplasms. It has been reported that the large scale conversion of muga food plantations (18.75 % to 32.93%) into other plantations mainly tea in three districts of Upper Assam during 2009-2012 due to environmental pollution contributed by pesticide application in tea-agro ecosystem and burning of hydrocarbons in oil fields (Ahmed *et al.*, 2012) causing a major threat to muga silk industry. It is needless to mention that loss of a food plant is directly related to the loss of silkworm germplasm as well. Considering the above facts, it is high time to address the conservation and commercial exploitation of *vanya* silk host plants and silkworm germplasm for sustainable livelihood of different stakeholders of the silk industry.

As a matter of fact, since time immemorial sericulture and silk weaving are inseparable part of the socio-economic activities of the rural folk of North East as a

whole. It provides occupation to nearly two lakh families at present, where involvement of women is about 65% and involvement of weaker section of the society is 52.4% (ST- 40.90% and SC-11.50%). The Schedule tribe and Schedule Caste population, who are contributors to sericulture industry of North East, comprises of 12.86% and 7.40%, respectively out of total population (Neog, K., 2011).

Table 2: Performance of Sericulture Sector during XI plan period (India)

Particulars	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Growth rate (%)
Mulberry Area (Lakh ha)	1.85	1.78	1.84	1.70	1.81	1.86	
Mulberry silk							
Bivoltine	1175	1250	1200	1400	1685	1984	68.85
Crossbreed	15070	14360	15122	14960	16587	16731	11.02
Total (Mulberry)	**16245**	**15610**	**16322**	**16360**	**18272**	**18715**	**15.20**
Vanya Silk							
Tasar	428	603	803	1166	1590	1729	303.97
Eri	**1530**	**2038**	**2460**	**2760**	**3072**	**3116**	**103.66**
Muga	117	119	105	124	126	119	1.71
Total (Vanya)	**2075**	**2760**	**3368**	**4050**	**4788**	**4964**	**139.23**
Total raw silk Production (Mulb. +Vanya)	18320	18370	19690	20410	23060	**23679**	29.25
Employment Generation (Lakh persons)	61.20	63.10	68.17	72.50	75.60	76.53	25.05
Exports (in Cr. Rs.)	2727.87	3178.19	2829.44	2863.76	2353.33	2303.53	-15.56

Eri culture plays significant role in rural livelihood security especially among marginalized and weaker section of the society. Eri culture is not an organized commercial activity as in the case of mulberry. Eri culture is prevalent

mainly amongst the tribal women in hill districts of Assam, Nagaland and northern hill areas of Meghalaya. Lower Brahmaputra Valley is the traditional home of eri spinners and weavers producing bulk of eri yarn and fabric.

Eri culture is being practiced by more than 1.83 lakh families of the country with an annual eri silk production of 3116 MT during 2012-13. It has been observed that there is a considerable increase in eri silk production during last decade from 975 MT (1999-2000) to 3116 MT (2012-13) and growth rate in raw silk production was 103.66% during XI plan period whereas muga silk production remains stagnant during same period (Table 2). The improvement in eri silk production was attributed by better production management practices, fully domesticated in nature, multivoltine, better scope for product development and diversification and mostly utilization of eri silkworm pupa in food sector.

Ericulture is practiced in Assam, Meghalaya, Arunachal Pradesh, Nagaland and Manipur of North East India. Of late, eri culture is being introduced in different non-traditional states like Andhra Pradesh, Gujarat, Madhya Pradesh, Chhattisgarh, Tamil Nadu, Karnataka, Maharashtra, Uttaranchal, Uttar Pradesh, Jharkhand, Bihar, West Bengal, Orissa and Sikkim. The largest share (above 90%) of eri silk production of India is contributed from North Eastern region of India and it shares 77% of the total non-mulberry raw silk produced in the country.

Eri-silkworm, *Samia ricini* (Donovan) is multivoltine and polyphagous in nature feeding on a number of food plants *viz*., Castor (*Ricinus communis* Linn.), Kesseru [*Heteropanax fragrans* (Roxb.) Seem], Tapioca/Cassava (*Manihot esculenta* Crantz), Korha (*Sapium eugeniifolium* Buch-Ham), Payam (*Evodia flaxinifolia* Hook), Borpat (*Ailanthus grandis* Prain), Borkesseru (*Ailanthus excelsa* Roxb), Gulancha (*Plumeria acutifolia* Poir), Papaya (*Carica papaya* Linn.), Bangali era (*Jatropha curcas* Linn.) and several others. Castor is the primary food plant of eri silkworm. Kesseru ranks second among all the food plants of eri

silkworm. However, Kesseru is distributed in few pockets of North Eastern Region and is difficult to raise the plantation in outside the North Eastern Region due to ecological adaptation and short viability of seeds. To overcome the seasonality and high recurring cost of Castor, *Ailanthus* may be the alternative better option as a perennial host plant on all India perspective of eri silkworm rearing. *Ailanthus* is cultivated for feeding the worms of a special kind of moth (*Attacus cynthia* Drury) for the production of "*Shantung silk*" in the Shantung Province of China. Ministry of Forest & Environment, Govt. of India has encouraged utilizing various *Ailanthus* species for rearing eri silkworm. Four species of *Ailanthus* exist in India *viz.*, *A. excelsa, A. grandis*, *A. altissima*, and *A. malabarica.*

Although Castor leaf is the best choice, *Ailanthus* can also be utilized for sustainable crop production (Phukan *et al.*, 2006) and steady source of farm income (Chowdhury, 2006). However, these *Ailanthus* plants are not commercially exploited as host plant of eri silkworm due to non-availability of database on rearing performance as well as biochemical constituents of the *Ailanthus* germplasm. Recently, Central Silk Board, Bangalore has also emphasized on collection, conservation and evaluation of *Ailanthus* genotypes for increasing eri raw silk production. Further, information on leaf biochemical constituents of food plants acts as a basis for understanding the role of different primary and secondary metabolites on growth and development of the eri silkworm. The data on primary and secondary metabolites along with rearing performances will be helpful in developing a semi-synthetic or artificial diet for eri silkworm in long run.

While reviewing the works done so far, it clearly indicates that

- the information on rearing performances of eri silkworm feeding on different germplasm of *Ailanthus* is not available and no systematic studies have been conducted in this regard so far.

- there is no package of practices and standard methods for rearing eri silkworm feeding on *Ailanthus* tree.
- there is a large gap in the information regarding biochemical composition of the leaves of the different food plants including *Ailanthus* particularly in respect of nutrition promoting substances.

In view of the above, the present investigation was proposed to evaluate the rearing performance, reproductive biology of eri silkworm feeding on different *Ailanthus* germplasm as well as to conduct the biochemical analysis to establish the basis of economic parameters with following specific objectives:

- to evaluate and define superior genotype (s) / species of *Ailanthus* through bioassay for eri silkworm rearing.
- to evaluate the grainage performance of eri silk feeding on different *Ailanthus* germplasm.
- to characterize the different *Ailanthus* germplasm based on biochemical analysis.
- to assess the fibre quality of eri silk feeding on *Ailanthus* species.