Chapter - I

INTRODUCTION

From the dawn of empire, cloths or fibre is important among the basic needs of human. Among the fibres silk has been obtained the position of emperor by virtue of its magnificence, shine, endurance and favorable usefulness, although share of silk among world production of textile fibres is just 0.15%. Today, sericulture is practiced in industrially developed as well as developing countries and has been verdict as the queen of textiles for ages. At present 60 countries are involved in sericulture in the globe.

Silk is the protein fibre produced by silkworm larvae during spinning to produce a protective case called cocoon. After processing the cocoons, the silk is get hold of the filaments from the cocoon through reeling process. The silkworms not only produce cocoons from which the valued silk is obtained but it has other areas of uses. Indian tribes use the mature larvae as food. Huge quantity of discarded pupae after reeling operation may be used as food of fish. The product of silk waste is very cheap and available easily from reeling centers. They are use in the handicraft as raw materials and they are transformed to attractive greeting cards, festoon, flowers, wall hangings and carpets, hankeys etc.

Sericulture is not only the production of cocoons and silk for income generation, but has become the weft of the cultural fabric of the Asian countries in general and India in particular. Silk has a long tradition with pivotal role in Indian culture. It is a cottage industry spread over 53,184 villages in India, employing 5.8 million people and it is potential tool for the improvement of economic condition in rural area, involving the marginal and small farmers. Besides, sericulture has been accepted as a strong instrument of poverty alleviation and generation of rural employment for India, as 70% of the gross population of the country are rural and depend on land-based activities for their livelihood. Sericulture has also been considered as a women friendly profitable enterprise ensuring the activity for socially deprived 50% women population of rural India.

India has the unique distinction of producing all five varieties of silk of commerce viz. mulberry, oak tasar, tropical tasar, eri and muga. India is the second largest producer of both the mulberry and tasar varieties of silk in the world with a share of 18% and 10% of the total respectively, while the golden yellow muga silk is produced only in India (Benchamin and

Giridhar, 2005). The Indian sericulture industry has grown many folds since independence, *i.e.* from about measure 900 MT in 1950 to the present production level of about 19000 MT in 2007 (table 1, fig. 1).

Table 1 : Raw silk production - India (Unit: MT)

Variety	2003-2004	2004-2005	2005-2006	2006-2007
Mulberry	13,970	14,620	15,445	16,805
Tasar	315	322	308	325
Eri	1352	1448	1442	1515
Muga	105	110	110	115
Total	15,742	16,500	17,305	18,760

Source : Silk prices, *Indian silk*, vol. 46(2), 2007 and vol. 44(5), 2005.

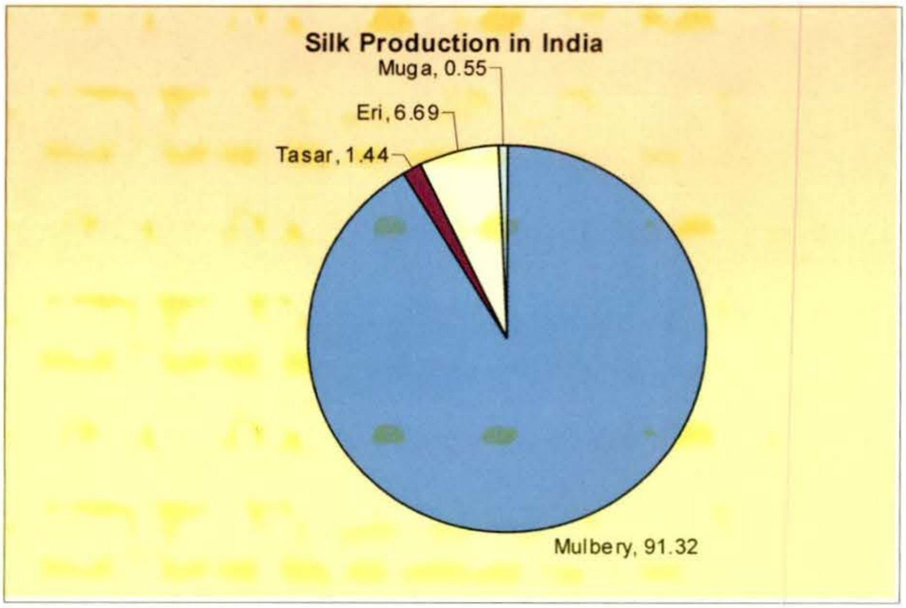

Figure 1 Silk production in India

"Wild silk" or "Non-mulberry silk" includes that fiber spun by various species of silk spinning insect, belonging to the Saturniidae, Lasiocampidae, Thaumetopoeidae, Paychidae families and others. Among these, many species from the Saturniidae produce a large size cocoon which is made by porous cocoon filaments and is different from *Bombyx* silk. The porous raw silks have a more complicated high shining than the *Bombyx* silk. Moreover, the porous cocoon filaments inhibit UV transmissivity by their repeated reflections in the textiles and also the fabrics woven by the porous silks are soft against the skin and are favored by the consumers.

On the other hand, sericine solution and powders from the wild cocoons or silks are used in cosmetics and are highly appreciated by users. For these reasons, wild silks are now recognized as a new material and have a high additional value, which is activating the silk industry.

Raw silk produced by *Bombyx mori* is the most popular textile material for high class fabrics and its uniqueness is highly praised, especially its special sheen. However, the silks of *A. yamama* and *A. assama* are even shinier than that of *B. mori.* The reasons probably because the wild silks have fine porous structure in the filament. In a compact cocoon filament like that of *B mori*, the incident rays pass straight through the filament while in the porous filament, fine porous structures create repeated reflections, hence, a more complex shine. Commercially, porous silk is highly valued because of its sheen, soft feel and the retention of desired warmth and comfort in the fabric (Akai, 2005).

This family makes a large cocoon which sells for a high price characteristics of the cocoon or the cocoon filament mainly its natural cocoon colour and porous filaments or thick and fine size are greatly appreciated by users. The cocoons of *Antheraea yamamai* are beautiful (green in colour) and extremely high priced. The *Antheraea pernyl* cocoon and si lk are produced in great quantities in China and are used widely. The *Samia cynthia ricini* cocoon is produced in India and other Asian countries and the filament is characterized by its porosity and fine size while the *Antheraea mylitta* cocoon is largest in size and filament. *Antheraea assama* produces a golden coloured raw silk, which is well known only, restricted to India, more preciously North-East India and northern West Bengal, and holds a high Price (table 2).

Table 2 : Silk price in India

Variety	Price (Rs/kg)			
	2004	2005	2006	2007
Mulberry silk	1053	1094	1343	1248
Taser silk	1450	1468	1575	1575
Eri silk	1100	1000	1000	1200
Muga silk	3150	2950	2950	3150

Source : Silk price, *Indian silk,* vol **46**(2) : 2007, **45**(2) : 2006, **44**(6) : 2005

Mulberry silk is found in different parts of the country, while the distribution of muga silkworm is mainly confined to the Brahmaputra valley of Assam and foot hills of East Garo hills of Meghalaya. Muga silk is produced by a variety of silkworm, *Antheraea assama.* In muga silkworm rearing, the worms feed on som and soalu leaves that are aromatic and rearing is done on trees. 100% muga silk produced from this region which share 6% of total silk production of the country.

Muga silkworm have about six overlapping generation in a year (Scitz, 1933). Out of six broods of muga silkworm, two are popular for commercial rearing (Thangavelu and Sahu, 1986; Yadav and Goswami, 1999) which are conducted during spring and autumn because the climatic conditions during the period are favourable for growth and development of muga silkworm as well as less environmental hazard. Muga silkworm *Antheraea assama* Westwood, being wild, reared outdoors, and hence prone to natural hazard such as high temperature, heavy winds or rain, hail storms etc. apart from falling prey to pests and predator. Autumn and spring were found as the most ideal seasons in Assam and the commercial rearing on large scales were conducted only during these periods, however, in seed zone rearing was carried out surrounding the year.

To increase the productivity three basic problems should be solved. Firstly, production loss due to field rearing should be minimized. Muga silkworm being reared outdoor on natural host plant suffers heavily due to the vagaries of the weather and pest attack leading to crop loss. Moreover, early larval instars suffer more from environmental hazards. Loss during early instars due to natural biotic and abiotic hazards minimizes the survivability leading to crop loss and ultimately poor silk productions. Therefore, to overcome this problem, scientists of Assam are trying to adopt indoor rearing (Thangavelu and Sahu, 1983, 1986; Azad *et al.*, 2000; Hazarika and Deka, 2002).

In terai region of West Bengal also, the environmental hazards affect muga culture, for this reason preliminary studies had been conducted to investigate whether at least partial indoor rearing can overcome the loss to some extent (Biswas and Ray, 2005; Ray, 2003; Ray *et al.*, 2005). Still, the complete domestication of the worm could not be made successfully. It is obvious that before attempting indoor rearing of muga silkworm, a detailed knowledge about its feeding behaviour, physiology of feeding and digestion are essential. Recent studies by Dey *et al.* (1999, 2002) on feeding behaviour have some important suggestions for indoor rearing which will certainly help in preparing the indoor rearing techniques.

Secondly, as the muga silkworm larvae fed on different host plants primarily on som and soalu, selection of host plant for rearing is the foremost work. The host plant has profound effect on relative survival behaviour, rate of food intake, digestion and assimilation, which directly influence growth, and development of silkworm (Krishnaswami *et al.*, 1970; Sinha *et al.*, 1993; Ray *et al.*, 1998; Rahaman *et al.*, 2004 and Balakrishna *et al.*, 2005). The amount, rate and quality of food consumed by a larva influence different parameters like growth, developmental time, final body weight, survival and reproductive potential (Das and Das, 2003). The insect feeds mainly on leaves of som (*Persea bombycina*) and soalu (*Litsea polyantha*). Soalu plant is naturally occuring host plant though systemic plantation of som plant for muga culture has been made. In this present situation a comparative analysis of these two host plants as well as their combinations are required especially on the basis of nutritional efficiency of the larva for selection of the host plant for successful muga culture for both commercial and seed crop.

Thirdly, extension of mugaculture outside the north-eastern states should be explored. Terai region of West Bengal particularly Cooch Behar district has choosen as non-traditional belt from last two decades (Singha *et al.*, 1991; Ray *et al.*, 2005). In Cooch Behar district, the district under consideration, there present micro climatic variations with Assam. This variations might effect the Muga culture in West Bengal. So, the climatic variation should be studied and a separate crop schedule should be prepared for successful Muga culture. In this context, in present study environmental factors will be assessed.

Bodenheimer (1928) who was one of the first to propose that the population of insects was primarily controlled by weather, which affects their development and survivability. While formulating his idea on the effect of low temperature on the rate of egg laying and the speed of development he observed the large-scale mortality (85-90%) of the insects caused by weather in their early stages. Uvarov (1931) regarded weather factors to be the major agents responsible for controlling populations and laid stress on correlation between insect population and weather. He emphasized the instability of populations in nature and doubted that all populations are in a stable equilibrium in nature. The most desirable form of insect survival is one, which is stable across locations and seasons. However, climatic and edaphic factors influence the level and nature of insect survivability. Several environmental factors are known to influence the inherited characters, especially those involving physiological characteristics of crop plants (Heinrichs, 1998; Dhaliwal and Dilawari, 1993; Kalode and Sharma, 1993; Panda and Khush, 1995).

Temperature is one of the most imperative physical factors of the atmosphere affecting the behaviour and physiological interactions of insects and host plant. Temperature induced stress can cause changes in plant physiology and affect the morphological defenses and / or changes in the levels of biochemicals or nutritional quality of the host plant. Temperature also has pronounced effect on plant growth, which indirectly influences the extent of feeding. Temperature also affects the biology and behaviour of insects and thus influences insect growth and general population climax. In general, moderate temperature is favourable for insect development.

The intensity of feeding influenced by water stress, high level of water stress reduces the quantity food ingestion by the organism; check the population build-up due to lower rates of reproduction on water stress condition. Atmospheric humidity also influences the insect-plant interaction. High humidity increases the ease of detecting of odors which may influence host preferability. Leaf moisture plays a vital role in improving nutrient level of leaves, which in turn, improves the palatability of leaves to the larva, enhances the feeding efficiency and increases the growth rate (Bose and Bindroo, 2001; Paul *et al.,* 1992).

Photoperiod has effects on the development of both the insects and their host plants. It may also bring about changes in the physico-chemical characteristics of crop plants and thus influences the interaction between insects and plants. Intensity and quality of light have been reported to influence biosynthesis of anthocyanins and phenylpropanoids.

Finally, success of silkworm breed in any eco-climatic condition depends on its acclimatization ability, survival efficiency to produce more dry matter (silk/egg) per unit food intake at the shortest duration without hampering quality parameters (Anantha Raman *et al.*, 1993). Non-traditional area like Cooch Behar district of West Bengal needs a detailed study on nutritional efficiencies of muga silkworm as nutritional quality as well as environmental conditions have greater impact on regulation over the quantum of ingesta, digesta and digestibility of food among silkworm. Waldbauer (1964) studied that nutritional deficiency or imbalanced diet, high content of crude fibre and deficiency of water in the food affecting digestibility. Moreover, the quality of leaf produced by different host plants or in the same plant are different in different seasons. The influence of host plants and seasons on the efficiency of converting ingested and digested food into the body weight, cocoon, cocoonshell and egg should be given emphasis particularly efficiency of conversion of ingested and digested food to cocoon and shell as according to Machii and Katagiri (1991) these are the ultimate indices to evaluate the production efficiency of a breed/hybrid in terms of the production of cocoon shell percentage vis-à-vis the food transformed.

Consequently, under present circumstances of technological development of muga culture, standardization of indoor rearing technique appears to be important item of research to avoid crop loss. Whereas evaluation of nutritional efficiencies of the muga silkworm larvae and selection of suited host plants spp. are the pre-requisite to technical feasibility for successful muga culture in terai region of West Bengal. Keeping this view under consideration the present investigation has been designed with the following objectives.

1) To compare relative economic performances between the field rearing and the indoor rearing of muga silkworm (*Antheraea assama* Ww.) larvae with a view to avoid environmental hazards such as heavy rainfall, storms, high and low temperature and to prevent predator attack in field causing heavy damage of the crop.

2) To evaluate the consumption of leaves of two principal host plant spp. (Som and Soalu) by the larvae of muga silkworm with an objective to select the better host plant for

food supply to the larvae as well as to measure the leaf requirement of the larvae in indoor rearing.

3) To assess the nutritional efficiencies of muga silkworm larvae fed on different combinations of leaves of two host plants with an ultimate objective to supply better nutrition to the larvae for better quality and quantity silk and seed yield.

4) To identify seasonal influence on nutritional efficiencies and its conversion to economic performances *i.e.* silk and seed production with a view to find out season-specific rearing schedule for the zone under consideration.

5) To determine the efficiency of conversion of ingested and digested dry matter (food) into cocoon, cocoon-shell and egg with an ultimate objective to find out the possibility of successful muga-culture in a newly explored area as well as to compare with conventional area of muga culture.