CHAPTER – II

SERICULTURE AND SILK WEAVING INDUSTRY: AN OVERVIEW

2.0 INTRODUCTION

Silk, the "Queen of Textiles" spells luxury, elegance, class and comfort and therefore occupies a prestigious place in the world of 'haute couture'. It has wonderful properties of movement, flow and luxurious sheen, which come from its smooth, triangular fibre, that reflect light. It is one of the strongest fibres of 2.5 to 5.1 grams per denier and has elasticity and can stretch 20-25% without breaking but at the same time is very delicate and light. The exquisite qualities such as its inherent affinity for dyes, vibrant colours, high absorbance, light weight, resilience and excellent drape have made silk an ideal choice for well dressed socialites all over the world. It has remained the undisputed queen of textiles for centurie even in the face of competition from other natural and artificial fibres.

2.1 HISTORY AND SPREAD OF SILK

The history of silkworm, which is also the story of silk, goes back to ancient times in China around 2,640 B.C. The stories handed down through generations border on fact and fantasy. The tale that still persists is about a Chinese Empress, Si Ling-Chi of emperor Huang-Ti. The empress often referred to as Lady of Silkworms accidentally dropped a cocoon in her cup of tea. When she retrieved it out came a silken thread. Fascinated by the beauty of the thread she pulled strands of several cocoons from the surrounding mulberry plants by passing it through her ring to form a thicker thread. Finally with the help of her court maidens she spun a beautiful piece of cloth to make a robe for the emperor. She is credited with the introduction of silkworm rearing and invention of the loom (Paolo, 1952).

Considerable information regarding the spread of silk is available. Though silk was not unknown to Westerners, its process of manufacture was a closely guarded secret known only to the Chinese. The secret, however, was eventually leaked when the Japanese carried away four Chinese maidens who knew the secret along with mulberry shoots and silk moth eggs. The secret was conveyed to the West when two monks appeared at the court of Justinian of Constantinople with silkworm eggs hidden in hollowed out walking sticks. Another story about the advent of silk in India is that it came along with a Chinese princess who carried silkworm eggs and the secret of silkworm rearing in her headdress when she married an Indian prince. Consequently, the process of the manufacture of silk was open knowledge.

2.2 SERICULTURE: AN INTRODUCTION

Sericulture, the technique of silk production, is an agro-industry. Thus Sericulture or the raising of silkworms is defined as the incubation of the tiny eggs of silkworm moth until they hatch and become worms. It is also the term used for the process of raising silkworms and producing silk yarn from their cocoons or to obtain raw silk.

2.2.1 Biology and Voltinism of Silkworm

The Silkworm (*Bombyx mori*), the source for the production of the fabulous silk is the caterpillar of a moth whose cocoon is used to make silk. It is not a worm at all. This insect is also called the silkworm moth and the mulberry silkworm. It is native to Northern China (Mukherjee, 1907).

Silkworm has four stages in its life cycle *viz.*, egg, caterpillar, pupa and moth. Man interferes this life cycle at the cocoon stage to obtain the silk. The tiny silkworm larva hatches from a tiny black egg. The larva eats mulberry (*Morus alba*) leaves almost constantly for 4 to 6 weeks until it is 2 to 3/4 inches long. The white caterpillar molts its skin many times during this stage. The caterpillar then pupates; it spins a white silk cocoon around itself taking 3 or more days. The silk covers a hard brown-shelled pupa. In around three weeks, the adult moth emerges from the pupa. But on silkworm farms, only enough adult moths are allowed to emerge to ensure continuation of the species, since they destroy the cocoon when emerging. The remaining silkworms are killed by heat while they are inside their cocoons, so that the silk can be drawn off, spun into threads and woven into fabric. The white moth that emerges from the cocoon cannot fly; it reproduces and dies within five days. The female lays from 200 to 500 lemon-yellow eggs that eventually turn black.

Voltinism is when some members of a species enter hibernation, which is a period of diapause, while others do not. Voltinism affects the quality and output of silk. Depending on various factors, such as the place of origin, voltinism, the colour, shape and size of the cocoons, the larval markings, the silkworms are classified into different breeds namely univoltine, biovoltine, trivoltine and multivoltine. When the silkworm strains pass through only one cycle in a year, remaining dormant in the egg or pupa stage for a long time they are called univoltines breed i.e. having only one brood or generation within a year. These breeds are bigger in size and posses more silk but are very sensitive to high temperature, therefore are reared in cooler regions. Biovoltines can have only two life cycles in a year because of the interruption of diapause. The multivoltine breed can be reared six times and the cocoons are harvested after every two months owing to the non-diapausing of the eggs and copious growth of the mulberry. These multivoltines hybrids suitable to warm regions have a short larval duration and are generally poor yielder of cocoons. The silk produced is poor in quality and is considered as D grade in International market whereas the univoltines and biovoltines consume more leaves than multivoltines and hence the yield and quality of cocoons are superior. Though the voltinism affect the quality and the output of silk, application of technology can circumvent the disadvantages inherent in different breeds. For example, the diapause in biovoltines can be broken artificially by treating one day old egg in Hydrochloric acid of 1.064 specific gravity at 46.1^{0}C and more than four crops can be obtained by adopting this technique (Pringle, 1922).

2.2.2 Silk Types

Indian sericulture contributes five major types of silk of commercial importance and is obtained from different species of silkworms which in turn feed on a number of food plants. These are as follows:

i) Mulberry Silk

Mulberry is synonymous with silk and is the only food plant, which plays a major role in silk industry. Hence, silk is often referred to as mulberry silk. The bulk of the commercial silk produced in the world comes from this variety that is obtained from the silkworm Bombyx mori found in all voltines solely feeds on the leaves of Morus. These silkworms are completely domesticated and reared indoors. Major mulberry silk producing states in India are Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu and Jammu & Kashmir which together account for 92% of the country's total mulberry raw silk production (Ullal, 1978).

ii) Tasar Silk

The traditional Tasar or Tussah or Tussar as it is called is a product of Antherea mylitta mainly thrives on food plants, Asan and Arjun. It is a wild species found in all voltines and is polyphagous in nature. The silkworms reared are wild in nature and survive exposed to the vagaries of nature and predators. This type of silk is less lustrous than mulberry silk but has its own feel and appeal. Tasar producing states are Jharkhand, Chattisgarh and Orissa. According to recent findings, a finer variety of tasar generated by the silkworm Antherea royeli are reared on oak plants in the sub-Himalayan range and in Manipur. Tasar culture is the main stay for many a tribal community in India (Gopalachar, 1987).

iii) Eri Silk

The word Eri is a derivative from the Sanskrit nomenclature 'ernade' for castor plant and is the main food of Eri silkworm Philosamia ricini and so named eri. Apart from castor, the species are fed on kesseru, tapioca, cassava, papaya, payam and baresark. The silkworm is multivoltine and is reared indoors. The cocoons are spun but cannot be reeled, as they are made up of uneven fibres and are therefore used for producing spun yarn. The eri culture is practiced mainly in Assam and eastern parts of India as the climatic conditions namely heavy rainfall and humid atmosphere are favourable (Gomez, 1983).

iv) Muga Silk

The golden yellow silk, belonging to the same Tasar family is a prerogative of India and the pride of Assam. It is produced by Antherea Assamansis, a semi domesticated multivoltine silkworm. The worms are polyphagous in nature and are raised on Som and Soalu, which grow abundantly in Brahmaputra Valley. It is popular for its natural golden colour, fine texture and durability.

2.2.3 Mulberry Cultivation

Mulberry foliage often referred to, as 'Kalpa Vruksha' with its utility ranging from silkworm feed to its use, as fuel is a member of Fig family 'Moraceae' and is recognized under the genus Morus. It is a fast growing deciduous woody perennial plant with simple, alternative, stipulate, petiolate leaves and thrives under various climatic conditions ranging from temperate to tropical located north of the equator between 28^0N and 55^0N latitude. A temperature range of 24-28^0C, rainfall ranging from 600 to 2,500m and atmospheric humidity in the range of 65-80% is ideal for mulberry growth. Sunshine also plays an important role for controlling growth and leaf quality. It flourishes well in flat, deep, fertile, porous, well-drained loamy and clayey soil that can retain moisture (Dandin, 1987).

Mulberry cultivation is purely an agricultural operation and forms the basis for sericulture. Mulberry leaf is a major economic component of sericulture since the quality and quantity of leaf produced per unit area have a direct impact on quantum of layings, which can be reared, and cocoons harvested. Hence, to boost the economy, it is imperative to pay attention to mulberry culture. Several varieties have been introduced and most of the Indian varieties of mulberry belong to M.Indica.

i) Propagation

In India, mulberry cultivation is practiced either through vegetative propagation or root grafting and bud-grafting. The system of plantation varies from region to region depending mainly on rainfall and nature of soil. In rainfed areas of West Bengal because of heavy rainfall and rich soil, a modified system of row plantation is practiced and is popularly known as 'Malda System'. In regions with sufficient rainfall mulberry in the form of tree plantation has also been introduced.

ii) Land Preparation

Land should be prepared during early spring or late autumn. The proposed land should be deeply ploughed during April-May and has to be ploughed repeatedly to loosen the soil and all the gravel, stones and weed should be removed to make the soil fine. Land leveling is also important in case of plains. However in hilly areas, generally where the land has a slope, pit system is adopted. In these areas June/July are favourable and the pits should be filled with loose soil and organic manure.

iii) Planting and Spacing

Nursery beds should be adequately watered and made wet one or two days earlier to planting. The mulberry cuttings are planted in the hole in a slightly slanting position, with bud pointing up, exposing only one bud above the surface of the soil. The soil around the cutting must be pressed firmly after planting.

Spacing is the sole discretion of the farmer but also depends on rainfall. In the rainfed areas, it is planted at a distance of 7.6x7.6cm while under irrigation the spacing of 5cmx5cm and a row system that is 4cm between plots are followed.

iv) Pruning

Pruning of mulberry trees should be done after one year of plantation. With the help of pruning the mulberry branches, leaf yield can be increased and production of leaf can be synchronized with silkworm rearing schedules all through the seasons. Pruning schedules controls the irregular growth of mulberry branches and thereby save wastage of nutrition and energy. Care should be taken during pruning so that the bark should not get peeled off since cut wounds do not heal, which leads to infections and diseases (Krishnaswamy, 1978).

v) Fertilizers

There is a close relationship between fertilizer dosage and quality and quantity of mulberry leaves. A plentiful supply of fertilizers and water is required for high yielding mulberry plantation. In irrigated land the recommended organic manure such as cattle dung compost @ 20 tonnes per hectare or @ 10 tonnes per hectare must be applied and mixed with soil by ploughing 2-3 times. Timing should be maintained and proper application method should be followed to obtain maximum positive result.

vi) Leaf Harvesting

Along with leaf production, leaf utilization is also important. Leaf harvesting depends upon type of rearing practice. Leaf is harvested by different methods, such as a) leaf picking, b) Branch cutting, c) shoot harvesting (Mukherjee, 1907).

a) Leaf Picking: In India mostly leaf picking is practiced. However, this is more labour intensive and therefore this method is being followed presently by most of the rearers where labour is not a problem. In a year 5-6 harvests are possible. The first leaf harvest takes place after 10 weeks of bottom pruning. The moisture content and the nutrient value of the leaves can be retained if the leaves are harvested with petiole. Generally the farmer picks up the leaves well in advance and feed to silk worms. Leaves are harvested according to the age of silk worms. Tender leaves are picked up, chopped and fed to chawki worms (Nanja, 1999).

b) Branch (Cutting) Feeding: Silk worms fed with mulberry branches are known as branch feeding. This type of feeding is adopted after 3rd moult of silkworm larvae. In this method, cost of labour, wastage of leaf is minimized as less labour is required for branch cutting compared to leaf picking and also maximum leaves are utilized to feed the silkworms. Succulence of leaves can be maintained, as the leaves are not detached from the branches for a longer duration. This is the easiest method to preserve and maintain the leaf quality.

c) Whole Shoot Harvest: This type of harvest reduces labour cost. In this type, mulberry branches are cut close to the ground level and fed to worms settled for 4th moult hence, uniformity in maturity of leaf observed. Shoots are harvested at an interval of 10 weeks and may extend to another 2-3 weeks depending upon availability of water and favourable climatic conditions. Around five harvests are possible in this method.

vii) Leaf Yield and Quality

Leaf yields vary enormously depending on climatic conditions and adoption of better techniques by understanding the problems of farm productivity. Many high yielding varieties have been introduced in India not only to double the leaf yield, but also to maintain the succulence of the leaves, a factor that is very important under tropical conditions. Mulberry leaf yield depends also on the factors like shape and age of the plant. Compared to the mature tree, both young and old trees have lower leaf yield since young trees need to form structural organs and old trees have lost physiological capacity. In case of shape, the low trunk trees can be formed in a short period and their leaf yield are also higher than the medium trunk trees, which take longer period to develop. Apart from the above-mentioned factors like shape and age of the plant, the mulberry leaf yield is also related to methods and frequency of harvesting and crop management (Reddy, 1983).

The quality of leaf produced in addition to proper maintenance of temperature and humidity plays a significant role in the production of healthy silkworms and finally quality cocoons. Leaf harvesting on time also has marked influence on leaf quality since mature leaf contain low nutrient value and silkworms fed upon them become disease susceptible (Ravindran, 1993).

2.2.4 Silkworm Rearing

Silkworm is domesticated over thousands of years and the sole food for the growth of silkworm is mulberry leaf.

i) Types of Rearing

Though rearing of silkworm is done in various ways in different areas, silkworm rearing is mainly of two types:

a) Chawki Rearing: Rearing of young age silkworms is called Chawki Rearing. In this method, worms are reared up to third moult and distributed to the rearers for late age rearing. Chawki Rearing at Chawki Rearing Centres not only control the attack of diseases but also facilitate the rearing in most scientific lines. Cost wise it is most economical as all the facilities such as the maintenance of coolers; heaters, exhaust fans etc. are provided in Chawki Rearing Centres, which is a costly affair for individual rearers.
b) Late Age Rearing: Compared to Chawki Rearing, Late Age Rearing is a little easier process as high temperature and humidity is not required after the third

moult. During late age, the quality of mulberry leaf required is more than 90% of total larvae period. During 5^{th} stage particularly the larvae eat voraciously as worms feel maximum appetite, loose water from their body hence less temperature, low humidity, and good ventilation is required.

ii) Silkworm Eggs

One of the inputs that play a decisive role in the success of silkworm crop is the silkworm seed. If the quality of eggs is good, one can harvest a successful cocoon crop and if it is inferior, the crop could be lost at any stage of rearing depending on the magnitude of defect or inadequacies of the seed. Therefore, silkworm rearing starts with the purchase of silkworm eggs often called DFLs. The required number of DFLs should be collected from either Govt. Grainage or licenced Pvt. Grainage. The transportation of eggs plays an important role in the development of embryo and successful crop harvest. Therefore, the DFLs are collected safely in a wet handbag in the early morning or in the late evening. Care must be taken not to cause any damage to the embryo. In case of loose eggs, the transportation box containing loose eggs should be covered with wet cloth; good aeration must be provided to the eggs. Then the eggs should be kept under incubation at 25^0C temperature and 80% humidity. Egg cards should be spread in the rearing trays that should be kept in cooler places only. The quality of seed should be free from pebrine disease, true to its breed, rich in fecundity and uniform in distribution, high fertility rate of above 95%, provides effective and uniform hatching, ensures successful cocoon crop and promotes good recovery of raw silk (Tripathi, 2003).

iii) Hatching and Brushing

Brushing is transferring of newly hatched larvae into rearing trays. After one hour of hatching, the newly hatched larvae get ready to feed on mulberry leaf and are fed with finely chopped tender mulberry leaves with high moisture content.

The brushing of newly hatched larvae can be done by various methods. In the first method, the newly hatched larvae are covered with a net and chopped mulberry leaves are sprinkled over the net. The larvae slowly crawl to the net and start to feed on mulberry leaf then they are transferred into rearing trays by gently tapping the net. This method is more convenient in case of loose eggs. In the second method, the egg cards containing larvae are placed in the rearing trays and chopped mulberry leaf is sprinkled over them, the larvae crawls on to mulberry leaves, later on the cards are removed. While providing proper spacing, care should be taken not to touch the newly hatched larvae with hands; instead chopsticks are used to spread the worms in the rearing tray (Tikadar, 2001).

iv) Mounting and Cocooning

Transferring of mature silkworm on to the mountage or cocoon frames is called 'mounting'. This is an important and skilled operation as any deviation in identification of maturity of worms lead to adverse effect on cocooning. This is the stage when silkworm become mature completely, turns yellowish and translucent, stops feeding on mulberry leaves and is ready to spin cocoons. The spinning of the outer protective cover by the mature silkworm is called cocooning. The larvae making an attempt to crawl on feeding trays further oozing liquid substance out of the mouth from the spinneret indicates that the larvae is ready to be transferred into the mountages for cocooning. Though selection of ripened worms is not a difficult task, due care is needed while handling them, care should be taken to avoid over crowding, as improper spacing may lead to the formation of double and strained cocoons. For this purpose the density of worms in the mountage should be limited to 40-50 worms per sq. ft. in case of bamboo made Chandrika that has a mat on the background of size 6′x4′ easily carries above 1000 worms but care should be taken to use the right type of chandrika in convenient size and shape (Truden, 1981).

v) Harvesting of Cocoons

Harvesting of cocoons is done on the fifth day of spinning. The seed cocoons should be harvested on the eighth day or ninth day of spinning depending upon atmospheric temperature. Harvesting should not be done immediately after pupation but should be done before the moth emerges out. The delay in harvesting will result in formation of pierced cocoons due to emergence of adult moth or uzi maggots.

vi) Cocoon Yield and Production of Silkworm Eggs

The cocoon yield varies from rearer to rearer. For every 100 DFLs the yield ranges from 25 kgs. to 50 kgs. A rearer may have 4 to 6 harvests in a year by rearing 800 to 1600 DFLs. The yield and quality of biovoltine cocoons are superior to those of multivoltines. The multivoltine silkworms yield about 25 kg of cocoons per 40,000 eggs reared, whereas the bivoltines yield 40 kgs. The average annual yield of cocoons in India is as low as 150 kg under rainfed conditions, and under irrigated conditions, it is about 400 kg. (Ullal, 1978).

Silkworm egg is the key to sericulture industry. The cocoons are preserved properly in the egg-producing factories, popularly called grainages, and the moths are allowed to emerge. The selected combination of moths is then kept to copulate for 4 hours. After copulation the male is either rejected or used for copulating with another female. Later, the female is consigned to a dark plastic 'cellule'. She lays about 400 eggs in 24 hours. At the end, the female is crushed and examined for hereditary diseases. Only certified disease-free eggs are reared for industrial silk production.

2.2.5 By-Products of Sericulture

In all the sectors of Sericulture, certain amount of waste and by-products are generated. The by-products and wastes thus, generated during the transformation process constitute inevitable and evitable portions. The wastes cannot be recycled, reclaimed or recovered but the possibilities of reuse are many. Efforts have to be intensified for better utilization of these by-products. (Halliyal, 1999). Depending on the source of generation, the wastes and by-products of silkworm rearing are classified as follows:

- Silkworm litter
- Pierced cocoons: Moth broken cocoon shell and uzi pierced cocoons
- Cut cocoons: Cocoons generated in grainages
- Floss: Fibres surrounding the cocoons
- Double cocoons
- Black or melted, flimsy, stained and urinated cocoons

2.3 SILK INDUSTRY: AN INTRODUCTION

Sericulture industry comprises mulberry cultivation, silkworm rearing, cocoon rearing, twisting, weaving processes and fabric finishing. Sericulture and reeling together are known as raw silk industry. Raw silk industry with silk weaving and knitting activities comes under the silk industry. These can be broadly grouped as pre-cocoon and post cocoon activities. The pre-cocoon activities are mainly agriculture based. The result of the pre-cocoon activities is the production of cocoons and that of post cocoon is the fabric finishing.

2.3.1 Reeling

The delicate process by which cocoons are cooked in hot water and the silk fibre is unwound from them is called 'reeling'or filature. Silk is a continuous filament fibre consisting of two proteins, the inner core of fibroin secreted from two salivary glands in the head of each larvae and an outer cover of gum called sericin which cements the two filaments together. Silk must be reeled off the cocoon quickly before the pupae begin to rot and taint the thread with unpleasant smells. Cocoons are then processed in hot water at 95-97 degree centigrade for 10-15 minutes to soften the sericin portion to make unwinding easy without breaks. The process is called cooking or stifling. After cooking the cocoons are reeled in hot water in different types of machines. Single filaments are drawn from cocoons in water bowls and combined to form yarn. This yarn is drawn under tension through several guides and eventually wound onto reels. Then the yarn is dried, packed according to quality and is now raw silk ready for marketing.

2.3.2 Twisting

The raw silk is twisted after reeling. The raw silk is twisted into a strand sufficiently strong for weaving or knitting. This procedure is called throwing. Different processes of twisting give different types of silk yarn with varying number of threads, direction of twist and its type. Four different types of silk thread may be produced from this procedure: organzine, crepe, tram and thrown singles. Organzine is a thread made by giving the raw silk a preliminary twist in one direction and then twisting two of these threads together in the opposite direction. Crepe is similar to organzine but is twisted to a much greater extent. Twisting in only one direction two or more raw silk threads makes tram. Thrown singles are individual raw silk threads that are twisted in only one direction. In general organzine thread is used for the warp threads of materials, tram threads for the weft or filling, crepe thread for weaving crinkly fabrics and a single thread for sheer fabrics. Broken or waste filaments and damaged cocoons are retained, treated and combed, to be processed into yarn marketed as spun silk which is inferior in character to the reeled product and much cheaper. In common with all other animal production systems, nothing is wasted if it can be sold.

2.3.3 Weaving

After the silk is harvested from the cocoons it is brought to the weavers for dyeing and preparation for weaving. Today most dyes are chemical although a lac (insect) dye was once used as well as plant dyes Low grade silk is made from damaged cocoons, which were spoiled by emerging worms. These can be used for breeding stock. Filaments from the coarse outer portion of the cocoon that is removed by brushing before reeling and the inner portion of the cocoon that remains after reeling the raw silk are mixed (with silk from damaged cocoons) to make low grade silk (Vijji, 1985).

2.3.4 By-Products of Silk Industry

The silk industry is a labour intensive, traditional cottage industry without much modernisation giving rise to increased amount of evitable wastes. Thus different types of material wastes are generated during the production of silk goods. The silk waste material constitutes considerable portion of the total cost of the final product and as such, all efforts should be made to minimise its generation in each stage of transformation process. The waste generated during reeling and further processing of silk needs more attention because of the value addition. It is also highly priced by-products and a source of income for the reeler (Halliyal, 1999). Depending on the source of generation, the wastes and by-products of silk industry are classified as follows:

i) By-products of reeling and further processing of silk

- Cooking waste: Waste generated during cooking process
- Reeling waste: Waste generated during reeling process proper
- Pelade layer-last parchment/basin refuse: Layer of the cocoon, which is unreelable
- Half reeled cocoons and unreelable cocoons
- Pupae
- Charka waste: Generated in charka system of reeling

ii) The wastes generated in the course of silk winding, throwing, spinning and weaving:

- Re-reeling wastes: Non-twisted silk waste generated during the re-reeling process
- Twisted silk waste: Yielded in the course of winding, throwing and weaving
- Silk noils: Noils are yielded in the course of silk spinning. They are used for noil spinning.

However, utilization of these wastes effectively and efficiently can reduce the cost of raw silk yarn production. Intensive efforts have to be made to find out the alternate and better use for the finished products manufactured by these ancillary industries. A number of industries have come up as ancillary industries utilizing the by-products of the silk industry.

2.4 GLOBAL AND DOMESTIC SCENARIO OF SERICULTURE AND SILK INDUSTRY

To understand the intricacies of the problems and prospects of this age-old agro-based cottage industry of India, we must take an overview of the global vis-à-vis domestic silk scenario.

The advent of synthetic fibers such as nylon and polyester, which are stronger than silk and lower in price, but do not possess the same hand, or quality, has caused a tremendous reduction in silk production and consumption. Table 2.1 shows that cotton and synthetic fibre contributes as high as 92% of the total world's production of textile fibres whereas wool and cellulosic fibres share is about 8% of the world production and the production of silk compared to other fibres is even less than 1%.

Table 2.1
World Production of Textile Fibres by Quantity, 1999

	Cotton	Synthetic	Cellulosic fibres	Wool	Silk	Total
Production in Th.MT	19200	28300	2700	1400	76	51676
%	37.15	54.76	5.22	2.72	0.15	100.00

Source: International Trade Centre-Silk Review-2001

2.4.1 World Green Mulberry Cocoon Production

A study of the world production data on green mulberry cocoons given in Table 2.2 below depicts that China had been the leading producer throughout and has shown increasing trend in the subsequent years. There has been a drastic fall in the production of cocoons in Japan and the Republic of Korea. On the other hand, India has significantly increased the production of green mulberry cocoons since 1980.

Table 2.2

Trend in World Production of Green Mulberry Cocoons(Tonnes)

Country	1980	1985	1986	1987	1988	1989	1990
China	2,48,000	3,77,500	3,28,000	3,45,000	3,94,000	4,20,000	4,78,500
India	8,508	76,700	81,600	86,500	96,471	1,10,433	1,16,672
Japan	73,060	47,300	41,400	34,700	29,600	26,890	24,924
U.S.S.R.	48,906	52,000	44,000*	44,000*	44,000*	44,000*	44,000@
Republic of Korea	20,035	10,300	10,300$	7,200	5,900	5,400	5,400@
Brazil	8,800	10,700	10,700$	11,760	11,800	11,970	15,829
Others	28,291	30,900	30,900$	30,900$	33,519	22,007	22,007@
Total	8,45,300	5,35,400	5,46,900	5,60,060	6,15,290	6,40,200	7,70,332

= Data refers to Financial Year from 1980 onwards.
**** = Estimated.***
$ = 1985 data repeated.
@ = 1989 data repeated.

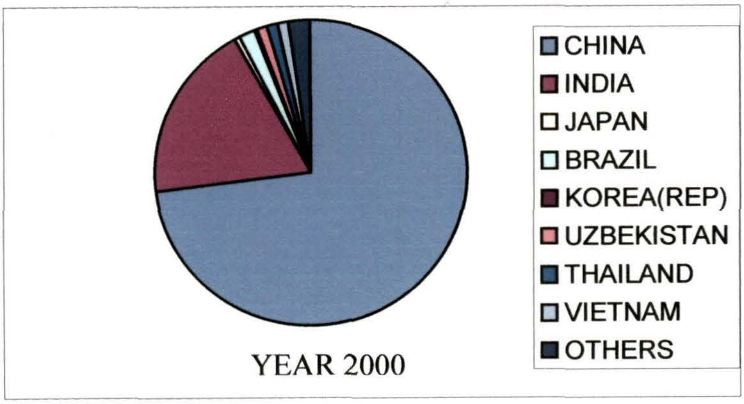
2.4.2 World Raw Silk Production

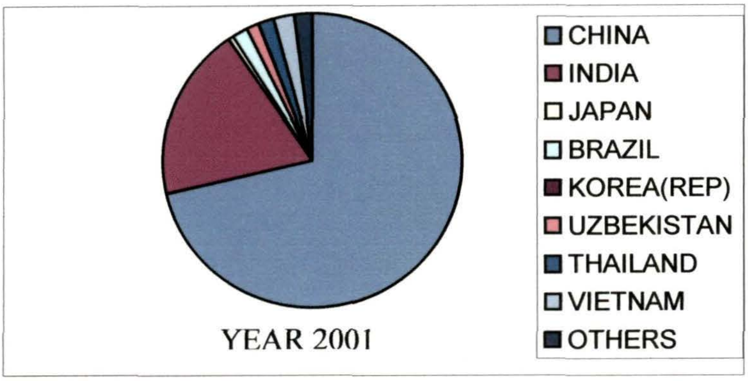
The global silk production scenario is undergoing changes that would reflect on the future of the industry. Table 2.3 and Figure 2.1 illustrate that world raw silk production, which was at its peak during 1996 at 95892 MT, has declined to 78530 MT in 1999, a decrease of 18% but there was slight increase in the year 2001 and 2002. In 2002 China and India together produced approximately 89% of the world production whereas it was only 85 % in 1995. Thus there has been an increase of 4.8% over the years. The contribution of rest of the countries was only 11% in 2002 and 15% in 1995.

The Chinese silk production was at its peak during 1995, a whooping 67113MT accounting for about 70% of the world raw silk production. However in the last two years, the production has been reduced considerably, due to factors like de-regulation in the weaving sector, de-regulation in the agriculture sector, which contributed towards stiff competition from other cash crops. But after giving more emphasis on the production of quality raw silk with a reasonably competent low price rather than low quality silk, the silk production has geared and finally the production started to rise since 2000.

The silk production situation in India is quite different than other silk producing countries. The Indian silk industry is slowly but steadily growing in the

WORLD RAW SILK PRODUCTION





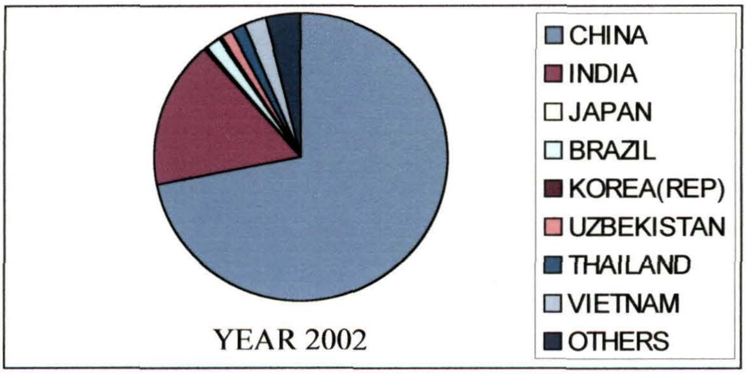


Figure 2.1

past several years. There is an increase of about 17.32% in 2002 compared to 1995. Almost 100% of the production emanates from the rural sector. The main advantage the industry enjoys is the existence of a domestic market and there would not be any major market problems for the industry in the next one or two decades as the usage of silk is related to the traditional and cultural heritage of India.

Table 2.3
World Raw Silk Production (Unit: MT)

Country	1995	1996	1997	1998	1999	2000	2001	2002
China	67113 (70.36)	68500 (71.43)	60300 (70.11)	57500 (70.99)	56956 (72.52)	61648 (73.04)	64567 (71.35)	68600 (71.56)
India	13909 (14.58)	14126 (14.73)	(15236) (17.71)	15544 (19.19)	15214 (19.37)	15857 (18.78)	17351 (19.17)	16319 (17.02)
Japan	3240 (3.39)	2580 (2.69)	1920 (2.32)	1080 (1.33)	650 (0.82)	557 (0.66)	431 (0.48)	394 (0.41)
Brazil	2468 (2.53)	2270 (2.37)	2120 (2.46)	1821 (2.25)	1554 (1.97)	1389 (1.64)	1485 (1.64)	1607 (1.67)
Korea Rep.	946 (0.99)	506 (0.55)	272 (0.31)	210 (0.25)	200 (0.25)	165 (0.19)	157 (0.17)	154 (0.16)
Uzbekistan	1320 (1.38)	2500 (2.61)	2000 (2.32)	1500 (1.85)	923 (1.17)	1100 (1.30)	1260 (1.39)	1260 (1.31)
Thailand	1313 (1.38)	1144 (1.19)	1039 (1.21)	900 (1.11)	1000 (1.27)	955 (1.13)	1510 (1.67)	1510 (1.57)
Vietnam	2100 (2.20)	1500 (1.56)	1000 (1.16)	862 (1.06)	780 (0.99)	780 (0.92)	2035 (2.24)	2200 (2.29)
Others	2967 (3.11)	2766 (2.88)	2117 (2.46)	15672 (1.94)	1250 (1.59)	1952 (2.31)	1692 (1.80)	3814 (3.98)
Total	95376 (100.00)	95892 (100.00)	86004 (100.00)	80982 (100.00)	78530 (100.00)	84403 (100.00)	90488 (100.00)	95858 (100.00)

Source: ISA Newsletter (July 2003)
Figures in parenthesis represent the percentage of the Total

There is always a correlation between silk production and industrialization that has mostly affected the production bases in the developed countries. And for the same reason, silk production in Japan has reduced considerably over the years. The country's production was less than one in the year 2002 compared to about 3% in 1995. The country once a major producer is increasingly dependent on imports for its internal requirements. The main reasons for the decline, apart from industrialization, are high labour cost, lack of interest among the younger generation to pursue sericulture as an occupation, urbanization and reduced land availability.

2.4.3 World Mulberry Raw Silk Production

It is observed from the data shown in Table 2.4 and Figure 2.2 that the total mulberry raw silk production in 1995 was at its peak with 91851MT but decreased during 1997-1999, and again increased and reached 89656MT in 2002..

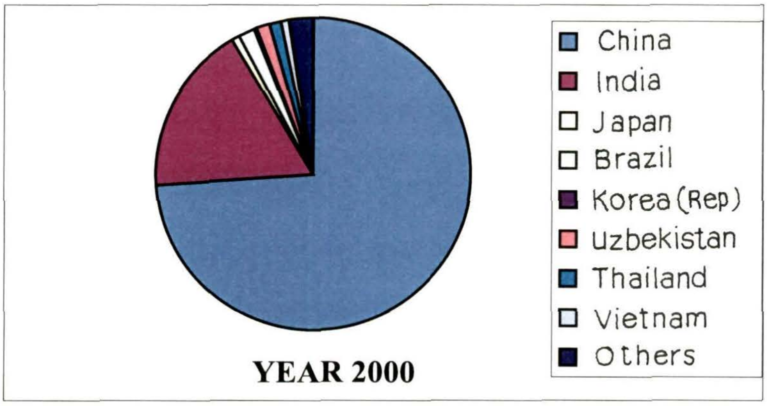
Table 2.4
World Mulberry Raw Silk Production (Unit: MT)

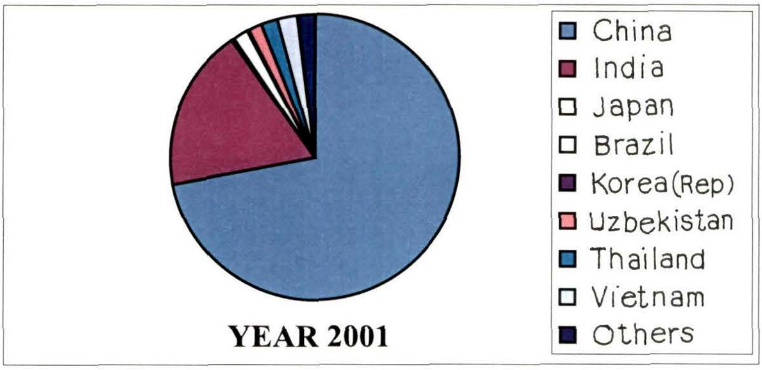
Country	1995	1996	1997	1998	1999	2000	2001	2002
China	64613 (70.34)	59000 (69.23)	52700 (68.25)	49430 (68.89)	55990 (73.39)	60000 (73.77)	62560 (71.93)	64100 (71.49)
India	12884 (14.02)	12954 (15.20)	14048 (18.19)	14260 (19.87)	13944 (18.27)	14432 (17.74)	15842 (18.21)	14617 (16.30)
Japan	3240 (3.53)	2580 (3.02)	1920 (2.48)	1080 (1.50)	650 (0.58)	557 (0.68)	431 (0.49)	394 (0.41)
Brazil	2468 (2.69)	2270 (2.36)	2120 (2.79)	1821 (2.53)	1554 (2.03)	1389 (1.71)	1485 (1.70)	1607 (1.79)
Korea	946 (1.03)	506 (0.59)	272 (0.35)	210 (0.29)	200 (0.26)	165 (0.20)	157 (0.18)	154 (0.17)
Uzbekistan	1320 (1.44)	2500 (2.93)	2000 (2.59)	1500 (2.09)	923 (1.21)	1100 (1.35)	1260 (1.45)	1260 (1.40)
Thailand	1313 (1.43)	1144 (1.34)	1039 (1.34)	900 (1.25)	1000 (1.31)	955 (1.17)	1510 (1.74)	1510 (1.68)
Vietnam	2100 (2.28)	1500 (1.76)	1000 (1.29)	862 (1.20)	780 (1.02)	780 (0.95)	2035 (2.34)	2200 (2.45)
Others	2967 (3.23)	2766 (3.44)	2117 (2.74)	1684 (2.34)	1250 (1.63)	1952 (2.40)	1692 (1.94)	3814 (4.25)
Total	91851 (100.00)	85220 (100.00)	77216 (100.00)	71747 (100.00)	76291 (100.00)	81330 (100.00)	86972 (100.00)	89656 (100.00)

Source: ISA Newsletter (July 2003)
Figures in parenthesis represent the percentage of the Total

Silk production and utilization is increasing along with the increase in production and utilization of artificial fibres. Presently 90% of the global silk production comes from the Asian countries. Although, there are vigorous attempts to produce silk in other areas, it may require some time for sustainability. At present, China and India continue to be the major suppliers of silk to the world market. The importing countries are Japan, U.S.A., U.K., West Germany, France, Italy and Switzerland. The exporting countries include China, Korea and Brazil. The white paper of I.S.A. and I.S.C. asserted that there would not be any problem of surplus silk in world markets, for it is a herculean task for new countries to reach the target of even producing 100 tonnes of quality raw silk during a generation. Developing countries may embark on sericulture development only to improve the standard of living of the rural population and meet the home demand and not to export silk to the international market.

WORLD MULBERRY SILK PRODUCTION





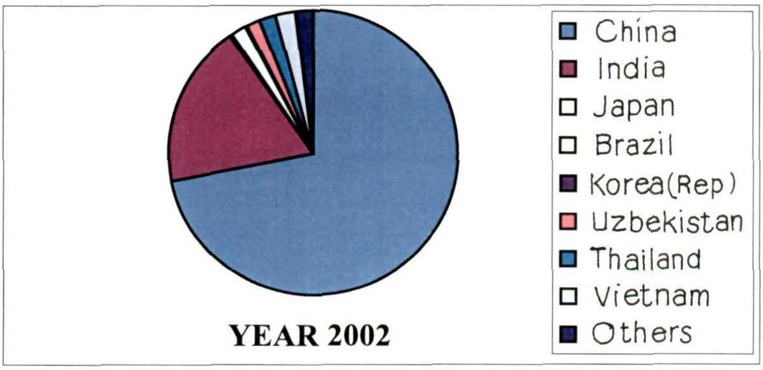


Figure 2.2

2.4.4 Sericulture and silk industry in India (State wise Study)

Silk in India is as old as civilization is an ancient industry itself and dates back to several centuries prior to the commencement of the Christian era when its origin was shrouded in the mists of the past. But as mentioned in the earlier paragraphs, this industry is said to have spread to India when a Chinese Princess, carrying silkworm eggs and mulberry tree seeds in her headdress, married an Indian prince. There was flourishing export trade in silk goods between India and Europe during the Second Century B.C. In its long history, it has passed through periods of both prosperity and depression. The industry showed a sign of decadence from 1875 due to various causes such as ravages of silkworm diseases and entry of Japan and China into the world markets.

The Second World War provided a turning boom period for the Indian silk industry when China and Japan stopped supplying silk to the Allies and after receiving financial assistance from the Government through several expansion schemes, Indian silk industry could supply three million yards of parachute components to the Allies during the War. The Indian silk industry is slowly but steadily growing in the past several years and has earned recognition of Government support in spite of passing through a challenging phase at times. Indian sericulture, during the first two decades after independence remained without much research support when the average cocoon yield was 16 to 18 kg/100DFLs indicating poor survivability (40%) and lesser single cocoon weight (1.0g). After the establishment of CSB, the apex body of the Indian silk industry in 1948, developmental efforts were made through successive plans (I to X) to modernise and usher improved technologies for better production and Indian silk is poised for a giant leap in the coming decades. Therefore sericulture today is a well-established healthy, stable and highly remunerative agro-based cottage industry. It is mainly due to the fact that sericulture is practiced as a small-scale family avocation among the marginal and small farmers in the rural sector; hence it is less affected by the massive industrial development.

In India, the sericulture industry is spread-over several states. Among them Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal and Jammu & Kashmir are considered as traditional states and the rest of the other states as non-traditional. As observed from the data shown in Table 2.5 that at the end of 2002-03, India has produced about 14617MT of raw silk, 2920.08 lacs of DFLs, 128181MT of reeling cocoons, 4514MT of silk waste and the mulberry cultivated area was 194463 ha.

Table 2.5
Mulberry Sericulture and Silk Industry Statistics in India

Year	Production				
	Mulberry area	DFLs	Reeling cocoon	Raw silk	Silk waste
	Ha.	Lac no.	MT	MT	MT
2000-01	18106	458.19	11328	1050	368
2001-02	18794	529.00	14329	1407	429
2002-03	12569	485.76	15171	1450	507

Source: Sericulture & Silk Industry Statistics – 2003, CSB

i) State wise Mulberry Raw Silk Production

Table 2.6 and Figure 2.3 illustrate that the Indian mulberry raw silk production was as its maximum during 2001-02 at 15842MT compared to only 14617MT in 2002-03. Major mulberry raw silk producing states in India are Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu and Jammu & Kashmir which together account for 92% of the country's total mulberry raw silk production. Karnataka is the leading raw silk producer. The production was above 55% during 1999-2002 but the production decreased to 47% during 2002-2003.The scenario tells an inclined story for Andhra Pradesh, rising from a share of approximate 27% during 1999 to 2002 to 39% during 2002-2003. West Bengal is the third largest producer. The production rose from less than 8% during 1999-2000 to very close to 10% during 2002-2003. The contribution of the rest of the states was negligible.

Table 2.6
State wise Mulberry Raw Silk Production (Unit: MT)

States	1999-2000	2000-2001	2001-2002	2002-2003
Karnataka	8121 (58.24)	8200 (56.82)	8728 (55.09)	6760 (46.24)
Andhra Pradesh	3757 (26.94)	4183 (28.98)	4775 (30.14)	5629 (38.50)
West Bengal	1152 (8.26)	1050 (7.27)	1407 (8.88)	1450 (9.91)
Tamil Nadu	672 (4.82)	711 (4.92)	655 (4.13)	490 (3.35)
Jammu & Kashmir	85 (0.61)	98 (0.68)	80 (0.50)	100 (0.68)
Others	157 (1.12)	190 (1.31)	197 (1.24)	188 (1.29)
Total	13944 (100.00)	14432 (100.00)	15842 (100.00)	14617 (100.00)

Source: Sericulture & Silk Industry Statistics – 2003, CSB
Figures in parenthesis represent the percentage of the Total

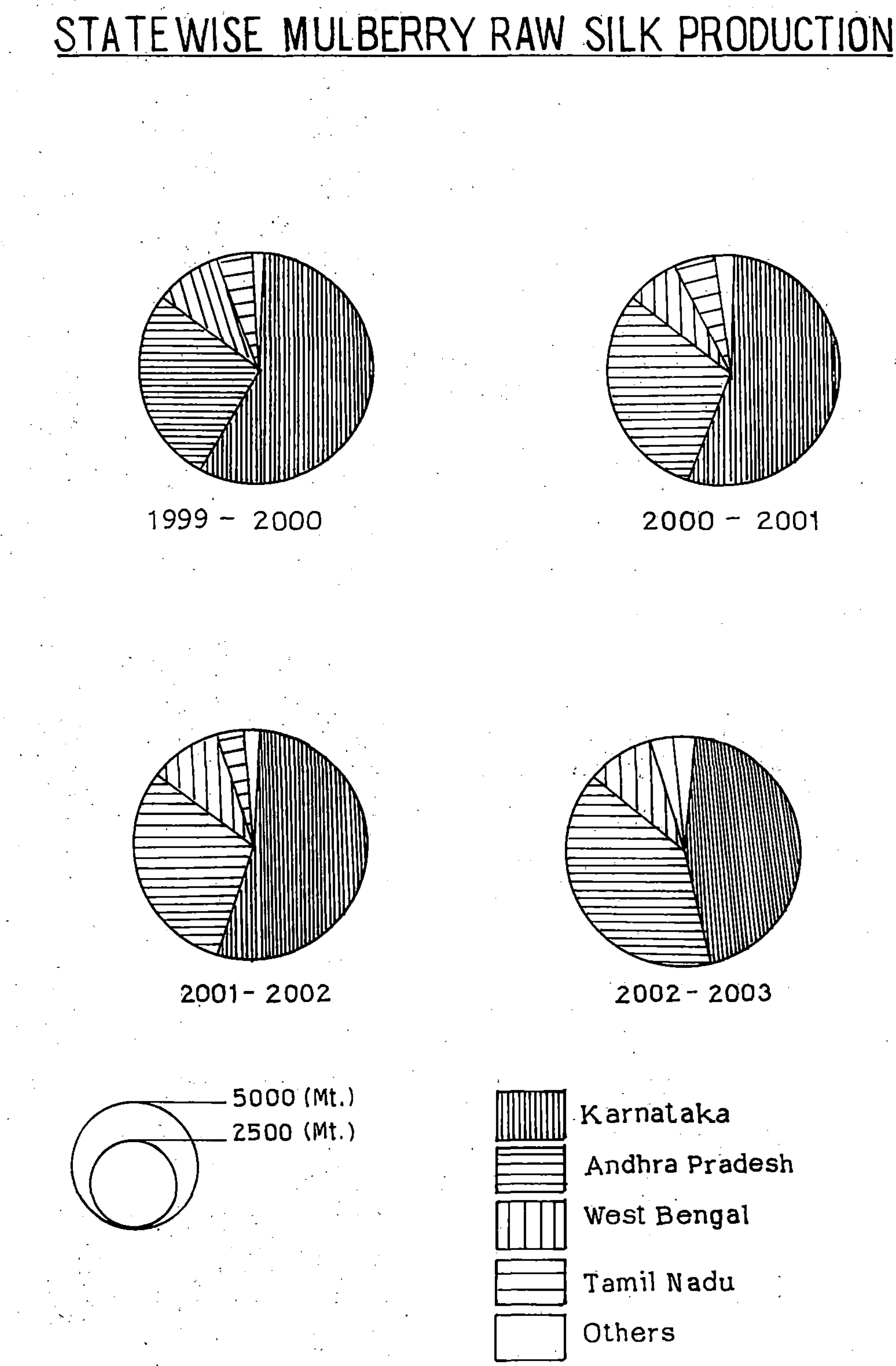

STATEWISE MULBERRY RAW SILK PRODUCTION
1999 - 2000
2000 - 2001
2001 - 2002
2002 - 2003
5000 (Mt.)
2500 (Mt.)
Karnataka
Andhra Pradesh
West Bengal
Tamil Nadu
Others

FIGURE - 2·3 .

ii) State wise Account of Mulberry Cultivated Area

Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area have a direct bearing on cocoon harvest. In India, most states have taken up sericulture as an important agro-industry with excellent results. Though mulberry cultivation is practised in various climates, the major area is in the tropical zone covering Karnataka, Andhra Pradesh and Tamil Nadu states, with about 90 percent. In the sub-tropical zone, West Bengal, Himachal Pradesh and the northeastern states have major areas under mulberry cultivation. The details of the mulberry cultivated areas in different states of India are given in Table 2.7 and Figure 2.4. As depicted in the table and figure, the total area of mulberry in the country has increased to 194463ha, during 2002-03 compared to 22715ha in 1999-2000. In Karnataka and West Bengal, the total land under cultivation has decreased to less than fifty percent and more than 5% in 2002-03 from more than fifty percent and 10% respectively during the 1999-2000, the main reason behind being the land utilization for other food crop production.

Table 2.7
State wise Mulberry Cultivated Area (Unit: ha.)

State	1999-2000	2000-2001	2001-2002	2002-2003
Karnataka	120119 (52.88)	112557 (52.13)	116158 (50.05)	88903 (45.71)
Andhra Pradesh	44641 (19.65)	48442 (22.43)	52225 (22.5)	54384 (27.96)
West Bengal	21619 (9.51)	18106 (8.38)	18794 (8.09)	12569 (6.46)
Tamil Nadu	10953 (4.82)	11060 (5.12)	13096 (5.64)	5394 (2.77)
Jammu & Kashmir	5605 (2.47)	5478 (2.53)	5740 (2.47)	5986 (3.07)
Others	24214 (10.66)	20278 (9.39)	26063 (11.22)	27227 (14.00)
Total	227151 (100.00)	215921 (100.00)	(232076) (100.00)	194463 (100.00)

Source: Sericulture & Silk Industry Statistics - 2003 CSB
Figures in parenthesis represent the percentage of the Total

iii) State wise Account of Mulberry Reeling Cocoons

Cocoons are the main source of production of raw silk. The finest sewing silk comes from the most perfect cocoons. The poorest cocoons, the deformed,

STATEWISE MULBERRY CULTIVATION AREA

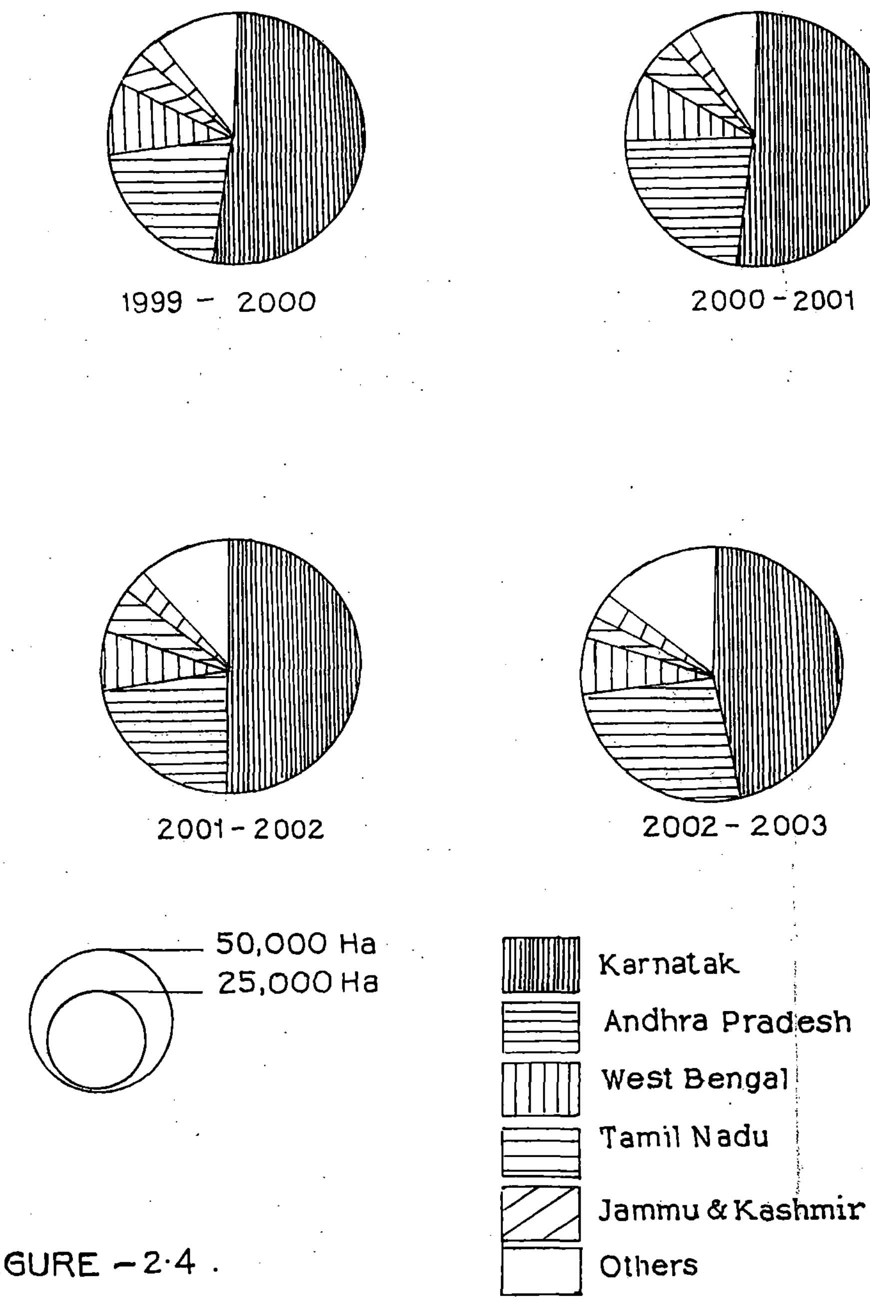


FIGURE – 2·4 .

discoloured, or otherwise defective ones, are often not reeled at all but are simply turned at once into silk floss. As per Table 2.8 and Figure 2.5, in India total production during 2001-02 was as high as 139616MT compared to that of 12453MT during 1999-2000, but again decreased to 128181MT during 2002-03. Among the producing states, Karnataka, which was leading throughout from 1999 to 2002 with more than fifty percent of the country's total output, decreased to less than the same fifty percent during 2002-03, whereas the other states has shown a positive result during 2002-03 compared to that with the previous figures.

Table 2.8
State wise Mulberry Reeling Cocoons (Unit: MT)

State	1999-2000	2000-2001	2001-2002	2002-2003
Karnataka	68920 (55.34)	66518 (53.35)	73860 (52.90)	55851 (43.57)
Andhra Pradesh	34194 (27.45)	37651 (30.20)	42982 (30.78)	50664 (39.52)
West Bengal	12670 (10.17)	11328 (9.08)	14329 (10.26)	15171 (11.83)
Tamil Nadu	6383 (5.12)	6400 (5.13)	5882 (4.21)	4005 (3.24)
Jammu & Kashmir	825 (0.66)	882 (0.70)	714 (0.51)	849 (0.66)
Others	1539 (1.23)	1884 (1.51)	1849 (1.32)	1641 (1.28)
Total	124531 (100.00)	124663 (100.00)	139616 (100.00)	128181 (100.00)

Source: Sericulture & Silk Industry Statistics - 2003 CSB
Figures in parenthesis represent the percentage of the Total

(iv) State wise Account of the Waste and by-products

Table 2.9 and Figure 2.6 illustrate that the total silk waste production was 4237MT, 4655MT and 4514MT during 2000-2001, 2001-2002 and 2002-2003 respectively. From the figure it can be depicted that the production has decreased during 2002-2003 from that of during 2001-2002, which means that result is positive, as lesser the waste production lesser will be the cost of silk yarn production. Karnataka was the leading producer of silk waste with 58% and more than 56% during 2000-2001 and 2002-2003 respectively, but the production reduced to 40% during 2002-2003.

STATEWISE MULBERRY REELING COCOON

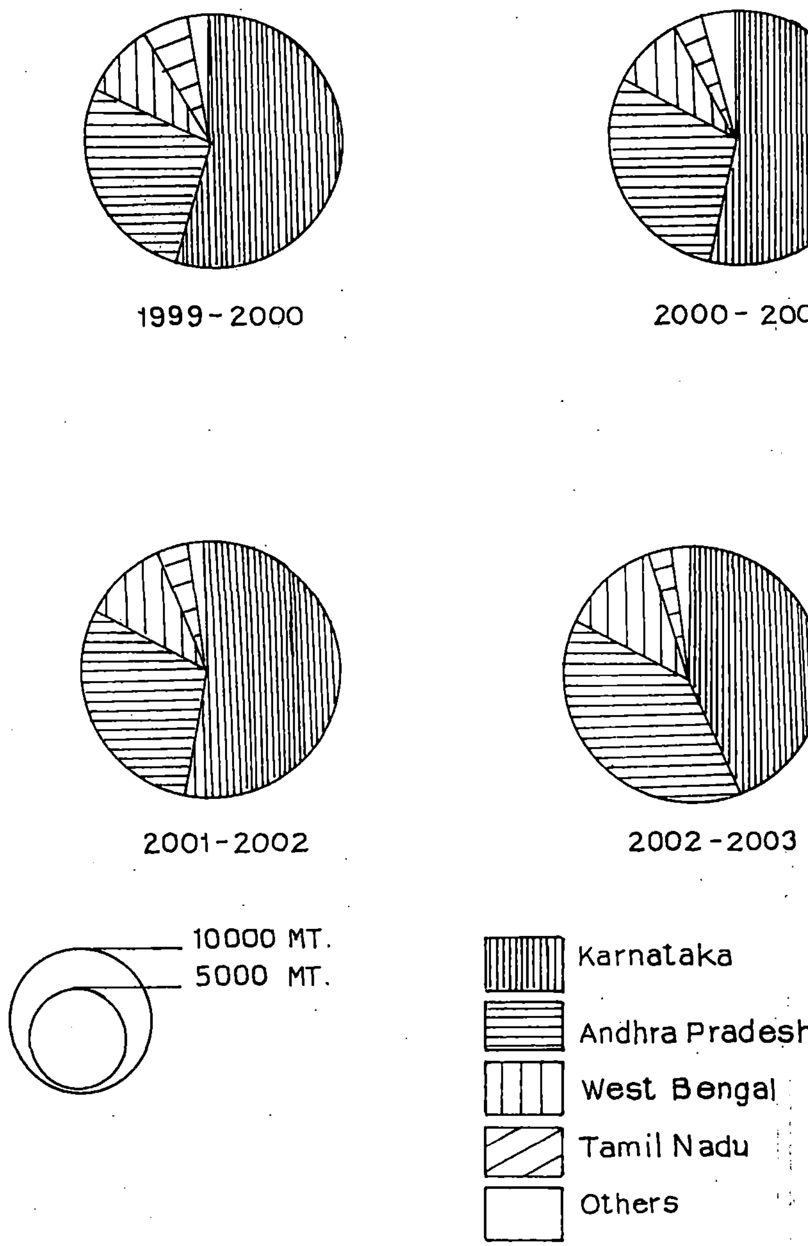


FIGURE - 2.5.

STATEWISE SILK WASTE PRODUCTION IN INDIA

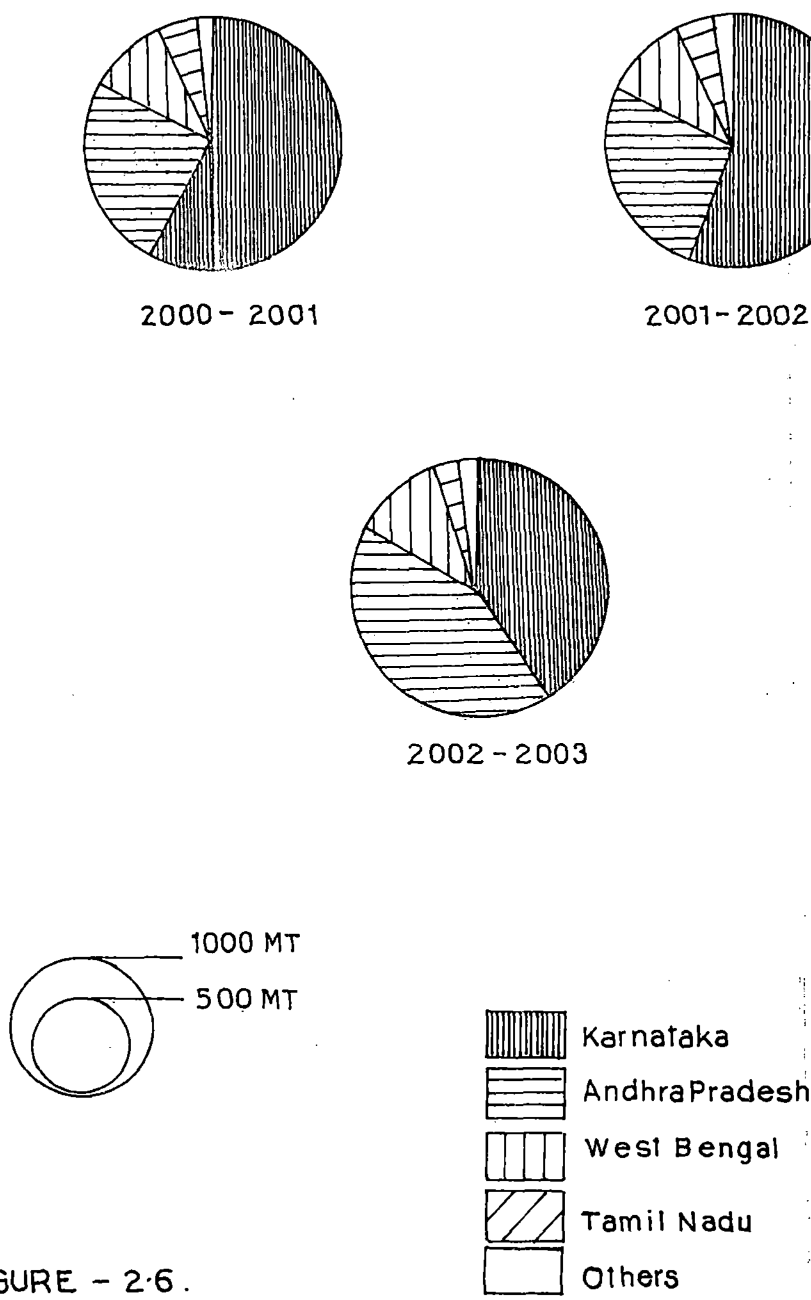


FIGURE - 2·6.

Table No. 2.9
Statewise Silk Waste Production in India (Unit: MT)

State	2000-2001	2001-2002	2002-2003
Karnataka	2460 (58.05)	2618 (56.24)	1825 (40.42)
Andhra Pradesh	1065 (25.13)	1265 (27.17)	1951 (43.22)
West Bengal	368 (8.68)	495 (10.63)	507 (11.23)
Tamil Nadu	249 (5.87)	197 (4.23)	147 (3.25)
Jammu & Kashmir	34 (0.80)	16 (0.34)	26 (0.57)
Others	61 (1.43) (1.43)	(1.44)	58 (1.28)
Total	4237 (100.00)	4655 (100.00)	4514 (100.00)

Source: Sericulture & Silk Industry Statistics - 2003 CSB
Figures in parenthesis represent the percentage of the Total

2.4.5 Sericulture and silk weaving industry in West Bengal

History reveals that Gangetic plain with special reference to undivided Bengal and Brahmaputra valley was once the epicentre of raw silk production and weaving. But since independence, gradually the region lost its role of leadership and today sordidly, West Bengal ranks third in India producing about 1450 MT of raw silk during 2002-03 only compared to that of 6760MT and 5629MT of Karnataka and Andhra Pradesh respectively (Table 2.5 and 2.10). The race or hybrids capable to produce quality yarn is reared only during winter and spring in plains of West Bengal and adjoining states. Moreover, the existing bivoltine are mainly suitable under high input and high management. The various studies showed that under farmer's condition only 50% yield potentials of the existing high yielding breeds and hybrids could be realized. This clearly indicated the scope and need of developing hardier and more adoptable high yielding breeds like biovoltine or univoltines) for the different seasons of West Bengal (Mukhopadhya, 1975). Presently, the hill region of West Bengal is mainly serving as the seed zone of high yielding (Bivoltine) breeds required for the hybrids utilized in plains of West Bengal.

Table 2.10
Production of Mulberry Raw Silk in West Bengal (Unit: MT)

Year	1999-2000	2000-2001	2001-2002	2002-2003
Production	1152	1050	1407	1450

Source: Sericulture & Silk Industry Statistics: 2003 CSB

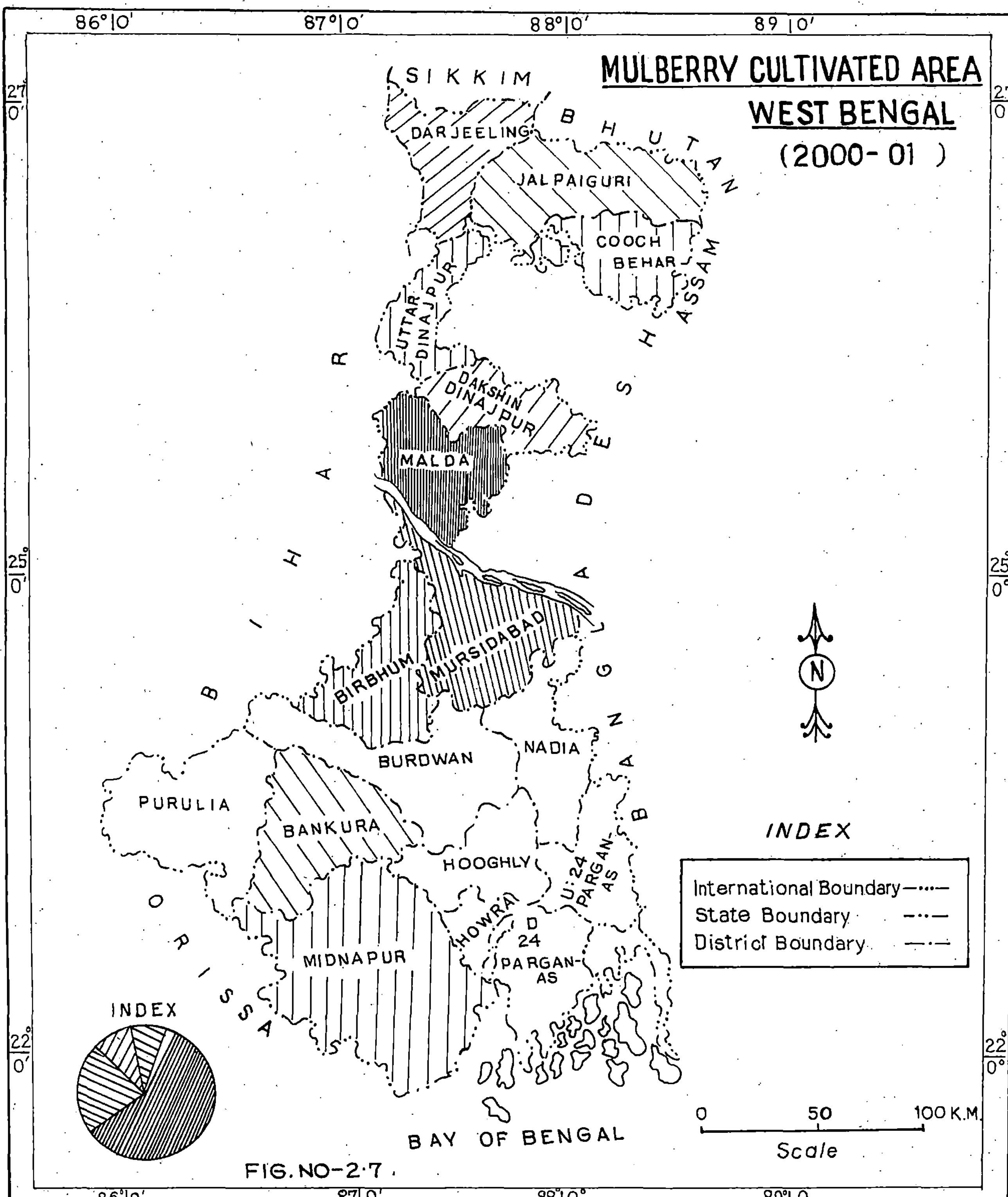
It is evident that Bengal province was the main source of mulberry raw silk in the international market. During the British period, the production of cocoon gradually declined due to the destruction of Indian handicraft. In between 1945-47 West Bengal had 15,000 acre of land under mulberry cultivation. Although the land under mulberry shows increasing trend the rate of growth is very low. The statistical records shown in Table 2.11 and Figure 2.7, depicts that by the end of March 2000-01, the mulberry cultivated land had reached nearly 18106 acres in West Bengal. (CSB, 2000-01).

Sericulture today is a well-established agro-based industry. It is an effective tool of rural development as it generates more income as well as employment. Out of 38,074 villages in West Bengal, sericulture is now practised in 1700 villages and West Bengal covers about 4.5 % villages in India. The industry provides full time and part time employment to more than 4.88 lac (1984-85) persons in rural areas. (CSB, 1986).

Table 2.11
Mulberry Cultivated Area in West Bengal, 2000-2001(Acre)

Sl.No	District	Acre	%
1	Malda	8523.48	47.07
2	Murshidabad	2380.97	13.14
3	Birbhum	2056.27	11.35
4	West Dinajpur (U&D)	1244.13	6.87
5	Darjeeling	1003.64	5.54
6	Cooch Behar	436.43	2.41
7	Jalpaiguri	425.10	2.35
8	Bankura	392.31	2.61
9	Midnapore	370.44	2.04
10	Nadia	331.58	1.83
11	24 Parganas	175.71	0.97
12	Purulia	151.01	0.83
13	Others	614.93	3.39
	Total	18106	100.00

Sources: Directorate of Sericulture, Malda.


MULBERRY CULTIVATED AREA
WEST BENGAL
(2000- 01)
86°10'
87°10'
88°10'
89 10'
27 0'
25 0'
22 0'
SIKKIM
BHUTAN
ASSAM
BANGLADESH
BIHAR
ORISSA
DARJEELING
JALPAIGURI
COOCH BEHAR
UTTAR DINAJPUR
DAKSHIN DINAJPUR
MALDA
MURSIDABAD
BIRBHUM
BURDWAN
NADIA
PURULIA
BANKURA
HOOGHLY
HOWRA
U. 24 PARGANAS
D 24 PARGANAS
MIDNAPUR
BAY OF BENGAL
N
INDEX
International Boundary
State Boundary
District Boundary
INDEX
0
50
100 K.M.
Scale
FIG. NO-2·7

2.5 CONCLUSION

Silk is the final end product of sericulture activity. Sericulture industry with its agricultural part of mulberry cultivation, silkworm egg production and silkworm rearing as well as industrial sector of cocoon processing and reeling involves a long chain of highly skilled operations. Therefore, it serves as an excellent mode of employment generation and augmentation of income. This requires not only providing fresh technological knowledge to the primary producers but more importantly, evolving and establishing new systems of organizing production and marketing. The salient features like higher yield due to technological advancements, better returns in the domestic as well as international markets for the silk and silk products, and scope for frequent cash accrual round the year has brought mulberry sericulture to a comparable level with other agricultural cash crops grown in the similar agro-climatic condition. However, the success is dependent on the integration of all the associated activities.

The foregoing account clearly explained the important place India has in sericulture and silk industry. West Bengal ranks only third with main concentration of the industry in Malda district. A detailed account of sericulture and silk industry in Malda district has been dealt with in the next chapter.