ASSESSING REELING PERFORMANCE OF THE DIFFERENT REELING MACHINES ESTABLISHING A REELING UNIT AND EVALUATING SERICULTURE AS AN INCOME GENERATING INDUSTRY FOR WOMEN

BY

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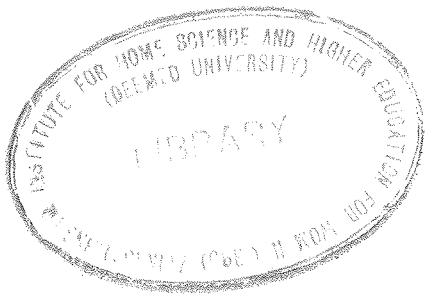

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Certificate

CERTIFICATE

This is to certify that the thesis entitled **"ASSESSING REELING PERFORMANCE OF DIFFERENT REELING MACHINES ESTABLISHING A REELING UNIT AND EVALUATING SERICULTURE AS AN INCOME GENERATING INDUSTRY FOR WOMEN"** submitted to the Avinashilingam Institute for Home Science and Higher Education for Women (Deemed University) in partial fulfilment of the degree of Doctor of Philosophy in Textiles and Clothing is a record of original research work done by **Mrs.N.VASUGI,** Lecturer in Textiles and Clothing, Avinashilingam Institute for Home Science and Higher Education for Women (Deemed University) Coimbatore, under my supervision and guidance and that the thesis has not formed the basis for the award of any Degree/Diploma/Associateship/ Fellowship or similar title to any candidate of any University.

Rajalakshmi 25/3/96

Signature of the Guide

Declaration

DECLARATION

I hereby declare that the thesis entitled **"ASSESSING REELING PERFORMANCE OF DIFFERENT REELING MACHINES ESTABLISHING A REELING UNIT AND EVALUATING SERICULTURE AS AN INCOME GENERATING INDUSTRY FOR WOMEN"** submitted to the Avinashilingam Institute for Home Science and Higher Education for Women (Deemed University), Coimbatore in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosphy is a record of original research work done by me under the supervision and guidance of **Dr. (Mrs) VIJAYALAKSHMI PRUSHOTHAMAN, M.Sc., Ph.D.,** Professor and Head of the Department of Family and Community Science, Avinashilingam Institute for Home Science and Higher Education for Women (Deemed University), Coimbatore and that it has not formed the basis for the award of any Degree/Diploma/Associateship/Fellowsship or other similar title to any candidate of any University.

Supervisor

Signature of the Candidate

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Introduction

I. INTRODUCTION

The very inevitable basic needs of man, namely food, clothing and shelter are obtained, only by exploiting nature using science as a tool. These needs are man's very breath for which he toils, suffers and struggles and attains them by inventing innovative methods.

Man has never been satisfied by merely eating some food, or having a simple shelter or by mere simple clothing. He has had a desire to have the best in everything. Naturally he wanted to decorate himself with beatiful clothing. It is this quest for satisfying the aesthetic sense in man, that led him to the invention of silk which till today sways with its bubbling fountain of tranquil and radiating golden beauty. Though this invention was by accident, it is the hidden treasure of Nature's marvel which has come as a boon to the mankind. Silk is simply resplendent, magnificent and elegant undoubtedly it is the diadem amongst drapery.

Reference on silk in India, was made in the famous Indian epics Ramayana and Mahabharatha, indicating that silk culture in India existed much before the commencement of Christian era around 2000 B.C. Silk, produced by the larvae

of silk moth, is one of nature's gift to man. Silk was discovered by the Chinese Princess in 2,500 B.C. and round about 289 A.D. Japan and India acquired knowledge about silk rearing. In India silk was first introduced in Bengal, and then it was spread to other parts of the country. Silk has become virtually a way of life in India for thousands of years and an inseparable part of Indian culture and tradition (Nanavathy, 1990).

Silk, the queen of textiles, rules supreme amidst a variety of look-alike synthetic fibres and commands fabulous prices in the international market. It is the most cherished of all the textile fibres. Silk remains an equisite fabric and occupies a covetous position due to the glittering lustre, soft feel, high tensile strength and comfort properties.

The natural lustre and smoothness which the silk fibre possesses is something unique which cannot be observed in other textile fibres.

Silk is the solidified viscous fluid secreted from the special glands or orifice by a number of insects and spiders. It is a polymer consisting of amino acids, glycine and alanine which are its main components (Venugopal, 1991).

Sericulture is now practiced in seventeen states out of twenty five states in India. India, is one of the few countries having tropical and temperate climate where

sericulture practices differ according to ecological conditions. In Kashmir sericulture is practiced as a monocrop pattern with single cocoon harvest in a year. In tropical conditions of Karnataka, Andra Pradesh and Tamil Nadu where the production of raw silk was 6214, 3194 and 1072 tonnes/year (1990-91) respectively, is practiced as a multiple crop of four to six per year and in West Bengal four specific seasons have been identified (Sharma *et al* 1993).

Sericulture involves mulberry planting, hatching of eggs to produce the silkworms, feeding the silkworms on the mulberry leaves and collecting cocoons spun by the silkworms and reeling silk (Dandin, 1994).

Of the four activities, two are land based activities and largely attended by agrarian families and the other two are indoor activities mainly attended by landless and skilled labourers in a decentralised sector. Hence, sericulture provides ample scope for both on - farm and non-farm activities. The industry therefore, ideally suits to the economy of developing countries like India, which faces the baffling problem of creating gainful employment to the ever exploding labour force, especially in rural and semi urban areas (Shah, 1993).

According to Thangavelu (1986) among the silk producing nations of the world, India enjoys a prominent status, producing commercially all the four varieties of raw silk viz., Mulberry silk (Bombyx mori), Tasar silk (Antheraea Mylitta), the Eri silk (Philosamia ricini) and the Muga silk (Antheraea Assamensis). Mulberry silk

accounts for about 95 per cent of the world production, as it is the most widely produced silk in the world (Venugopal, 1991).

The demands for silk has been increasing steadily and the current demand is estimated over 265 million square metres (Somsekhar, 1994). India is the second largest silk producing country in the world next to China. During 1991-92, the area under mulberry cultivation was estimated to be around 3,27,925 hectares, producing about 13,000 tonnes of raw silk (Samson et al, 1994).

Being labour intensive in character, sericulture offers vast scope for productive employment round the year, especially to people like women, old and handicapped who are normally disadvantaged in the labour market, providing them a small source of continuous income (Rao, 1994). One of the important features of the industry is that it can be practiced under a wide range of conditions, given a reasonably good soil, satisfactory rainfall and not extreme variation in temperature and humidity (Dixit, 1990).

Sericulture is identified as one, with less capital investment, minimal gestation period and high employment to the rural unemployed, consistant with their knowledge and skill. Sericulture is suited for small and large scale operations and the investment requirements are not that high and the output also finds immediate market.

It also helps in arresting rural migration and strengthen cottage and small scale agro-based industries (Dolli et al, 1993).

Sericulture provides employment to landless labourers, particularly landless women laboures for at least 120 days in a year (Radha, 1994).

With the dawn of Independence in our country, women have been progressively absorbed into the mainstream of economic life and they are, infact today in the forefront in many areas of economic and social activities. Modern Indian women have entered all walks of life and have branched out into diversified spheres of activitiy which were earlier considered as exclusive male domains.

Today in India, sericulture is both a way of life and a means to the security of the livelihood to nearly six million people in 59,198 villages (Das, 1992). Sericulture by virtue of its domestic nature, is a boon for rural women to enhance their socio-economic status in the society. More than 60 per cent of the activities in sericulture industry are attended by women. Sericulture is the only industry where primary producers and consumers are women. It is apt to say that sericulture, apart from agriculture is for the women, by the women and to the women (Devi, 1994).

Sericulture is known for its royalty since time immemorial. Of late, it has emerged as an indispensable livestock culture promising for greater farm and non-farm

employment. Sericulturecan be practiced as an intercrop or mixed crop with other agriculture crops. The by-products of sericulture industry can also be utilized for farming, with best results.

Sericulture has started gaining momentum in the rural areas of Tamil Nadu because it has not only raised the income of the small farmers but also has gone a long way in solving the problems of under-employment in agriculture.

Women tend to be sincere, hardworking, creative, flexible and inspire their sub-ordinates by setting a model themselves. The women's share of operation is about 90 per cent in mulberry cultivation, 100 per cent in silkworm rearing and 80 per cent in silk reeling. In silk reeling most of the activities such as sorting and grading, cooking, reeling, re-reeling and skeining can be carried out by women. Hence with adequate training in the various aspects of sericulture women can be helped to operate sericultural farm efficiently on their own. At the same time any health problem that might arise out of the nature of work in silk industry should be explored so that women can safe guard themselves from such health hazards (Dhandapani and Mukarji, 1994).

Women have braved entering the fiercely competitive world of business and industrial entrepreneurship involving risk of social and economic nature. Sericulture is one such aspect where women can

enter into and come up successfully availing benefits of the various development schemes. By enabling women to become entrepreneurs and participate fully and more effectively in a wide range of economic and industrial activities, it is possible not only to improve their position in society but also to make greater progress towards overall economic and social development, productivity, improved distribution of income, reduction in poverty and above all reduction of unemployment (Premchander, 1994).

According to Sundaramurthy and Narasingh (1991) reeling is a simple term meaning unwinding of the filament from the cocoon. The first stage in reeling known as cooking or boiling is the process of rendering cocoons to attain reelable conditions.

In India, silk reeling itself is a sort of handicraft, since personal skill is involved in taking out filament from cocoon and to form a silk thread, using various reeling devices (Sonwalker, 1985).

There are three distinct reeling devices in mulberry sector namely, charkha - the crude system of reeling, comprising of about 35,155 units whose production is about 50 per cent of the total production, cottage basin system (Improved over charkha) comprising of about 25,937 units whose production contributes to about 40 per cent and

the multi-end basin system supposed to be the modern version in India comprising of about 5,660 basins, contributing to ten per cent of the total silk production (Narayana et al, 1994).

The quality of raw silk depends upon the type of reeling apparatus used and the skill of the worker engaged in the different operations of reeling. In addition to these one should not forget that the quality of raw silk also depends upon the type of water used in the process of reeling (Rao et al, 1987).

The object of raw silk testing and classification is to test the quality of raw silk and to determine the grade for the purpose of establishing a standard for the quality improvement (Bhandiwad, 1988).

Katti (1991) states that quality control system has been found to be the most effective measure to maintain the requisite quantity and quality of any textile product either in yarn stage or fabric stage. The importance of this means has not been effectively adopted in Indian silk industry and hence the quality of Indian raw silk falls far short of international quality standards and as such does not figure in international trade. Indian silk has been graded in the international market as E grade while silk from China and Japan is graded as A and B respectively. Hence there is an urgent need to make our reelers and producers of silk be aware of the importance of adopting

strictly the quality control norms in an effort to improve the quality of silk produced.

The object of raw silk testing and classification should be to test the quality of raw silk and thereby determine the grade, so that we can improve the quality of silk and compete with the other countries. This not only facilitates fair and equitable transaction but also brings about quality consciousness in the industry.

In the present conditions of silk industry, every one speaks on the quality of materials produced. While referring to the quality of silk it is expressed as grade following Indian standards and International standards. Systems followed for reeling mulberry cocoons have a greater role on the quality of silk reeled. Reeling of cocoon on traditional charkha and cottage basin and testing the raw silk produced on these systems will help in estimating the influence of each system on the quality of silk. 4A, 3A, 2A and A grade silks have been claimed as the best quality silks internationally, while B is the lowest. Unlike other countries, in India, different reeling systems are practised so it is necessary to determine the difference in quality with respect to the different systems of reeling.

By and large it is evident that cocoon rearing is definitely profitable. Same thing does not appear to be true with respect to reeling, unless one has trained labourers and adequate number of basins in their unit.

Hence it is also essential to workout the cost benefit ratio for different sizes of units in reeling so that women may be advised to put up the desirable size units.

Having all these facts in mind, the current study was inspired with the following as objectives for the study.

1. To study the status of sericulture in and around Coimbatore with special reference to mulberry cultivation, silkworm rearing, and reeling of silk

2. To investigate role of women in sericulture with reference to their involvement, income and problems faced

3. To study the reeling performance of two popular systems of reeling silk namely the charkha and the cottage basin by assessing the quality of silk produced from the two systems and suggest ways and means of improving the quality of silk

4. Establish a reeling unit and work out the cost benefit ratio.

It is hoped that the study will throw light on the status of sericulture in the area under study and involvement of women in different capacities as entrepreneurs, reelers and labourers in the field of sericulture.

It is also hoped that women who are aspiring to take up any aspect of sericulture as an income generating activity, can take lessons from this study and proceed cautiously so that they are assured of profits from this industry.

Review of Literature

II. REVIEW OF LITERATURE

The review of literature pertaining to this study is discussed under the following heads :

I. Origin and history of silk

II. Production of silk

III. Nature and types of silk

IV. Sericulture - A multidisciplinary field

A. Cultivation of mulberry

B. Silkworm rearing and cocoon production

a. Silkworm rearing
b. Cocoon production

C. Silk reeling

a. Steps in silk reeling
b. Equipment used in silk reeling

D. Raw silk

a. Quality of raw silk
b. Production of raw silk
c. By-products in silk industry

V. Employment potential for women in sericulture

A. Women inmulberry cultivation and silkworm rearing

B. Women in silk reeling - As labourers and entrepreneurs

C. Problems faced by women in sericulture

I. Origin and history of silk

Silk was discovered in 2500 B.C. by the Princess Xi-Ling-Shi (Kannan, 1986 and Venugopal, 1991). Xi-Ling-Shi found white worms eating the mulberry leaves and spinning shiny cocoons. She accidently dropped a cocoon in the water and a delicate cobwebby tangle separated itself from the cocoon. Xi-Ling-Shi drew it out and observed that it was full of silk filament in the form of continuous length from the cocoon (Periasamy and Radhakrishnan, 1986).

The Chinese kept the knowledge of manufacturing silk as a secret for themselves for nearly 3000 years. About 555 A.D. the art of silk growing and making travelled to Persia, Central Asia and Sicily (Nanavathy, 1990). Round about 289 A.D. Japan and India acquired it. In India, silk was first introduced in Bengal from China and from there, the East India Company brought it to Madras Presidency. From then on silk production has found deep roots in the Indian culture. Production of silk goods began in the former princely state of Mysore during 18^{th} century. Later cultivation of mulberry and rearing of cocoons were encouraged by Devan Poornaiah and subsequently the regents and chief ministers of Krishnaraj Wodeyar fostered silk weaving and rearing of silkworms (Thimmaiah and Nagabhushana, 1986).

Narayana (1986) says that Indian sericulture was in dormant condition till the advent of II World War. It received the impetus during the war to develop further as this was the only country among the 'Allies' which could produce parachute silk. At that time, the silk production from multivoltine was taken wholesale for the preparation of parachutes. This support ceased with the end of the II World War. In order to avoid the progress from being stalled, the Central Silk Board came into existence in April, 1949.

Silk is produced by the larvae of the silkworm. Bombyx mori is a type of silkworm that is reared under controlled conditions and fed on mulberry leaves (Das, 1986). During the growing cycle of the larva, it moults four times and after the fifth moulting, it is ready to spin its cocoon. Silk is the solidified viscous fluid excreted from silk glands of the silkworm and forms a filament, an extremely long fibre of several thousand feet in length. It is a polymer chiefly made up of amino acids mainly glycine and alanine (Reddy et al, 1993). Morphologically, silk consists of two endless filaments surrounded by silk gum called sericin (Rayaredder et al, 1993). It is the only truly mythical fibre, surrounded by so much romance, mystery and adventure. This is due to a large degree of the silk routes of antiquity which were the first examples in the history of humanity of intercultural penetrations (Mouillard, 1988).

The mulberry plant is regarded as the native of the Himalayas. Its culture spread to India from China through Tibet by about 140 B.C. Mulberry leaves serve as food for the silkworms. Today it is being cultivated in over twenty nine countries all over the tropical and sub-tropical regions. Production of mulberry leaves on scientific lines is essential for organising sericulture on sound economic lines (Reddy and Kotikal, 1988).

In South India, the industry had an effective beginning not much more than two centuries back. In 1780's Tipu Sultan of Mysore, took steps to launch a raw silk industry in his domains. This involved the collecting of materials and technology, chiefly from Bengal. Simultaneously the ancient industry was being modernised with reeling technology and expertise from Europe also came through (Charsley, 1994).

According to Narayana et al, (1994), silk has become virtually a way of life in India for over thousands of years. It is an inseparable part of Indian culture and tradition. It is one of the ancient industries in India dating back to at least second century B.C. According to some historians, raw silk was exported from India to Rome during 58 B.C. Sericulture in India has passed through periods of great prosperity as well as decline (Thiagarajan et al, 1994).

Today, in India, sericulture is practiced in more than 50,000 villages across the country, employing millions of people and producing real goods and wealth for the country. Technology transfer programmes like 'Lab to Land' play a very effective role and brought research workers and farmers closer for expeditions and effective transfer of technology. Trade in both silk cocoons and silk fabrics play a vital role in the economy of the silk centres. Even today silk is a very important fabric in the world textile market (Nandi and Banerjee, 1992).

II. Production of silk

Bhargava (1994) opines that world silk production has doubled (72,879 tonnes) during the last 30 years, despite artificial fibres replacing silk. India is the second largest producer of silk thread after China. Some European countries like France, Italy and Spain, which used to have a fairly large scale of sericulture are no longer engaged in mulberry planting and silkworm rearing. Silk production, which ensures income to the most underprevileged rural populations, has become popular in a number of developing countries like Brazil, India, Malaysia, Philippines, Thailand and Vietnam.

China with its huge production base, almost 4-5 times the production of India, has emerged as a monopoly and a leader in the international market among 30 silk producing

countries. China's internal consumption is very low and is exporting silk goods to the tune of 90 per cent of her production. Japan is on a very low profile today in respect of quantum of production, but still produces silk of excellent quality with the support of advanced science and technology base. After Japan shifted over to more technology intensive industry from sericulture, the gap created in supply was fully exploited by the Chinese. However, India could not encash this opportunity because of its built-in deficiencies in the system. China is adding, almost the quantity of India's production every year, to her annual production. The success of silk industry depends upon quality, productivity and production cost. These factors are dependent on various parameters like raw material, process, machinery, technology, manpower and environment (Halliyal et al, 1994).

China, being the highest silk producer in the world, produces about 46,400 tonnes of raw silk annually, majority of which comes from bivoltine hybrid cocoons. India occupies the second place and produces 13,000 tonnes of raw silk annually which is dominated by multivoltine and biovltine hybrid (Thigarajan et al, 1994). Table I and Figure 1 show the trends in silk production.

Table I gives details regarding the world raw silk production and the percentage of silk production of China and India.

TABLE I

WORLD RAW SILK PRODUCTION

(tonnes)

Country	1983	1984	1985	1986	1987	1988	1989	1990
China	28,140	28,140	32,000	35,700	35,800	35,800	40,700	46,400
India	5,681	6,895	7,029	7,905	8,455	9,683	10,905	11,487
Japan	12,456	10,800	9,592	8,341	7,864	6,862	6,078	5,720
U.S.S.R.	3,899	3,899	4,000	4,000	4,000	4,000	4,000	4,094
Rep. of Korea	2,292	2,088	1,850	1,650	1,608	1,608	1,200	1,200
Brazil	1,362	1,458	1,558	1,780	1,780	1,700	1,697	1,693
Others	2,770	2,720	2,671	2,874	2,874	2,874	2,285	2,285
Total	56,600	56,100	58,700	62,250	62,381	62,527	66,865	72,879
				Percentage of total				
China	49.72	30.16	54.51	57.35	57.39	57.26	60.87	63.67
India	10.04	12.29	11.97	12.70	13.55	15.49	16.31	15.76

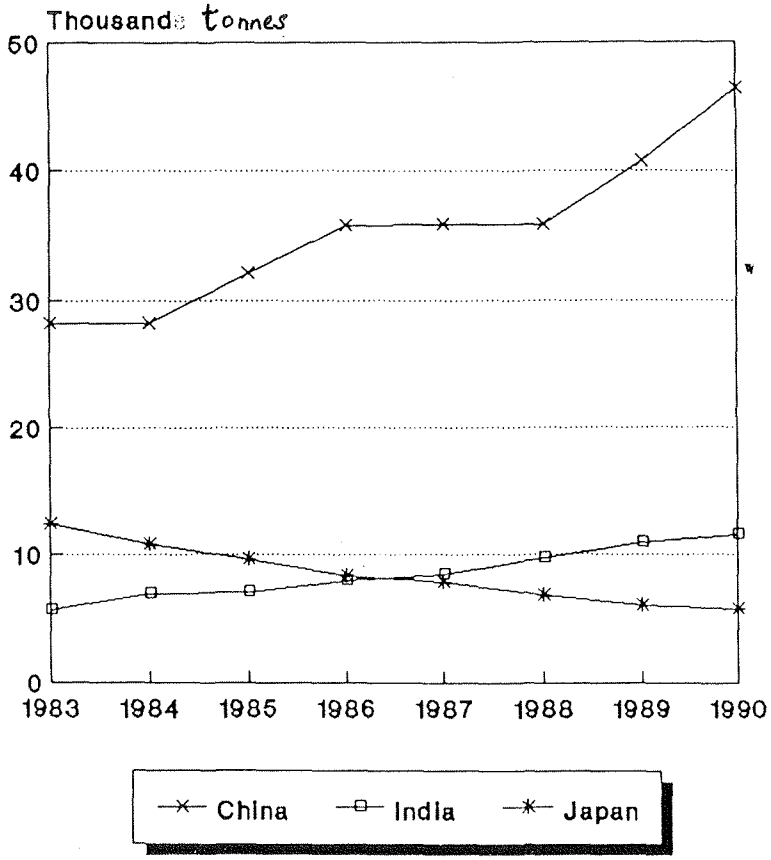


FIG.1 PRODUCTION OF SILK IN CHINA INDIA AND JAPAN

The Table I reveals that China with its huge production base and India stands second among 30 silk producing countries (Halliyal et al, 1994).

III. Nature and types of silk

Silk is the symbol of elegance and has no parallel for its replacement by any other natural or artificial fibres (Venugopal, 1991). Silk, the perennial queen of textiles, accounts for only 0.2 per cent of the total textile fibres available in the world. But it has occupied this covetous position due to its properties like the glittering lustre, soft feel, high tensile strength and comfort of wearing (Narayana et al, 1994).

Silk with its dignified drape and soft feel claims to be treated attentively and carefully throughout its processing (Kumar et al, 1992).

Silk is the most tenacious, continuous, natural textile fibre, coupled with high strength, silk fabrics have exceptional natural lustre, soft handle, good draping qualities and comfort properties desired of a textile fibre (Vijayaendra, 1993). Silk, which commands unique qualities over all other textiles, has lucrative lustre, facinating feel and dignified drape. Among textile fibres, silk stands for excellent quality, fashion and comfort (Jacob, 1994).

Among the silk producing nations of the world, India occupies a unique position. It is the only country producing on a commercial scale all four known varieties of natural silk namely; mulberry, tasar, eri and muga (Reddy et al, 1987).

Silk is classified as mulberry or cultivated silk and non mulberry or wild silk. Most silk is produced by the species Bombyx mori, an insect which feeds on mulberry leaves; hence the name mulberry silk. Tasar, eri and muga are called non-mulberry silk or the wild silks(Devi etal,1993). Among them, mulberry silk is the most common and it countributes as much as 95 per cent of world's production of silk (Narayana, 1994). Tasar silk a fawn coloured variety of silk, is obtained from silkworms Antheraea Mylitta feeding on the leaves of Sal (Shorea robusta) and Sygyzium cumini (Jamun) and other forest trees (Saluja et al, 1993). Muga silk, a golden coloured silk is obtained from worms of the species, Antheraea assama which feeds on the leaves of Sam (Machilus bombicina) and these two types of worms will have to be reared outdoors. Eri silk, creamy white in colour, is obtained from the worms of the species, Philosamia ricini that feeds on castor leaves, and being completely domesticated and reared indoors (Reddy et al, 1993).

a. Mulberry silk

The silkworm Bombyx mori is now extinct in the wild. It has been domesticated for over 4500 years and are unable to say what it really looked like and where exactly it lived, before man took it from the wild and domesticated it. During the long process of evolution, the silkworm had undergone many mutations. While attempting to preserve these mutants with desirable traits in their own way, the rearers attempted various combinations resulting in scores of silkworm races and varieties with different morphological and physiological traits. The total number of all these races exceeds more than 2000. Most of these races have been preserved in Japan. Silkworm races of various countries possess different characteristics. They differ in shape, size, quality of cocoons, larval markings, larval period, body physiology, resistance and brood character (Jayaswal and Datta, 1993). In case of mulberry silk, the natural colouring matters are confined mostly to the sericin layer (Das, 1989). Next to mulberry silk, dupion silk is as soft as the wings of a dove shiny and lustrous (Gupta, 1990).

b. Muga silk

Sericulture in North-East India is a traditional vacation, constituting an inseparable component among the lives of people of the region. The culture of non-mulberry silkworm is endemic to the region. Among them, production

of muga silk is the exclusive prerogative in North-East India in general and the Brahmaputra Valley in Assam in particular (Isa and Thangavelu, 1988). Muga is represented as a traditional symbol of Assammese culture and is indespensible in the Assames way life (Kakati, 1993).

India has the monopoly of muga flora and fauna, the out turn of the industry, both in respect of cocoon and raw silk, is far from satisfactory (Ghose and Sengupta, 1993).

Ancient kings of Assam patronised the development of non-mulberry sericulture. This led to advancement of the industry as it was obligatory for every household to rear silkworms, reel the yarn and weave the fabric (Kapila and Sahay, 1993).

The golden yellow muga silk is referred in literature since 1662 B.C. and in epics since time immemorial. Till the present day, muga silk occupies its unique position in the life style and the culture of Assam and neighbouring states regardless of community, class and caste. During the past few decades, muga silk industry witnessed a substantial decline because of various reasons including the indiscriminate felling of its food plants, and occurrence of frequent natural calamities such as flood and drought (Chakravorthy, 1986).

The muga silk is mostly used to produce dress materials like Dhoti, Chadder, Chapkan, Pugree, and Mehkela. However, if its silkworms are fed on Majankori lowes (Litsea citrata), the resultant cocoons produce silk of said name having creamy white more pronounced qualities of muga silk (Kapila and Sahay, 1993).

Assam, being the major muga producing state, has more than 25,941 number of families engaged in sericulture with 307 hectares of land. These plantations require 5 crore of seed cocoons for optimum commercial exploitation twice in a year. But, against the total requirement, only 2,70,34,200 number of seed cocoons were utilized during 1989-90 (Kakati, 1994).

c. Tasar silk

In India the production of tropical tasar silk stands next to mulberry silk, representing about 6 per cent of the total silk production (Bajpeyi et al, 1993). Tasar culture remained obscure though safe in the hands of tribals mostly inhabiting the dense humid tropical forest sprawling over the Central and Southern Plateau of India. Tasar silk has found mention in the legends, folk lore and fables since the onset of civilization itself. The master creators of the world famous Indian tasar belong to forest tribes (aboriginal) (Kapila and Sahay, 1993).

The word 'Tasar' is apparently, derived from the Sanskrit world 'Trasara' (Shuttle) and its history dating back to the Ain - I- Akbar (1590 A.D.). Its production is considered one of the throbbing symbols of tribal cultures. Tasar is the most important part of non-mulberry silks as 95 per cent of the global production of silk is presently contributed by the Tasar alone (Gupta, 1990). Tasar silk is famous for its natural fawn colour which is not easy to remove (Das, 1989).

Tasar looks coarse, wild and 'Crisp'. Indian tasar silk has been valued for its 'ethnic' appeal for both dress materials and furnishings, especially in Europe the largest importer of tasar silk from India to the tune of 65 per cent. Indian exporters and manufacturers are constantly striving to match the expectations of their European and American buyers by placing a sensitive finger on the pulse of the international market and its changing trends (Gupta, 1990).

Tasar silk produced by the worm Antheraea prolyee eating on Oak plant Quercus serrata is exploited for commercial production. It is considered to be the most suitable food plant which is grown abundantly in Manipur (Bidyapati et al, 1994).

According to Das and Chowdhury (1992) the growth of tasar culture is unpopular not only due to the uncertainty and risk of tasar silkworm rearing process which

is performed out doors and in forests but also due to the absence of a proper marketing system for tasar cocoons and silk which creates problems in ensuring an adequate remuneration to the rearer and the reeler (Sahay and Thangavelu, 1993).

d. Eri silk

The name eri is derived from the Assamese word 'era' which means castor oil plant, leaves of which are consumed by the domesticated silkworm, namely Philosamia ricini Boisdual producing white or brick red eri silk. The history of eri culture is also obscure even though it is known to have orignated in Assame state of India (Chakravarty, 1986).

The earliest reference to eri culture in India had been documented in 1779 according to which vast quantities of eri silk were produced in the environs of Ghoraghat region of the then undivided Bengal (Kapila and Sahay, 1993). Assam produces 90 per cent of the total eri silk produced in the country (Reddy et al, 1987).

Eri silk or endi is commonly known as poor man's silk and its production in India is considered as a small scale backyard venture, but the same can be developed into an industry with immense potentialities for self employment and in turn can play a vital role in the poverty alleviation (Siddiqui et al, 1993).

Eri silk production during the early decades of the 19th century, was about 38636.4 kilograms in Darang district of Assam (Kapila and Sahay, 1993). A total of 5,02,000 hectares of systematic castor plantations are available in the state of Andhra Pradesh, Orissa, Gujarat, Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh, Rajasthan, Bihar, Uttar Pradesh and West Bengal for oil seed production only. The rearing of eri silkworm can be taken up for earning additional money without affecting the castor oil seed production as defoliation of castor leaves upto the extent of 25 per cent does not affect the oil seed production (Siddiqui et al, 1993).

Apart from India, efforts are being made for the establishment of eri culture in Brazil which ranks first in world castor production (Reddy et al, 1987). Then the eri culture was successfully introduced in America and Europe in the middle of 19th century but could not take firm hold there (Kapila and Sahay, 1993).

Eri silk cannot be reeled and due to its non-reelable nature it fetches less price when compared to mulberry and other non-mulberry silks. Eri silk can be spun into yarn on very simple and cheap devices like takli and charkha. The Chaddar or Shawl prepared from spun silk are quite warm and can be used as substitute for woolen garments and are often used in North-Eastern states during winter (Siddiqui et al, 1993).

Eri culture extends from the low levels of plains upto an altitude at 5000 feet with the temperature conditions ranging from 13°C. It is said to be more resistant to diseases like bacteriosis, microsporidiosis and virosis than the mulberry silkworm and the tasar species (Reddy, et al, 1987). Non-mulberry silk production in our country amounts to nearly a thousand tonnes annually (Pandey, 1990).

IV. Sericulture - A multidisciplinary field

Sericulture is a unique joint venture of man, mulberry and worms. Sericulture is an agro based cottage industry which comprises multidisciplinary programmes like cultivation of mulberry plants (agriculture), production of cocoons (silkworm rearing), production of raw silk (silk reeling) and finally it involves production of fabrics (weaving) (Benchamin, 1993). The steps involved in silk production is shown in Figure 2.

The activity of rearing of silkworms from their hatching until they turn into cocoons is termed as sericulture (Narayana et al, 1994).

Sericulture has become the most important rural occupation in view of its quick turn over of the investment and great potential for employment (Siddaramaiah and Kumar, 1994). It provides a means of livlihood to a large section

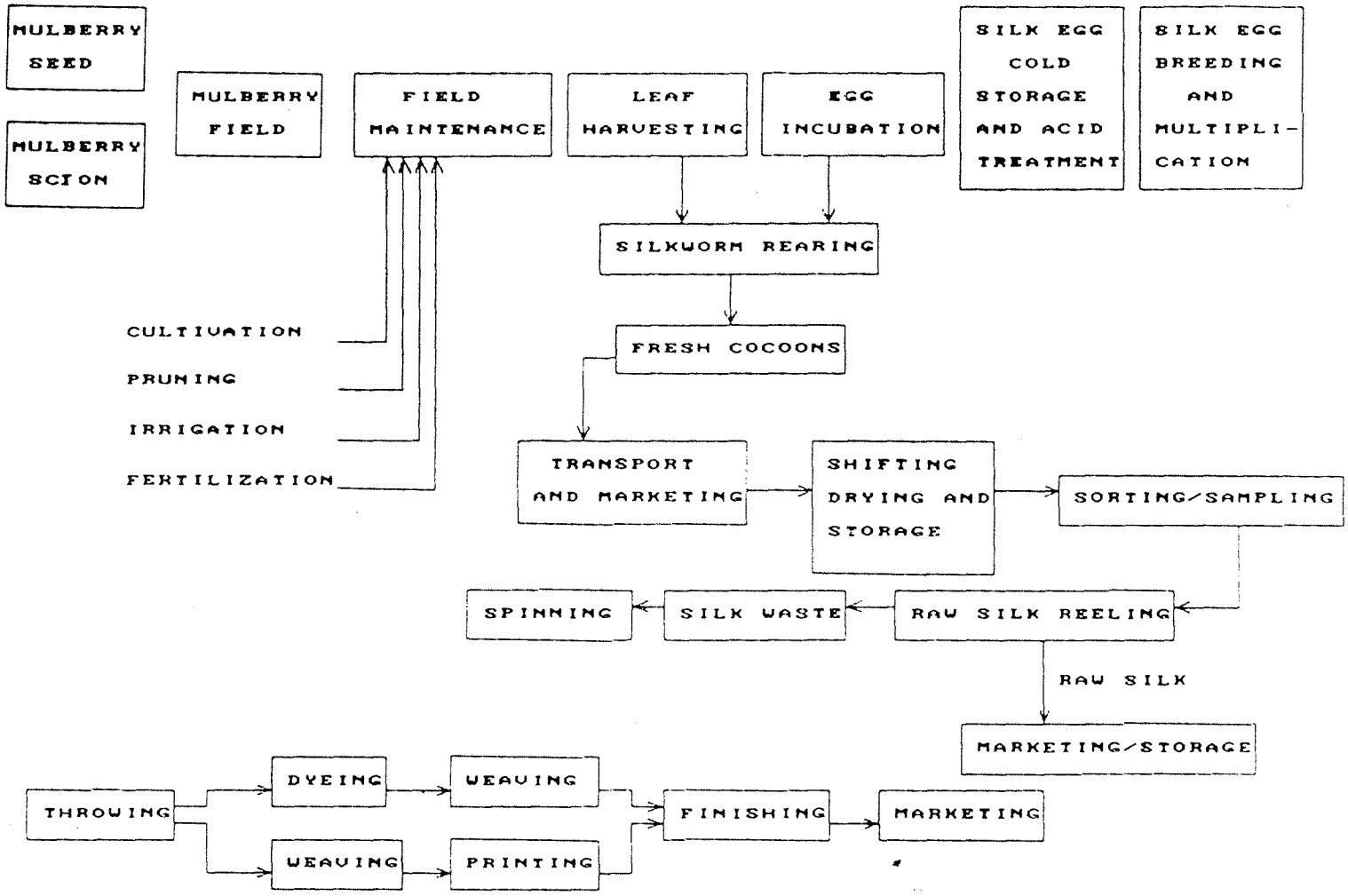


Fig. 2. STEPS INVOLVED IN SILK PRODUCTION

of the society including silkworm seed producers, farmers, rearers, spinners, twisters, weavers and traders (Narayana et al, 1994). Though it is an agrobased rural industry, it has effective linkages between agriculture and industry. It has the advantage of requiring low investment and providing high remuneration (Dolli et al, 1993). It is one of the most important section of economy in India and plays a significant role in poverty alleviation (Rao et al, 1991).

Compared to other crops in the irrigated and rainfed area, the income from sericulture is much higher according to (Das and Mathur, 1988). Sericulture is being labour intensive is ideally suited for developing countries like India in generating employment in rural areas (Sengupta, 1990). As an aid to socio-economic upliftment of India, which faces the baffling problems of creating gainful employment to the ever exploding labour force, especially in rural and semi-urban areas (Shah, 1993).

According to Prasad et al, (1988) sericulture, though for long has been considered a subsidiary occupation in rural areas, technological progress has made it worthwile to practice it on a large scale, yielding higher profits than most of the agricultural crops.

Sericulture is a boon to rural farmers. Its contribution to employment generation is undisputed. Its return are assured, regular and substantial (Thomas, 1993). It is a multi-faceted agro-based cottage industry which aims

at uplifting the socio-economic standards of its practices (Sudhakar et al, 1992).

Indian sericulture industries has been passing through its most dynamic phase of development during this decade and has crossed many of its traditional and agro climatic barriers successfully. With the result that today we find sericulture industry flourishing in almost all the regions, where it was never thought to be possible to cultivate (Kumar, 1988). It also earns considerable foreign exchange for the country. Sericulture has been practised in India for a long time, but only during the last decade has the country earned a good reputation in silk production and has developed to become the second largest silk producing country in the world. But a lot more needs to be achieved to improve the quality and quantity of silk produced in the coming years (Tewari et al, 1991).

Though India has made advances in sericulture, till 1970, Indian sericulture was mostly oriented to multivoltine silk. Multivoltine cocoons are soft and flossy, yielding less filament length. Efforts are being made to improve the quality of cocoons by introducing hybrids of bivoltine races and raw silk reeling technology by the research wing of Central Silk Board (Naik et al, 1994).

Sericulture in India is praticed both in temperate and tropical zones, where seasons and rearing conditions vary (Sinha and vathsala,1993). In India, presently about 10,31,439 families in 59,528 villages are engaged in silkworm rearing (Thiagarajan et al, 1994).

Sericulture was one of the protected industries in 1990's. During 1925, Madras Presidency has produced 105 kilograms of silk with 15,387 acres mulberry and Mysore has produced 5,27,272.7 kilograms of silk (during 1926-27) with 53,483 acres from then on, silk production was shrinking year after year in all the states due to uneconomic prices for cocoons. During the Second World War, India was the only country in the British Empire producing silk on the allies side. Increased production of quality silk needed for defence purposes made the kings look into the quick development of the industry. Services of technical experts were obtained and the Government of India helped the silk producing states to launch schemes for mulberry expansion and establishment of filatures (Uthaman, 1988).

Sericulture development has attracted many countries not only in Asia but also in Africa and South America which think of sericulture as a new source of employment generation. Brazil, Thailand, Vietnam, Bangladesh, Malaysia, Srinlanka, Botswana, Uganda, Zambia and Zimbabwe are already modest producers of silk while Indonesia, Nepal and Philliphines are introducing sericulture in their countries (Ramesha, 1993).

In India, now a days sericulture is practiced in almost all the states in one district or the other. In traditional states like Andhra Pradesh, Karnataka, Jammu and Kashmir, Tamil Nadu and West Bengal, it is being extended to all the districts (Rao and Kumar, 1993). Presently 0.313 million hectares are available under mulberry cultivation producing about 1,16,672 tonnes of cocoon and 11,487 tonnes of raw silk. Out of 6,29,143 villages in India, sericulture is practiced in about 59,198 villages (Dash, 1992).

The development of sericulture in Tamil Nadu is remarkable during the past one and a half decades. The area under mulberry plantation in Tamil Nadu during 1992 reached 22,668 hectares as against 5,160 hectares during 1977, only 1004 villages were covered under mulberry plantation which was 4.5 per cent of total villages (23,047) in Tamil Nadu. The number of villages covered under mulberry plantation by the year 1986 reached 4,655 which was 20.2 per cent of total number of villages in Tamil Nadu (Gangwar and Thangavelu, 1994).

Expansion of sericulture in more and more villages show horizontal growth of sericulture and is a good sign for future scope of expansion of the industry in the country.

A. Mulberry cultivation

Production of mulberry leaves on scientific lines is essential for organising sericulture on sound economic lines (Narayana et al, 1994).

Mulberry is the only food plant for the silk producing insect - Bombyx mori (Sharma et al, 1993). It is extensively grown wherever silk industries have been established (Bheemanna et al, 1990). Mulberry is a hardy plant belonging to the family of Moraceae. It can be grown under various climatic conditions ranging from 24°C to 28°C which is found to be optimum for good growth of mulberry (Rangaswami et al, 1988). It is generally accepted that quality of mulberry leaves varies depending on the mulberry variety, season, temperature, length of sun shine, nature of soil, kind of fertilizer used, level of ground water and method of raising (Subbasamy, et al, 1993).

Since mulberry is a deep rooted perennial and a long standing hard crop, the soil should be capable of supplying sufficient air, water and nutrients even in the deeper layers, where the root systempenetrates (Doraus and Vivekanandan, 1991).

Mulberry leaf production per unit area can be maximised through improved agronomical practices coupled with proper manual inputs. Leaf yields to the tune of 30,000-40,000 kilogram per hectare per year have been obtained in irrigated gardens through the application of recommended doses of manures and fertilizers (Satpathy et al, 1991).

Mulberry can be cultivated in the hilly areas about a height of 4,000 metres from mean sea level and mulberry leaves can be harvested throughout the year, in areas where height ranges from 600 metres to 1,500 metres from mean sea level (Kanyadi, 1989).

Bongale (1990) says that mulberry cultivation practice in India can be broadly classified into three categories like subsistence (wide spread in traditional area) moderate (non-traditional area) and affluent (stray cases) farming systems characterised respectively by nutrients, soil and moisture.

The quality and quantity of silk produced depend on mulberry leaf quality and yield and several other factors like silkworm race, climate etc. Adaphic conditions among the major factors determine the mulberry leaf production (Chandrasekhar and Thangavelu, 1988).

It has been reported that more than 60 per cent of the cost of the silkworm cocoon is incurred in mulberry cultivation (Bhat, 1991). Therefore, the productivity and profitability in sericulture depend on mulberry leaf yield per unit area at a reasonable cost. These necessiate increasing demand on soil fertility. High productivity of leaf cannot be sustained unless the depleted nutrients are replenished by means of supplementary application of their carrier (Suryanarayana, 1993).

Application of manure and fertilizer at recomended dosages are important factors for increasing the quality of mulberry leaf and improving the leaf yield. Quantity depends upon the type of fertilizer application(Reddy et al, 1993).

Instead of applying each nutrient separately compound fertilizers containing N:P:K (Nitrogen, Phosphate and Potassium) in split doses for irrigated rainfed, row system/pit system of mulberry cultivation have lately been recommended (Singh and Mathur, 1990).

It is also essential to supply sufficient component of amino acids for increased production for silk protein (Nagarajan and Radha, 1990). Mulberry leaves enriched with glycine increased growth of silk production up to 40 to 60 per cent (Bongale, 1993).

Soil plays an important role in the uptake of essential nutrients by the plants for their optimum growth. Soil characteristics, particularly soil reaction (pH) greatly affect absorption of available plant nutrients. Soil provides plant nutrients, water and air for root growth besides anchorage to the mulberry plants (Rao and Kumar, 1993).

Eventhough mulberry can grow in a wide range of soils, and can tolerate acidic conditions of the soil to some extent, higher acidity in the soil leads to disturbed growth and poor quality of mulberry plants, as uptake of

of nutrients in strongly acidic soils, gets retarded. For example phosphorous gets fixed as aluminium phosphate. They thrive in soils with pH of around 6.5 (Sundareswaran et al, 1993).

The success of sericulture depends on the quality of the mulberry leaves. The nutritional status of mulberry leaves can be enriched with extra nutrients like glucose, glycerin, egg albumin and molasses which were found to increase larvae growth and cocoon characteristics (Alagumalai et al, 1991). Hence it is essential to select suitable soil for its cultivation (Chandrasekar and Thangavelu, 1988).

Subbaswamy et al, (1993) stresses that plant growth and development depend on a favourable environment, adequate sunlight, water and plant nutrients. Productivity (Yield per unit area) in mulberry or any other crop is influenced by a judicious management of these inputs.

Water is also an important factor for the mulberry plant because succulency of the mulberry is depending upon the water availability from the soil. However excess of water in the soil is undesirable to the mulberry plant and also indirectly harmful for the silkworm rearing. Because, excess moisture in the leaves makes the silkworm susceptible to diseases. On the other hand, lack of water in the soil shows adverse effect, on the mulberry plant resulting in the reduction of quality leaf production (Mandal, 1993).

Irrigation makes a lot of difference in sericulture, since that alone can double the mulberry leaf production from 3000 kilogram to 6000 kilogram/acre/year. This means a chain of changes such as increase in number of crops (from 4-5 or 6), quantum of rearing per crop from (100 layings to 150 layings), type of silkworm hybrid (from conventional hybrid to improved hybrid), quantum of cocoon production (from 75 kilogram to 200 kilogram/acre/year) quality of cocoon and gross returns. The total improvement in leaf yield through the package is 100 per cent by irrigation alone and 320 per cent including other components (Benchamin, 1993).

Sericulture in Tamil Nadu adopt different spacing for their mulberry plantation which vary from 1' x 1½' to 3' x 3' in Coimbatore and Salem region. The sericulturists in Tamil Nadu still adopt three different spacing viz. 2' x 1', 2' x 2' and 3' x 3' (Gangwar et al, 1993). Different spacing both under rainfed and irrigated conditions, showed that closer spacing recorded higher leaf yield. A spacing of 2' x 1' in rainfed conditions registered the highest yield (Satpathy, 1990).

Manipulating the performance of available mulberry varieties under a given set of conditions, selecting better mulberry varieties, introducing selected exotic varieties and the combination of methods to be adopted upon the local requirements can improve the quality (Bongale, 1990).

Mulberry is attacked by pathogens. Compared to other plants, the damage caused by them is very severe as they affect both quality and quantity of leaves (Thangavelu, 1993). The kinds of diseases attacked by pathogens are powdery mildew, root and trunk rot, leaf spot, rust, bacterial leaf spot, dwarf and mosaic which are caused by fungi, bacteria, viruses and mycoplasma (Gunasekhar and Govindaiah, 1993). Disease incidence however varies with season, varieties and cultivation practices. The plant has to be protected from diseases. They drastically affect the economy of sericulture industry (Datta et al, 1993). Besides yield, the disease also affects the nutritive value of leaves, moisture, protein and sugar are reduced while starch cellulose contents are increased which will in turn result in bad cocoon output (Philip, 1990).

Govindaiah and Bhakuni (1988) say insecticides with residual toxicity is not advisable under ordinary circumstances as the leaves are to be utilised for silkworm rearing. Among the mulberry diseases, tukra diseases pose much more of a problem than any other mulberry disease. The insecticides will not bring about complete control of the disease as the disease continues to affect the mulberry tender leaves in subsequent crops. Under the existing conditions of mulberry as a subsistence crop under rainfed conditions with minimum input and maintenance, leaf yield is about 3000 kilogram/acre/year. A detail land preparation

and deep planting in pits of proper dimension to ensure retention of soil moisture and utilisation can boost the leaf yield to 4000 kilogram/acre/year, an increase by 33.3 per cent. Inter cultivation, organic manuring and fertilizer application can further increase the leaf yield by 12.5 per cent (4500 kilogram), 11.1 per cent (5000 kilogram) and 20 per cent (6000 kilogram) respectively. Choice of appropriate mulberry variety like K2 over local alone can bring further 15 per cent increase in leaf yield (6900 kilogram). All these practices as a total package could mean an increase in leaf yield by 1.3 times over the current level (Benchamin, 1993).

Tender leaves plucked from the mulberry garden are called pruning. The frequency of pruning revealed that there was reduction in the leaf yield with increasing number of shoot pruning to the ground level. The reduction in leaf yield was more pronounced in bottom pruning than in middle pruning (Nagaraj et al, 1994).

Leaves should be plucked invariably during the cooler hours of the day either early in the morning or late in the evening and immediately preserved in suitable containers, where the humidity must be maintained by repeated sprinkling or spraying of water (Krishnaswami, 1990).

Among the various sericulture activities, production of mulberry leaves shares about 60 per cent of the total cost of production of silk cocoons. Therefore any improvement practices either in increasing the productivity or decreasing the cost of production will have a significant contribution on the economics of silk cocoon production (Bhat, 1991).

B. Silkworm rearing and cocoon production

a. Silkworm rearing

Silkworm, Bombyx mori, L. generally lays two types of eggs namely diapausing eggs and non-diapausing eggs. Univoltine and multivoltine silkworm breeds generally lay non-diapausing eggs. Eggs of some multivoltine silkworm breeds also show a tendency to undergo diapause in winter. In tropics, if univoltine and bivoltine eggs are not kept in cold storage and exposed to natural conditions, the embryos will die whereas, multivoltine in temperate zones will not perish. In diapausing eggs, there is a hibernating substance which is released by the mother moth that inhibits the development of embryo (Mathur et al, 1992).

The female moths are kept for oviposition (egg laying) soon after depairing at room temperature (25°C) without any refrigeration. After four hours of mating, the female moths are collected and kept at 5°C for 10-12 hours to be released to a temperature of 25°C for quick and

uniform egg laying. It is reported that such a practice ensures laying of maximum number of eggs within a short time which in turn facilitates proper activation of eggs during acid treatment (Raju et al, 1990). The eggs can be cold stored upto 8 to 10 months. One gram of eggs will contain about 1500 to 2000 eggs. The period of incubation takes about 10-12 days at a temperature of about 25°C, which is accurately controlled (Dixit, 1990).

The life cycle of a silkworm has four distinct stages; egg, larva, pupa and moth. The duration of the stages may last for 20-35 days depending on racial characteristics and climatic conditions. In Indian conditions, to rear 20,000 eggs, the quantity of leaf required is about 350 kilogram to 400 kilogram. In general the environmental conditions like temperature, humidity, air and light are the factors that affect silkworm rearing. It is estimated that one tonne of mulberry for the rearing of silkworm emerging from out of one ounce of eggs yield about 25 kilogram to 30 kilogram of cocoons (Narayana, 1994).

The eggs produced in a grainage should be properly incubated under the conditions of optimum temperature (25°C), humidity (80 per cent), air (0.3 minutes/seconds) and light (16 hours). This will create uniformity in embryonic development and all the eggs will hatch out on 10^{th} or 11^{th} day after oviposition. The eggs, one day prior to hatching, change their colour from white to blue, due to

the pigmentation of the embryo. The blue stage in the embryonic life is very important and gives a clear indication to the sericulturists that the eggs will hatch out in a day or two. In order to increase the hatching percentage, black boxing method is adopted at the blue egg stage; i.e. the eggs are kept in a box covered on all sides with black material one day prior to hatching and they are exposed suddenly to bright light on the day following. By adopting this method, maximum hatching percentage can be obtained (Narayana, 1986).

The eggs are kept in cold storage until they are needed for hatching. It takes about 10 days for the eggs to hatch after they are taken from their storage rooms at 17°C and placed in incubators at 25°C. The worms are very greedy, it is estimated that each worm eats about 30,000 times its initial weight. At the end of about thirty days the worm ceases to eat, attaches itself to a piece of straw and begins to spin its cocoon (Benchamin, 1987).

The silkworm rearing involves feeding of silkworms from hatched worms to the adult stage with mulberry leaves at a proper size and time with maintaining the temperature and humidity of the rearing environment. The rearing has to be carried in hygenic condition in a separate room after thorough disinfection. Utmost care has to be taken during the rearing of young silkworms as they are highly susceptible to diseases (Narayana et al, 1994).

The silkworm rearing commences with the process of separating the newly hatched larva brushing from the empty egg shells or egg sheets and transforming them to the rearing bed. Chopped mulberry leaves are sprinkled over the newly hatched larva (Benchamin, 1987).

For good cocoon harvest, one of the important prerequisites is to fed the silkworm with adequate quantity of good quality mulberry leaves. Also uniform type of leaf has to be preferred during growing (Venkatesh et al, 1993). The quality of feed is determined by its major components such as water, carbohydrate, protein, mineral element, fats, amino acids and vitamins (Bongale, 1990). In Indian conditions, to rear 20,000 eggs the quantity of leaf required is about 350 kilogram to 400 kilogram (Narayana et al, 1994).

As the worms in the young stage are tiny in size, chopped leaves have to be used necessarily to feed them so that the leaves could be spread uniformly over the worms in the bed. If the leaves are chopped into too big pieces or used as entire leaves without chopping, the leaves tend to get over crowded in localised spots which is again not desirable for free and full growth of larvae (Krishnaswami, 1986). Inclusion of mulberry leaf powder or mulberry leaf extract in the artificial diet is highly desirable to stimulate the feeding behaviour of the newly hatched silkworm larvae (Philip, 1990). There are only small differences in the rate of growth and development of larvae

reared on mulberry leaves and artificial diets (Benchamin, 1987).

The silkworm grows to their full length measuring about 10 to 12 cm and weighing about 50 grams. It takes them about a week to complete the cocoon which contains 500 to 1,200 metres of silk thread.

Orifice of the silkworm is the opening in the head of the silkworm, through it silkworm ejects the silk fibroin to form the dual silk filament. Pupae is the waste obtained from the silk reeling industry (Datta et al, 1993).

Brin is one of the two strands of the silk fibroin or the silk filament. Bave is the central portion of the silk filament or fibroin (Dixit, 1990). Chrysalis is the enshrouded silkworm inside the cocoon (Dixit, 1990).

Chawki centre is the young age silkworm rearing centre, chandrike is a mountage made from bamboo stripes with spiral windings for placing cocoon spinning worms in the last stage of silkworm rearing (Mishra et al, 1993).

Temperature and relative humidity play a major role in the building of cocoon by silkworm. The ripe silkworm not only spins the cocoon at the spinning stage but also synthesizes a considerable amount of silk protein which takes place at the expense of disintegrated tissues, integument and gut proteins. The ideal conditions for good spinning are temperature between 22-23°C, relative humidity

between 60 and 70 per cent, good ventilation and uniform distribution of low intensity light (Mathur et al, 1989).

The rearing technology under tropical conditions includes providing more rearing space with less number of feedings as compared to conventional practice of over crowding of worms and giving eight feedings. The improved technology provides hygenic conditions in the rearing bed for healthy development of worms. Using a paraffin paper coverage and wet foam pads in the rearing bed maintains humidity and leaf moisture (Pasha, 1988). Maintenance of hygiene is one of the essential aspects of silkworm rearing. Since silkworms are prone to disease in the absence of hygiene, the rearing environment needs to be kept clean and free from pests (Gopalappa, 1993).

The mulberry silkworm is a domesticated variety of silkworm and is susceptible to diseases and attack by pests and parasites. There is no practical way of curing infected larvae, therefore, prevention and strong disinfection are the only means of preventing diseases (Kumar, 1992).

b. Cocoon production

In the life history of silkworm, when the feeding stage of the fifth instar comes to an end, the larva metamorphoses into a pupa. But, just prior to pupation, the silkworm begins to secrete a protein like substance through its spinneret opening under its jaws and turns into a filament (Rayaredder et al, 1993). The filament is in the

form of a double strand of fibroin held together by a gummy substance, sericin or silk gum (Nalankilli, 1992). Chemically, the silk fibroin and sericin are composed of approximately 95 per cent protein and five per cent was fats, salts and ash. The liquid substance hardens immediately on exposure to air. If left undisturbed, the crysalis (Pupa) inside the cocoon develops into moth (Reddy et al, 1993).

Towards the end of the final larval stage, silkworm stops feeding and gets ready to build the cocoon, and the fully matured larva becomes translucent and yellowish in appearance (Narayana, et al, 1994).

The cocoon shell has three distinct layers namely the outer layer "floss or blaze", the middle compact shell which constitutes the reelable silk and the inner most pelade layer. The outer floss and the innermost pelade which do not yield any reeled silk, form the waste. The floss or blaze is the foundation layer of cocoon shell which covers the compact shell. When the cocoon is harvested after spinning, it contains this floss covering all over the shell (Mishra, 1989).

Raw material for producing silk yarn is cocoon. Silk fibre is a long one as compared to other natural fibres like cotton, wool and other fibres. The fibre in the cocoon shell is continuous and is known as filament. The length of the filament varies in the range of four hundred to fifteen

hundred metres depending upon the variety of cocoon (Sonwalkar, 1986).

There are three types of cocoons produced namely univoltine, bivoltine and multivoltine. Dixit (1990) explains univoltine is a species of silk moth capable of giving one crop in a year. Bivoltine is a species of silk moth capable of giving two crops in a year and multivoltine is a species of silk moth capable of producing several crops of cocoon in a year. Multivoltine cocoons yields about 400 metres length of filament and bivoltine yields 800 to 1300 metres (Sonwalker, 1986). The cross breeds of multivoltine mulberry silkworms with bivoltine are used for higher cocoon production (Tayade, 1991).

The profits of the farmer depend on the quantity and quality of the cocoon harvested. Even if the worms are healthy, the quality of the cocoons depends much on the spinning conditions like the type of mountages, ventilation, aeration, humidity and temperature (Prasad, et al, 1988).

Raw silk is commonly understood to denote silk that is not degummed, the thread formed by combining the required number of silk filaments drawn from individual cocoons by a special technique called reeling. The cocoon is the raw material used for reeling raw silk. Economics of reeling and the quality and quantity of raw silk depend largely on the quality of cocoons used for reeling (Thiagarajan et al, 1993).

In India, cocoon transaction generally takes place in cocoon markets by open auction among the buyers and sellers in the presence of government agency. The rates are fixed by visual and actual examination of cocoons by buyers (Thiagarajan et al, 1993).

The marketing of silk cocoon is officially regulated in all the major silk producing states. Market regulation was introduced as early as in the 1950s to curb the practices of exploitation by middle man and traders. The Government of Tamil Nadu has established as many as 25 regulated cocoon markets in April, 1988. The Tamil Nadu State Silk Producer's Industrial Co-operative Marketing Federation Ltd (TANSILK) is fixing the minimum price of cocoon based on its silk content and raw silk price. Further, Tamil Nadu State Silk Producer's Industrial Co-operative Marketing Federation Ltd (TANSILK) communicates the price of raw silk to all the markets in the state periodically. Of the 25 regulated markets in the state, 12 markets are located in the intensive sericulture region, covering Dharmapuri, Salem, Periyar, Coimbatore and North Arcot districts, the remaining markets have been established in the new sericulture regions. All the markets are dealing in the cross breed reeling cocoon. However, there are also three seed cocoon markets operating from Dharmapuri district. In addition to cross breed cocoon, seed cocoon market has also been functioning in Hosur for bivoltine (Thangamuthu and Venkataravi, 1991).

In countries like Japan where sericulture is advanced, the price fixation of cocoons is done by regular cocoon testing, and in Tamil Nadu, the rate is fixed according to the shell content. Based on this, the minimum auction rate is fixed. The auctioners have to participate in the bid above this minimum price fixed. This helps both the reelers and rearers to get a reasonable price for their products (Thiagarajan et al, 1993).

C. Silk reeling

Silk reeling is the process of unwinding the filament from the cocoon by adopting necessary processes like stifling and cooking (Reddy et al, 1993).

According to Linda (1992) silk reeling is a crucial stage in silk production, and the reeling consists of a number of different process, some of which require considerable skill and experience.

Reeling industry is the backbone of sericulture, since the responsibility of the industry lies in the conversion of the cocoon into raw silk required by the weavers (Das, 1984). Silk reeling in India is yet to be modernised. Even now, marketing facilities for cocoons and establishment of reeling units are not adequate, which are deterrent to the development of sericulture industry in our country (Sonwalkar, 1986).

The raw silk reeling industry is still classed as one of the most difficult industrial techniques, because of the difficulty in establishing standard working techniques. This is mainly not only due to wide disparity of cocoon characteristics and qualities but also due to the lack of experience of the reeler, quality of water and variation in working and climatic conditions (Kim, 1989).

Hariraj et al, (1993) opines that Indian silk reelers purchase cocoons based on their experience and subjective assessment. They have hardly any knowledge of relationship between cocoon characteristics, reeling performance and silk quality. The basic assumption in the reeling industry is that silk quality and reeling performance highly depend upon the cocoon quality characteristics. With this assumption there is always a demand from industry towards improvement in cocoon quality.

The cocoon selection and price assessment are done by subjective methods, such as examining the completion of pupation, hardness of shell and rough assessment of defective cocoons in the lot. The price estimation is totally based on the experience of the buyer (Narayana et al, 1994).

Sundramurthy and Narasingh (1990) exhort that an indepth study of physical properties of cocoons will enable a reeler to determine the size and quality of raw silk so that yarn can be produced at an economical cost. The

physical characteristics cover several aspects like colour, shape and size, shell weight, shell ratio, granular formation, length of the filament, thickness of the filament and texture or hardness of the cocoons.

From 1925, when Navarathna Ram Rao, the first and pioneering superintendent of the sericulture department in Mysore, introduced his Mysore Domestic Basin, the official goal was the elimination of the charkha. The campaign started vigorously but came to a prolonged halt in the depression of 1930's every one of even the modest total of 130 new machines which had been brought into operation by then was abandoned. The effort was revived with success in the late 1950's and 60's, but in the event its first effect was to examine the possibility of improving the charkha without substituting a different machine for it (Charsley, 1994).

Silk reeling involves deflossing, stifling, sorting, cooking of cocoons, reeling and re-reeling of silk, skein books and bale making (Ramarksihan, 1989).

a. Steps in silk reeling

i. Deflossing

The process of removing the floss layer from the cocoon shell is known as deflossing. It is also known as "Peeling" and thus "deflossing" or "peeling" which consists of removing the hard outer layer is generally done at the

time of gathering of cocoons. Full deflossing of cocoons is generally done prior to boiling of cocoons, as the floss serves in the earlier stage as a protective covering for the well laid reelable layer of the cocoons, although the superficial floss must be removed, soon after harvesting. Generally, the (i) Multivoltine (ii) Multivoltine and Bivoltine cross and (iii) Bivoltine cocoon shells contain (i) 10-12 per cent (ii) 7-9 per cent and (iii) 4-6 per cent of floss respectively in respect of shell weight. During deflossing, the dirt and dust are also removed from the cocoon shell and the colour of cocoon will be brighter (Mishra, 1989).

ii. Sorting and storing

According to Sonwalkar (1991) sorting of cocoons is done to separate out defective cocoons from the good ones urinated cocoons, flimsy cocoons, double cocoons, malformed cocoons, mould-attacked cocoons, uzi affected cocoons and stained cocoons. From the good one after sorting, the cocoons are stored in thin layers in trays kept in wire meshed racks. Store room should be well ventilated so that aeration is free through the cocoons, store room should have humidity below 65 per cent and cocoon position should be changed often.

iii. Stifling and drying

After deflossing and sorting, the cocoons are subjected to stifling, for killing the pupae and drying

cocoons for storage. There are many methods for stifling, among which sunlight stifling, basket steaming, chamber stifling and hot air oven method of stifling are widely used. The live or raw cocoons are subjected to a high temperature hot air or steam to stifle the pupae inside the cocoons (Narayana et al, 1994).

iii.1 Sunlight stifling

In sun drying, the pupae are killed by prolonged exposure of fresh cocoons to scorching hot sun. When cocoons are exposed to bright hot sunlight, the original strength of the bave is very much affected due to ultraviolet rays of the sun. Hence this method of stifling, even though simple, is not advisable (Narayana et al, 1994).

iii.2 Basket steaming

This method is followed in small reeling units such as charkha system. For every batch of stifling, about 10-12 kilogram of cocoons are taken. Stifling is done for not more than 20-30 minutes. Top of the basket is covered with wet gunny cloth. Care is taken to avoid hot water directly contacting the cocoons (Gupta, 1990).

iii.3 Chamber stifling

Chamber stifling is used for stifling large quantities of cocoons, in cottage basin and multiend basin. At a time, about 25-30 kilograms of cocoons can be steamed depending upon the chamber capacity. In each tray, about 2"

thick layer of cocoons are spread. Steam is passed inside the chamber for 15-20 minutes. Care is taken to avoid condensed water of steam falling on the cocoons. After the steam is cut off, the chamber door is opened and the cocoon trays are removed for airing (Sonwalkar, 1986).

iii.4 Hot air oven method of stifling

The conveyer type of the hot air stifling device is best as they can be used to stifle the cocoons and also to store them for a longer period, but it is expensive to install (Sonwalkar, 1986).

According to the Haran (1988) it is not easy to get the cocoons of uniform shape, size and shell thickness. The standard percentage of cocoon drying adopted by most filatures is 38 per cent to 42 per cent although it differs according to the quality of cocoons and the duration of the storage of cocoons. When the cocoons are not uniform in size and shell thickness, there would be variation in the degree of driage; sometimes, more flossy cocoons lump or club together and obstruct the uniform drying.

iv. Cooking the cocoons

Cocoons are cooked in order to soften the sericin so that the filament can be unwound smoothly.

After deflossing, sorting and stifling, the cocoons are placed in the reeling pans and the ends from the requisite number of cocoons are drawn together, the pans

containing the cocoons are suitably heated, so that the temperature of the water, in which the cocoons are immersed, is kept at a constant temperature (Dixit, 1990).

1. Open pan cooking

For the multivoltine cocoons, open pan cooking is quite suitable. Cocoons are cooked in open for about 3-5 minutes. For each cooking, about 150-200 cocoons only are taken so that uniform cooking is ensured. The cocoons are neither over cooked nor under cooked. Otherwise the quality and productivity of silk will be affected. The water used for cooking basins are changed for every 2-4 kilogram of cocoon cooking.

2. Pressurised type of cooking

Conveyor type of pressurised cooking is best suited for bivoltine and multivoltine cocoons because six treatments are given under different temperatures under pressure and 97 per cent of the cavity of the cocoon is filled with water. When the required degree of cooking, softening and swelling of sericin are obtained, the reeling performance is superior. When the cocoons are not uniform it is difficult to maintain a particular temperature because some cocoons get optimum degree of cooking while the hard shelled cocoons get undercooked and the rest over-cooked, leading to wastage of silk and drop out of cocoons during the reeling process (Haran, 1988).

3. Modified smokeless oven

Modified oven has chimney system to get rid of ash emanating from the fire. Wood pieces are placed in the fire box and are lit. The fire intensity is concentrated below the cooking basin. So effective heating of water takes place since lid is closed and no fumes of fire would escape. The smoke will go through the chimeny with the result that absolutely there is no smoke in the working place. So the reeler can attend to the reeling work comfortably and produce better quality raw silk without in any way affecting yield, as compared to that of ordinary charkha oven (Sonwalkar, 1987).

v. Suitability of water for cooking

Hard water softened to the extent of 85-90 ppm improved cooking and reeling performance as well as quality of silk. Water used for silk reeling should be colourless, limpid and odourless, pH should be 6.8-7.4 (cold). Total hardness should be 35-90 ppm.

In India, majority of the reelers use water from available sources, whereas only a few organised filature units use treated water by installing water softening plants. Water is broadly classified on the source of supply i.e., surface water, sub-soil water and underground water. The quality of water may vary from source to source and season to season. Based on the quality of water, a

classification has been made, viz, soft water (below 100 ppm), moderately hard water (greater than 500 ppm and less than 1000 ppm). Similarly the alkalinity of water may be classified into low (less than 100 ppm), medium (less than 500 ppm) and high (greater than 500 ppm). Some of the important properties of water which influences the cooking, reeling and quality of raw silk are, total hardness, permanent hardness, pH, m-alkalinity and chlorides. These characteristics of water vary depending on the source, surface water, the subsoil water and deep well water. Silk is highly hygroscopic in nature, the dissolved substances in water used for silk reeling affect the quality of raw silk (Sanne et al, 1994).

6. Brushing

Brushing is an operation to remove the surface floss layer of the cooked cocoons and to get the reelable end of silk from cocoon for reeling.

Brushing is done in the cooking basin itself. A soft stick or brush is used for this purpose. By holding the stick or brush in one end, the floss are carefully removed by working the stick in a series of figures of eight among the cocoons in the basin. The collected floss is lifted about 25-30 cm above the cocoons and then the lump of waste is cut and kept aside.

Brushing can be done mechanically in semiautomatic reeling machine.

7. Reeling the cocoons

Reeling is a process in which filaments are unwound from the cocoons, combined to form the required denier and then wound on to a suitable package called reel. Reeler has to maintain the required number of cocoons per end to produce uniform denier silk.

8. Re-reeling

Direct reeled silk that is collected from the cocoon filament on the standard reel contains a number of defects like short ends of fine sizes, large slugs, entanglements and hard gum spots. In order to prevent formation of these defects and improve the quality of silk, re-reeling was used and came to be known as grant reel system of reeling (Sundramurthy and Narasingh, 1991). Therefore, utmost care is necessary to maintain the continuity of the yarn. Frequent breakages means too many knots and consequently these knots will lead to low production in weaving.

The re-reeling process has vastly improved the windability of the yarn for attaining higher production and higher grades in the international market. The word re-reeling ofcourse, indicates that the silk is reeled for the second time. During the re-reeling process, fine ends are

eliminated, broken ends are knotted to get the continuity of the yarn and to a certain extent defects are eliminated and the much dreaded hard gum spots removed (Kanna, 1988).

In this, the reeled silk taken from re-reeling machine is made into a skein in skeining machine. The twisted skein should be about 30 cm in length with five spirals with percentage top portion having two cm flawes and five cm fascia (Sonwalker, 1985).

Now-a-days it is common to reel multiples of lengths of 450 metres into hanks weighing about 70 grams. A 70 denier yarn therefore will contain 20 skeins of 450 metres each or one hank of 9000 metres with a circumference of about 150 cms (Dixit, 1990).

10. Book making

The skeins are made into a book of approximately equal weight in a book making machine. Each book is a bundle. Each book should be neatly tied with cotton bands at three different places and are wrapped in a tissue paper. The standard weight of raw silk book should be two kilogram (Narayana et al, 1994).

b. Equipment used in silk reeling

The post - cocoon technology is broadly categorised into three types like traditional (Country charkha), intermediate (Cottage basin and multi-end reeling

units) and advanced (automatic and semi-automatic units) technologies (Mattigatti et al, 1994). In India silk reeling process can be classified into two types, simultaneous and sequential. The simultaneous process includes charkha reeling and sequential process-cottage or filature, multiend and semi automatic reeling (Sonwalkar, 1986).

In simultaneous process, the cocoon boiling and reeling are done in the same water bath, which is kept at high temperature (80°C-90°C) and filament wound onto the reel with a circumference of 150 cm. In the sequential process, the cocoon boiling is separated from reeling (Narayana et al, 1994). The cottage-filature reeling method consists of six to eight reeling ends/units termed as basin. Here button and croissure pulleys are used to improve the quality of yarn and yarn is wound on to the reels either made of wood or aluminium, or nylon through a traverse guide. The machine is either power-operated or manually driven. The speed of the reel varies from 100 rpm to 160 rpm and produces about 850 grams to 1000 grams of silk per basin in eight hours (Sonwalkar, 1986).

Multiend device is a further improved version of the cottage basin and it is power driven. Normally cocoon cooking is done according to single pan system, as in the case of cottage basin. Multi reeling machine is supposed to be a modern version in India and it is possible to use

superior quality cocoons on those machines with better performance (Sonwalkar, 1988).

Charkha which is the simple hand driven reeling machine with one basin and four to six ends consists of a large cooking cum reeling pan where boiling water is maintained (Charsley, 1994). The cocoons are cooked in it and filaments collected in a bunch after brushing, are passed through a hole on an ordinary thread guide device. Afterwards the thread is crossed with another co-thread for forming a chambon type of croissure in order to aggultinate the filaments and remove the water from the body of the thread. Then it is passed through a distributor before it is wound on to a large wooden reel. Four threads are maintained in this device one person rotates the reel by hand and another person sitting near the cooking pan manipulates the cocoon cooking and reeling. In this process, inferior cocoons are converted into cheap and substandard raw silk. This silk is known as 'Varna' yarn and is used as weft during weaving. In this process, cocoons are cooked in an open pan at higher temperature and just after removing the upper layer (flossy layer), ends of 10-12 cocoons are joined together and are wound on a bigger swift at a high speed (Roy et al, 1993).

Cottage basin is an improved version over charkha and is indigenously designed. It is a technique of imparting cohesiveness to the composite thread drawn of several filaments unwinding in the course of reeling and

removing off excess moisture in the thread collecting on the reels (Sonwalkar, 1986). Filature operation is one of the operation which gives the good quality silk filament yarn (Uthaman, 1988). Here cocoon cooking is done separately in boiling water basin and reeling is done in a hot water basin attached to the reeling bench. Thread is first passed through a button to clean the slubs and waste etc. Then it is independently passed through a tavellete type of croissure which is more efficient than that in charkha. After the croissure the thread is passed through a traverse guide and finally on to a small reel. So, the quality of silk is superior to charkha silk. Superior quality cocoons like bivoltine can also be reeled on this device. But cottage basin is generally hand driven and alignment of the basin is not sufficiently perfect (Sonwalkar, 1986).

Generally, the silk produced in cottage basin is used as 'warp' and therefore, it should have better size deviation, winding quality and cohesion to make weaving process efficient (Roy et al, 1993).

Multiend filature basin is an improved version over the cottage basin and is power driven. Boilers are invariably installed and steam is used for cooking and reeling purpose. In filature basin, some additional

attachements like Jette-bout which picks up the filament to increase the efficiency of cocoon feeding, individual break motion for each reel, etc, are provided. The average silk production per basin/day is about 600-800 grams. The quality of the silk reeled on this device is superior to that of cottage basin (Sonwalkar, 1986).

In this process, fully dried and conditioned cocoons are cooked on three pan principle to achieve optimum cooking. The superior hybrid cocoons like multivoltine, bivoltine combination or bivoltine of good quality are only suitable as raw materials for this process of reeling (Roy et al, 1993).

Silk reeling is based on traditional level of technology and quality of yarn is not assured in India. Poor quality of yarn, not meeting the norms of evenness, neatness and cleanness, could not motivate the Indian weavers to go for better weaving systems where quality yarn is the first requirement and hence Indian silk weaving remained a handloom activity (Kumar et al, 1993).

Installation of various types of reeling machines with the object to reel different varieties of cocoon is an expensive endeavour for marginal reelers. The marginal reelers use traditional charkha for reeling both indigenous varieties of multivoltine cocoon which restricts their income due to production of inferior type raw silk, out of them. In order to sort out this problem, installation of

improved charkha with certain modifications and accompanied with an oven, the operation of which can be manoeuvred according to the reeling condition, is considered to be the appropriate measure (Chowdhury, 1990).

Raw silk yarn manufacture is carried out mostly in the cottage basins and country charkha. Most of the raw silk that is produced on country charkhas gets converted into fabrics on handlooms (Someshekar, 1985).

Nanavathy, (1990) reports that traditional manual silk reeling in India is a labour intensive process which accounts for over fifty per cent of reeled silk produced. It is undertaken on some 22,000 reeling charkhas, largely by poor rural or semi urban families without access to agricultural land. More than 60 per cent of silk reeling tasks are performed by women.

All encouragement should be given to the reelers who are actually the roots of the industry and they must be nurtured to grow into modern filatures. This would be the most effective way of promoting modernisation in reeling. Once the idea of modernisation catches up in the reeling industry, there would be no limit to its influence on the development of sericulture, because, efforts of sericulture industry are oriented to meet the needs of reeling industry (Haran, 1988).

The main reason why charkha is still dominating the Indian silk reeling industry is that the bulk of raw silk produced is used in the handloom industry, wherein the cost factor of the raw material has to be kept as low as possible for the rate of finished product to the saleable. Secondly, the establishment of the charkha unit does not need any big investment. Thirdly, the inferior quality multivoltine and defective cocoon available at lower prices can be reeled more economically on charkha than on cottage basin or multiend basin (Sonwalkar, 1987).

CSTRI (1991) reports that the automatic reeling system is a Japanese version of sunken system which is suitable only for better quality cocoons like bivoltine cocoons. The automatic reeling machine comprises automatic cocoon feeder and a mechanical brushing unit. In addition, it is equipped with an automatic denier control device, wherein human error is avoided to a larger extent and there by ensuring a minimum size deviation.

In recent years, the gradual increase of research attention to reeling has led to the development of a number of improved versions of the traditional silk reeling methods. These versions were developed by CSTRI in Bangalore, and Mysore and also by private entrepreneurs Rural Industries Konakpur (Sonwalkar, 1986).

It can be envisaged that with inferior cocoons, production of good quality raw silk is not economical

whereas in the production of good quality raw silk with superior races, the reeler can derive more techno-economic advantages which makes the reeling much economical (Roy et al, 1993).

D. Raw silk

a. Quality of raw silk

Raw silk, the compact untwisted and undegummed silk thread is formed by combining the required number of silk filaments drawn from individual cocoons. The raw silk varies according to the characters as well as reeling appliances. The quality of silk suffers due to very high variation in the quality of available cocoons in India which are either multivoltine or cross combinations and to some extent bivoltine (Sing et al, 1992).

The nature of silk offers a very high strength of the thread which compares favourably with other materials, but it is tappered and therefore a part of the unevenness is unavoidable. Filament, while unwinding from cocoon, also has entangled parts (loops) depending upon the silkworm race. These loops also cause neatness defect that is minor cleanness defect, lowering the grade of raw silk (Sonwalkar et al, 1992).

Singh et al, (1992) says that cocoon weight, shell weight, shell content, reelable length, egg weight, etc, can be predicted before completing or even before reaching to that particular stage because they are interdependent.

Cocoon weight has an intimate correlation with reelable length. Three hundred and sixty time, 675 times and 512 times of cocoon weight can be expected into the reelable length in indigenous multivoltine, bivoltine and multivoltine x bivoltine hybrid combinations.

A fully grown silkworm weighing about four to five grams ultimately gives a cocoon weighing about 2100 milligram of which the chrysalis weighs about 1700 milligram and the silk portion about 400 milligram of the 300 metres of silk on the cocoon, only about 100 metres weighing about 200 milligram is available for reeling. The remaining silk which is unreelable goes into the making of various types of spun silk. Reelable silk is about 10 per cent of the weight of the cocoon and the unreelable silk is about 10 per cent of the weight of the cocoon (Dixit, 1990).

Reelability of cocoon is one of the most important parameters which needs attention in the improvement programme but, it is a very complicated character to be improved, because it is negatively correlated with filament length and positively with neatness and is also under the influence of polygenes, the expression of which differs with environmental conditions like temperature, humidity, light and air during spinning period (Singh et al, 1992).

An indepth study of the physical properties of cocoons will enable a reeler to determine the size and quality of raw silk so that he can produce the yarn at an

economic cost. The physical characterstics cover several aspects like colour, shape size, shell weight, shell ratio, granular formation, length of the filament, size thickness of the filament and texture or hardness of the cocoons. A study of these characteristics will help to choose the right type of reeling machines, proper method of cocoon boiling and selection of the proper size of raw silk thread to be produced at an economic cost, the number of ends managable for maximum output per reeler and highet recovery of good silk from the lot (Sundaramurthy and Narasing, 1990).

On hatching of the eggs, the silkworms emerge as whitish wriggling worms. Each measures about three mm in length and about five milligram by weight. The silkworm is not a true worm, but is a caterpillar having eyes and legs. It is a voracious eater and grows with extra-ordinary rapidity, its length and weight increasing almost 30 times and 1000 times respectively. At this stage, it starts spinning the silk thread by turning itself into chrysalid inside the cocoon, which it has spun during 6-7 days. After remaining in the chrysalid stage for about further 12 days, it converts itself into a moth, which has a short life span of about four days (Dixit, 1990).

Colour of the cocoon is essentially a racial character, indigenous multivoltines in the South India are pale yellow to greenish yellow while in West Bengal, they are deep yellow to golden yellow. It may suffer slightly with the method of stifling, later during drying and also

while storage for long period. The colour is only superficial and due to the presence of colouring pigments in the sericin layer of the bave. It does not however influence reeling and therefore need not be critically considered for evaluating the reeling efficiency. This colour may show a declining tendency from outer layer to the inner layer. The shape of a cocoon is essentially a racial characteristic and partly due to the type of mountages used. However each race has its own characteristic shape. The volume of the cocoon is expressed as the number of cocoons per kilogram. In most of the multivoltine races, the number of cocoons per kilogram may range between 700 and 1000.

Shell weight is of commercial importance as it is the source of raw silk yarn. It varies in different races, however within the single race variation arise on account of rearing and spinning conditions. Among the indegenous multivoltines in India, the weight ranges between 100 milligram and 140 milligram and in the cross-bred multivoltine races, from 160 and 300 milligrams (Sundaramurthy and Narasingh, 1990).

Filament is the silk fibre of continuous length obtained from the silk cocoon, the extent of the length ranging from 300 to 1400 metres. Length of reelable filament is an important character. Length is generally greater in large cocoons. Denier is the measure of size of cocoons filament, it is defined as weight in gram of 9000

metres of filament. It varies according to the variety of cocoons (Shamachary, 1987).

Though it is known that the tenacity of silk decreases due to degumming, the role of sericin in depicting the mechanical properties is not well understood. The effect of sericin as a cementing layer, plasticizer and the related phenomenon on the tensile properties are discussed. The thread tension may have to be kept at the minimum possible level below the yield point during silk reeling (Nadiger, 1988).

There are criteria such as tensile strength, number of winding breaks, gum adhesion etc., which affect the amount of wastage and hence profitability of subsequent stages. Secondly, there are also criteria such as lustre, uniformity and denier which affect the appearance and price of the final product (Mayou, 1992).

Sonwalkar et al, (1992) opine that slugs is considerably thickened places in the thread seven millimetre and above in length, or extremely thickened places with less length, long knots which have loose ends, from three millimetres to less than 10 millimetres in length and corkscrews are places in which one or more cocoon filaments are longer than the remainder and give the appearance of a very thick and large spiral form.

Sonwalkar (1986) opines that in any productive industry there are three important factors which influence

the efficient working of a unit on profit line. These are (1) Raw material (2) Men and (3) Machine. Out of these, the raw material is the major influencing factors. Quality of the final product depends mainly on the quality of raw material. This is more so in the case of silk industry. Cocoons with improved characteristics, like longer filament length and more compact shell are required to reel superior quality of raw silk (Vasumathi et al, 1986).

The quality of raw silk also depends upon the type of water used in the process of reeling. Water is used in boiling (cooking) process and reeling process. Properties like pH, total hardness and total alkalinity of original water have predominant effect on the quality of raw silk (Bhandiwad, 1988).

The quality of raw silk depends upon the type of reeling apparatus used and the skill of the worker engaged in the different operations of reeling and quality control (Rao et al, 1987). However in grading, raw silk is visually and texturally examined in order to determine uniformity of colour, luster and hand, condition of general finish and nature of lot. This is more or less subjective test, but very important. Quality of Indian raw silk available for weaving is poor and rates 'E' of international grade while China's and Japan's silk is graded as A.
(Katti et al, 1991). The quality of Indian silk suffers in respect of winding, size deviation, evenness, cleanness and

neatness, whereas tenacity and elongation characteristics stand to the level of 2A to A grade. One of the main objectives of grading is to assess the assignable causes of the variation within the process (Sonwalkar, 1986).

b. Production of raw silk

In Tamil Nadu raw silk production was 4.67 lakh kilograms in 1980-81 and has increased to 6.77 lakh kilograms in 1987-88. Despite this increasing trend in production of raw silk, TANSILK (Tamil Nadu State Silk Producers Industries Co-operative Marketing Federation) could not transact the entire production of raw silk and it has transacted as low as 1.67 lakh kilograms out of 6.77 lakh kilograms in 1987-88.

During the 1980s the raw silk production in Tamil Nadu had increased with an annual growth of 7.03 per cent, whereas, the demand has increased by 6.87 per cent per annum in this period. Paradoxically, the inadequate marketing network within the state has been indicated by the low level of transaction by the TANSILK (Tamil Nadu State Silk Producers Industrial Co-operative Marketing Federation). Of the total production it has transacted, 18.63 per cent in 1980-81 and increased only to 24.66 per cent in 1987-88.

Any amount of investment to increase the availability of raw silk within the state means employment and income generation for the poor farmers, reelers, twisters and many artisians indirectly connected with cocoon and the raw silk production (Venkataravi, 1992).

In sericulturally advanced countries, like Japan, the price fixation of cocoons is done by regular cocoon testing and in Tamil Nadu, the rate is fixed according to the shell content. Based on this, the minimum auction rate is fixed. The auctioners have to participate in the bid above this minimum price fixed. This helps both the reelers and rearers to get a reasonable price for their products (Thiagarajan et al, 1993).

Silk industry in India continued to be based on traditional level of the technology and therefore, could not match the standards required in world market both in terms of quality and production. Silk reeling is based on traditional level of technology and quality of yarn is not assured in India. Poor quality of yarn, not meeting the norms of evenness, neatness and cleanness, could not motivate the Indian weavers to go for better weaving systems, where quality yarn is the first requirement and hence Indian silk weaving remained a handloom activity (Kumar, et al, 1993).

c. By-product in silk industry

In sericulture, lot of wastes are generated throughout the year due to silkworm rearing, mulberry cultivation and silk reeling. During silkworm rearing considerable amount of wastes and by products are produced which have got direct and indirect utility in agriculture and village industry (Mishra and Dash, 1992).

The wastage from silkworm rearing and mulberry cultivation can easily be recycled into good organic manure, through composting. Organic matters help in soil management for sustainable sericulture organic matter consists of materials derived from living organisms of both plant and animal origin (Chowdhury et al, 1993).

The use of green manuring crop as means of maintaining soil fertility is a long standing activity. Leaves of silkworm food plants, especially mulberry leaves, leftover after rearing can be utilised as a rich source of green manure. Leaf stalk remanants after feeding silkworms can also be used for feeding cattle. Poultry birds fed on mulberry based diet show increased egg production. Due to high protein content, young mulberry leaves formam excellent supplement to protein deficient diet. The dried mulberry branches and that of other food plants can be readily utilised as fuel wood. Mulberry wood is extremely suitable for house building and for manufacture of agricultural implements (Mishra and Dash, 1992).

The silkworm larval litter, generated by feeding mulberry leaves from one acre, will be around 1000 kilograms on the feed stock equivalent and this can replace the feed stock from one cattle. In addition, this nitrogen rich waste is a possible supplement to the nitrogen deficient agricultural wastes, that are put into the plant for biogas generation (Nagarajan et al, 1989). Protein content of silkworm litter is inferior, but compared to wild grass it

contains far greater quantity of protein. It can be utilised as an excellent organic fertilizer. The use of litter through feeding of animal is more economical than direct application as manure. It has been estimated that silkworm litters produced from rearing of 100 layings of silkworms meet the fuel requirements for a family of two adults and two children for about two weeks (Mishra and Dash, 1992).

Dry floss is the best quality of silk waste for the production of spun silk yarn, which can be conveniently spun by the hand spinning devices, and hence it secured highest price among the silk wastes in the market. The dry floss can be used as filling material in pillows and beddings, as it is used in Japan and China. From the dry raw floss, a coarse hand spun yarn is produced which can be conveniently used for knitting of winter jackets and gloves (Mishra, 1989).

Defective cocoons include immature rearing of the silkworms, stained cocoons, accidental squeezing of the worms inside the cocoons, discoloured cocoons, pierced cocoons and doubled cocoons. All the defective cocons are not wastes to be rejected and thrown away. Among these defective cocoons pierced cocoons cannot go for reeling (Venugopal, 1991). The moth breaking the cocoons and flying, give rise to damaged silk waste and it is a lucrative proposal to extract the pure silk from silk waste which can be used for spun yarn (Chakraborti and Sengupta, 1992).

Though silk and silk materials are costly, the by-products of silk waste is very cheap and easily available. Therefore, the techniques are to be developed for utilisation of silk waste for handicrafts. More over, there is not dearth of persons with a high degree of skill and artistic talent. One such handicraft is the making of greeting cards (Mathur, 1987). Silk takes wonderful shades when dyed and the silk waste material become pleasant when they are assembled in an orderly fashion. Similarly different coloured cocoons can also be used. If the technique is developed it would help to some extent to improve the economic standards of people involved (Magdi, et al, 1989).

Pupae waste which includes the pupae and de-oiled pupae powder can be utilised in a number of ways. Linseed oil (75 per cent) and pupae oil (25 per cent) can be used for preparation of emulsion solution in jute industry to soften the jute fibres. Pupae oil can be used by farmers for burning purpose and for preparation of soap (Mishra and Dash, 1992).

From bivoltine mulberry fed Bombyx mori cocoon, only 19-20 per cent silk waste was recoverable during reeling (Pandey, 1990).

V. Employment potential for women in sericulture

In India women constitute about 48 per cent of the total population. According to FAO the majority of women live in extreme poverty. If rural poverty has to be eradicated and the rural households are to be made economically viable, rural women should be given suitable employment. Sericulture is a promising appropriate technology which can generate employment for rural women. An acre of mulberry could provide gainful employment for five persons all the year round in traditional areas. Many of the landless labourers could also gain employment through silk production. Sericulture meets the national objectives of providing employment opportunities to tribals, villagers and women and could help continuing migration from villages to towns and cities (Madan and Sharma, 1991).

In order to highlight the involvement of women in sericulture and also to focus the attention of everybody on this aspect, it was decided to observe the year 1994 as the 'year of women in sericulture'. Under the National Sericulture Project, a sum of Rs.6.64 lakh has been allocated to Tamilnadu for various components to promote the participation of women in various activities of sericulture in a larger way (Pasha, 1994).

Women have been involved in the sericultural activities in various capacities viz., workers (unskilled, semi-skilled and skilled) supervisors and supporting

personnel for the sericultural activities within the family (Nadigar, 1994). In our country about 75,000 women are involved in sericulture (De'Heireli, 1994). Women contribute to about 60-62 per cent of the work force input (Rao, 1994).

Women, most often, play a major role in sericulture as that of menfolk. There is indeed a general perception that women take part only in silkworm rearing activity. But, actually they make significant contributions in the field of mulberry production too. Further, women take part in management as well as decision making responsibility in sericulture (Rao, 1994).

There is a greater realisation today of women's role in sericulture. There are all round efforts to initiate women to effectively participate in sericulture and realise its impact not only in the development of sericulture but also in upgrading their position in the society. Women's training is one such effort by departments of sericulture whereby women are acquiring the appropriate technology and attaining self confidence in the sericulture activities, realise their contribution and reinstate their rightful place in the family and society (Gregory et al.,1994).

Silk industry is unique in that the success of a technology is determined by the socio-economic conditions of the community, as the activity is well woven into the way of life of rural communities. This realisation has broadened the responsibilities of consultants which makes them to be

visionaries, human resource development and marketing experts, sociologists and psychologists. Since human element is crucial in the development of the industry, they need to have good human relations capacities. Women instinctively are better suited in such areas to introduce an activity and have a better potential to make good sericulture consultants (Shekar, 1994).

Women in our society especially the rural, finds herself well established in the lower rungs of the family rearchy both in terms of social and economic status. She often becomes the target of all social injustices, exploitation, repression and economic constraints. Women engaged in sericulture seem to be no way all exception to this age old social system. Their fingers run continuously either in picking ripe worms or twisting the silken thread or handling the weaving spindle without any hope and future passing down the traditional heritage and culture through generation (Basu, 1994).

The recent industrialisation is alsmost urban and men oriented. Women workers have limitations to involve themselves in such type of work which involve literacy, skill upgradation and staying away from home. These aspects necessitates to generate jobs for less educated (Dandin, 1994).

According to Kannan (1987) 51 per cent of women are assisting men in this lucrative industry to produce the queen of textiles. Women are mostly favoured because of their delicate nature, patience and hardwork whether they are employed in a mulberry garden or silkworm rearing, grainage, and garment making.

Creation of more than 10 lakhs employment opportunities in rural and semi-urban areas in the downstream activities which include six lakhs employment opportunities to women (Reddy, 1994).

Sericulture provides employment of landless labourers particularly landless women labourers for at least 120 days in a year. It is observed that in sericulture compared to men, the women's share of operations is about 90 per cent in mulberry cultivation, 100 per cent in silkworm rearing and about 80 per cent in silk reeling. Hence, with a little training in the various aspects of sericulture women can be helped to operate sericulture farms efficiently on their own (Dhandapani and Mukerji, 1994).

Women's contribution and the significant role played by them has so far not been explicity recognised (Basu, 1994). The National Sericulture Project has given a special emphasis on women in sericulture and integrate them more effectively in the economic growth of the industry. Special thrust has been given to various promotional activities for women which will provide them with better

technical inputs and access to resources like land, credit etc., and lead to their empowerment. This will help in integrating them into the main stream of sericulture and they would make significant contribution to the vertical and horizontal development of the industry (Pradhan, 1994).

Women spend 54.8 per cent of the time for sericulture activities and 17.1 per cent of time for farm activities in traditional areas while neo-sericulturists spend 57.7 per cent of the time for sericultural activities and 10.9 per cent for farm activities (Iyengar et al, 1994).

Acquisition of technical knowledge and skill development are vital to empower the women for playing a more effective role besides contributing to the productivity and quality. Imparting better knowledge to women is sought to be achieved through training, special teaching aids and monthly meetings (Pradhan, 1994).

It is commonly recognised that women, in all traditional sericultural states, constitute a substantial proportion (53 per cent) of the total work force in sericulture and contribute vitally to the sectors of silkworm rearing, reeling of cocoons and even in twisting, weaving, printing and dyeing (Devi, 1994).

Involvement of women in all aspects of sericulture is increasingly visible and well documented. There have been several efforts by the governments of three southern sericultural state to promote entrepreneurship among women,

in an effort to pass on ownership over the activity to people undertaking it. Control over means of economic activity has led to empowerment of women in other sectors and also lead to better management of the income generating unit (Dhandapani and Mukerji, 1994).

In sericulture, the unit of production is the family wherein men, women and children participate in the process of production, the roles not being sharply demarcated on the basis of sex. The introduction of new technology seems to have made a lot of difference in the participatory levels of women. However, the spread of information regarding the new technology, favouring men, has created imbalances in the family and also within the society. If these changes are not planned properly, there exists the danger of women being thrown out of the production process. Because, it is the men who derive the knowhow, they naturally become the decision makers. To make women more competent in the various process of production, training her in sericulture would be the best answer (Radha, 1994).

Sericulture comprises the activities of mulberry cultivations, silkworm rearing and reeling - both male and female family labour is engaged in rearing but hired labour engaged for leaf plucking and weeding is predominantly women (Dhandapani and Mukerji, 1994).

Women's contribution to sericultural development is getting devaluated (like domestic work), since it is combined with domestic work, child care and other work with continuous rearing schedules (Devi, 1994).

A. Women in mulberry cultivation and silkworm rearing

In mulberry cultivation and management including preparation of land (digging, levelling), planting of cuttings, intercultivation (weeding, earthing up), irrigation, harvesting and transportation of mulberry leaves, women edges out men in operations like planting, manuring, weeding, and leaf plucking. In general, it is estimated that about 29.80 per cent of work involved in mulberry leaf production is done by women (Narayanaswamy et al, 1990).

Most of the activities like rearing carried out by women are indoor and skill intensive. Moulting care, frequency of feeding, bed disinfection and bed cleaning contribute significantly to the cocoon yield (Iyenger et al, 1994).

Women's participation is high in the rearing sector than it is in mulberry cultivation (Devi, 1994). In the rearing section women are engaged from brushing of worms till the marketing of cocoons. A lady assists men in chopping and feeding of leaves, bed cleaning, picking and mounting of ripened worms, besides their help in maintenance of hygenic rearing conditions most of the work during chawki

rearing is done by women in the family while men are usually engaged in other agricultural activities. In general about 43 per cent of the operations involved in the silkworm rearing are done by the women. Often women are involved in the transportation and marketing of cocoons too (Narayana swamy et al, 1990). Women should posses the essential knowledge of all the aspects of mulberry cultivation and silkworm rearing and master all the skills (Rao, 1994).

As expressed by farm women, they are interested in both mulberry cultivation and silkworm rearing. They want to gain knowledge and skills in both these areas. Women specially emphasis on minimising the cocoon crop losses. They are also interested in understanding the economics of the venture as compared to their competing farm enterprises. Going beyond they seek to understand waste utilisation, employment generation and securing credit for sericultural ventures (Rao, 1994) and ameliorating technologies for soil and water conservation (Reddy, 1994).

Rearing can be promoted amongst women from landless, marginal and small farmer households rural women have been traditionally involved in agriculture related activities and rearing can easily be adopted by them. Landless women, the most marginalised segment of rural population, can also undertake this activity on leased land as it is profitable even if prevailing lease rent of Rs.5,000 per acre of irrigated land is paid (Dhandapani and Mukerji, 1994).

B. Women in the silk reeling industry - As labourers and entrepreneurs

Silk reeling is a crucial middle stage in silk production , the production of raw silk yarn from cocoons. It is a skilled labour process involving high value raw material fluctuating prices of cocoons and the final product of raw silk. It requires considerable amounts of capital, and involves substantial degree of risk.

Rural women are born entrepreneurs, they have to take difficult decisions often and it is possible to harness this strength of women in their economic activity but there must be special efforts made to do so. The training inputs given to them must specificially aim at bringing out their entrepreneurial capacity (Premchander, 1994).

Reeling consists of a number of different labour processes, some of which require considerable skill and experience. There are fundamental differences between charkha and basin reeling. In charkha reeling both the cooking of cocoons and reeling are done by one worker, whereas in basin reeling these are separate processes. In basin reeling a further process of rewinding is necessary to improve the quality of the silk (Nadiger, 1994).

Women are mostly involved in reeling itself. Basin reeling is the only task for which daily wages are fixed. Women along with male and female children are also employed in a number of lower paid tasks including cooking,

turning, and waste sorting. Women are often informal supervisors in family establishments but no women were working as supervisors in paid employment. Women are employed as rewinders, and also engaged in fetching water and fuel (Mayoux et al, 1992). It is estimated that about 61.3 per cent of the total labour requirement on reeling operation is met by women (Narayana swamy et al, 1990).

Women are given highest preference in training in silk reeling and efforts are made to ensure that at least 50 per cent of the total trainees will be women. The women entrepreneurs are given preference over the wage employees, thus broadening the scope for human and income advancement of the women. Reeling is one of the important activities of the silk industry and it is a fact that most of the actual reelers are women though the owners of the reeling units are mostly men (Parthasarathy, 1994).

According to Nadiger (1994) there are various reeling technologies in the country that are used to produce different qualities of silk, the prominent ones being cottage basin and charkha, a traditional device which contributes to more than 50 per cent of the silk production in the country. Women engaged in producing charkha silk can be categorised into entrepreneurs, supervisor, women of the family based units and wage earners. For the second and the third category of women, entering reeling has become something inevitable since the work process is carried at home (Reddy, 1994).

In the charkha units, there is no specific well defined time to start work. A women wage earner works for seven to eight hours a day. A break in the work is taken after converting every drop of cocoon to silk, which may take about one to one and a half hours, depending on the quality of cocoons. In the family based units, the work at times extends to late in the night, depending on the time at which cocoons are purchased and its quality. There are, however, no shifts in the charkha industry, the number of working hours put in by the entrepreneurs and the supervisors are not quantifiable (Shasikala, 1994). Given the unique nature of the sericulture industry and the profile of women engaged in it, these interventions need to be examined and adopted to meet the requirements of potential women entrepreneurs (Dhandapani and Mukerji, 1994).

In reeling, the role of women is more predominant because of the finger dexterity and supple fingers coupled with the skill and delicacy of the women makes them to dominate the activity (Dandin, 1994).

In the speculative sericulture industry, especially in reeling, an entrepreneur needs to have sufficient resources and acumen to react to the dynamics of the market, to be successful. Reeling is generally undertaken using hired labour, except by small charkha units which operate seasonally using family labour, both female and male, child and adult. About 65 per cent of labour engaged in reeling is female, usually from families living

below the 'poverty line' (Dhandapani and Mukerji, 1994).

Nadiger (1994) opines that the concept of entrepreneurial profit and profit reinvestment appears to be absent with reeling entrepreneurs, as the activity is being extended as a tradition in majority of the cases. It is necessary to educate enterprise for ensuring satisfactory cost benefit ratio and good quality.

C. Problems faced by women in sericulture

Mayoux and Anand (1992) opine that in silk reeling units, the reelers are facing a number of problems like seasonality in cocoon supply and consequent fluctuation in prices. Analysis of the supply and prices of cocoon show severe slumps in supply of improved variety cocoons in August, December, March and April. In summer cocoon supply is low and prices relatively high. Prices received for silk are also low. For all the reelers prices received in summer were only about 75 per cent of those received in November/December/January. This is a reason for many stopping operation in the summer. While the climatic conditions, social background and availability of cheap agricultural labour are important, it is proper planning, technical know-how in various sericultural aspects, generation of sound technical manpower, efficient seed production and effective coordination and ready domestic market for the produce, improvement of marketing facilities are important factors that determine the success of sericulture in any place (Das and Mathur, 1988).

Of all the activities in sericulture, reeling involves the greatest uncertainty on account of fluctuations in prices of cocoons and raw silk. Cottage basin reelers in Tamil Nadu may incur a loss in the months of February, May, June and August, if they were to sell their product immediately after production. A charkha reeler, with a renditta of 10, is likely to incur a loss in the month of May while one with a higher renditta of 12 may incur a loss in the month of May to August and in January to March (Dhandapani and Mukerji, 1994). Hence silk reeling in India is yet to be modernised as this sector was neglected so far.

The present socio-economic status and tradition bound rural set-up poses some problems for women to develop themselves as entrepreneurs and labourers. Following are few aspects which needs to be looked into, to provide a better atmosphere for upgrading the present status of women in sericulture.

The major technologies developed are not known to majority of women who are actually engaged in these activities. Most of the extension education systems are men-oriented and for literate groups. Uneducated women do not have access to these formal education. Disparity in wage structure and superiority complex discriminate the women in activity (Dandin, 1994).

In the charkha units, there is no specific well-defined time to start work. A women wage earner work for

seven to eight hours a day. In the family based units, the work at times extends to late in the night. The number of working hours put in by the entrepreneurs and the supervisors are not quantifiable. All days are working days unless there is no work available. Since majority of the women engaged in the reeling industry are illiterate, their general awareness is low. Women in the reeling sector work in the close proximity of fire, heat and dust and are constantly dipping their hands in boiling water. As such, they complain of breathing problem, chest pain and blisters on the hand. Malnutrition, vitamin deficiencies, skin diseases and bronchial asthma are the common ailments (Shashikala, 1994).

The greatest disadvantage for poor entrepreneurs is, poor access to credit. The ability to mass sufficient credit are the keys to upward mobility. The reeling requires substantial amounts of credit for a number of different purposes. On setting up an enterprise capital is needed for purchase of machinery and possibility to construction of a shed, purchase of cocoons, labour costs and advances. Capital is then constantly needed to continue to purchase cocoons and pay labour, including subsistence advances, frequently needed to store silk when market prices are unfavourable. Moreover profits are very instable and capital is needed to continue operation whilst sustaining what are occasion substantial losses (Mayous and Anand, 1992).

Methodology

III. METHODOLOGY

The methodology pertained to the study on "Assessing reeling performance of the different reeling machines establishing a reeling unit and evaluating sericulture as an income generating industry for women", is discussed under the following heads:

I. Conduct of the baseline surveys
   - A. Selection of the area and the sample
   - B. Selection of the tool
   - C. Preparation of the interview schedules
   - D. Pre-testing the schedules
   - E. Conducting the survey
   - F. Consolidation and analysis of data

II. Studying the quality of cocoons
   - A. Selection of raw material
   - B. Assessment of the cocoons in 1 kilogram lot
     1. Total number of cocoons
     2. Total number of defective cocoons
     3. Total number of reelable cocoons
   - C. Characteristics of single cocoons
     1. Cocoon weight
     2. Shell weight
     3. Shell-ratio per cent
     4. Average filament length
     5. Average non-breakable filament length

III Study the two different reeling systems with reference to the quality of silk yarn

A. Selection of reeling systems

1. Traditional charkha
2. Cottage basin

B. Pre-reeling techniques

1. Stifling and drying of cocoons
2. Sorting of cocoons
3. Storing of cocoons
4. Cocoon cooking or boiling
5. Brushing of cocoons

C. Reeling of cocoons in the two different systems

D. Post-reeling operations

1. Re-reeling
2. Skeining

E. Raw silk yarn testing

1. Renditta
2. Visual inspection
3. Mechanical tests
   a. Winding breaks/skein/hour
   b. Average size, size deviation and maximum deviation
   c. Evenness, cleanness and neatness
   d. Tenacity and elongation

IV. Establishing and running a silk reeling unit

1. Conduct of the baseline surveys

A. Selection of the area and the sample

Twenty five sericulturists both the men and women were engaged in the cultivation of mulberry and cocoon rearing from Gudalur, Goundampalayam and Samichettipalayam, located in Coimbatore district were selected randomly to gather the details required on the status of sericulture in the area and details regarding cultivation of mulberry and production of cocoons. Eight reeling centres where both men and women were engaged at Podanur, Kurichi, Vadavalli, and Singanallur (Two in each area) in Coimbatore district were selected at random to study details regarding machinery, labour structure, production of silk, income and expenditure pattern. Twelve women entrepreneurs involved in mulberry cultivation and silkworm rearing and another 12 women involved in silk reeling were selected based on convenience sampling technique to findout their role, problems and prospects in these industries. Sixty five women labourers involved in sericulture were randomly selected to gather details regarding various factors related to them. The close proximity of the place and co-operation rendered by the sericulturists and reelers were the factors for selecting the specified areas.

B. Selection of the tool

The technique used for the collection of information was the interview method, and the data collected by this method was first hand in character. The interview method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses (Kothari, 1990). The information obtained by this method is likely to be more accurate because the investigator can clear the doubts wherever needed. Hence the method was selected for conducting the survey.

C. Preparation of the interview schedules

Two different interview schedules 'A' and 'B' were prepared. The schedule 'A' was used to elicit information from sericulturists engaged in cultivation of mulberry and cocoon rearing and schedule 'B' was used to collect information from the reeling centres.

Schedule 'A' contained details about the income of the sericulturists, cultivation of mulberry such as acreage, type of soil, fertilizers and pesticides used and number of prunings done. Details about silkworm rearing such as type of rearing, space available, yield and cost of production and marketing facilities were also collected through schedule 'A'.

Schedule 'B' contained information on the factors that motivated the reelers to start this activity, wage

structure, labour force available, space requirements, purchase of cocoons, quantity and cost of production, details regarding by-products and their uses. Schedules 'A' and 'B' are given in Appendix I and II respectively.

Information from twelve women sericulturists were collected using an interview schedule 'C' and this schedule contained information regarding the amount of land, cropping pattern, production of cocoon, pattern of disposal of pupa, problems faced and measures taken to solve the same. The schedule 'C' is given in Appendix III.

For gathering information from women reelers schedule 'D' was evolved and this schedule contained information on money investment in business, availabity of work force, production and marketing of silk, factors affecting silk production and problems faced in marketing of silk. Details of schedule 'D' are given in Appendix IV. Schedule 'E' was evolved to collect information from 65 women labourers who were involved in different operations in the reeling units. The information gathered included details on reasons for taking up the job, training inputs, years of service, kind of work undertaken, duration of work, wages earned and health problems arising out of this work. The detailed schedule 'E' is given in Appendix V.

D Pre-testing the schedules

Sadhu and Singh (1986) stress that a trial survey is necessary to gain specific knowledge and to get an idea

of the various problems likely to be faced while administering the schedule. Accordingly pre-testing was conducted, and the schedules were suitably altered for use in data collection. All the schedules given in Appendices I - V are the final modified versions.

E. Conducting the survey

The investigator established rapport with the sericulturists and women entrepreneurs by visiting their houses personally and interviewing them at their convenience. The reeling centres were also surveyed in the same manner and necessary information was collected. Women labourers were met either in their workspots or in their houses and necessary data was collected. This was supplemented with the investigator's personal observations for ensuring reliability of the data.

F. Consolidation and analysis of data

Consolidation and analysis are important steps in problem solving and these procedures are required in any kind of research, to arrive at meaningful conclusions. Hence the collected data was consolidated systematically, analysed, percentages calculated and compared. Results of these treatments are presented and discussed under results and discussions.

II. Studying the quality of cocoons

A. Selection of raw material

Though India is unique in producing all the four varieties of silk, namely, mulberry, eri, muga and tasar, a major share of silk comes from the mulberry sector. The variety of cocoons reeled mainly, in India, is multivoltine which is suitable for both charkha and cottage basin reeling (Nanavathy, 1990). Hence multivoltine cocoons were selected for the study.

Out of the twenty five lots of cocoons which purchased from the local cocoon market for reeling purposes, five lots were randomly selected and from each o these lots one kilogram/lot was randomly taken for assessing the quality of cocoons.

B. Assessment of the cocoons in the selected lots

1. Total number of cocoons
2. Total number of defective cocoons
3. Total number of reelable cocoons

1. Total number of cocoons

One kilogram of cocoons from each of the five lots were weighed with an accurate beam balance and the number of cocoons present in each lot was counted and recorded.

2. Total number of defective cocoons

Defective cocoons which were not suitable for reeling were sorted out and separated before the samples from the five lots were sent for reeling. Defective cocoons included double cocoons, deformed cocoons, melted cocoons and urinated cocoons. Details regarding the defective cocoons in one kilogram lot were recorded for all the five randomly selected lots.

3. Total number of reelable cocoons

The number of good reelable cocoons in one kilogram of each lot, are the total number of reelable cocoons, and these were counted for each of the five lots.

C. Characteristics of single cocoons

1. Cocoon weight
2. Shell weight
3. Shell-ratio per cent
4. Average filament length
5. Average non-breakable filament length

1. Cocoon weight

The cocoon weight shows a continuous loss of weight from the time of its completion till the emergence of the moth because of loss of moisture.

The average weight of the cocoon, like most of its other commercial characteristics, varies considerably in any single race depending on its cultivation and the conditions

of rearing. Uniformity of the cocoon weight is important because it has an impact on the uniformity of behaviour in the reeling process. Single cocoon weight was recorded at random and average weight of the cocoon was arrived at.

2. Shell weight

Weight of cocoon shell is an important characteristic. The shell weight was recorded after removing the pupa from the cocoon. Higher shell weight indicates higher silk content in the cocoon.

3. Shell ratio per cent

It is the ratio between the weight of the cocoon shell and the cocoon weight.

$$\text{Shell ratio per cent} = \frac{\text{Weight of the cocoon shell}}{\text{Weight of the whole cocoon}} \times 100$$

Shell ratio indicates fairly the quantity of raw silk that can be reeled from the lots of fresh cocoons under transaction and also helps in estimating renditta and thereby fixing a proper price for the cocoons. Shell ratio per cent was calculated following the above procedure.

4. Average filament length in metres

Length of reelable filament which is actually the length of filament obtained from a single cocoon is an important character, and the same was measured in the selected lots. Filament is generally longer in large cocoons as compared to small cocoons.

5. Average non-breakable filament length

Denier is the measure of size of the cocoon filament. It is defined as weight in grams of 9000 m of filament. It varies according to the variety of cocoons. Denier varies within the cocoons and between the cocoons of the same lot.

III. Study the two different reeling systems with reference to the quality of silk yarn

After evaluating the cocoons for their characteristics, they were subjected to a series of operations some of which were done as pre-reeling operations, some were done during reeling and some during post reeling. The sequence of operations in the silk reeling are shown in Figure 3.

A. Selection of reeling systems

The reeling systems chosen for the present study were :

1. The traditional charkha and
2. The cottage basin

The reeling units were randomly chosen and were located in Singanallur in Coimbatore city belonging to private owners.

1. Traditional charkha

More than 50 per cent of raw silk produced in India is from charkha reeling. Bulk of raw silk produced by

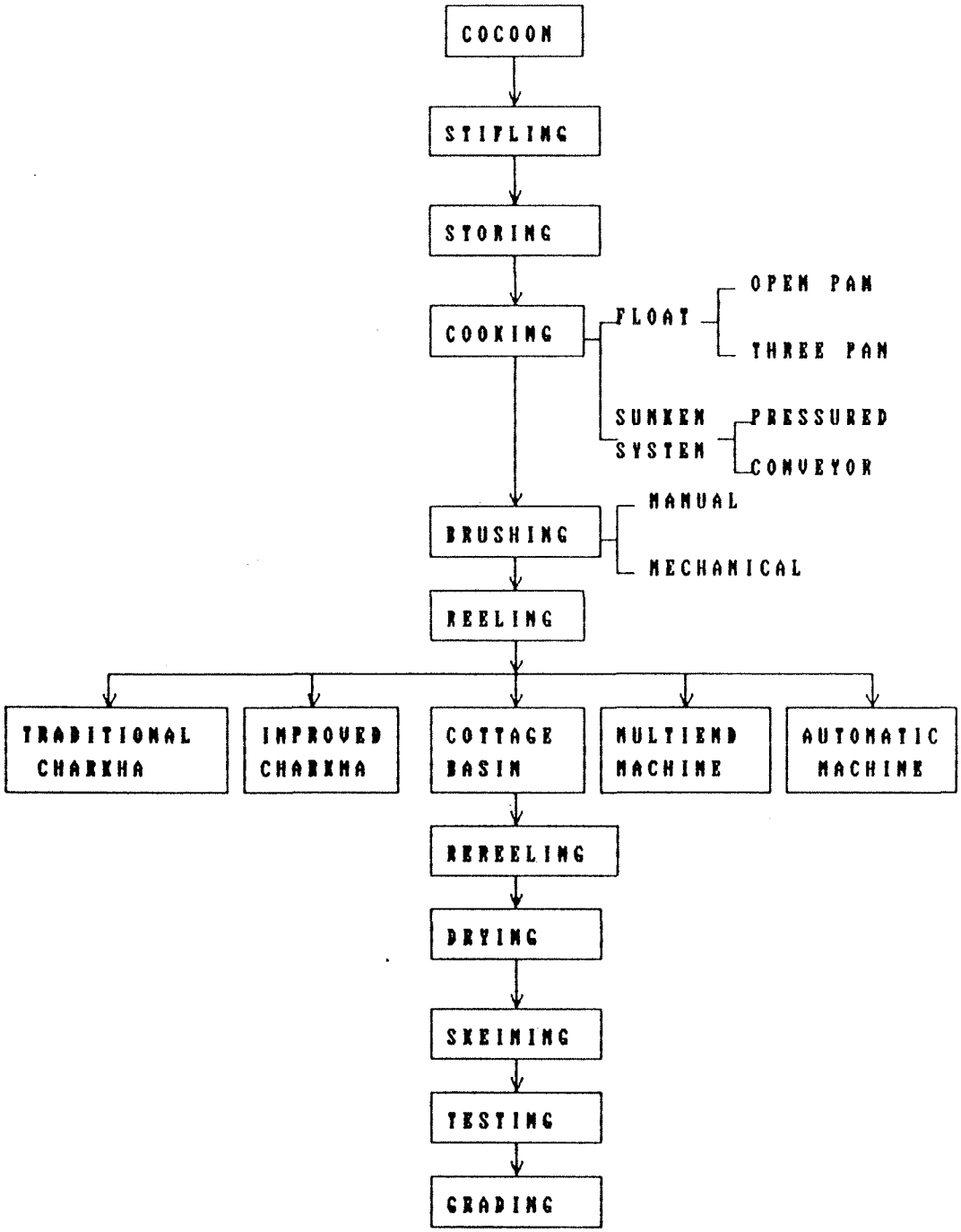


Fig. 3. SEQUENCE OF OPERATIONS IN THE SILK REELING AND TESTING

charkha is used in the handloom industry.

Charkha which is a simple hand driven reeling machine with one basin and four to six ends consists of a large cooking cum reeling pan where boiling water is maintained. The cocoons are cooked in it and filaments collected in a bunch after brushing, are passed through a hole on an ordinary thread guide device. Afterwards the thread is crossed with another thread for forming a chambon type of croissure in order to agglutinate the filaments and remove the water from the body of the thread. Then it is passed through a distributor before it is wound on to large wooden reel. Four threads are maintained in this devise, one person rotates the reel by hand and another person sitting near the cooking pan manipulates the cocoon cooking and reeling. In this process, inferior cocoons can also be converted into silk. This silk is known as 'Varna' yarn and is used as weft during weaving. In this process, cocoons are cooked in an open pan at higher temperature and just after removing the upper layer, (flossy layer), ends of 10-12 cocoons are joined together and are wound on a bigger swift at a high speed (Ray et al, 1993) (Plate 1)

2. Cottage basin

Cottage basin is an improved version over the charkha, for the production of better quality silk. This device works on the principle of Japanese multiend reeling machine. Cottage basin reeling is a slow speed, six end

PLATE .1. SILK REELING WITH CHARKHA

PLATE .2. SILK REELING WITH COTTAGE BASIN

reeling. Cocoon cooking is separate, and is done in boiling water and reeling is done in lukewarm water, with improved gadgets such as reeling basin, button, tavellete type of croissure pulleys as shown in Plate 2. Reeling on small reels to facilitate re-reeling was provided in cottage basin, which consisted of one cooker and four reelers and was driven by power.

B. Pre-reeling techniques

The pre-reeling techniques were selected based on the feasibility and availability of the techniques among the local reelers in Coimbatore city.

1. Stifling and drying of cocoons

After the cocoons were purchased, they were subjected to stifling for killing the pupa and drying the cocoon for storage. The method followed was basket stifling.

For every batch, one lot was taken and stiffled (Steamed) for not more than 20-30 minutes. The baskets were covered with a wet gunny cloth. Care was taken to avoid contact of hot water with the cocoons. Immediately after stifling, cocoons were handled carefully as they disintegrate even on slight pressure. After the cocoons were stifled they were spread in thin layers in a tray to facilitate drying.

2. Sorting of cocoons

Cocoons were sorted to separate the defective cocoons from the good ones to ensure the quality of raw silk as shown in Plate 3. The defective cocoons included double, deformed, urinated and melted cocoons.

3. Storing of cocoons

The sorted cocoons were stored in thin layers in bamboo trays, for three days without deterioration. These trays were kept in wire meshed racks. Store room was well ventilated so that enough air circulation through the cocoons was ensured to avoid fungal attack. The store room humidty was maintained below 65°F. The position of the cocoons were changed often and also the room was made ant and rat proof to avoid damage to the cocoons.

4. Cocoon cooking or boiling

Just before reeling, cocoons were cooked in water, to soften the sericin so that the filament can be unwound smoothly. The method chosen for the present study was open pan cooking. In this process cocoons were cooked in open pan for about three to five minutes. For each cooking, about 150-300 cocoons were taken for uniform cooking. Care was taken to avoid overcooking or under cooking. Water used for cooking was changed for every two to four kilograms of cocoon cooking. Well trained persons were engaged for cooking the cocoons. The process of cooking the cocoons is shown in Plate 4.

PLATE .3. SORTING OF COCOONS

PLATE .4. COOKING THE COCOONS

5. Brushing of cocoons

Brushing is an operation to remove the surface flossy layers of the cooked cocoons and to get the one end of the silk filament from the cocoon for reeling. For the present study hand brushing was adopted, as it was in practice among the reelers. In this method brushing was done in the basin itself with the help of a soft stick to remove the floss by working the stick in the direction of Figure '8'. The collected floss was lifted about twenty to thirty centimetres above the cocoons and then the lump of waste was cut and kept aside. The cocoons with released reelable baves were provided to the respective reelers.

C. Reeling of Cocoons in two different systems

Since the worm has already spun a long continuous silk fibre (filament) there is no further spining needed to prepare a yarn as in the case of other natural fibres, except that individual long filaments are combined together after unwinding them from cocoons and winding the resultant yarn on to a convenient device. This process is called silk reeling.

For the present study the five lots of cocoons were cooked as per procedures adopted in the charkha and in the cottage basin and the cooked cocoons were prepared for feeding by gathering 6-8 clean ends of the filaments in the cocoons and passing them through a tavellette type of

croissure. After this the thread was passed through a traverse guide and finally on to a small reel. Mending of the thread breakages was done whenever required.

D. Post-reeling operations

1. Re-reeling

Re-reeling was done to improve the quality of raw silk by avoiding gum spots, and also to minimise loose ends, slubs and waste as shown in Plate 5. Re-reeling was done from small reels to standard size hanks of one hundred and fifty centimetre periphery. The small reels were soaked in cold water for a period of ten to fifteen minutes before re-reeling. In case of any breaks occuring during re-reeling they were mended properly. While removing the silk from the swift, care was taken to avoid breaking of silk thread by sticking to the wooden bar. Throughout the process diamond formation in the hank was maintained.

2. Skeining

For skeining a hank of about 60 grams to 70 grams weight is laced like that of cotton hanks. The skeins are given a slight twist and packed in to 2 kilogram bundless called book as shown in Plate 6. Books are packed into bales. International silk bale has a weight of 60 kilograms and Indian bale is 20 kilograms normally (Sonwalker, 1986). Care was taken to avoid any breaks during skeining. Two deniers were produced for studying their qualities.

PLATE .5. RE-REELING

PLATE .6. SKEINING OF RAW SILK

E. Testing the raw silk yarn

For the present study, twenty raw-silk skeins reeled from five lots (samples) of the cocoons (Four skeins/lot) on two different reeling systems (i.e.) two skeins per systems were randomly selected and systematically tested for their quality characteristics.

The various tests conducted for the quality characteristics were :

1. Renditta
2. Visual inspection
3. Mechanical tests

1. Renditta

Renditta is the ratio between cocoon weight and silk weight. It is the quantity of cocoons required to produce a standard unit quantity of silk. In India it is expressed on the basis of fresh cocoon weight. Renditta was calculated for all the selected samples in the present study.

2. Visual inspection

For grading, raw silk yarn was visually examined and graded using a rating scale. The rating scale used for the visual examination of raw silk yarn included criteria like uniformity, general finish, colour/shade of filament, luster, hand-nature and smoothness. Visual inspection of raw silk was conducted in a standard visual inspection room.

3. Mechanical tests

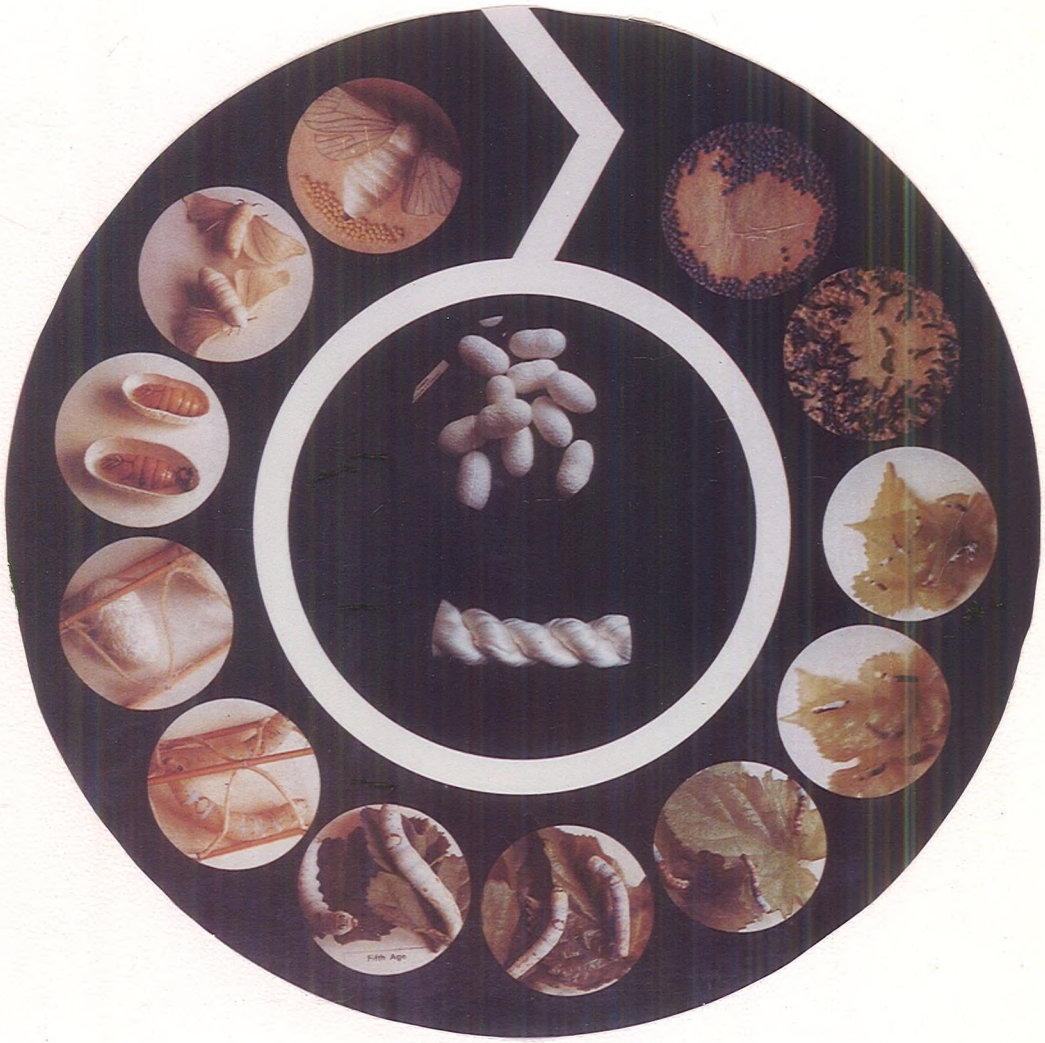
The following mechanical tests were carried out to assess the quality of silk. Before testing all the samples were conditioned for 48 hours in a standard atmosphere of 25° ± 2° C and 65 ± 2% relative humidity.

a. Winding breaks/skein/hour

b. Average size, size deviation and maximum deivation

c. Evenness, cleanness and neatness

d. Tenacity and elongation



" STAGES THROUGH WHICH

THE QUEEN OF FIBRES EMERGES"

PLATE .7. WINDING BREAKS - MACHINE

PLATE .8. MOTOR DRIVEN WRAP REELS

characteristics of raw silk. For proper evaluation of the characteristics of raw silk, the tests to determine standard deviation in size (or size deviation) and maximum deviation within a sample are necessary.

Small test skeins or hanks ranging from 112.5 m to 450 m in length were prepared by motor driven wrap reels as shown in Plate 8 and they were individually weighed as shown in Plate 9 for determining the size (count) and the size deviation and maximum deviation were recorded.

c. Evenness, cleanness and neatness

These parameters have a direct influence on the weaving quality of fabrics. Short ranged irregularities were measured by evenness test, while long ranged irregularities were measured by size (count) deviation test. Uster evenness test shown in Plate 10 was used for determining evenness, neatness and cleanness characteristics of raw silk. In cleanness, thick places are counted by the evenness tester. The parameter neatness indicates the frequency of short yarn length (maximum 3 millimetres), which according to their mass over stepped the normal yarn cross section, by more than fifty per cent. In other words neatness refers to the frequency of neps.

d. Tenacity and elongation

The unique strength and fineness makes silk yarn very useful in certain important sectors such as, surgical field and fabrication of precision equipment. Hence the

PLATE .9. MAXIMUM DEVIATION (Weighing of Silk)

PLATE .10. USTER EVENNESS TESTER

determination of strength and elongation of raw silk yarn is an important test. Breaking load, that is, a load the thread can stand just when it breaks, is expressed in terms of grams per tex or denier and is known as tenacity.

The tenacity and elongation test was carried out on the uster dynamate shown in Plate 11. The tester is fabricated on the principle of a constant rate of traverse pendulam type of yarn strength testing machine, graduated in grams and capable of recording simultaneously the breaking load and the corresponding elongation of the threads. Normally, the tenacity and elongation percentage of mulberry raw silk yarn are in the range of 3-4 g/d and 16-22 per cent respectively.

IV. Establishing and running a silk reeling unit

In general the sericulture farmers were happy with their inputs in silkworm rearing and the returns they got. However the picture was different with those who were running the silk reeling units, and they expressed that unless they were extremely careful with the whole process, from the time they buy the cocoon until the time the raw silk yarn is produced and sold, reeling may result in loss.

The idea of a silk reeling unit was conceived with the hope of finding out the possibilities of involving fully women workers in an effort to provide jobs for them and also study the problems and prospects of running a reeling unit.

For establishing this silk reeling unit a proposal was put up and the same forwarded to the Sericulture board

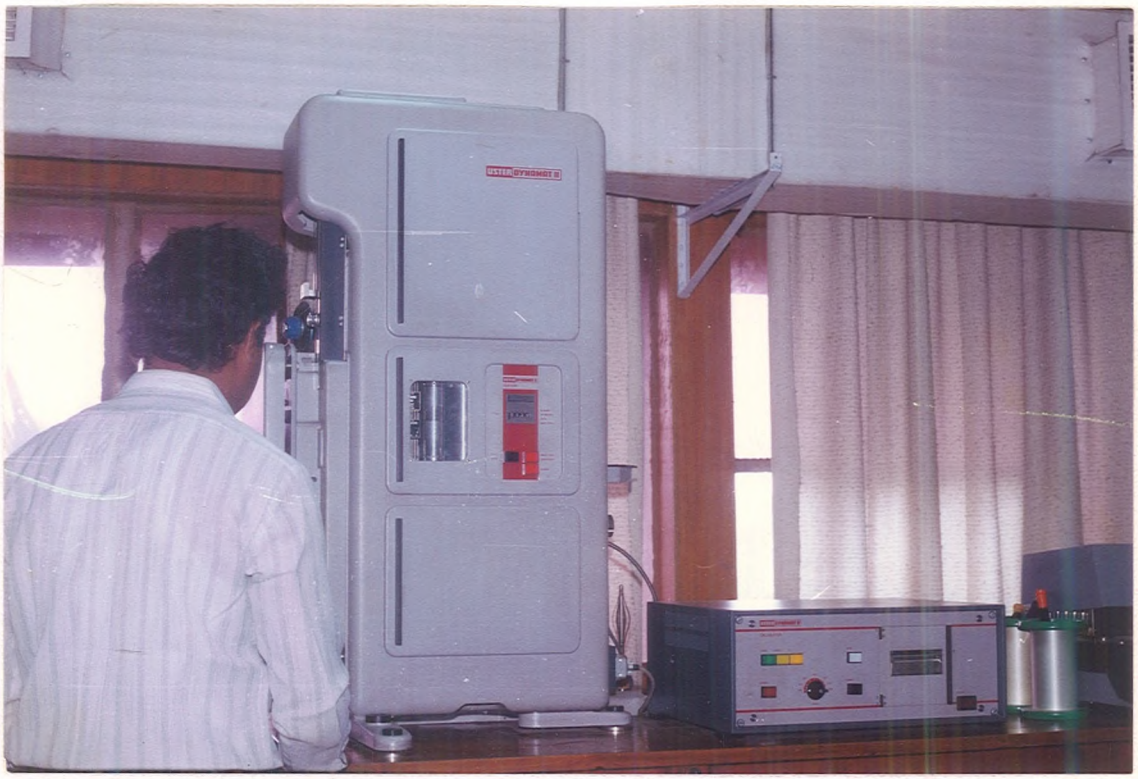


Plate .11. Uster dynamate

for financial and technical assistance to the investigator. The silk reeling unit was established in a shed provided by the Avinashilingam Education Trust Institutions. In the institution shed, the flooring was done and the raised platform near the rewinding section was built, water tank and chullah for cooking of cocoons was constructed with the guidance of local sericulture officials. The electricity and water connection was given. The officials from local sericulture department purchased 4 cottage basins and rewinding machines and the same were installed in the campus. Reeling work was carried out for a period of six months, after obtaining the necessary licence from the Sericulture Board and taking the cocoons in the auction conducted in the sericulture office in Coimbatore. During the above period, on the whole, the investigator bought 25 lots of cocoons, for the reeling work to be carried out. Each time the cocoon weight and cost varied. All the lots purchased were reeled in the cottage basins that were set up in the University campus. The findings regarding this are presented in results.

Results and Discussion

IV RESULTS AND DISCUSSION

The results of the study on, "Assessing Reeling Performance of Different Reeling Machines, Establishing a Reeling Unit and Evaluating Sericulture as an Income Generating Industry for Women" are presented in the following pages.

The general information obtained from sericulturists and entrepreneurs of reeling centres in and around Coimbatore where men and women shared equally the responsibility are presented first, and next to this findings on women entrepreneurs in silkworm rearing and silk reeling units are presented, after which position of women labourers in silk reeling units are highlighted and discussed.

Reeling performance of different reeling machines, the resulting quality, quantity, cost and other factors related to silk yarn along with the results of establishing a reeling unit and working out the cost benefit ratio are presented as the last part of the results and discussions. The various headings under which the results are presented are given below :

I. A. Background information and socio-economic status of the sericulturists

B. Cultivation of mulberry and production of cocoons

1. Factors that motivated sericulturists to start this activity
2. Area of land and number of men and women employed
3. Type of soil and yield
4. Number of prunings of mulberry per year
5. Type of fertilizers and pesticides used and problems faced
6. Type and area of sheds, type of rearing and number of racks
7. Wage structure of the employees
8. Cost, quality, quantity and by-products in cocoon production
9. Transport facility by sericulture department and the ways of transport
10. Place and frequency of purchase of egg sheets

and 11. Problems in silkworm rearing

II. Details regarding the silk reeling centres

A. Factors responsible for starting the units and labourers employed

B. Years of existence and number of the basins in each unit

C. Frequency of purchase of cocoons and their cost

and D. Silk reeled, by-products produced, fuel cost and the problems faced

III. Findings on women entrepreneurs running silkworm rearing units

A. Family background of the entrepreneurs

B. Reasons for starting silkworm rearing

C. Mulberry cultivation

D. Problems faced in mulberry cultivation

E. Details regarding the shed, employees and salary

F. Quality of cocoons

G. Diseases that affect the silkworms

h. Problems faced by sericulturists

and I. Problems faced in Transportation and marketing

IV. Findings on women entrepreneurs running silk reeling units

A. Family background

B. Source and purpose of loan taken

C. Reasons for starting the unit

D. Problems faced in raw material procurement

E. Details regarding the reeling units

F. Employees and their salary

G. Production of silk

H. Problems faced in silk reeling units

I. Problems faced in silk selling markets

and J. Domestic problems of the women entrepreneurs

V. Findings on women labourers in silk reeling units

A. Family background

B. Details regarding employment and years of service

C. Job satisfaction of the labourers

D. Activities of the labourers

E. Details regarding training of the labourers

F. Duration of work, wages and attitude of family members

and G. Problems of the labourers

VI. Details regarding cocoons

VII. Reeling performance of different reeling machines, as assessed by the qualityof silk yarn

A. Nature of raw silk yarn as judged by visual inspection

B. Findings of mechanical tests

and C. Comparison between charkha reeled and basin reeled silk yarn

VIII. Findings on establishing and running a reeling unit

I. A. Background information and socio-economic status of the sericulturists

Table II shows the details about type of family, size of family, age distribution of the members in the family, educational qualification and monthly income of the sericulturists who were taken up for this study.

TABLE II

FAMILY BACKGROUND

S.No.	Contents	Number	Per cent
1.	Type of family		
	Joint	9	36
	Nuclear	16	64
2.	Size of family		
	1 - 4	13	52
	5 - 9	12	48
3.	Age in years		
	21 - 40	16	64
	41 - 60	9	36
4.	Educational qualification		
	I - V	3	12
	VI - XII	16	64
	Graduates	4	16
	Illiterate	2	8
5.	Income per month*		
	Below 1500	20	80
	1501 - 5000	5	20
	Above 5001	nil	nil

* According to the Hous ing Board Urban Development Corporation (1987) the income level of the family was categorised as the low income group (below Rs.1,500 per month) Middle income group; (Rs.1,500-5000 per month) and high income group (Rs.5001 and above)

It is evident from Table II that among the 25 sericulturists, only 36 per cent were living in joint families and 64 per cent had nuclear families showing a general trend towards nuclear family. Fifty two per cent of families had 1 to 4 members and 48 per cent had 5 to 9 members in the family. Out of the total of 25 sericulturists, 64 per cent were in the range of 21-40 years, and 36 per cent were in the range of 41-60 years.

Regarding educational qualification of the sericulturists, it was noticed that 12 per cent of them had studied upto V^{th} standard and 64 per cent had studied from VI-XII^{th} standard,while two per cent were illiterate and four per cent were graduates.

Out of 25 sericulturists, 80 per cent had an income range below Rs.1,500/month and 20 per cent had an income range between Rs.1,501-5,000 and no one had an income above Rs.5,001.

I. B. Cultivation of mulberry and production of cocoons

1. Factors that motivated sericulturists to start this activity

Table III shows the different factors that motivated sericulturists in starting the industry.

TABLE III

MOTIVATING FACTORS

S.No.	Motivating factors	Number	Per cent
1.	Government loan and initiative	12	48
2.	Genuine interest in the industry	7	28
3.	To earn a living	6	24

It is evident from Table III that there were mainly three factors which motivated people to take up sericulture. Forty eight per cent started this industry because it was initiated by the government and were able to get loans, 28 per cent expressed their genuine interest in the industry and 24 per cent took up sericulture to earn a living.

2. Area of land and number of men and women employed

Table IV includes the area of land possessed by the sericulturists and the total number of labourers employed.

TABLE IV

AREA OF LAND EMPLOYMENT DETRAILS*

Area of Land (in acres)		Land Owners		Number employed			
				Male		Female	
		N	%	N	%	N	%
Small	(< 2)	18	72	9	30	21	23
Marginal	(2-5)	6	24	17	57	58	64
Big	(> 5)	1	4	4	13	11	13
Total		25	100	30	100	90	100

* Excluding Family members

Table IV shows that 72 per cent of the farmers engaged in sericulture were small land holders, 24 per cent marginal holders having an area of over two acres but below five and a small minority of four per cent were big land holders having an area of above five acres.

It was seen that women labourers out numbered men, as shown in figure 4. The employment of larger number of women may be due to the fact that cocoons have to be handled with utmost care and patience and women are more suitable for this sort of work. The women contribute about 50-75 per cent of labour to mulberry cultivation and silkworm rearing. Inbanathan and Vijayalakshmi (1994) pointout that womens participation is predominent in silkworm rearing. They spent 73 per cent of the total time in bed cleaning, 64 per cent in feeding, 59 per cent in disinfecting while men spent only 27 per cent 36 per cent, and 41 per cent respectively for the above activities.

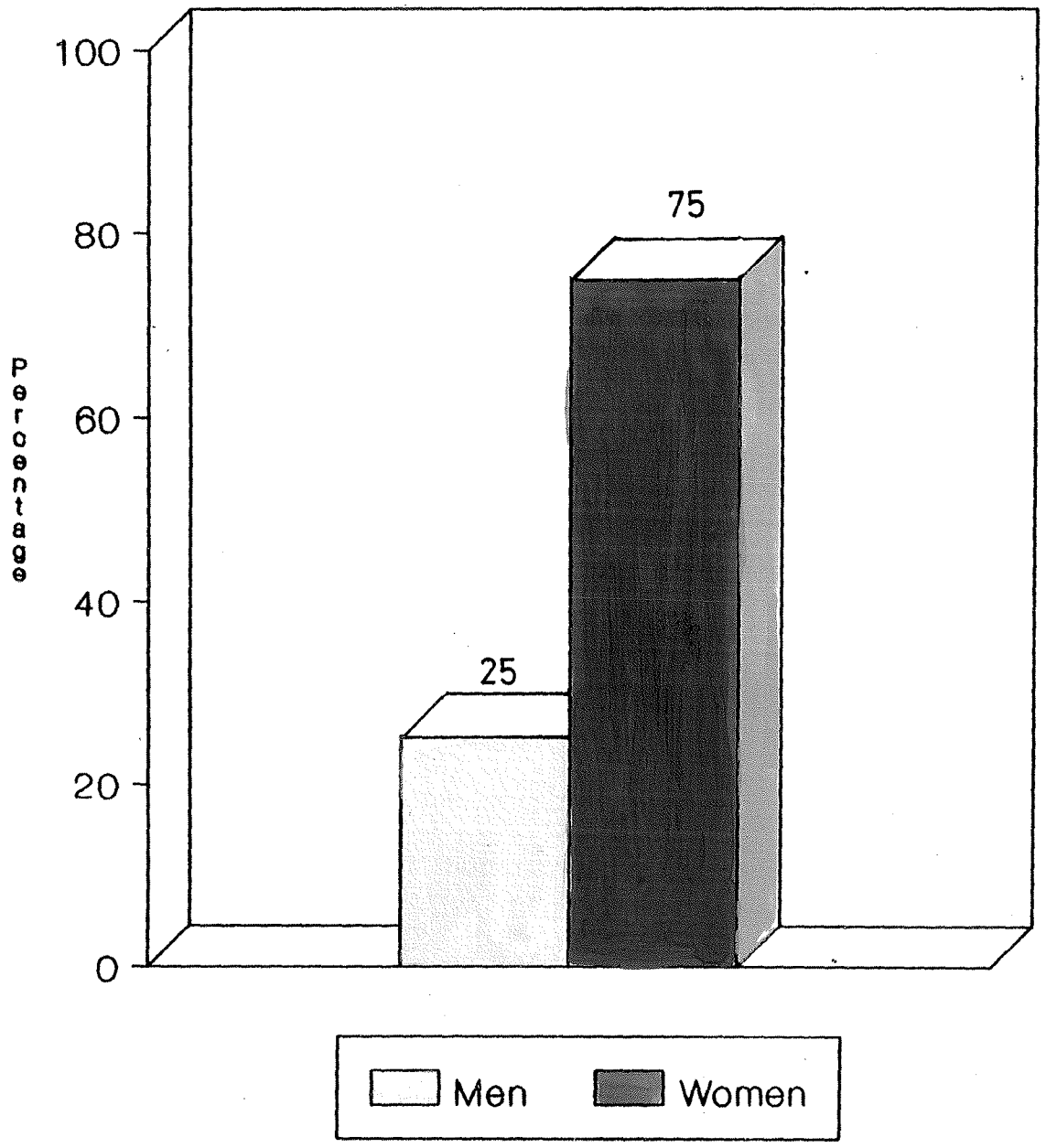


Fig. 4. NUMBER OF MEN AND WOMEN EMPLOYED IN THE MULBERRY FARM AND COCOON PRODUCTION

2.a. Area of Land and Income

Table V gives detail regarding the same.

TABLE V

AREA OF LAND AND INCOME

S.No.	Area	Income in rupees /month			
		500-1000	1001-1500	1501-2000	Above 2000
1.	Below 2 acres	2	6	4	0
2.	Two acres and above	1	2	4	6

Obviously with increasing area, more mulberry leaves are available and more cocoons can be produced resulting in larger income for the family.

When cultivation systems are considered, their performance is often characterised by average such as mean yield or mean net returns. An increasingly more productive system is needed to effectively respond to the expanding needs of rapidly growing sericulture industry. Mulberry cultivation should be oriented in such a way that the proper and maximum utilisation of land is possible.

3. Type of soil and yield

Table VI shows the type of soil where mulberry cultivation was done and the yield of cocoons in kilogram.

TABLE VI

TYPE OF SOIL AND YIELD/ACRE

S.No.	Type of Soil	Number of sericul-turists	Per cent	Yield in kilogram		
				< 50	51-100	> 100
1.	Red	14	56	4	9	1
2.	Black	7	28	3	3	1
3.	Others	4	16	3	1	0

It is clear from Table VI that among the 25 sericulturists, 56 per cent were cultivating mulberry in red soil, 28 per cent in black soil and 16 per cent in soil which was a mixture of sand and small pebbles.

Very exacting conditions of soil are not necessary for mulberry and also since all sericulturists used standard fertilizers, there was a levelling effect.

4. Number of prunings of mulberry per year

TABLE VII

PRUNINGS PER YEAR

S.No.	Prunings per year	Number of sericulturists	Per cent
1.	Twice	5	20
2.	Thrice	13	52
3.	Four times	6	24
4.	Five times	1	4

Table VII highlights the fact that there was no uniformity in the number of prunings done during an year. Fifty two per cent gave three prunings per year which looks like the optimum and 20 per cent gave only two prunings whereas 24 per cent gave four prunings and a minority of four per cent gave more than five prunings which appears rather excessive.

5. Types of fertilizers and pesticides used and problems faced

Table VIII shows the types of fertilizers and pesticides used and the problems faced by the sericulturists.

TABLE VIII

TYPES OF FERTILIZERS AND PESTICIDES USED AND PROBLEMS FACED

S.No.	Contents	Number of sericulturists	Per cent
1.	Using fertilizers		
	Yes	25	100
	No	nil	nil
2.	Fertilizers used*		
	17-17 Complex	20	80
	Cowdung	5	20
	Urea	4	16
3.	Use of pesticides		
	Yes	4	16
	No	21	84
4.	Pesticides used		
	Silk powder	1	4
	Silk medicine	1	4
	Metastagine	1	4
	Uzicide	1	4
5.	Problems faced		
	Diseases	16	64
	Nil	9	36

* Multiple response

It is evident from Table VIII that all the sericulturists were using fertilizers for the cultivation of mulberry to get a better yield. The majority of sericulturists (80 per cent) preferred using chemical fertilizers such as 17-17 complex. Among the 20 per cent who used cowdung, 16 per cent used either urea or 17-17 complex also along with cowdung. Urea was chosen only by 16 per cent and even here one person mixed it with 17-17 complex.

Out of the 25 sericulturists, only 4 used pesticides and the rest did not. There was a general tendency to avoid pesticides probably due to the difficulties in handling pesticides and the risks involved. The pesticides commonly used were silk medicine, uzicide, silk powder and metastagine.

Bheemanna et al, (1990) opined that the cyclic and simultaneous rearing of crops with gaps had reduced the incidence of uzifly. They felt that continuous rearing might result in more of cross infection and higher build up of germ load. This could happen in both continuous and sporadic rearing if proper hygienic measures were not adopted, as the survival period of most of these germs are known to range from months to years.

According to Kotikal et al, (1989) the biggest setback in popularising sericulture among small and marginal farmers was their fear of losing the total crop in case of

disease. The incidence of diseases in mulberry silkworms is known to cause 30 to 40 per cent loss in the silk yield in India.

6. Type and area of sheds, type of rearings and number of racks

Table IX shows the types of shed possessed by the sericulturists for the rearing of silkworm.

TABLE IX

TYPE OF SHEDS

S.No.	Type	Number of sheds 1	Number of sheds 2	Total	Per cent
1.	Solidly built and permanent	9	7	16	64
2.	Mud wall with thatched roofing	6	2	8	32
3.	Dwelling house	1	nil	1	4

It is clear from Table IX that among the 25 sericulturists, 64 per cent had permanent or concrete type of sheds, 32 per cent had sheds with mud wall and thatched roofing and four per cent used their dwelling places as sheds.

Out of the 16 farmers with solidly built sheds, 9 had single sheds only, while seven had two sheds each. Of the eight sericulturists having sheds made of mud wall and thatched roofing, six had single sheds, while two had two sheds each.

Table X shows the area of shed, type of silkworm rearing followed by sericulturists and the number of racks kept for silkworm rearing.

TABLE X

AREA OF THE SHED, TYPE OF REARING AND NUMBER OF RACKS

S.No.	Contents	Number	Per cent
1.	Area in square feet		
	0 - 200	7	28
	201 - 400	9	36
	401 - 600	3	12
	601 - 800	6	24
2.	Type of rearing		
	Shelf	23	92
	Shoot	2	8
3.	Number of racks		
	2 - 3	14	56
	4 - 5	6	24
	6 - 7	4	16
	8 - 9	1	4

Table X reveals that 36 per cent of the sheds had an area between 201-400 square feet, 28 per cent had 0-200 square feet sheds while 24 per cent and 12 per cent had 601-800 square feet and 401-600 square feet area for their sheds respectively.

Shelf rather than shoot rearing was the popular method in the area, 92 per cent preferring it. Fifty six and twenty four per cent of the sericulturists had two to three racks and 4-5 racks respectively.

7. Wage structure of the employees

Table XI shows the wage structure of men and women working in the cultivation of mulberry and cocoon production farms.

TABLE XI

WAGE STRUCTURE

	Wages/day	Number	Per cent
Women	Rs.12/-	45	37.5
	Rs.15/-	45	37.5
Men	Rs.20/-	14	11.7
	Rs.25/-	14	11.7
	Rs.30/-	2	1.6

Table XI shows that on the whole 120 people were working in the farms; out of whom 37.5 per cent of women were paid Rs.12 per day and another 37.5 per cent were paid Rs.15 per day. Eleven point seven per cent of men were paid Rs.20/day, another 11.7 per cent were paid Rs.25/day and one point six per cent were paid Rs.30/day.

The wages compared favourably with the other types of labour such as farm labourers and construction workers but not with skilled labourers like masons and carpenters who earned Rs.40-50 per day.

8. Cost, quality, quantity and by-products in cocoon production

Table XII shown the amount of cocoons produced per batch (in kilogram), the cost of production in rupees/batch, the quality of cocoon and resulting by-products.

TABLE XII

PRODUCTION OF COCOONS, COST AND QUALITY

S.No.	Details	Number	Per cent
1.	Production of cocoons/batch in kilogram		
	11 - 30	8	32
	31 - 50	9	36
	51 and above	8	32
2.	Cost of production/batch in rupees		
	500 - 1,500	15	60
	1,500 - 2,500	6	24
	2,501 and above	4	16
3.	Quality of cocoons		
	Good	24	96
	Poor	1	4

It is evident from Table XII that the total production from a unit depends on the size of the unit, the number of people engaged, acreage, water facility, humidity and related factors. Units with problems, produced less cocoons than others with more favourable conditions.

Among the 25 sericulturists 96 per cent were satisfied with the quality of the cocoon while 4 per cent were not very much satisfied with it. Forty per cent used the by-products of the silkworm, like litters, as manure and 60 per cent of them disposed it off. The manure was used in the mulberry field itself.

9. Transport facility by sericulture department and the ways of transport

Table XIII indicates the help rendered by the sericulture department and ways adopted to bring cocoons to the market.

TABLE XIII
DETAILS OF TRANSPORT

S.No.	Contents	Number	Per cent
1.	Help from sericulture department		
	Yes	Nil	Nil
	No	25	100
2.	Means of transport		
	Van	12	48
	Autorickshaw	8	32
	Bus	5	20

It is clear from Table XIII that none of the 25 sericulturists received any help from the sericulture department for the transportation of cocoons from the farm to the market. They had to make their own arrangements for the transportation.

Forty eight per cent of the sericulturists took the cocoons to the market by van and 32 per cent used autorickshaws, and 20 per cent by bus.

10. Place and frequency of purchase of egg sheets

Table XIV illustrates the place of purchase of egg sheets and the frequency of purchase per month.

TABLE XIV

PLACE AND FREQUENCY OF PURCHASE OF EGG SHEETS

S.No.	Details	Number	Per cent
1.	Place of purchase		
	Government sericulture department	21	84
	Kollaikalam	3	12
	Bangalore	1	4
2.	Frequency per month		
	Once	16	64
	Twice	5	20
	Thrice	3	12
	Four times	1	4

From Table XIV it is evident that 84 per cent of the sericulturists bought egg sheets fromthe Central Silk Board (CSB). Twelve per cent bought it as worms from the Chawki and four per cent got it from Bangalore.

Sixty four per cent purchased egg sheets once a month, 20 per cent twice a month, 12 per cent thrice a month and 4 per cent four times a month.

11. Problems in Silk worm rearing

Table XV presents the problems expressed by the sericulturists in rearing of silk worms.

TABLE XV

PROBLEMS IN REARING OF SILK WORMS

S.No.	Problems	Number	Percent
1.	Non-availability of loan	3	12
2.	Poor egg quality	18	72
3.	Water scarcity	3	12
4.	Difficultyin maintaining hygienic conditions	1	4

The problems faced were non availability of loan on easy terms from the sericulture department, poor egg quality, water scarcity and technical difficulty in maintaining proper humidity and hygienic conditions inthe sheds. Consultation facilities were poor and the lukewarm interest of the department was a negative factor. Parthasarathy and Sundaravelli (1994) found that in Royalseema a drought prone area, the sericulture programmes failed due to inadequate supply of water and also due to the sericulture departments not responding when technical assistances is sought for.

Rao (1979) opines that successful running of the industry largely depended on the basic infrastructural facilities provided in meeting the requirements of the sericulturists, like providing proper mulberry seedlings, timely supply of disease-free silkworms or egg sheets besides technical guidance and facilities for marketing of the product. If this is assured the industry will not only provide gainful employment to all members of the rural households and thereby improve their economic condition, but will also help in discouraging their migratory habits.

II. Details regarding the silk reeling centres

A. Factors responsible for starting the units and number of labourers employed

Table XVI shows the factors responsible for starting the silk reeling centres and the total number of labourers employed, and their salaries.

TABLE XVI

FACTORS RESPONSIBLE FOR STARTING THE REELING CENTRES, LABOURERS INVOLVED AND THEIR SALARIES

S.No.	Factors	Number	Per cent
1.	To earn a living	3	37.5
	Interest	2	25.0
	Tradition	3	37.5
2.	Number of labourers		
	Men	17	12.5
	Women	119	87.5
3.	Income/day		
	Men Rs.20	17	12.5
	Women		
	Raw recruits Rs.15	79	58.0
	Trained Rs.18	40	29.5

It is evident from Table XVI that the silk reeling units were initiated either by interest in the industry or by the fact that they were traditionally following this occupation. Quite a few expressed that they had started the unit to earn a livelihood. Reeling industry employees considerably more women than men. The surveys showed that 87.5 per cent were women and only 12.5 per cent were men.

It is evident from Table XVI that the salary of raw recruits among women was Rs.15 and that of experienced women was Rs.18 per day. The salaries for men and women was comparable with those of labourers in other units such as construction work, farming, and cotton ginning. However considering the fact that these people are skilled they got less income than other skilled people like masons and carpenters.

B. Years of existence and number of basins in each unit

Table XVII shows the number of basins and years of existence of the reeling units.

TABLE XVII

NUMBER OF BASINS AND YEARS OF EXISTENCE OF THE UNIT

S.No.	Name of the place	Units	Number of years	Number of basins
1.	Podanur	A	13	10
		B	10	2
		C	4	6
2.	Kurichi	D	9	24
		E	3	20
3.	Vadavalli	F	12	31
4.	Singanallur	G	10	10
		H	6	6

Table XVII shows that several units had basins that were over 10 years old and were in a poor condition, rusty and crumbling. However the work was going on and replacement was not planned in the near future.

C. Frequency of purchase of cocoons and their cost

Daily purchase of cocoons was the most common custom, as the keeping quality of cocoons was poor, and three days' stock was the maximum kept by each unit. The price of the cocoons varied between Rs.60 and 90/kilogram. The price was fixed after testing the cocoons for their silk content.

According to Bheemanna et al, (1990) continuous availability of cocoons was helpful for cocoon reelers, as they need to work with a lower capital, making them less prone to price fluctuation in raw silk.

D. Silk reeled, by-products produced, fuel cost and the problems faced

Table XVIII shows the amount of silk reeled per month and fuel cost per kilogram of silk, the problems faced by the reelers and the by-products produced.

TABLE XVIII

SILK REELED, BY-PRODUCTS, FUEL COST, AND PROBLEMS FACED

S.No.	Details	Number	Per cent
1.	Silk reeled/day (in kilogram)		
	0 - 5	2	25.0
	6 - 10	3	37.5
	11 - 15	3	37.5
	16 - 20	nil	0.0
2.	Fuel cost/day (in rupees)		
	10 - 30	2	25.0
	31 - 50	1	12.5
	51 - 70	5	62.5
3.	Problems faced		
	Non availability of cocoons	5	62.5
	Non availability of labour	2	25.0
	Nil	1	12.5
4.	By-products *		
	Double cocoon	8	100
	Degummed waste	8	100
	Silk waste	8	100
	Thrower's waste	8	100

* Multiple response

The quantity of silk reeled ranged from 0-5 kilogram to 11-15 kilogram per day depending on the number of basins. The fuel cost showed large variations, due to the kind of wood used, efficiency of the oven, and rate of feeding of fuel. Further a certain amount of uncertanity prevailed about the fuel cost as part of the fuel came from the owner's farm itself.

The lack of timely arrival and non-availability of cocoons pose a big problem for the reeling industry. The tendency of the labourers to leave without notice especially during reeling poses another problem. The by-products had a good market and fetched sizeable income for all units. However, utilization of the by-products was not attempted, and no unit had plans to do so in the near future. All the buyers of the by-products were from outside the state.

III. Findings on women entrepreneurs running silkworm rearing units

Information regarding women entrepreneurs running silkworm rearing units were collected from 12 women entrepreneurs and the relevant results are discussed.

A. Family background of the entrepreneurs

Table XIX represents the age and educational status of the women entrepreneurs.

TABLE XIX

AGE AND EDUCATION OF THE WOMEN ENTREPRENEURS

Details	Number	Per cent
Age in years		
25 - 30	2	17
31 - 35	8	66
36 - 40	nil	nil
41 - 45	2	17
Education		
Illiterate	nil	nil
Literate	12	100

It is clear that 66 per cent of the women entrepreneurs belonged to the age group 31-35 years because at this stage of life their children grow and need for more money makes them to take up such work. The others were in the age group 25-30 years and 41-45 (17 per cent each) years respectively. Hundred per cent of the entrepreneurs were educated upto school level.

B. Reasons for starting silk worm rearing units

When interviewed about the reasons for starting the unit, the women entrepreneurs expressed various views; these are preesented in Table XX.

TABLE XX

REASONS FOR STARTING THE UNIT

Reasons	Number of persons	Per cent*
Provides good future prospects	10	86
Satisfies economic necessity	8	71
Encourages to meet challenges in life	8	71
Offers better standard of living	7	57
Engages one's time usefully	3	28
Provides subsidy	2	14

* Multiple response

Eighty six per cent of entrepreneurs opined that this occupation provided good future prospects. Seventy one per cent of them stated that it satisfied not only economic necessity but also encouraged to meet challenges in life. Fifty seven per cent became entrepreneurs because they felt that better standard of living was possible and 28 per cent felt that they could utilize their time usefully.

C. Mulberry cultivation

Details regarding mulberry cultivation are discussed in Table XXI.

TABLE XXI

DETAILS REGARDING MULBERRY CULTIVATION

S.No.	Details	Number	Per cent	Number employed		Percentage of women	Wages/day in rupees	
				Men	Women		Men	Women
1.	Area of cultivation (in acre)							
	0-0.9	3	25	Nil	1	100.0	Nil	12
	1-1.9	5	42	1	3	75.0	20	15
	2-2.9	3	25	2	4	66.6	25	20
	3 and above	1	8	2	10	83.4	25	20
2.	Year of starting							
	From 1977-78	1	8					
	1979-80	4	33					
	1984-85	3	26					
	1988-89	4	33					

Forty two per cent of the entrepreneurs had 1-1.9 acres of land for mulberry cultivation. Twenty five per cent had less than 0.9 acre for mulberry cultivation and another 25 per cent had 2-2.9 acres for mulberry cultivation. Only 8 per cent had 3 acres and above for mulberry cultivation.

As the area of land increases the employees also show an increase. Compared to the men, women were always paid low salary. For 0.9 acre of area, one woman employee

was appointed with a salary of Rs.12 per day. For 1-1.9 acres of area, 3 women were employed for Rs.15 per day each and one man worked for Rs.20 per day. For 3 acres of land 10 women worked for Rs.20 per day and two men worked for Rs. 25 per day.

One woman entrepreneur started her unit in 1977-78; 3 women had started in 1984-1985, 4 women had started in 1979-80 and another 4 women had started in 1988-89; thus all the units were running for the past 5 years at least.

All the 12 women entrepreneurs had their units near their house, so that they could take care of the silkworms themselves. As frequent feedings were required, the women entrepreneurs had to be near the shed.

All the 12 farms had black soil and only hard water was used. They were able to harvest 17 tonnes of leaves from one acre of land on an average. In one acre of mulberry cultivation, 100 dfls, (Diseases free laying) eggs could be reared which give 60 kilogram of cocoons. One kilogram of cocoon costed Rs.60-80. Cost of 100 dfls eggs was Rs.2.25 only.

Thirty per cent of the women entrepreneurs used cowdung and urea as fertilizers and 10 per cent used ammonium sulphate. Remaining 60 per cent were very innovative and used the mulberry waste leaves itself and excreta of the worms after cleaning the bed. None of them used pesticides as they destroyed the silkworms.

D. Problems faced in mulberry cultivation

All the 12 entrepreneurs agreed that spraying pesticides on mulberry leaves destroyed the silkworms. Even if the neighbouring farm used pesticides at the times of silkworm rearing, it killed the silkworms. Ten entrepreneurs expressed that lack of labourers was their biggest problem, and so in the 4^{th} moulting stage (after 11^{th} day) they adopted the shoot rearing method. Remaining, plucked leaves for rearing.

During summer, the leaves became very dry and so they were plucked before sunrise and covered with a wet cloth. During rainy season, the leaves became very wet and so they were put under the fan to dry the excess moisture, and during this season uzifly were present in the leaves which entered the rearing shed and this resulted in poor quality cocoons, due to their laying eggs on the worms.

Canal irrigation was available for the farms. Women were appointed for plucking the leaves. Sometimes the mulberry leaf juice fell on their hand and peeled of their dry skin.

E. Details regarding the shed, employees and salary

E.1 Type of sheds

Information regarding the type of sheds owned by women is discussed in Table XXII.

TABLE XXII

DETAILS REGARDING THE SHED

Type of shed	Number	Per cent
Solidly built and permanent	6	50
Dwelling house	5	42
Mud wall with thatched roofing	1	8

It is clear from the Table XXII that among the 12 sericulturists, 50 per cent had permanent concrete type of sheds made for silkworm rearing. . Eight per cent had sheds with mud wall and thatched roofing and 42 per cent used one portion of their house as shed. Previously this portion had been used as godown to store grains.

E.2. Employees and their salary

Details regarding employees and their salary are given in Table XXIII.

TABLE XXIII

DETAILS REGARDING AREA, EMPLOYEES AND THEIR WAGES

Area of land	Employees		Wage per day in Rs.	
	Women	Men	Women	Men
50 cents	1	Nil	12	Nil
1 - 1.5 acres	3	1	15	20
2 - 2.5 acres	4	2	15	20
5 acres	10	2	20	25

Table XXIII reveals that the number of women employed increased along with the increase in area of cultivation. The wage per day was Rs.12-20 for women and Rs.20-25 for men.

F. Details on cocoons

Table XXIV highlights details regarding cocoons with reference to disease free layings, total cocoon production, cost of production, quality ofcocoon and use of waste.

TABLE XXIV

DETAILS REGARDING COCOONS

S.No.	Details	Area in acres			
		0-0.9	1-1.9	2-2.9	3 and above
1.	Disease free laying (Cards)	70	100-150	200-250	500-700
2.	Total cocoon production per batch (in kg)	30-40	50- 70	80-100	200-300
3.	Quality of cocoon				
	i. Good	2	5	3	1
	ii. Poor	1	nil	nil	nil
4.	Cost of production per batch in rupees	700	1500	1500	3000
5.	Waste used for				
	i. Biogas	1	2	2	1
	ii. Manure	2	3	1	nil

It is evident from Table XXIV that the total cocoon production depends on the acre of land possessed. In 1-1.9 acre of land, 100-150 (DFls) eggs can be reared and 50-70 kilogram of cocoon can be produced. The total production of cocoon also depends on the

number of people engaged, quality of land and humidity. The units with problems produced less than the units which had favourable conditons.

The general trend was that the cost of production increases with the amount of production and largeness of the unit, though not proportionately.

Among the 12 women sericulturists, 11 of them produced good quality cocoons.

If the eggs are affected by pebrine, the cocoons are not well formed, and the whole lot is being destroyed. The cocoons also become very soft. If undetected early, greater losses are incurred by the sericulturists.

Fifty per cent of the sericulturists used the silkworm litter for production of the biogas. Due to this, efficiency of the biogas production had increased. The resulting slurry was used as manure. The remaining 50 per cent used litter as manure, as they did not possess biogas plants. As this litter and leftover leaves are a very good manure, no one disposed it off but used it very efficiently.

G. Diseases that affect the silkworms

The most common diseases affecting silkworms in the egg stage were flacherie, grasserie, muscardine and pebrine. If they were present, the whole egg lot was destroyed in the department or the farmer destroyed it if brought to her farm.

Uzifly affected the silkworm itself. To prevent this, net was used on the doors and windows. All the sheds, trays and racks were cleaned with formaline before the next batch arrived. Data revealed that 64 per cent of farmers had to overcome various diseases in the production of cocoons while 36 per cent did not have any problem. Most of the farmers did not use pesticides as according to them their use would affect the quality of silk.

Bheemanna et al, (1990) opine that the cyclic and simultaneous rearing of crops with gaps reduce the incidence of uzifly.

H. Problems faced by the sericulturists

H.1. Finance

Twenty per cent of the sericulturists had no problem regarding finance as they had received government loan. Eight per cent of the entrepreneurs had their own money. The profit was used to build the shed and buy the trays and chandrikha.

Seventy two per cent of the sericulturists had financial problems as they received money after 30 days only. They faced difficulty in paying salary to the workers on time.

H.2. Space and feeding problems

Just sufficient quantities of leaves should be fed to the worms. If the leaves were toomuch, it resulted in

wastage of leaves, which dried off. If the quantity of leaves fed was insufficient then the cocoon formation was affected, in the chandrikhas. If too many of worms are present then shortage of space for the worms to spin cocoon occurs, and so double cocoons are formed which are inferior in quality. So, now rope type of chandrikhas are used.

H.3. Scientific methods adopted for cocoon production

Sixty per cent of the women entrepreneurs wished that they and their family members needed training in latest technologies for rearing preferably in their villages itself in the evening time. Thirty per cent of the entrepreneurs expressed that since cutting leaves into small pieces was time consuming, development of a cutting machine would reduce the time spent on cutting leaves. Ten per cent of them expressed their wish to know about the scientific methods to produce good quality cocoons, as they felt that lack of adoption of scientific method resulted in the poor quality of cocoons some times.

H.4. Difficulties in maintaining cleanliness

The shed should be properly cleaned every day and maintained to safeguard the worms from uzifly and ants. Before each batch, the shed had to be cleaned with formalin, spraying formalin on the walls, on the trays and on the chandrikhas. Once a day the bed should be thoroughly cleaned, the litter and used leaves removed.

H.5. Non-availability of labourers

Non-availability of labourers was the main problem. As the labourers are not well paid, no one comes to work. Only women come to work in the fields. Most of the entrepreneurs pluck the leaves, clean the trays, and feed the worms themselves, when labourers are not available.

H.6. Changing climate

Four entrepreneurs expressed that during winter, heater bulbs are used in the rearing shed. Electricity Board was not allowing them to give electric connection from their house or well. Electricity Board insisted them to have separate service connection for the rearing shed and they charge as per industrial tariff. Therefore they expressed that, the rearing centre should also come under domestic tarrif.

Remaining entrepreneurs expressed that during rainy season, the leaves become wet and if the worms consume this they urinate inside the cocoon and the cocoon colour changes to dark yellow. During rainy season, uzifly were maximum, and so, extra precaution had to be taken to protect the worms. If uzifly attacked, holes were formed on the cocoons and cocoon cost fell down. Hence during such times, the leaves had to be dried before feeding. During summer season the leaves dried off fast, so the plucked leaves were covered with moist cloth. The first two stages of the worms

had to be kept in cool atmosphere and so the trays were covered with moist cloth and sponge strips dipped in water were kept around the worms.

H.7. Problems in storage

Though cleaning the shed with formalion keeps ants away, rats came for the pupae inside the cocoon. Hence the cocoons had to be sold immediately. Thus if sericulturists wanted to store the cocoons to fetch a better price, it became a big problem unless the whole shed was fitted with wire meshwhich could not be done by all. Three entrepreneurs had the shelf legs dipped in water to prevent ants. Remaining sprinkled formalin on the legs of racks.

Pugazhendi (1994) opines that the rearing sheds are poorly ventilated and mostly unhygienic, and climatic conditions are not properly maintained. Number of trays used for rearing are not adequate and the worms are crowded. In a nutshell, farmers need to be educated in rearing practices.

H.8. Health problems

When the worms had reached the fourth stage (after 18^{th} day) they became big and heavy and the person was unable to give feeds and clean the trays. At this time, due to the strain of taking the trays from the top, the person got severe back pain. So 20 per cent of the entrepreneurs had changed to fixed bed from trays. Remaining 80 per cent used only trays due to shortage of money to change to bed.

Eight per cent of the entrepreneurs expressed skin irritation when plucking and shredding the mulberry leaves, juice fell on their skin resulting in the dryskin. Remaining expressed that they had no problems.

The worms and mulberry leaves produced heat which advances the menstrual cycle and causes heavy bleeding, among women workers. So for five days the women entrepreneurs did not enter the shed. This was expressed by 80 per cent of the entrepreneurs.

I. Problems faced in transportation and marketing

Details regarding the transportation are discussed in Table XXV.

TABLE XXV

DETAILS REGARDING TRANSPORTATION

Means of transportation	Number	Per cent
Bus	6	50
Van	3	25
Autorickshaw	2	17
Bullock cart	1	8

All the women entrepreneurs had their own ways of transporting the cocoons. None of them got any help from the sericulture department. Fifty per cent of the entrepreneurs depended on bus for transportation while 25 per cent depended on vans that were hired, and 17 per cent on autorickshaws, 8 per cent on bullock carts.

Market structure refers to the number of buyers and sellers of silk cocoons in the market area, the extent

of product differentiation, entry of new farmers and reelers which affected the ability of entrepreneurs to exercise some degree of market control, the nature of price determination and the nature and type of competition.

The main problem in marketing is the fixation of price by the auctioner according to the quality of cocoons. The government should fix the price for cocoon at Rs.100-150 per kilogram so as to increase the profit; this was expressed by 60 per cent of the entrepreneurs whereas 30 wished that the government should fix the rates for both eggs and cocoons. Ten per cent of the entrepreneur expressed that when the leaves were ready for feeding, the eggs from the grainage were not available.

IV. Findings on women entrepreneurs running silk reeling units

The results of the survey regarding the women entrepreneurs in the reeling unit are discussed below :

A. Family background

All the 12 women entrepreneurs were married. Three women entrepreneurs (25 per cent), who were from Karnataka, were living in a joint family system. Their traditional occupation was silk reeling. Remaining 9 entrepreneurs (75 per cent) were living in a nuclear family system. Nearly 70 per cent of them got a helping hand from their spouses for running the unit. Remaining 30 per cent of them did not get help from their spouses for running the

unit, but they got help from them for selling the raw silk in Kancheepuram.

B. Source and purpose of loan taken

Three entrepreneurs (25 per cent) had got basin and other equipment from the family funds itself. Seven entrepreneurs (58 per cent) invested their own money and got basins. Two entrepreneurs (17 per cent) got fifteen thousand loan which they repaid in portions/month. They had taken the loan from the nationalized bank.

C. Reasons for starting the unit

Details regarding the reasons for starting the units are discussed in Table XXVI.

TABLE XXVI

REASONS FOR STARTING THE UNIT

Reasons	Number	Per cent *
Provides good future prospects	6	50
Satisfies economic necessity	5	42
Offers better standard of living	4	33
Encourages to meet challenges in life	5	42
Engages one's time usefully	2	17
Provides subsidy	1	8

* Total exceeds hundred due to multiple responses

When interviewed about the reasons for starting the unit, the women entrepreneurs expressed various views. Fifty six per cent of them opined that this occupation provided good future prospects, 42 per cent stated that it satisfied economic necessity and encouraged to meet challenges in life, while 33 per cent said that it offered better standard of living, 17 per cent expressed that they started the unit because they were able to get subsidy.

D. Problems faced in raw material procurement

Regarding raw material procurement, only thirty per cent came forward and expressed their willingness in procuring the cocoons from the market, participating in the auction process. The rest of them (70 per cent) had their spouse or another member carry out this activity as they felt shy to attend the auction.

E. Details regarding the reeling unit

The size of the reeling unit, year of starting the unit, and ownership are discussed in Table XXVII.

TABLE XXVII

DETAILS REGARDING THE SIZE OF THE UNIT, YEAR OF STARTING AND OWNERSHIP

Details	Number	Per cent
Size of the unit (Number of basins)		
6	3	25
8	4	33
10	3	25
12	2	17
Year of starting		
1979 - 80	4	33
1983 - 84	6	15
1987 - 88	2	17
Mode of ownership		
Own	12	100

Regarding the size of the unit, three of them (25 per cent) had installed 6 basins, whereas 33 per cent had installed 8 basins, two of them had installed (17 per cent) 12 basins, and three of them (25 per cent) had installed 10 basins.

All the twelve entrepreneurs owned the building in which reeling was taking place.

F. Employees and their salary

Details regarding the employees and their salary are discussed in Table XXVIII.

TABLE XXVIII

EMPLOYEES AND THEIR WAGES

Number of basins	Employes		Wage/day in Rs.	
	Men	Women	Men	Women
6	2	4	40	25
8	3	5	40	25
10	3	7	45	25
12	4	7	45	30

Table XXVIII shows that as the number of basins in the unit increased the number of employees also increased. Due to the hardworking nature of women and low wages which need to be offered to women, they are preferred to men. Men were paid a salary of Rs.40-45 per day whereas women got Rs.25-30 per day only. It is also evident from the Table XXVIII that 34 per cent were men while 66 per cent were women employees.

G. Production of silk

Out of the twelve women entrepreneurs four entrepreneurs reeled about 800g of silk per basin per day. Remaining units reel one kilogram of silk per basin per day due to experienced reelers. Remaining had problems with

unskilled workers, because of whom there was more loss of silk as silk waste. All the women entrepreneurs expressed that the qualityof silk reeled in their unit was good.

H. Problems faced in silk reeling unit

H.1. Finance

All the women entrepreneurs had financial problems because all of them purchased cocoons daily and paid the wages every week, whereas they were able to sell the silk only once a month.

H.2. Labour and health problems

All the women entrepreneurs faced acute labour problem because the labourers had to work in hot water throughout the day. They were having health problems like pain in the hand, neck and leg, and skin lesions.

Three entrepreneurs were unable to run the newly purchased basins due to scarcity of labour, and had to get workers from Karnataka. Since they had come from outside the state, they had to be provided with food and shelter, which were additional responsibilities for the women.

H.3. Storage of reeled silk

Storing of the reeled silk is one of the problems faced by all the entrepreneurs. Rats are the most dangerous ones. Five entrepreneurs had made shelves with doors to store the cocoons. Remaining had nets in their windows and kept the doors of the unit tightly closed.

H.4. Mechanical problems

Mechanical problems arose in the reeling machines very often and this affected the output. Hence normally all the units have two to three basins extra in the unit, to tide over any emergency. Also they pay handsomely to the mechanics who repaired the unit.

H.5. Unskilled workers

Unskilled workers wasted silk, and the reeling was not uniform. One of the two skilled workers from Karnataka had been appointed in each unit so that all the other labourers had training.

H.6. Transportation and marketing

Raw silk is either sold to private dealers or at Kancheepuram which ever fetched higher price. The women entrepreneur's spouse took the raw silk to Kancheepuram by bus or train. Most of them preferred bus as it dropped them in front of the co-operative itself.

In addition to this the waste cocoons, cooking waste and rewinding waste were also sold by the women entrepreneurs in the local silk market.

I. Problems faced in silk selling markets

Some times due to delay and inefficiency or the nature of water used in reeling, the colour of the raw silk changes and loses its softness. This silk is sold for less price, if the price of silk is very less, then the reelers

keep it in the godown in the co-operative society for a week or month till the prices become favourable. This means lack of funds for further rotation.

J. Domestic problems of the women entrepreneurs

Domestic problems of the women entrepreneurs are discussed in the Table XXIX.

TABLE XXIX

DOMESTIC PROBLEMS OF THE WOMEN ENTREPRENEURS

Problems	Number	Per cent *
Inability to look after the children	3	25
Less training to husband and others	2	17
Inability to fulfil social obligations	6	50
Less care to dependents	2	17
Disapproval of society for innovative ideas	4	33
Lack of support from family members	1	8
Get frustrated and angry over small maters	3	25
Irregularity of paid servants	4	33

* Total exceeds hundred per cent due to multiple responses

Table XXIX showed that 50 per cent were unable to fulfil social obligation, 33 per cent expressed disapproval from society on innovative ideas, and 33 per cent spoke about the irregularity of paid servants. Twenty five per cent of the entrepreneurs each were unable to look after

their children well and lost their temper soon. Seventeen per cent of them felt guilty that less time was given to their spouse and other dependents at home. Only one entrepreneur (8 per cent) expressed the problem of lack of support from family members. These details on women entrepreneurs revealed that women are also capable of running this industry inspite of meeting several problems.

Parthasarathy and Gregory (1994) report that the failure in reeling industry is due to using water unsuitable for reeling, labour problem, unpredictable price fluctuations and the problem of getting suitable cocoons.

V. Findings on women labourers in silk reeling units

The results of the survey conducted regarding the role of women in silk reeling unit are discussed in the following pages.

A. Family background

Table XXX presents details regarding the family background of the women labourers.

TABLE XXX

AGE AND EDUCATIONAL QUALIFICATION OF WOMEN LABOURERS

Details	Age in years				Total	Illiterate	Literate
	10-12	13-15	15-18	19-50			
Number	3	10	16	36	65	22	43
Percentage	5	15	25	55	100	34	66

From Table XXX it is clear that fifty five per cent of the women labourers belonged to the adult group (19-50 years) and 40 per cent belonged to the adolescent group between 13-18 years. Only five per cent were in the age group of 10-12 years. Regarding educational status, 66 per cent of the labourers were educated, and 34 per cent were illiterate.

B. Details regarding employment and years of service

Table XXXI gives the information regarding the reasons for taking up the job, employment sector and years of services.

TABLE XXXI

DETAILS REGARDING EMPLOYMENT AND YEARS OF SERVICES IN SERICULTURE

S.No.	Details	Number	Per cent
1.	Reasons for taking up the job		
	a. To earn a living	49	75
	b. Interest in the field	3	5
	c. For better standard of living	13	20
2.	Years of service		
	a. Less than 5 years	35	54
	b. 6 to 10 years	20	31
	c. 11 to 15 years	10	15
3.	Employment sector		
	a. Private sector	50	77
	b. Government units	15	23

It is seen that 75 per cent of the labourers were working to earn a living. Twenty per cent worked because they were able to achieve a better standard of living, and only five per cent opted for this occupation out of interest for a job in this industry.

It is also seen from Table XXXI that 77 per cent of the labourers worked in private units, whereas only 23 per cent worked in government units. The reason for a higher per cent of people opting for private units is that the wages are slightly higher in private units. Regarding their years of service 54 per cent of the labourers had experience less than five years, and 31 per cent had six to 10 years of service, 15 per cent had 11 to 15 years of experience.

C. Job satisfaction of the labourers

Table XXXII and Figure 5 give the degree of job satisfaction of the labourers with salary and nature of work.

TABLE XXXII

JOB SATISFACTION

Details	Satisfaction from salary				Satisfaction from nature of work			
	HS	S	DS	NR	HS	S	DS	NR
Number	9	32	14	10	6	35	13	11
Per cent	14	49	22	15	9	54	20	17

HS = Highly satisfied DS = Dissatisfied

S = Satisfied NR = No reply

Only fourteen per cent of the labourers were highly satisfied with their work and 49 per cent of the labourers expressed just satisfaction with their salary while 22 per

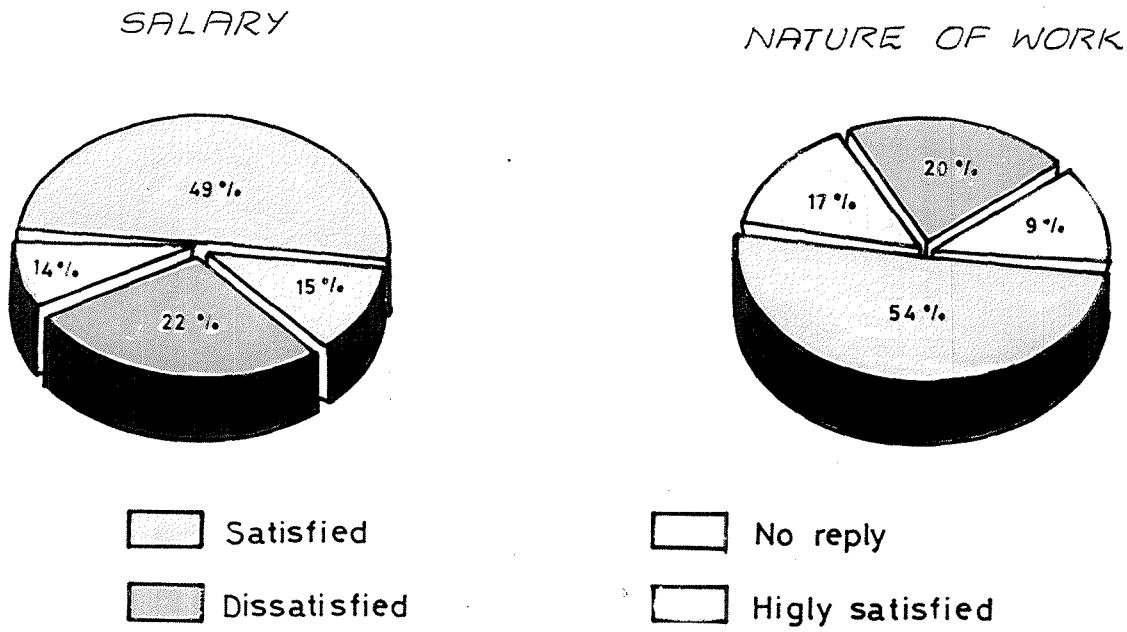


FIG.5 SATISFACTION FROM SALARY AND NATURE OF WORK

cent were dissatisfied due to low salary and health problems arising out of the work. Fifteen per cent did not give any kind of response as they themselves were not sure whether they were satisfied or not. About 63 per cent were satisfied with the nature of work, while 20 per cent were dissatisfied and 17 per cent had no answer.

D. Activities of the labourers

The various activities carried out by the labourers are given in Table XXXIII.

TABLE XXXIII

ACTIVITIES OF THE LABOURERS IN REELING UNITS

Activities	Number	Per cent
Sorting and grading	6	9
Cooking	8	12
Reeling	35	54
Re-reeling	6	9
Skeining	5	8
Bundling	5	8

Fifty four per cent of the labourers were engaged in reeling activity as it was highly labour intensive and large chunk of the wages goes to this activity while only nine per cent were involved in sorting and grading, and 12 per cent were involved in cooking, nine per cent in re-reeling, eight per cent in skeining and remaining eight per cent in bundling.

E. Details regarding training of the labourers

The details regarding the training received by the

labourers are given in Table XXXIV.

TABLE XXXIV

TRAINING OF THE LABOURERS

Details	Skilled (from other places)	Trained by the government			No training
		6 months	4 months	1 month	
Number	21	8	6	5	25
Per cent	32	12	9	8	39

From Table XXXIV it is evident that 39 per cent of the labourers had no training but were trained after joining the work in the unit. Thirty two per cent of the labourers had received the skills from Mysore when they joined the present units. These labourers hailed from families whose traditional work was silk reeling. Since duration of the government training programme in silk reeling units varied from one month to six months, 12 per cent had received training for 6 months while 9 per cent and eight per cent had received training for four months and one month respectively.

F. Duration of work, wages and attitude of family members towards the job

The duration of work and wages for the labourers are depicted in Table XXXV.

TABLE XXXV

DURATION OF WORK AND WAGES OF THE LABOURERS

Details	Details of work/ day in hours		Wayges / day in rupees				
	8	10	10-15	16-20	21-25	26-30	Above 31
Number	47	18	13	10	25	7	10
Percent	72	28	20	15	39	11	15

It is observed that 72 per cent of the labourers worked for 8 hours a day, while 28 per cent worked for nine to ten hours a day. Highly skilled workers 15 per cent were paid Rs.31 and above per day and 11 per cent were paid Rs.26 to 30 per day while thirty nine per cent workers were paid Rs.21 to 25 per day. Among the untrained labourers 15 per cent were paid Rs. 16 to 20 and remaining 20 per cent workers were paid Rs. 10 to 15 per day.

Acharya et al, (1992) reported that the reelers wages are paid at piece rates in terms of ganis (1 gani = 1.800 kg of cocoons reeled) and a reeler reeling 5 ganis will get a wage of Rs.25 (Rs.5/gani) and the one reeling of ganis will get Rs.40/day. The others involved in activities related to reeling get Rs.2/gani and on an average they earn Rs.16-20/day.

G. Problems of the labourers

The problems faced by women labourers in the domestic and silk reeling units are given in Table XXXVI.

TABLE XXXVI

PROBLEMS OF THE LABOURERS

Problems	Number	Per cent *
Allergy and cough due to smoke	6	9
Skin irritation	27	42
Low wages	10	15
Headache	10	15
Physical exhaustion	5	8
Far away from home	7	11
No time for household duties	17	26
Children's education affected	14	21
No time for socializing	5	8
No problems	29	45

* Multiple responses

Table XXXVI shows that due to inhaling smoke while cooking the cocoons, nine per cent of the labourers had developed allergy and cough. Forty two per cent of the labourers had skin irritation in the hand due to sericin in boiling water. Twenty six per cent of the labourers had no time for household activities, while twenty one per cent could not give time for their children's education and eight per cent had no time for social gatherings. However forty five per cent of the labourers did not face any domestic problem as they belonged to adolescent age group between 13 to 18 years and they had their mothers taking care of work at home. Low wages, being for away from home, head-ache and

physical exhaustion were the other problems expressed.

From the total of 65 labourers interviewed, only 43 per cent had taken measures to overcome their health problems. The rest were continuing their work with their problems.

VI. Details regarding cocoons

A. Quality of cocoons

Table XXXVII gives the quality of cocoons in the five different samples.

TABLE XXXVII

DETAILS REGARDING THE QUALITY OF COCOONS

S. No.	Items/kg	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
1.	Total number of cocoons	627	670	680	645	521
2.	Good cocoons	575	596	568	534	432
3.	Defective cocoons	52	74	112	111	89
a.	Double cocoons	21	17	37	14	22
b.	Urinated	6	49	57	70	32
c.	Deformed	nil	5	15	14	10
d.	Melted	25	3	3	13	15

As it is evident from the Table XXXVII, the number of defective cocoons ranged from 52-112 in the five one kilogram sample lots which had 521-680 cocoons on the whole.

In other words 8 to 17 per cent of the total cocoons were defective. Among the defective cocoons, the defects which were predominently noted were double cocoons and urinated cocoons, while there were deformed and melted cocoons also present in the samples.

Quality of the cocoons can be scientifically judged by calculating the renditta, shell ratio and filament length also.Table XXXVIII gives details regarding renditta, shell ratio and filament length of the cocoons selected for the study.

TABLE XXXVIII

RENDITTA, SHELL RATIO AND FILAMENT LENGTH

Sample	Shell ratio (%)	Renditta	Average filament length (m)	Average non-breakable filament length (m)
1	14.2	11.6	590	438
2	12.5	13.2	468	266
3	16.7	9.9	692	452
4	20.0	8.3	684	329
5	15.4	10.7	520	423

1. Renditta

It was noted that the lower the value of renditta, the better was the performance of the cocoon. According to the results obtained, it was seen that cocoon sample number 4 with a value of 8.3 showed a better performance while

sample number 2 with a value of 13.2 showed a poor performance.

2. Shell ratio (%)

From the results obtained it was clear that higher shell weight was indicative of higher silk content in the cocoon, which is expressed as shell ratio per cent. Among the selected lots of cocoons, the fourth lot with a high ratio of 20 per cent had a better performance and the second lot had a low shell ratio value of 12.5 per cent which had a poor performance.

3. Filament length

When the five selected samples chosen for the present study were tested for filament length, it was noted that sample number three was superior in both average filament length of 692 metres and average non-breakable filament length of 452 metres whereas sample number two showed a poor performance with values 468 metres of average filament length and 266 metres of average non-breakable filament length. The findings in the present study are inclose agreement with those of Singh et al, (1992) who report that shell ratio varies from 13.4-16.7 per cent, renditta from 10-14, average filament length from 400-579 metres and average non-breakable filament length from 300-506 metres.

VII. Reeling performance of the different reeling machines as assessed by the quality of the silk yarn

A. Nature of raw silk yarn as judged by visual inspection

The denier of the silk produced by charkha was 47 and that of cottage basin was 13 in the present study.

1. Uniformity

Basin reeled silk which was rated to be good had a better uniformity than the charkha reeled silk which was rated to be fair.

2. General finish

Depending on the rating done, the cottage basin reeled silk was rated to be excellent, while charkha reeled silk showed only a fair rating. Since charkha being a crude way of reeling, the general finish had been affected.

3. Colour of silk

The colour of the cottage basin reeled silk and traditional charkha had a medium greenish yellow and a light greenish yellow colour. To some extent the colour was affected by the hardness of the water used for cooking and reeling.

4. Lustre

The silk obtained from cottage basin was found to have a moderate kind and bright lustre which is the best and the traditional charkha reeled silk was of the light kind and medium lustre.

5. Hand

Cottage basin reeled silk was soft and smooth in nature. While the traditional charkha was rough hand.

B. Findings of mechanical tests

1. Winding performance

Table XXXIX presents the winding breaks/skein/hour of the selected silk samples.

TABLE XXXIX

WINDING BREAKS/SKEIN/HOUR

Samples	Charkha reeled silk (47 denier)	Basin reeled silk (13 denier)	't' value
1	6.5	3.5	
2	4.0	5.0	
3	3.0	5.5	
4	4.0	5.5	
5	3.0	7.5	
Mean	4.1 ± 3.21	5.4 ± 3.32	1.4356^{NS}

NS - Not significant

In the charkha reeled silk with 47 denier among the five samples subjected to winding performance test, sample number three and five showed a minimum of 3 breaks per skein per hour, while sample number one had a greater number of 6.5 breaks. In the case of cottage basin reeled silk with 13 denier, the greater number of breaks, 7.5 were noted in sample number five and a minimum of 3.5 breaks in sample number one.

As judged by the winding performance of the traditional charkha reeled silk did not come up to the standards of the basin reeled silk. However, statistical analysis of the data, indicated that the differences between the means of the samples were not statistically significant.

2. Size deviation

Size deviation

Table XL and figure 6 gives the size deviation (denier) among the selected silk samples.

TABLE XL

SIZE DEVIATION (DENIER)

Sample	Charkha reeled silk (47 denier)	Basin reeled silk (13 denier)	't' value
1	6.2	2.0	
2	8.9	1.3	
3	7.5	2.0	
4	15.3	1.8	
5	8.9	1.2	
Mean	9.36 ± 3.51	1.66 ± 0.38	4.87*

Significant at $P < 0.01$

A lower size deviation is desirabl and is normally preferred with respect to silk or any other fibre. Sample number one in charkha reeled silk had the least deviation of 6.2 and sample number four had the maximum deviation of 15.3. In the basin reeled silk, sample number five and sample number three showed a minimum and maximum deviation of 1.2 denier and 2.0 denier respectively.

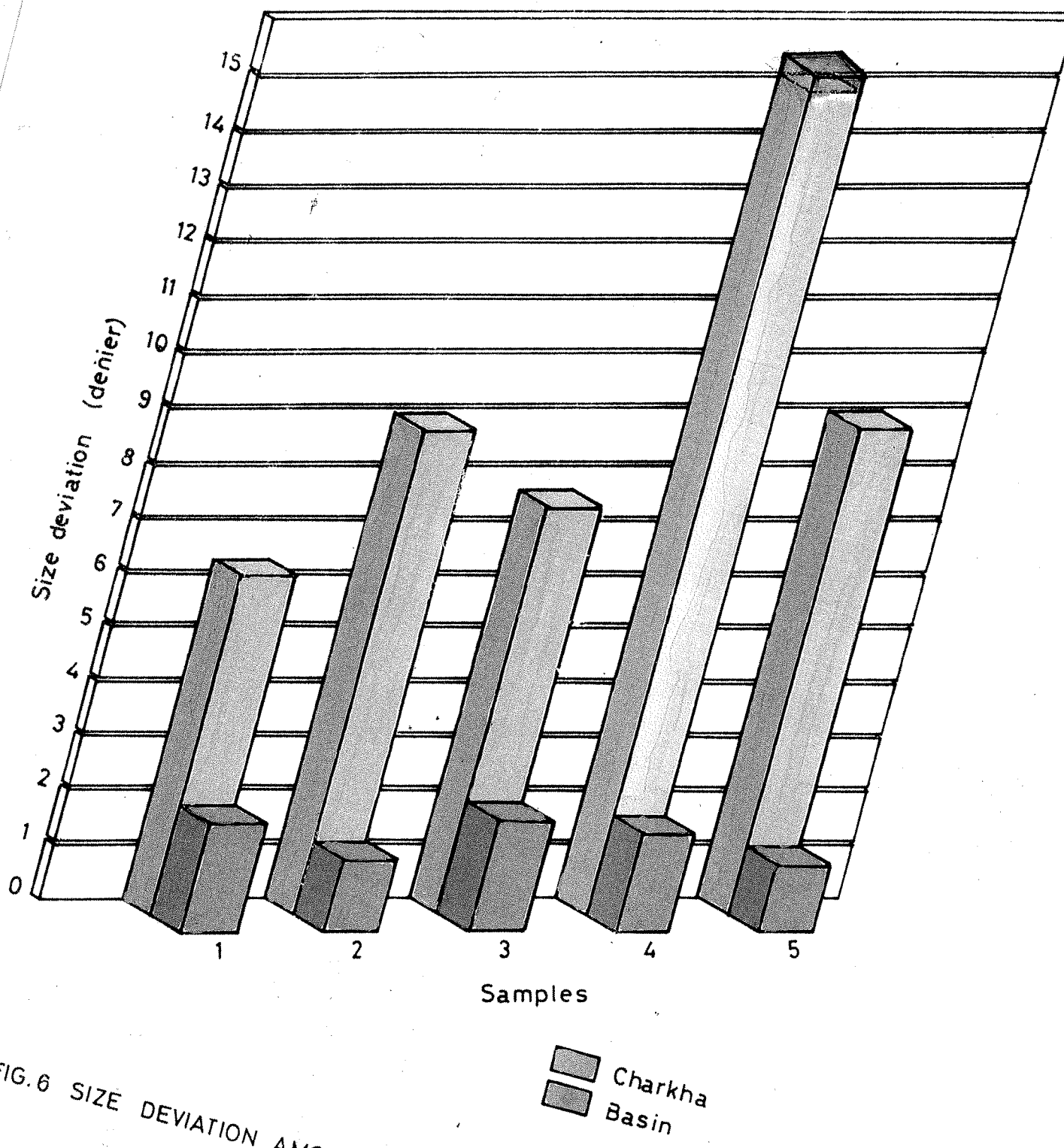


FIG. 6 SIZE DEVIATION AMO.NG THE SELECTED SILK SAMPLES

Size deviation was maximum among the charkha reeled silk samples in general in all the cases, while, basin reeled silk was better off with a minimum size deviation. Statistical analysis of the data revealed a significance at 1 per cent level between the means of the samples.

3. Maximum deviation

The maximum deviation of the selected silk samples shown in Figure 7 are presented in Table XLI.

TABLE XLI

MAXIMUM DEVIATION (DENIER)

Samples	Charkha reeled silk (47 denier)	Basin reeled silk (13 denier)	't' value
1	8.2	3.1	
2	13.6	2.0	
3	10.5	2.9	
4	23.6	2.9	
5	15.6	1.7	
Mean	14.3 ± 5.93	2.52 ± 0.63	4.42*

* Significant at $P < 0.01$

Among the five samples of charkha reeled silk, first sample showed a maximum deviation of 8.2 denier and sample number four had a deviation of 23.6 which was not at all desirable in a good quality silk. In the case of basin reeled silk, it was noticed that the sample five with a value of 1.7 was considered to be superior in quality while sample number one with a value of 3.1 denier showed a fair performance.

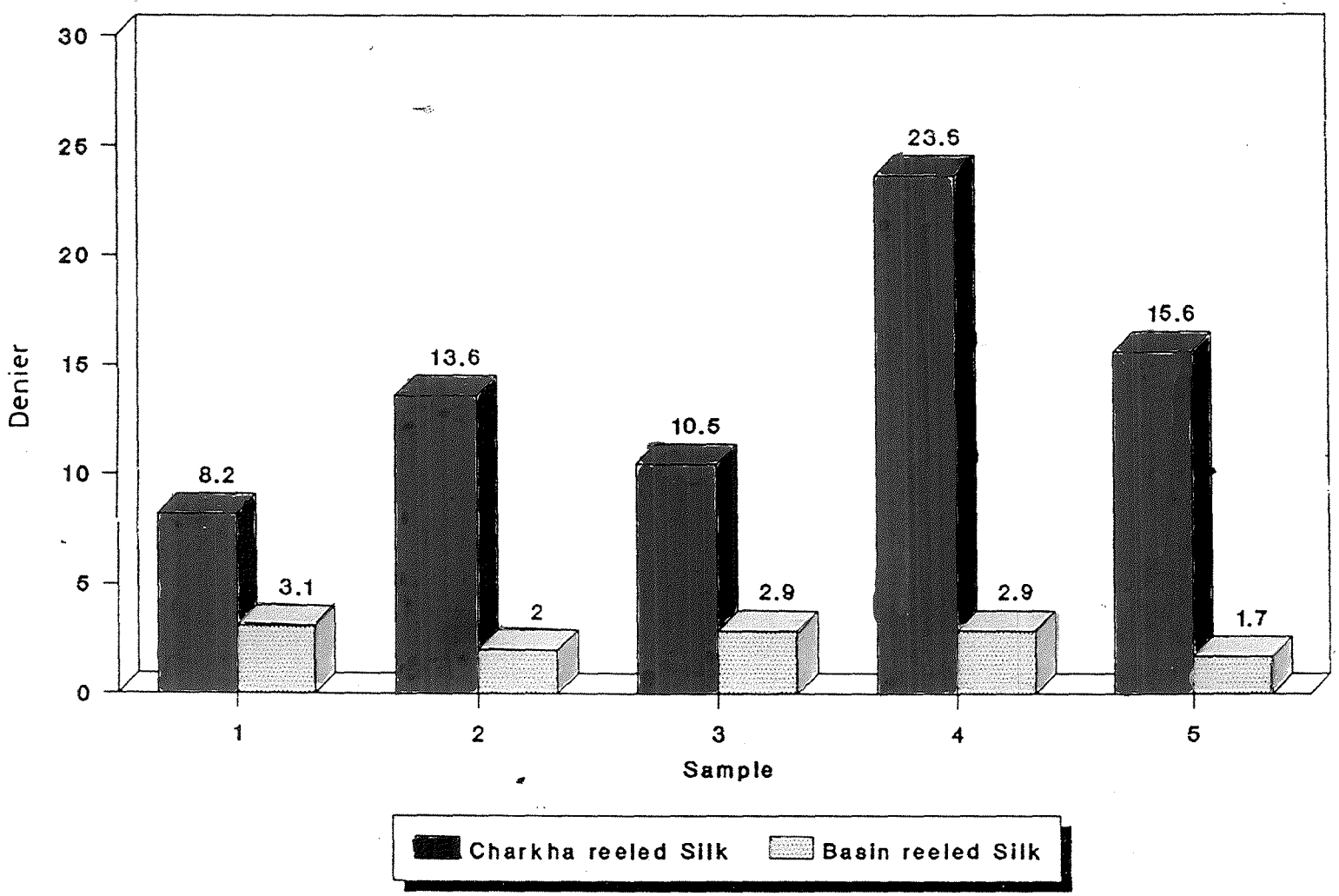


FIG.7 MAXIMUM DEVIATION OF THE SELECTED SILK SAMPLES

From the above comparison, it was clear that charkha reeled silk was far below the required standard and the basin reeled silk was of superior quality. Statistical analysis of the data between the means of the samples revealed 1 per cent significance.

4. Average evenness

Values of the average evenness per cent of the selected silk samples are shown in Figure 8 and Table XLII.

TABLE XLII

AVERAGE EVENNESS (%)

Samples	Charkha reeled silk (47 denier)	Basin reeled silk (13 denier)	't' value
1	79	88	
2	77	78	
3	78	82	
4	76	74	
5	78	83	
Mean	77.6 ± 1.14	81.0 ± 4.29	1.40 NS

NS - Not significant

Sample number one, of the charkha reeled silk had a higher evenness percentage of 79 and sample number four showed a lower evenness quality of 76 per cent. However there was not much variation among the samples. Among the basin reeled silk samples, sample number one with a percentage of 88 was considered to be the

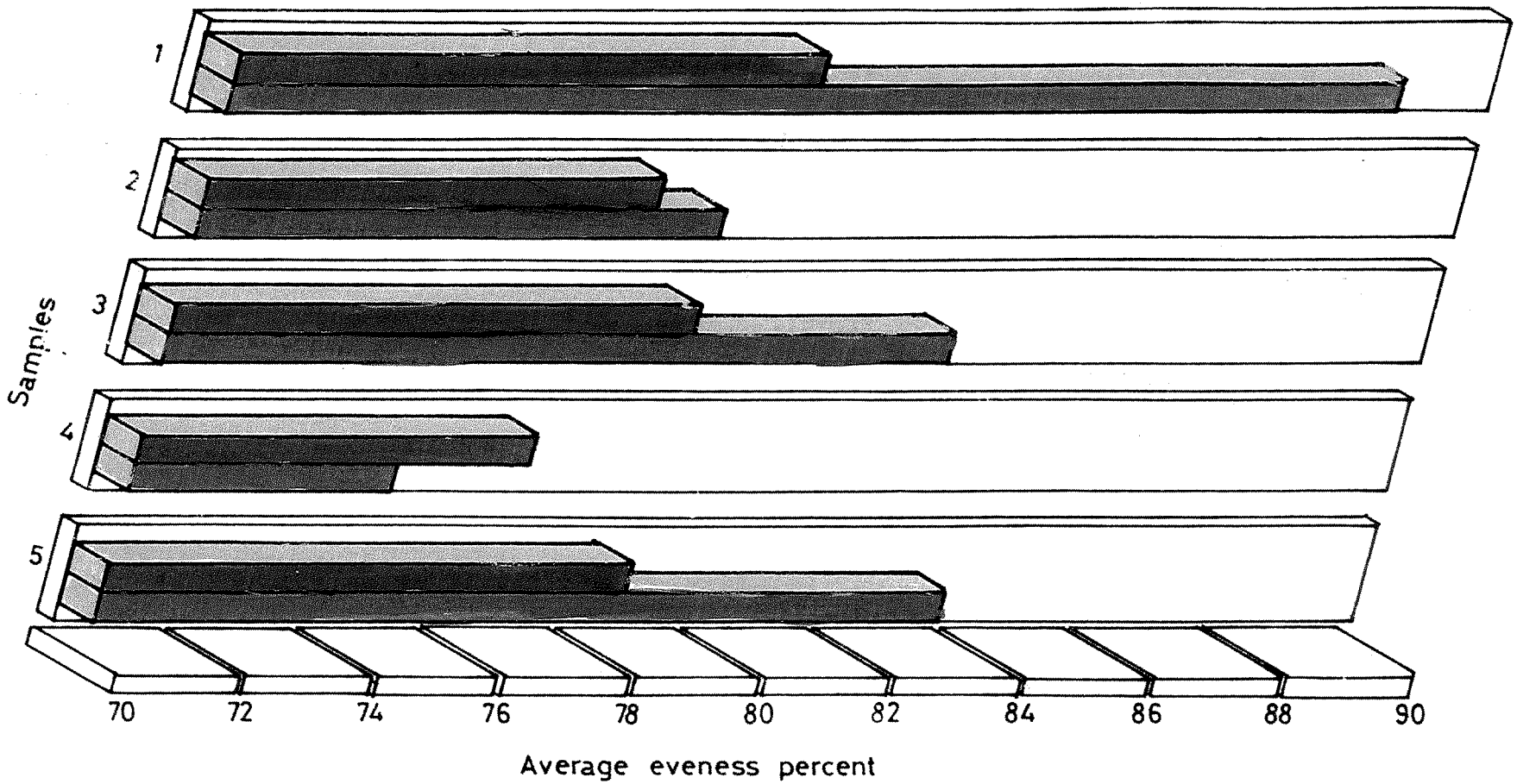


FIG.8 AVERAGE EVENNESS PERCENT OF THE SELECTE

best, while sample number four showed a lower evenness quality with a percentage of 74. On the whole, basin reeled silk had better evenness than the traditional charkha reeled silk, which may be due to the fact that the basin is provided with a proper process to check the eveness. Statistical analysis of the data, however did not show any significance between the means of the samples.

5. Average low evenness

The average low evenness per cent of the selected silk samples are shown in Figure 9 and Table XLIII.

TABLE XLIII

AVERAGE LOW EVENNESS (%)

Sample	Charkha reeled silk	Basin reeled silk	't' value
1	72	72	
2	70	68	
3	65	75	
4	62	65	
5	68	73	
Mean	67.40 ± 3.1	70.6 ± 3.2	1.26^{NS}

NS - Not significant

The average low evenness of sample one charkha reeled silk was found to be 72 per cent, being the best, and sample number four with a percentage of 62 and a low evenness. Among the basin reeled samples a low evenness of

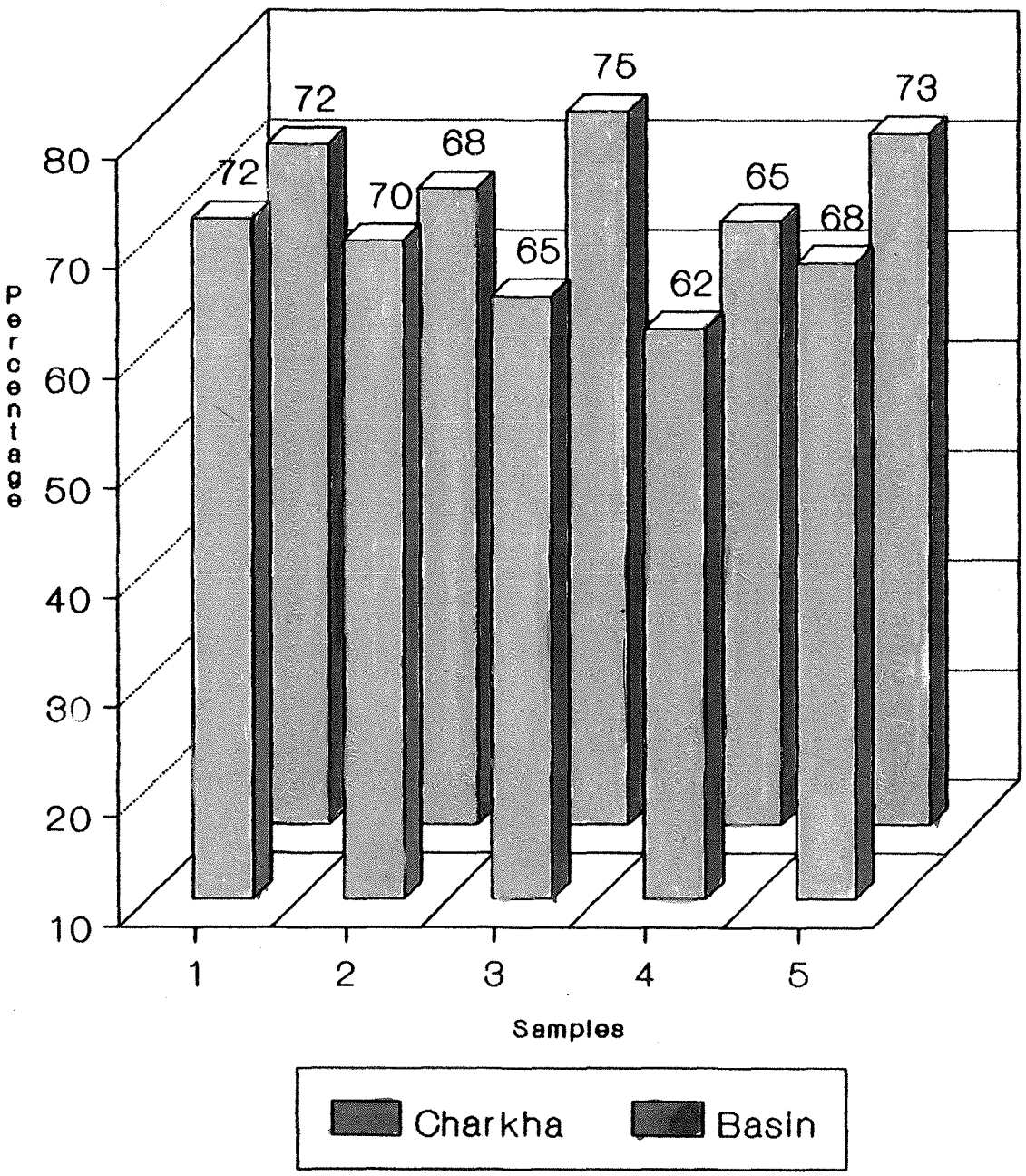


Fig. 9. AVERAGE LOW EVENNESS PER CENT OF THE SELECTED SILK SAMPLES

75 was noted in sample number three, while sample number four showed a lower performance of 65 per cent.

Thus the comparison the samples obtained from traditional charkha and cottage basin showed that basin reeled silk had a better quality, when it comes to average low evenness also. However the differences were not statistically significant.

6. Cleanness

Table XLIV and figure 10 present the cleanness of the selected silk samples.

TABLE XLIV

CLEANNESS (%)

Samples	Charkha reeled silk	Basin reeled silk	't' value
1	41	78	
2	56	69	
3	37	71	
4	58	72	
5	59	68	
Mean	50.20 ± 9.3	71.6 ± 3.3	4*

* Significant at $P < 0.01$

Higher the value for cleanness, the better was the silk quality. Out of five samples obtained from charkha, it was noted that sample number five had a higher cleanness percentage of 59, while the third sample had a low value of 37 per cent. The samples related in basin had a highest value of 78 per cent cleanness in sample

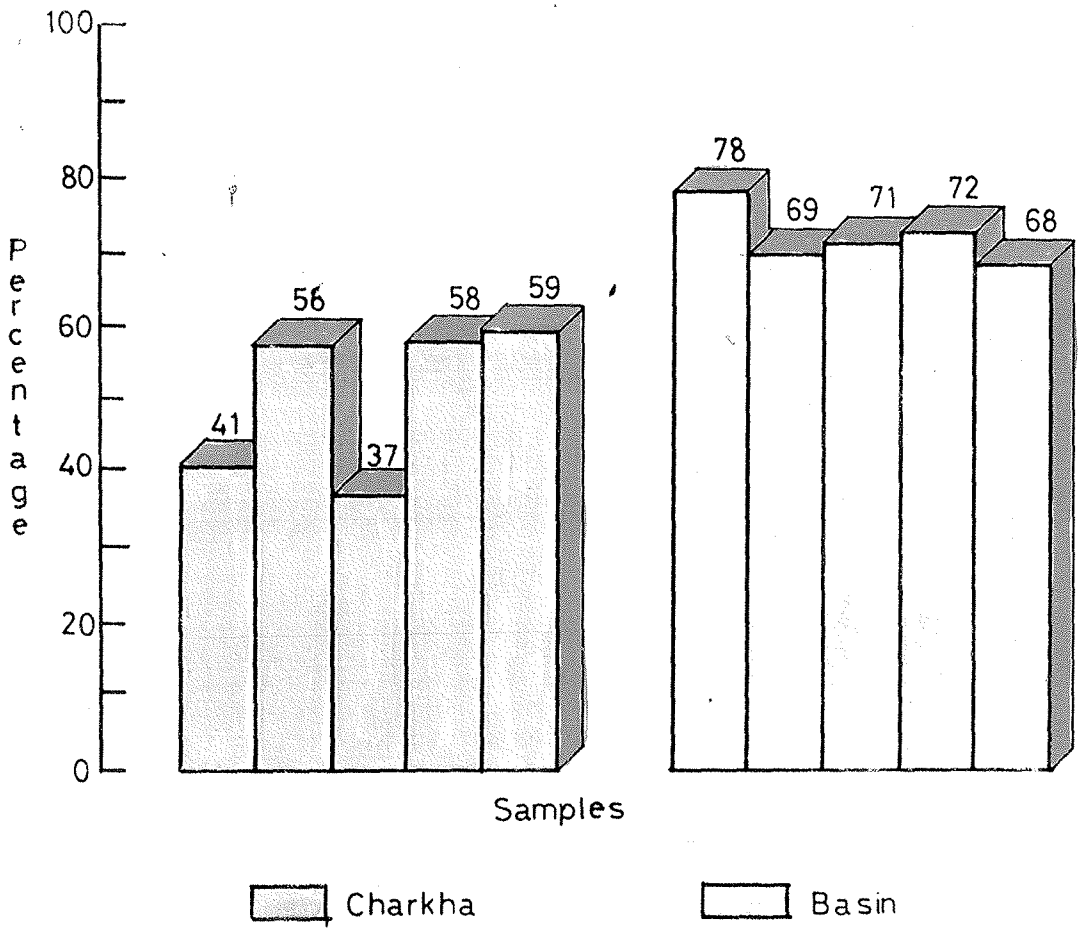


FIG.10 AVERAGE CLEANNESS OF THE SELECTED SILK SAMPLES

number one and a lowest at 68 per cent in sample number five. Statistical analysis of the data revealed a significance at 1 per cent level between the means of the samples.

Thus basin reeled silk had better cleanness property than charkha reeled silk samples. The superiority of cottage basin reeled silk is evident.

7. Average neatness

Thus average neatness of the selected silk samples shown in Figure 11 are presented in Table XLV.

TABLE XLV

AVERAGE NEATNESS (%)

Samples	Charkha reeled silk	Basin reeled silk	't'
1	73	75	
2	77	73	
3	72	76	
4	74	67	
5	75	72	
Mean	74.20 ± 1.4	72.6 ± 3.4	0.89 NS

NS - Not significant

A high value for average neatness depicted a better quality among the samples. As shown Table XLV among the charkha reeled samples, number two showed the highest neatness of 77 per cent while a lowest of 72 per cent was noted in sample three. In the case of basin reeling, a highest value of 76 per cent

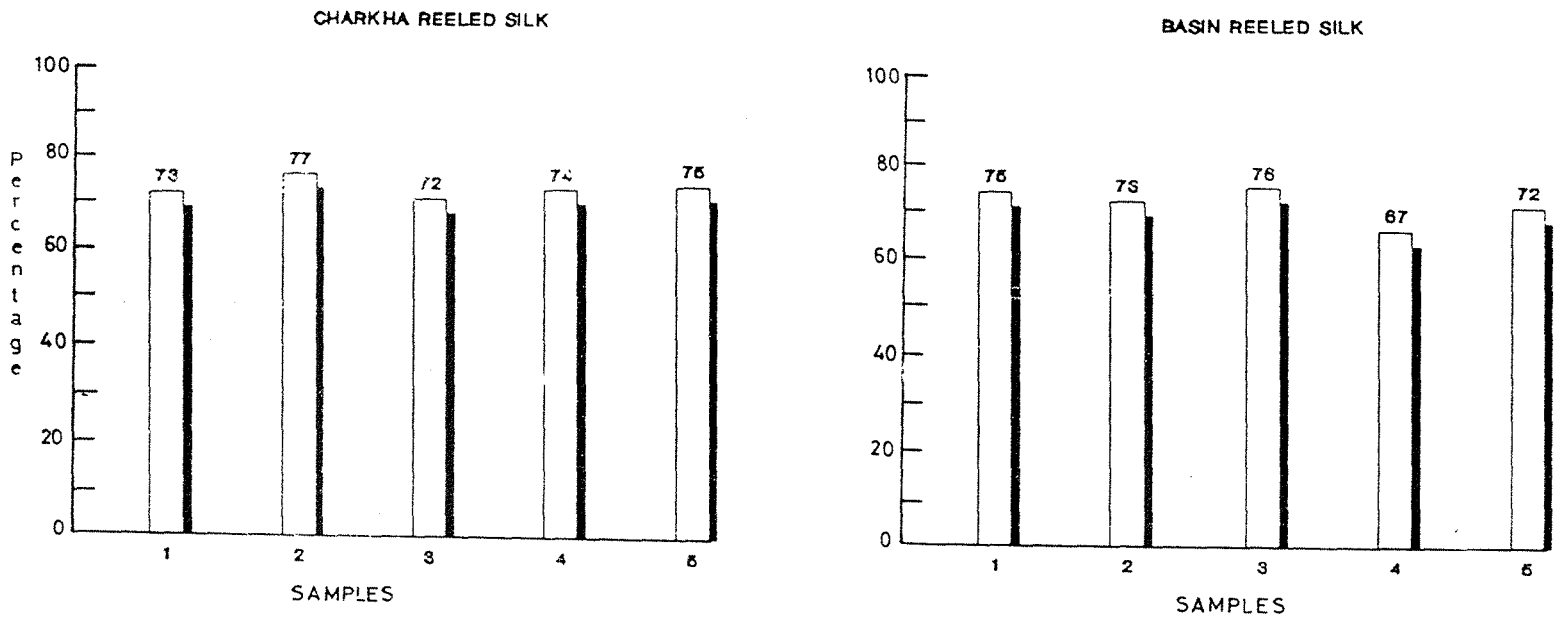


FIG.11 AVERAGE NEATNESS OF THE SELECTED SILK SAMPLES

was obtained by sample three and lowest value of 67 per cent was noted in sample four.

Average neatness achieved was similar between charkha reeled silk and basin reeled silk and the differences were not statistically significant.

8. Average low neatness

Table XLVI and Figure 12 present the average low neatness per cent of the selected samples.

TABLE XLVI

AVERAGE LOW NEATNESS (%)

Samples	Charkha reeled silk	Basin reeled silk	't' value
1	69	70	
2	67	65	
3	62	67	
4	65	60	
5	67	65	
Mean	66 ± 2.3	63.4 ± 3.4	0.298 NS

NS - Not significant

Among charkha reeled silk samples, sample one showed a better value of 69 per cent and a low value was noted in sample three with value of 62 per cent. Among basin reeled silk samples, samples one showed a value of 70 per cent and sample 4 had alower performance of 60 per cent.

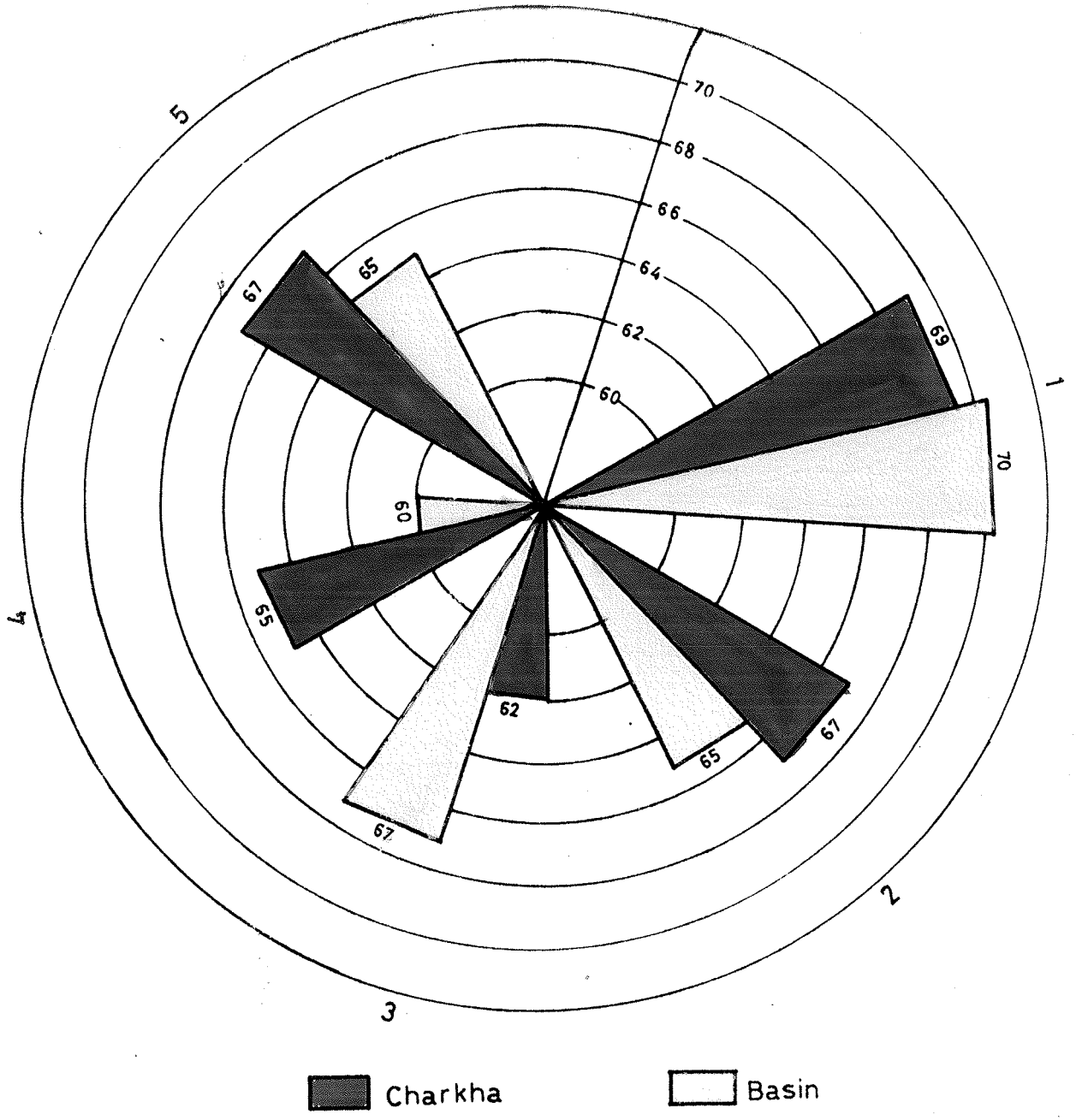


FIG.12 AVERAGE LOW NEATNESS PERCENT OF THE SELECTED SILK SAMPLES

Differences between the means of samples were statistically not significant.

Here again basin reeled silk, was comparable with the charkha reeled silk.

9. Tenacity

Table XLVII and Figure 13 represent the tenacity values of the selected samples.

TABLE XLVII

TENACITY (GRAM/DENIER)

Sample	Charkha reeled silk	Basin reeled silk	't' value
1	3.3	4.5	
2	3.3	4.1	
3	3.6	3.9	
4	3.3	4.2	
5	3.4	4.6	
Mean	3.38 ± 0.98	4.26 ± 0.68	6.22*

* Significant at $p < 0.01$

From Table XLVII it is seen that among the five charkha reeled silk samples three had a similar value of 3.3 (g/d) for tenacity, while the other two showed a value of 3.4 (g/d) and 3.6 (g/d). Among the samples obtained from basin reeling, highest value was 4.6 (g/d) and the lowest was 3.9 (g/d). Thus the tenacity of basin reeled silk was higher than that of charkha reeled silk. Statistical analysis of the data revealed a significance at

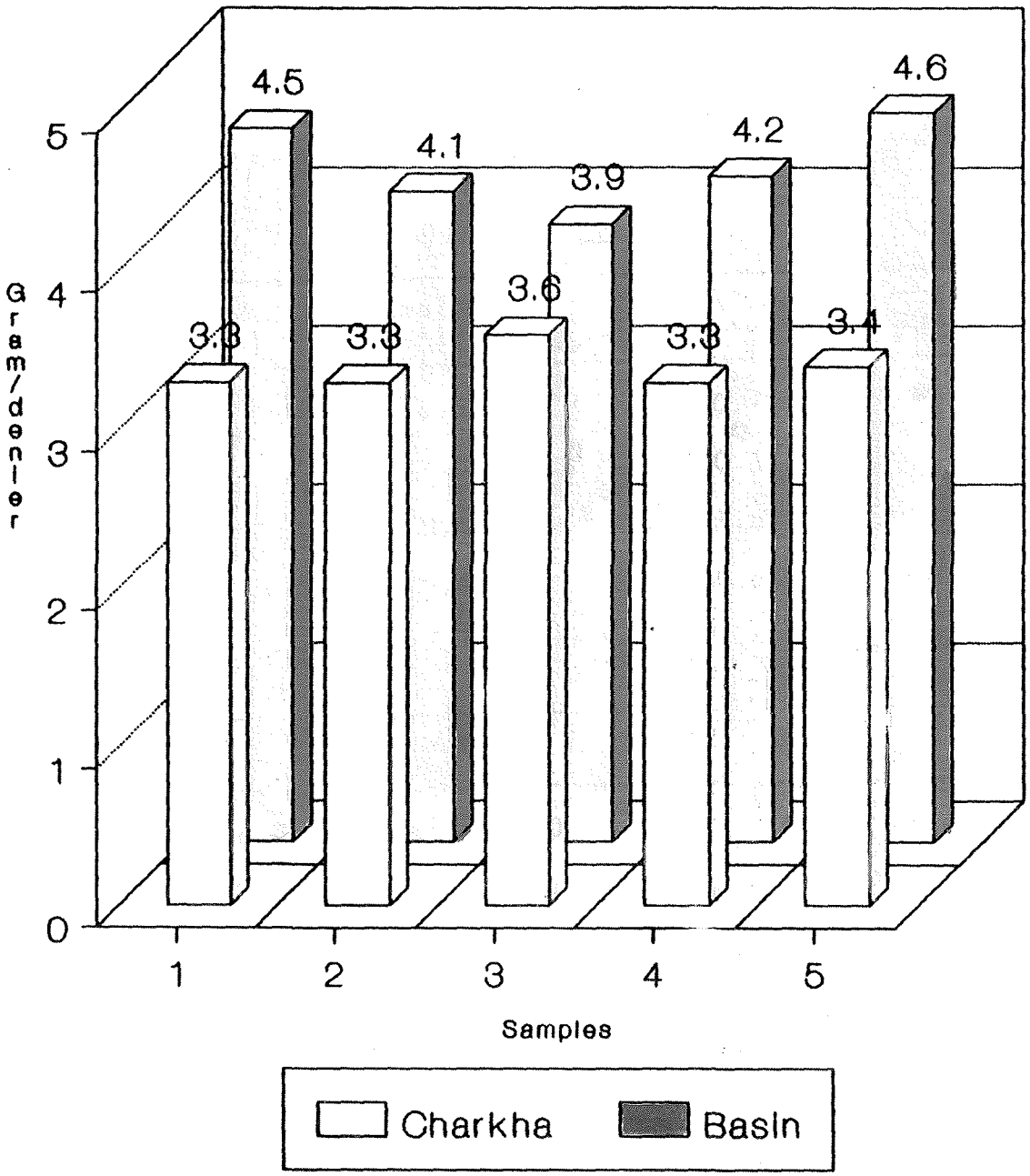


Fig. 13. TENACITY VALUES OF THE SELECTED SILK SAMPLES

1 per cent level between the means of the samples.

10. Elongation

Elongation per cent value of the selected silk samples shown in Figure 14 are presented in Table XLVIII.

TABLE XLVIII

ELONGATION (%)

Sample	Charkha reeled silk	Basin reeled silk	't'
1	6.5	10.9	
2	7.6	10.6	
3	8.4	11.6	
4	8.6	10.6	
5	7.7	11.4	
Mean	7.76 ± 0.75	11.02 ± 0.96	7.70*

* - Significant at $p < 0.01$

The elongation values of charkha reeled silk indicated that sample four had a higher value of 8.6 per cent and sample one had a lowest of 6.5 per cent among the five samples and in basin reeled samples it was seen that sample three had values of 11.6 per cent and sample five had 11.4 per cent and both had a better performance while sample two and four had a lower value of 10.6 per cent.

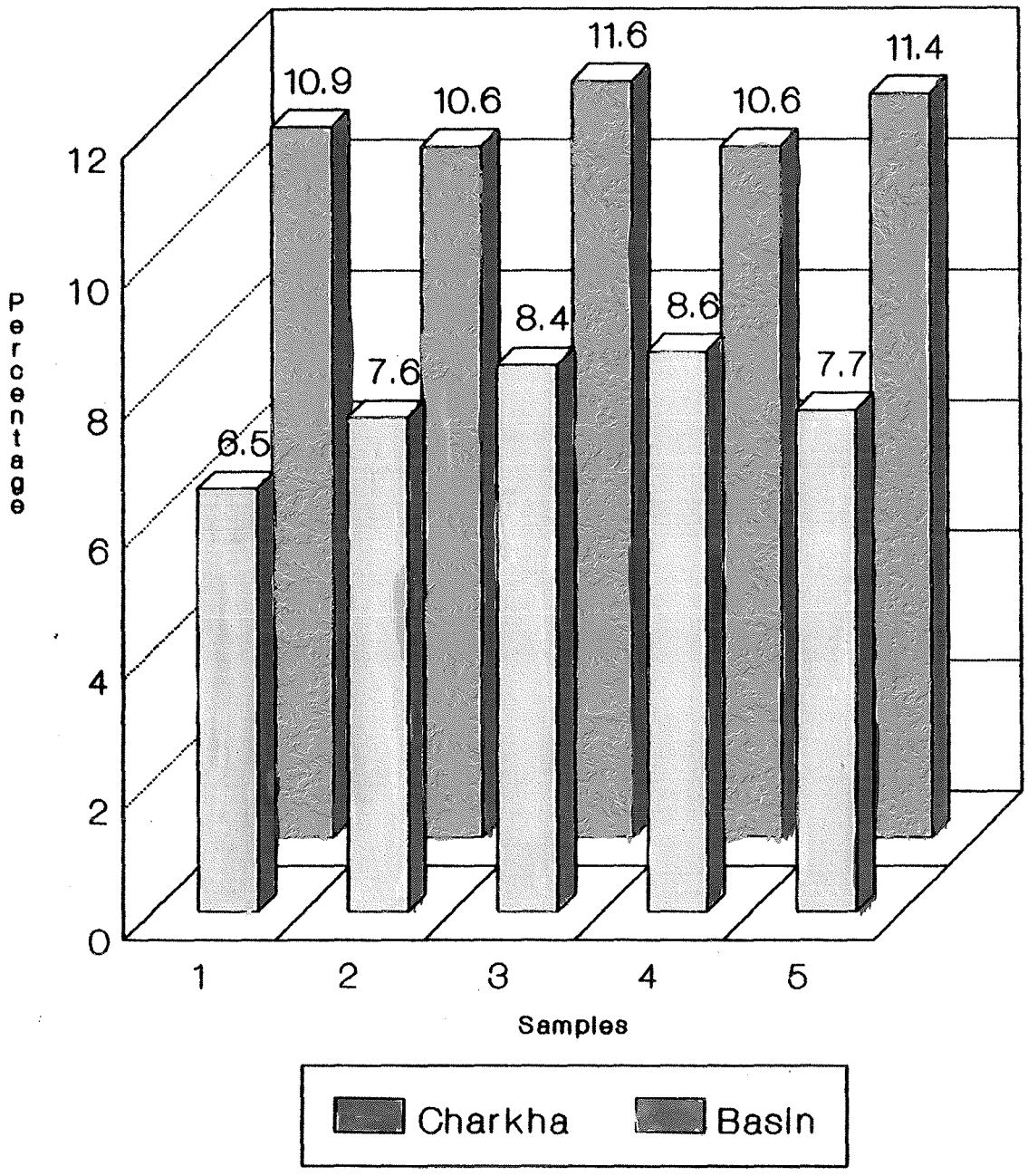


Fig. 14. ELONGATION PER CENT OF THE SILK SAMPLES

C. Comparison between charkha reeled and basin reeled silk yarn

From the results obtained mean values for the performance of charkha and cottage basin were calculated for samples obtained from both and the same are presented in Table XLIX.

TABLE XLIX

PERFORMANCE OF CHARKHA AND COTTAGE BASIN

Quality of silk	Charkha 47 denier	Cottage basin 13 denier
Size deviation (denier)	9.4	1.7
Maximum deviation (denier)	14.3	2.5
Evenness (%)	77.6	81.0
Average low evenness (%)	67.4	70.6
Average cleanness (%)	50.2	71.6
Average neatness (%)	74.2	72.6
Low neatness (%)	66.0	65.4
Tenacity g/d	3.4	4.3
Elongation (%)	7.8	11.0
Winding breaks/skein/hour	4.1	5.4

Table XLIX reveals that the overall performance of cottage basin was better than the charkha with reference to size deviation, maximum deviation, evenness per cent, average low evenness, average cleanness, tenacity and elongation.

Hence the cottage basin system with four basin capacity was selected for running a model unit, providing jobs for women and also to educate the women workers regarding the cost involvement in the process, the profitability of the cottage basin industry and equip them for self employment.

VIII. Findings on establishing and running a reeling unit

Table L shows details regarding purchase of cocoons and their cost.

TABLE L

COCOON WEIGHT AND COST

S.No.	Quantity of cocoon (kilogram)	Cost/kilo-gram in Rs.	Total amount (in Rs.)
1.	25.550	127.413	3,255.50
2.	10.000	94.3	943.00
3.	10.950	83.37	913.00
4.	20.000	58.1	1,162.00
5.	11.850	75.08	889.75
6.	22.650	75.28	1,705.30
7.	24.100	78.98	1,903.50
8.	29.700	83.29	2,474.00
9.	30.900	78.59	2,428.65
10.	26.150	72.51	1,896.30
11.	19.750	75.10	1,483.25
12.	21.950	74.09	1,626.30
13.	21.950	70.99	1,558.25
14.	13.950	75.67	1,055.60
15.	31.750	94.29	2,993.85
16.	29.600	84.90	2,513.10
17.	33.250	86.49	2,875.80
18.	16.350	86.92	1,421.20
19.	34.850	90.08	3,139.50
20.	27.300	90.71	2,476.40
21.	41.450	86.09	3,568.70
22.	10.250	88.09	903.00
23.	4.050	87.24	353.35
24.	14.600	85.93	1,254.70
25.	47.300	64.10	3,032·00

Table L reveals that cocoons were purchased twenty five times, and each time the weight of the cocoons and their price/kg were different. On an average, the cocoon price per kilogram during the study period was Rs.82.7, and 580.2 kilogram of cocoon was purchased on a cost of Rs.47,825.80.

Table LI gives details regarding the input of cocoon and ouput of silk yarn in Kg for each lot, and the resulting renditta.

TABLE LI

DETAILS REGARDING INPUT, OUTPUT AND RENDITTA

S.No.	Input of cocoon in kilogram	Out put of silk yarn in kilogram	Renditta
1.	25.550	1.50	17.03
2.	10.000	0.60	16.67
3.	10.950	0.65	16.85
4.	20.000	1.20	16.67
5.	11.850	0.72	16.46
6.	22.650	1.40	16.2
7.	24.100	1.50	16.1
8.	29.700	1.88	15.8
9.	30.900	2.0	15.45
10.	26.150	1.65	15.85
11.	19.750	1.4	14.11
12.	21.950	1.6	13.72
13.	21.950	1.6	13.72
14.	13.950	1.0 18.70	13.95
15.	31.750	2.4	13.2
16.	29.600	2.2	13.5
17.	33.250	2.4	13.9
18.	16.350	1.24	13.2
19.	34.850	2.7 10.94	12.9
20.	27.300	2.40	11.4
21.	41.450	3.60	11.5
22.	10.250	0.90	11.4
23.	4.05	0.40	10.1
24.	14.6	1.40	10.4
25.	47.3	4.33 13.03	10.9

From Table LI it is evident that the out put of silk varied with different quantities of cocoon purchased. The renditta values ranged rom 17.03 - 13.95 for the first 14 lots and there after reduced slowly from 13.02 to 10.9 towards the end. Since the quality of cocoons were more less similar, the decrease in renditta may be attributed to the ability of the workers to extract silk yarn completely from the cocoon.

The general finish, uniformity, colour, lustre and hand were good for all the silk yarn produced except the first 4-5 lots.

Table LII presents the data relating to the expenses incurred in the unit by way of wages.

TABLE LII

DETAILS OF EXPENSES BY WAY OF WAGES

S.No.	Out put of silk yarn in kilogram	Wages in Rs.	Wages/kilogram out put in Rs.
1.	18.70	9530.00	509.60
2.	10.94	4902.20	448.10
3.	13.03	5423.20	416.20

During the first two months the total wages incurred were Rs.9,530.0 for an output of 18.70 kilograms, which works out to Rs.509.6 per kilogram. During the second phase of output for 10.94 kilogram, the total wages paid were Rs.4,902.2 which worked out Rs.448.1 per kilogram and during the last phase, the wages per kilogram reduced to Rs.416.2. This trend in the reduction of wages per kilogram of raw silk yarn indicate that if the labourers were adequately trained the profit margin is likely to improve. Any women wanted to establish a reeling unit should be sure of getting well trained personnel so that profit is assured.

Table LIII presents the data relating to all the miscellaneous expenses incurred for producing 42.67 kilogram of silk yarn apart from cost of cocoons and wages and rates working out for each kilogram.

TABLE LIII

MISCELLANEOUS EXPENSES INCURRED

Items	Total amount spent in Rs.	Rate/kilogram in Rs.
Fuel cost	2,749.00	64.42
Electricity	280.00	6.56
Transport	898	21.05
Repair and maintenance of equipment	5,651.25	132.4
Total	9,578.25	224.43

It is clear from Table LIII that on the whole Rs.9,578.25 was spent by way of other expenses to process 580.2 kilogram of cocoon which worked out to Rs.224.43 for processing one Kg of cocoon.

Summing up all the expenses involved in the processing of 580.2 kg of cocoon the picture emerges as follows.

Cost of 580.2 kg of cocoon	Rs.47,825.80
Wages for processing 580.2 Kg	Rs.19,855.40
Other expenses involved in the processing of 580.2 kg	Rs. 9,578.25
Total expenses for cocoon purchased & processing 580.2 kg of cocoons	Rs.77,259.45

Table LIV gives details regarding the sale of silk yarn.

TABLE LIV

SALE OF SILK YARN

Quantity in / kg	Value in Rs.	Cost/ kilogram
18.70	18,077	966.68
19.34	19.340	1000.00
4.63	4,630	1000.00
42.67	42,047	988.9*

Table LIV reveals that 42.67 kilogram of silk yarn was produced and sold for Rs.42,047 working out to Rs.988.9 per kilogram.

Summary and Conclusion

V. SUMMARY AND CONCLUSION

The present study entitled "Assessing Reeling Performance of Different Reeling Machines, Establishing a Reeling Unit and Evaluating Sericulture as an Income Generating Industry for Women" was carried out with the following specific objectives:

1. To assess the present state of sericulture in and around Coimbatore with special reference to mullberry cultivation, silkworm rearing and silk reeling
2. To investigate the role of women in sericulture with reference to their involvement in silkworm rearing, silk reeling, income realized and problems faced
3. To study the reeling performance of two popular systems of reeling silk namely, traditional charkha and cottage basin, by assessing the quality of silk produced
4. To establish a reeling unit and work out the cost benefit ratio for different sizes of reeling units.

For the study, 25 sericulturists both men and women engaged in the cultivation of mulberry and silkworm rearing were selected from Gudalur Goundampalayam, and

Samichettypalayam and eight reeling units where both men and women were engaged in Podanur, Kurichi, Vadavalli and Singanallur in Coimbatore district were selected. From these sericulturists and reeling units, data regarding socio-economic status, area and soil under cultivation, number of prunings done, types of fertilizers and pesticides used, wage structure, quality and quantity of cocoons produced, problems faced and other related information were collected along with details regarding cocoon purchase and cost of silk reeled. The technique used for collecting the data was the interview method.

For the purpose of investigating the role of women in sericulture, the above information was collected from 12 women sericulturists from Perianaickenpalayam, Gudalur, Goundampalayam and Samichettypalayam, and 12 women entrepreneurs engaged in reeling, from Podanur, Kurichi and Ramanathapuram, in Coimbatore city. The same technique of interview method was followed for collection of data.

Sixty five women labourers working in the reeling units were selected to study their employment position, salary, job satisfaction, training and problems related to home and health. Reeling performance of, two popular reeling systems namely traditional charkha and cottage basin, was studied by assessing the quality of silk yarn produced in the two systems.

A silk reeling unit with four basin capacity was established in an effort to provide jobs for women and study the problems and prospects of running a reeling unit. Cost benefit analysis was carried out for different capacities of basins (2, 4, 6, 10, 24).

The data collected in each of the above aspects were consolidated and analysed. The salient features of the results are presented in the following pages:

I. Status of sericulturists and silk reelers

1. Out of the 25 sericulturists studied, 64 per cent were in the age group of 21-40 years and 36 per cent were 41-60 years old. They were not highly educated.
2. Eighty per cent were from low income group while twenty per cent were in middle income group.
3. Government loan and intiative, genuine interest in the field and need for earning a living were the motivating factors for starting the industry.
4. Seventy two per cent were small farmers while 24 per cent were marginal and 4 per cent were big farmers, and income increased with the increase in land holdings.
5. Mulberry could be cultivated on any type of soil, with suitable fertilizers.
6. A majority of 52 per cent did three prunings per year. Everyone used fertilizers like 17-17 complex, cowdung and urea while only 16 per cent used pesticides.

7. Sixty four per cent had solidly built sheds while others had temporary sheds.

8. Shelf rearing than shoot rearing was popular in the area.

9. Women working in sericulture farm were paid Rs.12-15 while men were paid Rs.20-30 per day.

10. The quality of cocoons produced were good among 96 per cent while the same was poor among 4 per cent of the farmers.

11. Cost and quantum of production/batch differed greatly among the farmers.

12. Government sericulture department provided the egg sheets.

13. Non-availability of trained labourers, non-availability of loan, poor egg quality, water scarcity and lack of hygiene were the main problems faced.

14. A higher per cent of women (87.5 per cent) were employed in sericulture and silk reeling units.

15. While daily purchase of cocoons was preferred, three days stock was most common. The prices of cocoons varied from Rs.60-90/kilogram.

16. Silk reeled/day ranged from 1 kilogram - 15 kilogram and fuel cost ranged from Rs. 10-70/day and the common by-products were degummed silk waste and throwers waste.

II. Role of women in sericulture

1. Findings regarding women entrepreneurs in silkworm rearing units revealed that 66 per cent of them were in the age group of 31-35 years.

2. Reasons for starting the unit included ambition for good future prospects, economic necessity, wanting to meet challenges in life and to achieve a better standard of living.

3. The land under mulberry cultivation was less than three acres among 92 per cent of the women sericulturists.

4. Non-availability of labourers was a major problem.

5. Only fifty per cent of the women entrepreneurs had solidly built sheds.

6. As the area of land increased number of women labourers employed also increased and the salary for women ranged from Rs.12-20 while for men it was Rs.20-25/day.

7. The quantity of eggs purchased, cost of production and the total production of cocoon/batch increased with an increase in the area of land.

8. Cocoons produced were generally good in quality and waste was used either for producing biogas or used as manure.

9. The most common diseases affecting silkworms in the egg stage were flacherie, grasserrie, muscardine and pebrienem. uzifly affected the silkworm itself.

10. Sixty per cent of the women entrepreneurs expressed that they need training in latest technologies related to silkworm rearing.

11. Maintaining cleanliness and non-availability of labour were repeatedly mentioned as problems. Changing climate, lack of adequate storage space, health problems and problems in transportation were the other problems mentioned by the women.

III. Findings on women entrepreneurs running silk reeling units

1. Reasons for starting the reeling units were similar to those stated by the sericulturists.

2. Procuring cocoons from the market was a big problem for the women, as bidding was adifficult task for them.

3. Size of the reeling units ranged from 6-12 basins, and there were more women working in the reeling units than men. Salaries of women ranged between Rs.25-30 while for men it was Rs.40-45/day.

4. Problems faced in running the reeling units were related to finance, labour, health, storage space, machinery, unskilled workers, transportation, marketing of silk yarn and domestic demands.

IV. Findings on women labourers in silk reeling units

1. Women of all ages starting from the age of 10 to 50 years were working as labourers and 66 per cent of them were not educated.

2. Reasons for taking up a job were to earn a living, achieve better standard of living and interest in the field.

3. About 63 per cent were satisfied with their wages and nature of work.

4. The activities carried out by labourers included sorting and grading, cooking, reeling, re-reeling, skeining, and bundling.

5. Thirty nine per cent of the labourers did not have any training while the others had some kind of training.

6. Seventy two per cent worked for about 8 hours a day while the rest worked for 9-10 hours a day and 20 per cent earned Rs.10-15 while 39 per cent earned Rs.21-25 and 15 per cent Rs.30/day.

7. The health problems faced by women reelers were allergy to smoke, skin irritation, headache, and physical exhaustion, work place being far away from home, no time for household work, and socializing, and inadequate wages were the other problems.

V. Reeling performance of the different reeling machines

Uniformity, general finish, colour of silk, lustre and hand were better fo. thc silk yarn obtained from the cottage basin.

Findings of the mechanical tests of the silk yarns, reeled from cottage basin and charkha, revealed that the samples obtained from cottage basin in the present study were better than the samples obtained from charka reeled with reference to winding breaks, size deviation, maximum deviation, average evenness, average low evenness, cleanness, average neatness, tenacity and elongation.

VI. Establishing and running a reeling unit

Establishing a reeling unit with 4 cottage basins revealed the fact that on the whole 580.2 kilogram of cocoons were purchased and Rs.77,259.45 was spent on cocoon and processing these cocoons. The quantity of silk produced was 42.67 kilogram which fetched Rs.42,047.00 resulting in a loss of Rs.35,212.45. This loss was mainly due to poor machinery, poorly trained labourers, price of silk yarn and limited working capital.

From these results and discussion the following recommendations emerged.

1. There is ample scope for expansion of sericulture in Coimbatore and acutal expansion would depend on proper management and availability of capital and trained workers.

2. Due to lack of adequate training for the workers, lot of silk is wasted, and hence institutions which give training must make sure that they train the candidates sufficiently, before certificates are issued. Field placement for a reasonable duration of time should be made compulsory. Training centres should become more active and produce well trained labourers.

3. The rearing of silkworms, and reeling of cocoons require reasonable capital expenditure and hence sericulturists and reelers must be aware of this financial requirements and be prepared to spend a big amount, to tide over varying situations.

4. It is imperative that government should take adequate steps to ensure that the reeling centres are located in close proximity to the silkworms rearing units so that transport problems could be minimized. Co-operative societies are required to improve the market structure, so that the bidding is avoided and silkworm rearers and reelers get a reasonable price.

5. Adoption of smoke free improved ovens for cooking is necessary to give relief to the workers. Providing burnol, codliver oil and ointments for accidental burns in reeling units is essential and should be made compulsory. Providing protective

equipment like goggles, gloves, slippers and apron wherever necessary will reduce the incidence of health problems.

6. While issuing licences for establishing new reeling units the government should insist on locating them outside the town limits and nearer to the sericulture farms.

7. Workers below 18 years should not be engaged as their health may be affected at that tender age.

8. Wage revision and uniformity in wages should be enforced so that migration from one place to the other can be avoided.

9. Good quality eggs should be reared and distributed to the sericulturists so that they are able to produce good quality cocoons.

10. Since most of the units obtained loan from the Sericulture Board, proper monitoring and timely assistance and guidance should be provided by the sericulture department so that the farmers or the reelers do not incur loss but make money out of the project.

11. The sericulturists and reelers should aim at improving the quality of silk produced so that we can compete with other countries in the international market.

Bibliography

BIBLIOGRAPHY

Alagumalai, K., Sheeba, C., Hep Shyba, C., Ramaraj, J. 1991 : Bran of pulses as an extra nurient to silkworm, Indian Silk, Vol.30, No.6, Pp.10-11.

Basu, P. 1994 : Bangles jingle while twisting the golden thread, Indian silk, Vol.32, No.11, Pp.11-13.

Bajpayi, C.M., Dubey, O.P., Thangavelu, K. 1993 : Tasar chawki rearing on bush plantation, Indian silk, Vol.31, No.11, P.26.

Benchamin, K.V. 1993 : Techno-economic aspects of mulberry cultivation and silkworm rearing, Indian silk, Vol.32, No.8, Pp.3-9.

Benchamin, K.V. 1987 : Silk egg handling, A hand book for sericulture extension workers, Pp.97-110, 116.

Bhandiwad, R. 1988 Effect of water on reeling silk quality, The Indian Textile Journal, Vol.3, No.6, P.11.

Bhargava, S.K., Rajalakshmi, E., Thiagarajan, V. 1994 : An evaluation index for silk yarn contributing traits in bombyx mori - silkworm selection, The Indian Textile Journal, Vol. CIV, No.11, P.84.

Bhat, G.G. 1991 : Quantitative generic analysis method for mulberry breeding programme, Indian silk, Vol.30, No.6, P.15.

Bheemanna, C. Hremath, P.C., Palakshappa, M.G., Govinda, R. 1990 : Powdery mildew of mulberry and its control, Indian silk, Vol.29, No.2, Pp.43-44.

Bidyapati, L., Nomani, M.K.R., Das, P.K. 1994 : Pest complex of oak tasar, Indian silk, Vol.33, No.3, P.44.

Bongale, V.D. 1990 : Mulberry varieties in the context of Indian sericulture, Indian silk, Vol.29, No.2, Pp.16-19.

Bongale, V.D. 1993 Fertility evaluation and fertilizer recommendation for mulberry garden soils, Indian silk, Vol.31, No.9, P.5

Chakravorthy, R. 1986 : Muga culture, Indian silk, Vol.XXV, No.3, Pp.17, 20.

Chakraborti, A., Sengupta, D. 1992 : A techno-economic appraisal for processing of silk waste, Textile trends, Vol.XXXV, No.2, P.31.

Chandrasekar, M., Thangavelu, K. 1988 : Soil amelioration techniques for mulberry cultivation, Indian silk, Vol.XXVII, No.6, P.13.

Charsley, S.R. 1994 : The Country Charkha, End of the road?, Indian silk, Vol.33, No.2, Pp.11, 16.

Chowdhury, S.K. 1990 : Improved charkha is an effective device for marginal reelers, Indian silk,Vol.29,29.3, P.31.

Choudhury, P.C., Das, P.K., Asisghosh, R.K., Mishra, R.K., Datta, R.K. 1993 : Recycling technology of sericultural waste as compost, Indian silk Vol.32, No.7, Pp.28-30.

CSTRI 1991 : Influence of Softened Water in Mulberry Silk Reeling, 4th edition, Pp.1-2.

Dandian, S.B. 1994 : Women in sericulture development issues, Indian Silk, Vol.33, No.5, Pp.15-20.

Dandin, S.B., Ramesh, S.R. 1987 : A Kalpa Vruksha Called Mulberry, Indian Silk, Vol. XXVI, No.6, P.50.

Das, S.K. 1984 : Silk reeling process, equipment and output Khandi Gramodyog, Journal of Rural Economy, Vol.XXX, No.4, P.188.

Das, B.C. 1986 : Mulberry breeding, Lectures on Sericulture, Bangalore, Surmya Publishers, P.19.

Das, P.K., Mathur, V.B. 1988 Problem confronting the expansion of Indian sericulture and their solution, Indian Silk, Vol.XXVII, No.2, P.5.

Das, S. 1989 Practices of bleaching Tussah silk, Indian Silk, Vol.XXVII, No.9, P.27.

Das, S. 1992 Role of sericulture in rural development of India, Textile trend, Vol.XXXV, No.7, P.39.

Das, S., Chowdhury, S.K. 1992 : Wet reeling - A new dimension in Tasar silk reeling, The Indian Textile Journal, Vol.CIII, No.3, P.98.

Datta, R.N., Majumder, S.K., Kar, R., Chinya, P.K. 1993 : Pupae-waste may be a source for amino acids preparation, Indian Silk, Vol.32, No.1, Pp.4-5.

De'Heireli, 1994 : Some personal thoughts from an advocate of women's promotion, Vol.32, No.11,Pp.9-10.

Devi, B. Sinha, R.K., Noamani, M.K.R. 1993 : Measures not for suggestion only; Indian Silk, Vol.32, No.5, P.3.

Devi, G.K.G. 1994 : Karnataka! A status report on women in sericulture, Indian Silk, Vol.32, No.11, Pp.31-38.

Dhandapani, G., Mukerji, R. 1994 : Poor women as entrepreneurs in sericulture - Myth or reality?, Indian Silk, Vol.32, No.11, P.39.

Dixit, M.D.
1990 : Sericulture and the production of silk fibres, filaments and Colourage, Vol.XXXVII, No.19, Pp.52,-54, 96-97.

Dixit, M.D.,
1990 : A glossaryof silk terminology, Colourage, Vol.XXXVII, No.18, Pp.44-51.

Dolli, S.S.,
Kalappa, H.K.,
Subramaniam, R.K.,
Chikanna.,
Singhvi, N.R.,
Sen, A.K.,
Iyengar, M.N.S.,
Datta, R.K.
1993 : Extent of adoption of improved sericultural practices by the sericulturists, Indian Silk, Vol.31, No.10, P.35.

Dorcus, D.,
Vivekanandan, M.
1991 : Simple biotechnological methods for production of good quality mulberry leaves, Indian Silk, Vol.30, No.5, P.19.

Gangwar, S.K.,
Thangavelu, K.,
Nagaraj.
1993 : Impact of mulberry spacing on silkworm crop performance, India Silk, Vol.31, No.11, P.24.

Gangwar, S.K.,
Thangavelu, K.
1994 : An overview of Sericulture in Tamil Nadu, Indian Silk, Vol.33 No.4, P.29.

Ghose, J.
Sengupta, A.K.
1993 : Muga post cocoon technology New Dimension, Indian Silk, Vol.31, No.9, Pp.13-15.

Gopalappa, D.V. 1993 : Decision making in sericulture, Indian Silk, Vol.32, No.6, Pp.61-12.

Govindaiah., Bhakuni. 1988 : Tukra disease of mulberry in tropical region, Indian Silk, Vol.XXVI, No.11, P.57.

Gregory, S., Pugazhendhi, P., Saraswathi, G. 1994 : Non-mulberry sericulture - transfer of technology through training, Indian Silk, Vol.32, No.11, P.51.

Gunasekhar., Govindaiah. 1993 : Monitoring of the mulberry disease, Indian Silk, Vol.31, No.10, P.10.

Gupta, S. 1990 : Tasar, wild and ethnic, Indian Silk, Vol.29, No.6, Pp.7-15.

Halliyal, V.G., Hadimani, V.V., Bhandiwad, R., Dandin, S.B. 1994 : Silk industry status, SWOT-analysis of Indian silk industry, The Indian Textile Journal, Vol.CIV, No.5, P.26.

Haran, S.P. 1992 : A note on development of silk processing (Reeling) Technology, Indian Silk, Vol.XXVII, No.2, Pp.25-27.

Kakati, A.K., 1993 : Diapause strain of muga silkworm - an alternative to boost up muga industry, Indian Silk, Vol.31, No.9, P.22.

Haran, S.P. : Problems related to the cooking of the cocoons and their reeling, Indian Silk, Vol.XXVII, No.3, P.55.
1988

Harriraj, G., Cocoon characteristics and silk quality, The Indian Textile Journal, Vol.CIII, No.12, P.22.
Ramesha, Y.S.,
Divakar Bhat, Y.,
Kiran Marali, B.
1993

Isa, Md., : North-West Sub-Himalayan belt A Potential zone for muga culture, Indian Silk, Vol.XXVII, No.2, P.7.
Thangavelu, K.
1988

Iyengar,M.N.S., Need for special extension drive for women sericulturists, Indian Silk, Vol.32, No.11, P.79.
Dollis.,
Chikkanna.,
Sen, A.K.
1994

Jacob, M., : Blending of mulberry silk with polyester and acrylic - silk blended fabrics, The Indian Textile Journal, Vol.CIV, No.6, P.48.
Latha, P.V.D.,
1994

Jayaswal, K.P., Some popular mulberry silkworm races in India, Indian Silk, Vol.31, No.9, p.50
Datta,R.k.
1993

Kakati, L.N., 1994 : Seed channelization of muga culture, Indian Silk, Vol.32, No.12, P.33.

Kannan, V.A. 1987 Women in silk industry, Indian Silk, Vol.XXVI, No. 1, P.37.

Kannan, V.A., 1988 : How defects can mar the silk fabrics/ frontline, Indian Silk, Vol.XXVII, No.8, P.29.

Kanyadi, N.M. 1989 : Sericulture in the hill areas of Karnataka, Encouraging past, Bright future, Indian Silk, Vol.XXVIII, No.3, P.23.

Kapila, M.K., Sahay,A. 1993 : Non-mulberry sericulture, Indian Silk, Vol.32, no.2, Pp.9-11.

Katti, M.R., Dobhadkar, D.R., Nigam, J.K. 1991 : Potential polymer-fibroin, Indian Silk, Vol.29, No.2, Pp.22-24.

Kim, B.H. 1989 Observation on raw silk reeling in India, Indian Silk, Vol.XXVIII, No.2, P.38.

Kothari, C.R. 1990 : Quantitative techniques, Vikas Publishing House Pvt. Ltd. P.30.

Krishnaswami, S. 1986 : Progress, prospects and problems of sericulture in India, Indian Silk, Vol.XXV, No.12 and 1, P.17.

Krishnaswami, S. 1990 : What ails our bivoltine silk production programme?, Indian Silk, Vol.29, No.1, Pp.6-14.

Kumar, A.K.K., Sanjay Pathak., Sambhulingappa, H.H. 1992 : Silk weaving - A review, The Indian Textile Journal, Vol.CIII, No.1, P.62.

Kumar A.K.K., Sambhulingappa, H.H., Sanjay pathak. 1993 Basic requirement in silk loom, The Indian Textile Journal,Vol.CIII, No.10, P.82.

Kumar, R.C. 1988 : Western ghats as a bivoltine region - prospects, challenges and strategies for its development, Indian Silk, Vol.XXVI, No.9, Pp.39-51.

Kumar, R.S., Vathsala, T.V. 1992 : Grainages in India, Indian Silk, Vol.32, No.7, P.7.

Kumar, A.K.H. 1992 Disinfection of the rearing house, The Indian Textile Journal, Vol.CIII, No.1, P.134.

Linda, M. Anand, S., Umashankar, V., Anand, S. 1992 : Women reeling labourers in Kollegal Taluk, Karatak, A statistical profile and some issues for comparative research, Indian Silk, Vol.31, No.3, Pp.5-10.

Madan, M., Sharma. 1992 Mulberry sericulture in the non-traditional areas, Indian Silk, Vol.30, No.6, P.35.

Magdi, S.P., Vijieendra, M.K., Hadimani, V.V., Mahadevappa, D., Patil, C.S. 1989 : Versatile, fashionable handicrafts from silk waste, Indian Silk, Vol.XXVII, No.12, Pp.47-49.

Mandal, S.K. 1993 : Effects of water, temperature and pollution on mulberry, Indian Silk, Vol.32, No.3, Pp.21-22.

Mathur, S.K. 1987 : Cocoon based handicrafts - An additional source of income, Indian Silk, Vol.XXVI, No.5, P.33.

Mathur, S.K., Kumar, K.C.M., Prammanik, D.R., Mukerjee, P.K., Rao, S.G. 1989 : Influence of ecological conditions of different locations on silkworm spinning (Bombyx mori, L.), Indian silk, Vol.XXVII, No.11, Pp.17-19.

Mathur, S.K., Kumar, K., Rao, S.G., Singh, B.D, Lall, S.B. 1992 : Hot water treatment to break diapause in silkworm eggs, the Indian Textile Journal,Vol.CIII, No.2, P.46.

Mattigatti, R., Dolli, S. Iyengar, M.N.S. 1994 : Scope for 'Anand type' co-operatives in sericultures, Indian Silk, Vol.32, Vol.32, No.10, P.25.

Mayoux, L.C. 1992 Between quality and equitey : Policy options for development, Indian Silk, Vol. 30, No.10, P.7.

Mayoux, L.C., Anand, S., Uma Shankar, V. 1992 : Women reeling labourers in Kollegal Taluk, Karnataka, A statistical profile and some issues for comparative research, Indian Silk, Vol.31, No.3, P.5-10.

Mayoux, L.C., Anand., 1992 : A success story : Basin reelers of silkupura, Indian Silk, Vol.30, No.10, Pp.14-15.

Mishra, S.N. 1989 : Cocoon deflossing : An important operation before silk reeling, Indian Silk, Vol.XXVII, No.9, Pp.39-41.

Mishra, S., Dash, M.C. 1992 : Utility of sericultural wastes and by-products in agriculture, Indian Silk Vol.31, No.7, P.39-40.

Mishra, R.K., Chowdhury, P.C., Ghosh, A., Singh, G.B., Datta, R.K. 1993 : Cultivation technology for chawki mulberry garden, Indian Silk, Vol.31, No.12, P.11.

Mouillard, R. 1988 Only silk deserves to touch your skin, Indian Silk,Vol.31, No.11, Pp.11-16.

Nadiger, G.S. 1988 : Influence of Sericin Content on the Tensile Properties of Silk Yarn, Scientific paper abstracts, New Delhi, Central Silk Board, P.66.

Nadiger, G.S. 1994 : Women entrepreneur development in silk reeling, Indian Silk, Vol.32, No.11, Pp.65-62.

Nagaraj, B., Ramesh Babu, M., Bhargava, S.K., Thiagarajan, V. 1994 : Pruning - A beneficial hazard to mulberry, Indian Silk, Vol.33, No.1, P.36.

Nagarajan, P., Radha, N.V. 1990 : Supllementation of amino acids through mulberry leaf for increased silk production, Indian Silk, Vol.29, No.4, P.21.

Naik, S.V., Hariraj, G., Lakshmi Pathaiah, B.N., Someshekar, T.H. 1994 : Reeling performance and raw silk quality traits - Bivoltine hybrid cocoons, The Indian Textile Journal, Vol.CIV, No.7, P.20.

Nalankilli, G. 1992 : Enzymatic degumming of silk, Indian Textile Journal, Vol.C,III, No.3, P.110

Nanavathy, M.M., 1990 : Silk Production, Processing and Marketing, New Delhi, Johir, V.S, Willey Eastern Limited, Pp.2,5,96,157 and 164.

Nandi, S., Banerjee, K. 1992 : Management of Adoption Practices, Indian Silk, Vol.31, No.5, P.17.

Narayana, A.S.R. 1986 : Silkworm Rearing - The present practices, Lecture on Sericulture, Bangalore, Suramya Publishers, Pp.51-59.

Narayana. 1986 : Modernisation of silk reeling in China, Indian Silk, Vol.XXVI, No.3, P.31.

Narayana, J.H.S., Shankar, A.G., Bhandiwad, R., Halliyal, V.G. 1994 : Queen of textiles - Indian sericulture and silk industry: An overview, The Indian Textile Journal, Vol.CIV, No.8, Pp.58-65.

Narayanaswamy, K.C., Bhat, G.G., Reddy, D.N.R., Vijajendra, M. 1990 : Women behind the silk fabric, Indian Silk, Vol.29, No.3, Pp.23-24.

Pandey, R.K. 1990 : Why oak tasar cocoon is to reel, Indian Silk, Vol.29, No.4, P.32.

Parthasarthy, B. 1994 Karnataka : Hopes galore, Indian Silk, Vol.32, No.11, Pp.15-18.

Pasha, M.M. 1988 : Sericulture research in India - The CSB leads the way, Indian Silk, Vol.XXVII, No.6, Pp.21-25.

Periasamy, K., Radhakrishnan, S. 1986 : Silk Through the ages, lectures on sericulture, Bangalore, Suramya Publishers, P.1.

Philip, T. 1990 : And now, an artificial diet for silkworm, Indian Silk, Vol. XXVIII, No.9 P.39.

Pradhan, P.K., 1994 : West Bengal : Recognition to women in the Offing, Indian Silk, Vol.32, No.11, P.27.

Prasad, S.K., Rao, S.M., Benjamin, D.A.I. 1988 : The mounts that surmount the factor, Indian Silk, Vol.XXVII, No.2, P. 48.

Premchander, S. 1994 : Management training needs for women cooperatives, Indian Silk, Vol.32, No.11, P.58.

Radha, T.M. 1994 : Sericulture technology for rural women, Indian Silk, Vol.32, No.11, P.39.

Ramakrishna, T.K. 1989 Economics of silk reeling, Indian Silk, Vol.XXVII, No.9, Pp.23-24.

Ramesha, M.N. 1993 : ICTRETS : 111 Orientation Programme, Indian Silk, Vol.32, No.8, Pp.17-18.

Raju, S.C., Thangarajan, V., Reddy, V.G., Suryanarayana, I., Tork, P., Pallavi, S.N. 1990 : Refrigerating the female moths of Mulberry silkworm, An experiment, Indian Silk, Vol.XXVIII, No.9, P.17.

Rangaswami, G., Narasin, N.N., Kasivishwanathan, K., Shastry, C.R., Manjeet, J.S. 1988 : Moriculture - Sericulture Manual I Ranchi, Oxford and IBH Publishing Company, P.42.

Rao, N.H.A., Mangannvar, R., Nadigar, G.S. 1987 The moisture regain of raw silk, Indian Silk, Vol.XXVII, No.6 Pp.48-53.

Rao, S.M.K. 1994 : Sericulture extension and women in sericulture, Indian Indian Silk, Vol.33, No.4, Pp.35-39.

Rao, K.J.V., Kumar, P.T. 1993 Silkworm crop insurance, Indian Silk, Vol.31, No.41, Pp.11-16.

Rao, N.P.P., Ranganath, B.K., Chandrasekhar, M.G. 1991 : Remote sensing applications in sericulture, Indian Silk, Vol.30, No.4, P.7.

Rayaredder, F.R., Kumar, A.K.K., Pathak Sanjay, Shambulingappa, H.H., Nagabhushanaiah, Y.V., Sonwalkar, T.N. 1993 : Raw, Partially degummed and fully degummed silk, The Indian Textile Journal, Vol.CIII, No.4, P.70.

Reddy, K.S.S., 1994 : Women - The strength of sericulture, Indian Silk, Vol.XXXII, No.9, Pp. 3-7.

Reddy, D.N.R., Kotikal, Y.K. 1988 : Pests of mulberry and their management, Indian Silk, Vol.XXVI, No.11, P.9.

Reddy, M.M., Sinha, A.K., Subbaswamy, M.R. 1993 : Methods of fertilizer application in mulberry gardens, Indian Silk, Vol.32, No.6, Pp.13-14.

Reddy, D.K., Bajpeyi, G.M., Thangavelu, K. 1993 : The worm, the cocoon and the silk, Indian Silk, Vol.32, No.5, P.7.

Reddy, D.N.R., Kotikal, Y.K., Nagalakshmamma, K. 1987 : Scope for Ericulture in Karnataka, Indian Silk, Vol.XXVI, No.7, P.34.

Roy, S., Chowdhury, S.K., Bhatt, P.N. 1993 Is production of good quality Raw Silk with Indigenous cocoons uneconomical, Indian Silk, Vol.32, No.7, Pp.39-43.

Sadhu and Singh 1986 : Research Methodology in Social Sciences, Himalaya Publishing House, P.127.

Sahay, A., Thangavelu, K. 1993 Marketing in tasar industry, Indian Silk, Vol.32, No.5, P.51.

Saluja, N., Madan, M., Vasudevan, P. 1993 : Physical and chemical properties of mulberry, tasar and eri silk fibres, Indian Silk, Vol.31, No.9, P.35.

Samson, M.V., Chandrasekaraiah., Singh, T. 1994 : Seri-post cocoon transcription and deflosing, Indian Textile Journal, Vol.CVI, No.4, Pp.22-25.

Sanne, S., Ramesh, C.K., Prabhu, J., Nadiger, G.S., Someshekar, T.H. 1994 : Role of water in filature reeling - silk reeling, The Indian Textile Journal, Vol.CIV, No.10, P.38.

Saratchandra, B. 1988 : Cutworm, a new mulberry, Pest and its control, Indian Silk, Vol.XXVI, No.9, P.14.

Sharma, P.C., Boriah, P., Bordoloi, 1993 Vegetative propagation of mulberry Indian Silk, Vol.32, No.1, P.37.

Satpathy, B., Raja, U., Ghosh, P.L. 1991 : Azotobacter in mulberry cultivation, Indian Silk, Vol.30, No.6, P.32.

Sengupta, K. 1990 : Problems of developing sericulture in the new areas and how to over come them, Indian Silk, Vol.XXVII, No.5, Pp.7-9.

Shah, A.M., 1993 : Cost return analysis of sericulture in Kashmir, Indian Silk, Silk, Vol.32, No.5, P.47.

Shamachary, 1987 : Stifling methods suited to our cocoons and reelers, Indian Silk, Vol.XXVI, No.7, Pp.22-23.

Shashikala, S. 1994 : The status of women in charkha silk reeling, Indian Silk, Vol.32, No.11, Pp.73-78.

Shekar, P. 1994 : My experience as a sericulture consultant, Indian Silk, Vol.32, No.11, Pp.47-50.

Siddaramaiah, B.S., Kumar, P.R. 1994 : Adoption of improved sericultural practices by big and small farmer, Indian Silk, Vol.33, No.4, P.5.

Siddiqui, A.A., Ram, R., Sengupta, A.K., 1993 : Eri- A common Man's silk, Indian Silk, Vol.32, No.4, Pp.34-36.

Singh, T., Mathur, S.K. 1990 : Are heavy doses of chemical fertilizers profitable? Indian Silk, Vol.29, No.3, P.29.

Singh, K. 1991 : Manuring and fertilizers for mulberry cultivation, Indian Silk, Vol. 26, No. 8 Pp.31-35.

Sinha, R.K., Vathsala, T.V. 1993 Grainages in India, IndianSilk, Vol.32, No.7, P.7.

Singh, T., Singh, K., Das, M. 1992 : Astounding effect of correlated parameters in Silk industry, The Indian Textile Journal, Vol.CII, No.12, Pp.26-30.

Somasekhar, T.H. 1985 Post cocoon technology, IndianSilk, Vol.XXIV, No.6, 7, and 8, P.31.

Sonwalkar, T.N. 1985 : Silk Reeling and Handicrafts, Bangalore, CSTRI, P.103.

Sonwalkar, T.N. 1986 : Silk Reeling and Raw Silk Testing, Lectures on Sericulture, Bangalore, Suramya Publishers, P.221.

Sonwalkar, T.N. 1986 : Silk Reeling Technology in India, Lecures on Sericulture, Bangalore, Suramya Publishers, Pp.205, 207.

SOMASHEKAR, T. H. 1994 Reeling in India - Challenges Ahead, Indian Silk, Vol. 33, No. 6. PP. 40-42.

Sonwalkar, T.N. 1987 : Improved reeling charkha and spinning wheel towards rural industrialisation, Indian Silk, Vol.XXV, No.12, Pp.52-55.

Sonwalkar, T.N. 1991 : Manual for Reelers, Ministry of Textiles, CSTRI,PP.3-7.

Sonwalkar, T.N., Roy, S., Vasumathi, B.V. 1992 : Effect of cleanness defects of raw silk on tenacity and elongation, Indian Journal of Fibre and Textile Research, Vol.17, No.2, Pp.77-79.

Subbaswamy, M.R., Reddy, M.M., Sinha, A.W. 1993 : Nutrient depletion in mulberry gardens, Indian Silk, Vol.32, No.4, Pp.21-22.

Sudhakar, R., Tikader, A., Sen, S.K. 1992 : Trained man power resources and their impact on silk production, Indian Silk, Vol.30, No.9, P.7.

Sundaramurthy, T.S., Narasingh, K.A.L. 1990 : The silk cocoons - Speaking of silk, Indian Silk, Vol.29, No.5, Pp.28-30.

Sundaramurthy, T.S., Narasingh, K.A.L. 1991 : Definitions of technical terms pertaining to reeling, Indian Silk, Vol.XXX, No.1, P.47.

Sundaramurthy, T., Narasingh, K.A.L. 1990 : Cocoon testing and classification, Indian Silk, Vol.29, No.8, Pp.17-20.

Suryanarayana, N. 1993 : Integrated nutrient supply system for mulberry, Indian Silk,Vol.32, No.2, P.5.

Sundareswaran, P., Subbarayappa, C.T., Subbaswamy, M.R., Sinha, A.K. 1993 : Reclamation of acidic soil by appropriate fertilization, Indian Silk, Vol.31, No.11, P.9.

Tayade, D.S., 1991 : Sericulture in Maharashtra; Challenges and solutions, Indian Silk, Vol.30, No.5, Pp.29-31.

Tewari, S.K., Gwynn, T.A., Kumar,N.S., Kumar, U. 1991 : Sericultural research beyond human eyes, Indian Silk, Vol.30, No.4, p.28.

Thangavelu, K. 1986 Sercigenous flora of North Eastern India, Lectures on Sericulture, Bangalore, Suramya Publishers, P.126.

Thomas, P.S., 1993 : Is sericulture a new boon for women in development paradigm, Indian Silk,Vol.32, N.2, P.1.

Thangamuthu, C., Venkataravi, R. 1991 : Cocoon market structure and price behaviour in Tamil nadu, Indian Silk, Vol.30, No.7, PP.7-10.

Thangavelu., Thiagarajan, V., Babu, R.M., Bhargava, S.W., Nagaraj, 1993 : A new economic method to fix the floor price for silk cocoons, The Indian Textile Journal, Vol.CIV, No.2, P.42.

Thiagarajan, V., Masilamani, S., Babu, R.M., Chauhan, T.P.S., 1994 : Market impact on sericulture - Cocoon price trends and its impact on bivoltine sericulture, The Indian Textile Journal, Vol.CIV, No.10, P.60.

Thimmaiah, G., Nagabhushana, C.S. 1986 : Silk exports, past performance and future prospects, Indian Silk, Vol.XXV, No.12 and 1, P.29.

Uthaman, V.R. 1988 : Silk, The ultimate solution is increasing the productivity, Indian Silk, Vol.XXVI, No.9, P.7.

Vasumathi, B.V., Sonwalkar, T.N., Lakshmipathiah, B.N. 1986 : Assessment of Cocoon Quality Under Indian Condition, Bangalore, CSTRI, P.8.

Venkataravi, R. 1992 : Alternative strategies for raw silk supply in Tamil Nadu, Indian Silk, Vol.30, No.10, Pp.38-49.

Venkatesh, M., Chinnaswamy, K.P. Raju, M., Devalah, M.C. 1993 Mulberry for environmental food sercurity, Indian Silk, Vol.31, No.12, P.34.

Ven ugopal, B.R. 1991 : Silk - Queen of textiles, : Colourage XXXVIII, NO.1, Pp.46-47.

Vijayeendra, M.K., Hadimani, V.V. 1993 : A study on the influence of process parameters on the strength of silk, The Indian Textile Journal, Vol.CIV, No.2, P.78.

ADDENDUM

Acharya, J., Govindarajn, K.V., and Saraswathi, G. 1992 — Silk reeling in Tamil Nadu - Problems and Prospects - A study of Dharmapuri' - A beneficiary assessment report, De. 1992. Institute for social and Economical Change. DOC ISEC/BA/029

Inbanathan, A. and Vijayalakshmi, V. 1994 — Oganising the Unorganised Gender Analysis of Women in sericulture households. A study in Tamil Nadu - A beneficiary assessment report, 1994. DOC. No.ISEC/ BA/054. P.3.

Parathasarathy, V.S. and Sundaravalli 1994 — NGO's and Sericulture Development A case study of Andra Pradesh. A Beneficiary Assessment report Dec. 1994 DOC No ISEC/BA/056/P.4.

Parathasarathy V.S. and Gregory, S. 1994 — NGO's and Sericulture Development . A case study of Tamil Nadu. A beneficiary Assessment Report, Dec. 1994 DOC No ISEC/BA/056 P.56.

Pasha, H.M.M. 1994 — Tamil Nadu : Future is bright, Indian Silk, vol.32, No.11, P.25.

Pugazhendi, P. 1994 — Productivity in sericulture. A study on three clusters in Tamil Nadu. A beneficiary Assessment Report, Dec. 1994 DOC. No ISEC /BA/052/ P.10

Singh, T., Singh, K., Das, M. 1992 — Astounding effect of Correlated parameters in silk Industry, The Indian Textile Journal, Vol. CII, No.12, Pp.26-30.

Appendices

APPENDIX - I

SCHEDULE A

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING CULTIVATION OF MULBERRY AND PRODUCTION OF COCOONS

1. Name of the investigator :

2. Name and address of the sericulture :

3. Type of the family

   1. Joint :

   2. Nuclear :

4. Details about the family :

S. No.	Name of the member	Relation to head of family	Marital status	Age in years	Educational qualification	Occupation	Income per month

Source of income	Amount per month
a. Business	
b. Building	
c. Agriculture	
d. Any other	
Total	

5. What factors motivated you to do silkworm rearing?

   a.

   b.

   c.

6. Are you doing a large-scale production or small-scale production?

7. How many members are working at your farm?

   Men : Women :

8. What are the probems you face during production?

9. Details about mulberry farm

a. Type of farm		Area in acres
i.	Small	2
ii.	Marginal	2-5
iii.	Big	5

b. i. Red

ii. Black

iii. Any other

c. Number of prunings done in a year

i. Once

ii. Twice

iii. Thrice

iv. Four times

d. Do you use fertilizers for your crop?

Yes ☐ No ☐

e. If yes, state the fertilizers used

i.

ii.

iii.

iv.

f. Do you use pesticides to control pests?

Yes ☐ No ☐

g. If yes, name the pesticides used

i.

ii.

iii.

iv.

v.

10. Details about silkworm rearing

a. i. Space in square feet

ii. Type and amount spent

S.No.	Type	Amount (in Rs.)
1.	Strongly built	
2.	Mudwall with thatched roofing	
3.	Any other	

b. Methods used with other details

S.No.	Types	Number of racks	Number of people working		Wages	
			Male	Female	Male	Female
1.	Shelf rearing					
2.	Shoot rearing					

11. Do you get help from the sericulture department for transportation of cocoons to the market?

Yes ☐ No ☐

12. If no, how do you manage?

13. What is the yield of cocoons per month in kg?

14. Are you satisfied with the quality of cocoons?

Yes ☐ No ☐

15. From where do you get the egg sheets?

Place: Frequency of purchase :

16. What is the total cost of production till the cocoon stage?

17. Suggestions for better yield

APPENDIX II

SCHEDULE B

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING REELING CENTRES

1. Name and address of the reeler :

2. Date of establishment of the unit :

3. What motivated you to take up silk reeling? :

(Private units only)

a. Interest :

b. Tradition :

4. What is the wage per day? :

	Private unit	Government unit
Male :		
Female :		

5. Number of basins installed :

6. Total number of labourers engaged :

	Wage/day	
	Private unit	Government unit
Male :		
Female :		

7. Frequency of cocoons purchased and price per kg

S.No.	Frequency	Price/kg
1.	Daily	
2.	Fortnightly	
3.	Three times a week	

8. How much silk do you reel per day?

9 Give the fuel cost per day

10. What are the problems you face during reeling?

11. What are the by-products you get after reeling process?

12. Give your suggestions for improving silk reeling

13. Details regarding investment of money

Particulars	Cost in rupees
Building	
Water tank	
Basin	
Re-reeling machine	
Other accessaries	
Cooking vessels	
Cleaning stand	
Bundling machine	
Skein making machine	
Denier scale	
Single epprovette	
Water cane	
Cocoon storage stand	
Trays	
Hot air oven	
Motor	
Re-reeling motor	
Total cost	

APPENDIX III

SCHEDULE C

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE STUDY OF WOMEN ENTREPRENEURS IN SILKWORM UNIT

1. Name of the investigator :
2. Name of the entrepreneur : Age in years
3. Educational qualification :
4. Address of the unit
5. Give the details regarding your family background

S. No.	Name of the member	Relation to the interviewee	Age in years	Education	Occupation	Income in Rs.

6. Source and purpose for loan taken
7. Reasons for starting the unit
8. Details regarding mulberry cultivation

S. No.	Acre of land	Water	Soil	Fertilizer	Pesticides

9. What are the problems faced in mulberry cultivation?

10. Details regarding the shed, employees and their salary

S.No.	Regarding the shed		Employees		Salary in Rs.	
	Type	Number	Men	Women	Men	Women

11. Is the quality of cocoon produced in your unit good or poor

12. Details regarding the cocoon by products

    a. Double cocoon

    b. Degummed waste

    c. Silk waste

    d. Jelly

    e. Throwers waste

    f. Any other

13. What are the diseases that affects silkworm production?

14. What are the problems faced by sericulturists? Give reasons

i. Finance

ii. Poor quality cocoons

iii. Space and feeding problem

iv. Scientific methods

v. Cleanliness

vi. Labour

vii. Climate

viii. Health problems faced by the entrepreneur

15. What are the problems faced in marketing and transportation?

16. Give details regarding trasportation

17. What are the domestic problems faced by the entrepreneurs?

APPENDIX IV

SCHEDULE D

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE STUDY OF WOMEN ENTREPRENEURS IN SILK REELING

1. Name of the investigator :

2. Name of the entrepreneur : Age in years :

3. Educational qualification :

4. Address of the unit :

5. Give details regarding your family background

S. No.	Name of the member	Relation to the interviewee	Age in years	Education	Occupation	Income in Rs.

6. Source and purposes for loan taken

7. Give details regarding your unit

S. No.	Reasons for starting the unit	Year and date of starting the unit	Size of the unit number of basins installed	Mode ownership	Rented the amount spent as rent per month	Total amount invested	Area utilised

8. Give details regarding raw material

S. No.	Raw material procurement access to market/transportation charges	Place of purchase	purchaser price/kg	Quantity purchased	Frequency purchase	Method of storage

9. What fuel and water used for cooking cocoons

10. Details regarding employees and their salary

Number of basin	Employees		Salary per day in Rs.	
	Men	Women	Men	Women

8. Give details regarding raw material

S. No.	Raw material procurement access to market/transportation charges	Place of purchaser purchase price/kg	Quantity purchased	Frequency purchase	Method of storage

9. What fuel and water used for cooking cocoons

10. Details regarding employees and their salary

Number of basin	Employees		Salary per day in Rs.	
	Men	Women	Men	Women

11. Problem faced in the reeling unit

i. Money

ii. Smoke from fuel

iii. Labour and health problems

iv. Storage

v. Mechanical problem

vi. Unskilled worker

vii. Marketing

viii. Transportation

12. Problems faced in silk selling markets give reasons

13. What are the domestic problems faced by the women entrepreneurs?

APPENDIX V

SCHEDULE E

INTERVIEW SCHEDULE TO ELICIT INFORMATION OF THE STUDY OF WOMEN LABOURERS IN SILK REELING UNITS

1. Name of the investigator :

2. Name and address of the interviewee

   Age in years :

   Educational qualification :

3. Marital status :

4. Give details regarding your family background

S. No.	Name of the member	Relation to the interviewer	Age in years	Education	Occupation		Income in Rs	
					Before	Now	Before	Now

5. Give details regarding your job

S. No.	Reasons for taking up the job	Total years of service	Whether govt. or private	Satisfaction from salary power
		a. Below 5 years b. 6-10 years c. 11-15 years d. 16-20 years e. Above 20 years		a. HS b. S c. DS d. No reply

HS. Highly satisfied DS. Dis satisfied
S. Satisfied

6. Give details regarding the activities done by you

a. Activities

a. Sorting and grading

b. Cooking

c. Reeling

d. Re-reeling

e. Skeining

f. Bundling

b. Did you undergo any trainings? Yes ☐ No ☐

Ifyes, give the following details

S. No.	Training under-gone	Duration of training	Money spent self sponsor Rs.	Amount of money spent Rs.	Contents learnt

7. Give details regarding the following

S. No.	Days of work per month	Hours of work/day	Timings		Wages per/ day Rs.	Shifts		Work load			Over	
			Regul-ar	Irr-regular		Yes	No	Excess	Moderate	Sedantary	Same	More

8. Do you seek help from your male collegues for completing the worki? Yes ☐ No ☐

9. What are the problems you face?

   a. Allergy towards smoke

   b. Skin irritation

      i. Beginning

      ii. Persistant

   c. Inadequate wages/salary

   d. Stress

   e. Headache

   f. Physical exhaustion

   g. Travelling

10. What measures have you taken to solve your problems?

11. Do you seek help from your male collegues for completing the work? Yes ☐ No ☐

12. Do you find it difficult to combine your duty at workplace with your domestic obligation Yes ☐ No ☐

13. If yes to what extent?

    a. Very much

    b. Much

    c. To some extent

14. What is the attitude of your family members towards your job?

	Favourable	Unfavourable	Indifferent
a. Children			
b. Husband			
c. In-laws			
d. Parents			
e. Relative/friends			