Shri R.L.T. College of Science, Akola, Maharashtra

Department of Zoology

E- Certificate Course in Sericulture from 11th -14th May 2020

History or Origin of Silk Fabric

Silk is a natural protein fibre produced by mulberry silkworm which is used for textile manufacturing. Silk fiber has a triangular prism-like structure which allows silk cloth to refract incoming light at different angles and with that to produce different colours.

History of silk began in the 27th century B.C. in China where it remained in sole use until the commercial ways appeared from China to the Mediterranean Sea. There is also evidence of silk dating between 4000 and 3000 BCE. During the latter half of the first millennium BC, Silk Road opens and silk starts to spread the world. Cultivation of silk spread to Japan somewhere around 300 CE while by 522 the Byzantines managed to obtain silkworm eggs and were able to begin silkworm cultivation of their own. In time Chinese lost their secret to the Koreans and later the Indians.

In China, only women farmed silk worms. Many women were employed on the farms of silkworms. Silk was considered a luxury item and silk became very popular among high society. Popularity was such that laws were made to regulate and limit use of silk to the members of the imperial family. That rule stayed in power for over millennia. In time other classes of Chinese society were allowed to wear silk.

Mulberry Cultivation

Mulberry foliage is the only food for the silkworm (Bombyx mori) and is grown under varied climatic conditions ranging from temperate to tropics. Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area has a direct bearing on cocoon harvest. In India, most states have taken up sericulture as an important agroindustry with excellent results. The total acreage of mulberry in India is around 282,244 ha.

Climatic Conditions: Mulberry thrives under various climatic conditions ranging from temperate to tropic located north of equator between 28° N to 55°N latitude. The ideal range of temperature is from 24-28°C. It grows well in places with annual rainfall ranging from 600mm to 2500mm. In area with low rainfall, the growth is limited due to moisture stress resulting in low yields. On an average mulberry requires 85,000 gallons of

water per hectare once every 10 days in case of loamy soils and 15 days in clayey soils. The atmospheric humidity in the range of 65-80% is ideally suited for mulberry growth. Sunshine is one of the important factors controlling growth and leaf quality. In tropics, mulberry grows with a sunshine range of 9.0 to 13.00 hours a day. Mulberry can be cultivated from sea level up to an elevation of 1000 m above mean sea level.

Soil Condition: Mulberry flourishes well in soils which are flat, deep, fertile, well drained, loamy to clayey, porous with good moisture holding capacity. The ideal range of soil pH is 6.2

to 6.8. The optimum pH required for mulberry is 6.5 to 6.8. Soil amendments may be used to correct the soil to get required p H. The quantity of gypsum or lime to be applied in different cases are as mentioned below: Soil amendments: (To be taken up after soil test) PH range (To bring pH to 6.8) Quantity of gypsum/ha 7.4 to 7.8 2.0 MT 7.9 to 8.4 5.0 MT 8.5 to 9.0 9.0 MT 9.1 to above 14.0 MT


Species and varieties under cultivation in india:

There are about 68 species of the genus Morus, the majority of them occur in Asia, especially in China (24 species) and Japan (19). Continental America is also rich in its Morus species. The genus is poorly represented in Africa, Europe and Middle East, and it is not present in Australia. In India, there are many species of Morus, of which Morus alba, M. indica. M. serrata and M. laevigata grow wild in the Himalayas. Several varieties have been introduced belonging to M. multicaulis, M. nigra, M. sinensis and M. phillippinensis. Most of the Indian varieties of mulberry belong to M. indica.

Mulberry is a fast growing deciduous woody perennial plant. It has a deep-root system. The leaves are simple, alternate, stipulate, petiolate, entire or lobed. Number of lobes varies from 1 to 5. Plants are generally dioecious. Inflorescence is catkin with pendent or drooping peduncle bearing unisexual flowers. Inflorescence is always auxiliary. Male catkins are usually longer than the female catkins. Male flowers are loosely arranged and after shedding the pollen, the inflorescence dries and falls off. Number of parianth lobes are 4. Number of stamens are 4 and implexed in bud. Female inflorescence is usually short and the flowers are very compactly arranged. Number of parianth lobes are 4 and persistent. Ovary is one-celled and stigma is bifid. The chief pollinating agent in mulberry is wind. Fruit is a sorosis and the colour of the fruit is mainly violet black. Most of the species of the genus Morus and cultivated varieties are diploid having 28 chromosomes. However, triploids (2n=(3x)=42) are also extensively cultivated for their adaptability, vigorous growth and quality of leaves.

Mullbery Plantation:

Nursery for raising mulberry saplings:

Salient features:

- Well drained land with loamy soil is ideal for nursery
- The land to be ploughed or dug 30-40 cm deep
- Allow for weathering in sun for 2-3 weeks
- Prepare beds of size of 300 cm x 120 cm
- Provide irrigation channels of 25-30 cm width & 20 cm depth
- Treat the cuttings with 0.2% Bavistin solution for 10-15 min
- Plant cuttings at 8 cm distance in rows 20 cm apart
- Irrigate immediately after planting and then once in 4-5 days
- Apply chemical fertilizer after 55-60 days
- Use 3-4 months old saplings to establish plantation
- In nurseries saplings get established quickly and grow vigorously and ensures uniform growth.

Do's:

- For clayey or black cotton soil, add sand to beds
- Select healthy, 6-8 months old 10-15 mm thick cuttings

Don't's:

- Don't use stout lower and tender-green portion of shoots
- Tukra or scale infested cuttings should not be used.

Mulberry cultivation for late age silkworm rearing:

Salient features:

- Cultivate mulberry in spacing of 90 cm x 90 cm or in paired rows [(150+90)x60 cm/ (5'+3')x2']
- Apply 20 MT of farm yard manure/ha/year in two splits and NPK @ 350:140:140 kg/ha/year in five splits in the form of straight fertilizers
- V1 and G4 are suitable for late age silkworm rearing
- Expenditure: ` 20000/- per acre § Cost benefit ratio: 1:3
- Harvest leaves as per schedule for maximum utilization of quality leaf
- Do not allow the leaves to over mature

Pruning and Training of Mulberry:

Salient features:

- stump to maintain ideal shape
- Facilitates uniform growth of entire plantation and allows mechanized inter-cultivation activities
- Uniform growth results in reduction in diseases and improved productivity

Establishment of plantation and stump development:

- Plant healthy saplings and prune at a height of 15 cm from the ground
- Allow plant to grow for six months without leaf harvest, and take up first rearing by leaf picking

- Later select 3 strong & healthy shoots in each plant and prune at a height of 25cm from the ground
- After every rearing, cut all shoots at a height of 30 cm from the ground and remove the weak and dry branches.
- Maintain only 10-15 healthy shoots/plant

Do's:

- Maintain 10-15 healthy shoots/plant by removing weak shoots
- Use sharp secateures for pruning
- Thin out all weak shoots between 30-40 days of pruning
- Stump development is useful for mechanized pruning using bush cutters

Dont's:

- Do not prune plants at ground level, while pruning with machines
- Do not allow more than 15 shoots/ plant

Mulberry cultivation package for young age silkworms:

Salient features:

- Cultivate mulberry in spacing of 90 cm x 90 cm or paired rows [(150+90)x60 cm/ (5'+3')x2']
- Apply 40 MT of farm yard manure/ha/year and NPK @ 260:140:140 kg/ha/year in eight splits in the form of straight fertilizers
- Adopting top clipping method of training (alternate harvesting of leaves and shoots) 30 MT/ha/year of quality leaves for rearing young age silkworms can be produced
- S36, V1 and G2 are suitable for young age silkworm rearing
- Provides quality leaves for rearing young age silkworms
- Expenditure: 20,000/- per acre
- Cost benefit ratio: 1:3 `

Do's:

- Harvest leaf as per schedule for maximum utilization of quality chawki leaf
- Usage
- Mulberry cultivation package for young age silkworms
- Provides quality leaves for rearing young age silkworms

Don't :

- Do not allow the leaves to over mature.

Package for tree mulberry cultivation:

Salient features

- Choose S-13 mulberry variety and plant with a spacing of 2.4 m x 2.4 m. Maintain crown height of plants at 150 – 180 cm, and provide fertilizer @ 50:25:25 kg/ha/year of NPK under rainfed conditions
- Grow green manure crops during rainy season for improving the soil fertility

- The trees yield mulberry leaves @ 6–7 MT/ha/ year
- Mulberry leaves can be harvested 4 times in a year
- Full productivity would be reached after three years
- Expenditure: 20,000/- per acre
- Cost benefit ratio: 1:1.6 `
- Suitable for water deficit or low soil moisture conditions.

Do's:

- Use water efficient mulberry varieties.

don'ts:

- Do not plant with closer spacing.

References:

R. K. Datta: Mulberry cultivation and utilization in India, Central Sericultural Research and Training Institute, Central Silk Board, Sirampura, Mysore-570008, India.

Text Book of "Commercial Chawki Rearing" by V Sivaprasad, M T Himantharaj, Satish Verma and T Mogiti, November 2015

Silkworm Biology

Systematic Position

Class: Insecta
Order: Lepidoptera
Family: Bombycidae
Genus: Bombyx,
Species: B. mori

Stages of life cycle

The domestic silkmoth, *Bombyx mori*, is a member of the family Bombycidae of about 300 moth species under the order Lepidoptera. The life cycle of silkworm represents the most advanced form of metamorphosis. Termed holometabolous, the silkworm completes life cycle through serial progression of four distinct stages of development; egg, larva, pupa and adult. The number of life cycles (generations, which is termed as voltinism) per year depends on the silkworm strain and it varies with the environmental conditions particularly temperature. Silkworm strains which go through multiple generations (5-6) in a year are poly-voltines or multi-voltines. These strains do not undergo egg diapause, which is an adaptation to tropical condition in which there is no severe winter. Under natural conditions, silkworm strains which undergo only one generation in a year are uni-voltine strains. This is an adaptation to overcome harsh winters in temperate countries. Artificially, these eggs which hibernate during winter are stored at 4^{o}C. After removal from cold storage to room temperature (25^{o}C), about two weeks later ova in diapause eggs begin final development until hatching.

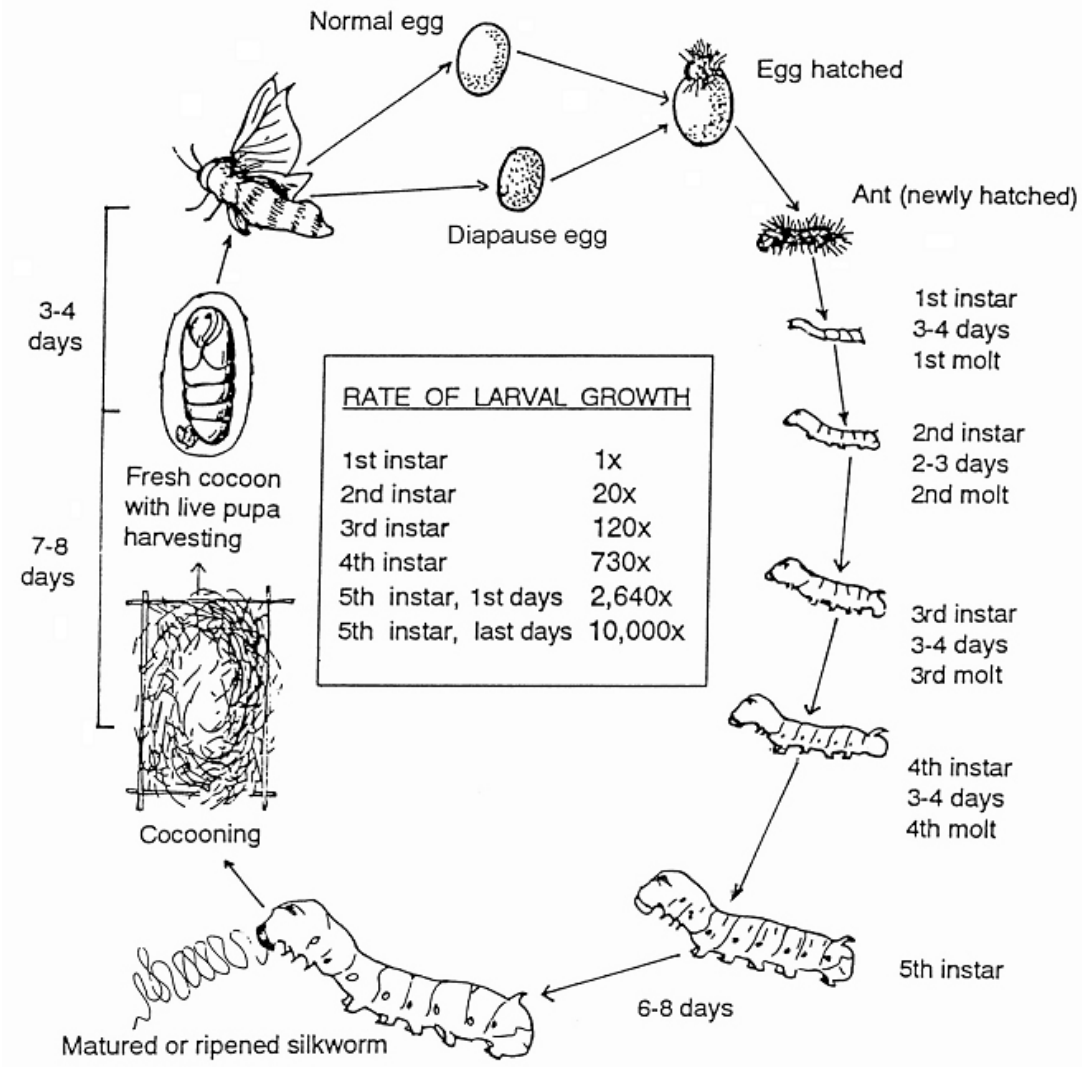

Fig.: Life Cycle of Silkworms

Eggs: The egg is about the size of a pinhead and resembles a poppy seed. The eggshell provides a protective covering for embryonic development. When first laid, an egg is light yellow. Fertile ova darken to a blue-grey within a few days.

Larva: The larva is an elongated caterpillar, the only feeding stage in the life cycle. The larva is monophagous, feeds only on mulberry (*Morus alba*). During larval life, the larva sheds its skin (molt) 4 times to accommodate growth. The period between successive molts is called an instar. At the end of the 5^{th} instar, the larva spins a silk cocoon of one continuous fibre within which it undergoes pupation.

The larval life may last from 20-24 days in the case of the multivoltine species in tropical areas or 24-28 days in the case of uni and bivoltine races in temperate areas, being shorter under warmer summer and autumn conditions, and some what longer under cooler spring conditions. During the larval life the worm moults or casts off its skin four times to be able so as to grow. There are also varieties of worms which moult three and five times but they are not of importance economically. In view of the four intervening moults, the larval life is divided into five distinct stages or instars which are referred to popularly as five different ages. The first three instars are referred to as "young ages" and the fourth and fifth instars as "late ages". The duration of the different instars and moulting periods for the different races is as follows:

<table>
<tr><th colspan="6">Duration of different instars and moulting periods</th></tr>
<tr><td colspan="2"></td><td colspan="2">Multivoltine races</td><td colspan="2">Uni and bivoltine races</td></tr>
<tr><td colspan="2"></td><td>Duration</td><td>Temperature and humidity conditions</td><td>Duration</td><td>Temperature and humidity conditions</td></tr>
<tr><td>I</td><td>instar</td><td>3 days</td><td rowspan="6">27°C
80-85% R.H.</td><td>3 days</td><td rowspan="4">27°C and 85% R.H.</td></tr>
<tr><td>I</td><td>moult</td><td>20 hours</td><td>20 hours</td></tr>
<tr><td>II</td><td>instar</td><td>2 days</td><td>2 days</td></tr>
<tr><td>II</td><td>moult</td><td>20 hours</td><td>20 hours</td></tr>
<tr><td>III</td><td>instar</td><td>3 days</td><td>3 days</td><td rowspan="2">25°C and 30% R.H.</td></tr>
<tr><td>III</td><td>moult</td><td>1 day</td><td>1 day</td></tr>
<tr><td>IV</td><td>instar</td><td>4 days</td><td rowspan="3">25-26°C
70-80% R.H.</td><td>5 days</td><td rowspan="2">22-24°Cand 75% R.H. ₀</td></tr>
<tr><td>IV</td><td>moult</td><td>1 day</td><td>1 day</td></tr>
<tr><td>V</td><td>instar</td><td>6-7 days</td><td>9-10 days</td><td>20-23 Cand 70%</td></tr>
<tr><td colspan="2">Total Duration</td><td>22-23 days</td><td></td><td>26-27 days</td><td></td></tr>
</table>

Cocoon: Silk cocoons are the commercial source of silk. From the time larva hatches out from the egg up to the time of spinning silk thread at the end of larval life, grows about 10,000 times. Bred in captivity for thousands of years on trays of mulberry leaves, *B. mori* is fully domesticated and cannot survive without the assistance of man.

Pupa: The silk cocoon serves as protection for the pupa. Cocoons are shades of white, cream and yellow depending on silkworm variety. After a final molt inside the cocoon, the larva develops into a brown, chitin covered structure called the pupa.

Adult or Imago: Metamorphosis of the pupa result in an emerging moth or adult. The moth is covered with heavy, round, furry scales and lacks functional mouthparts, so are unable to consume food. The forewing has a hooked tip, which is a characteristic feature of this family;

however, it is flightless. Wings and body are usually white, but may vary in shades of light brown. Wingspan is 1.5 to 2.5 inches. (4-6 cm). It is the reproductive stage where adults mate and females lay eggs. Adult is the final stage in the life cycle of *B. mori.* Once the adult moth comes out of its cocoon, its only purpose is to find a member of the opposite sex, and mate. Males are larger than females and more active. They flap their wings rapidly to attract the females. Within 24 hours of mating, the male moth dies, while the female lays abundant eggs, after which it dies as well.

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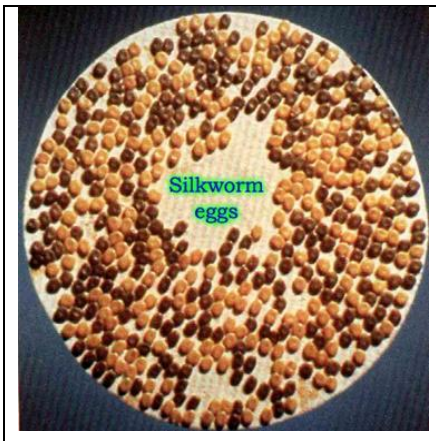
<tr><td> 
</td><td> 
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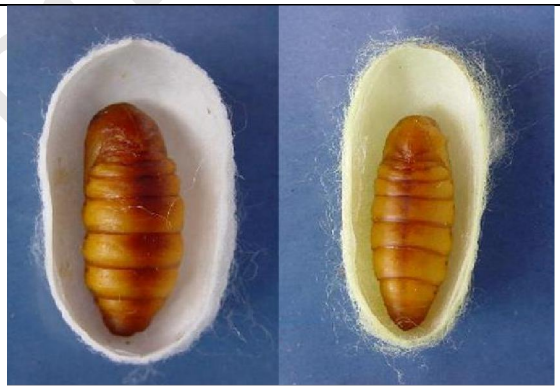
<tr><td>Silkworm Eggs</td><td>Fifth Instar Larva</td></tr>
<tr><td> 
</td><td>  </td></tr>
<tr><td>Yellow and White Cocoons</td><td>Pupa: Cut-open Female and Male</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Adult Silk Moth or Imago</td><td>Mating of male and female Moth</td></tr>
</table>

Rearing of Silkworms

Introduction:

Young age silkworm rearing generally called as chawki rearing has become a vital cog in the sericulture industry. Silkworm larval stage from hatching to cocoon spinning is of about 2324 days duration, which is clearly differentiated in to five instars by four moults. The stage from hatching up to the end of second moult covering the first two instars is considered as the young age or chawki stage. Chawki rearing refers to the rearing of young silkworms under controlled micro climate. The process of chawki rearing may be compared to the establishment of nursery in horticulture and plantation crops. The purpose of chawki rearing is to grow quality silkworms under disease free environment, to reduce the cost and silkworm rearing duration with famers, and to improve the cocoon quality and productivity. Robust and healthy worms ultimately produce quality cocoons. In the developed silk producing countries like China, Korea and Japan, the farmers (95%) receive silkworm as chawki worms. The young age silkworms are referred as Chawki (India), Kego (hairy silkworms in Japan) and Ants (China). The basic requirements for successful commercial chawki rearing centre (CRC) are suitable rearing house for chawki rearing with required rearing appliances, well maintained and irrigated exclusive chawki mulberry garden and well trained man power. Before the advent of CRCs, farmers generally used to procure silkworm eggs from government or private grainages and incubate the eggs and grow the worms in their dwelling houses or in the silkworm rearing houses. The chawki being a vulnerable stage requires perfect hygiene and suitable micro-climate. Quite often, the farmers cannot provide the required care and environment, which leads to improper hatching, unhealthy young worms and ultimately a poor cocoon yield and returns. The CRCs facilitate the farmers to purchase healthy and uniform chawki worms after 2nd moult at a reasonable rate, saving them nine days' labour and from the delicate task of incubation, brushing and young age rearing. It is recorded that the cocoon productivity from CRC supplied worms is about 20-25% higher. The CRCs also promotes batch rearing among the farmers, and also helps to increase the number of crops per year for more sustainable economic returns. Chawki rearing must be carried out scientifically with technical skill and expertise, which is now provided to the famers by the commercial enterprises known popularly as Chawki Centres or Commercial Chawki Rearing Centres (CRCs). In recent years several commercial CRCs have been established by private entrepreneurs across India, especially in the traditional sericulture areas. Supply of chawki worms is an integral part of bivoltine silk promotion programmes of the Central Silk Board, and is being strictly implemented in its

Cluster Promotion Programme (CPP) and Institute Village Linkage Programmes (IVLP). The CSRTI, Mysuru has designed and is operating a model CRC for distributing chawki worms to farmers as an institutional activity and also for training the entrepreneurs and farmers in CRC operation.

i) **Rearing house:** A separate rearing house with adequate rearing space and sufficient ventilation is essential for a CRC to enable effective disinfection, maintenance of optimum environmental conditions of humidity & temperature and hygienic conditions. The rearing building should be constructed away from the dwelling houses and late age rearing buildings and preferably close to the chawki mulberry garden. The ideal CRC building is designed by CSRTIMysuru for rearing 5000 dfls/crop and 32 crops in a year. The CRC building should have RCC roof and adequate facilities for good ventilation. If the CRC building is larger than required, maintenance of micro-climate would become tougher.. The CRC room can also be used as incubation room for silkworm eggs. The CRC building should possess a rearing hall measuring 32 x 30 ft and two rooms of 10 x 20 ft each for leaf preservation and for storing rearing appliances. The rearing house should meet certain specification, as the silk worms are very sensitive to weather conditions like humidity and temperature. The rearing room should have proper ventilation optimum temperature and proper humidity. It should be ensured that dampness, stagnation of air, exposure to bright sunlight and strong wind should be avoided.

ii) **Rearing stand:** Rearing stands are made up of wood or bamboo and are portable. These are the frames at which rearing trays are kept. A rearing stand should be 2.5 m high, 1.5 m long and 1.0 m wide and should have 10 shelves with a space of 20 cm between the shelves. The trays are arranged on the shelves, and each stand can accommodate 10 rearing trays.

iii) **Ant well:** Ant wells are provided to stop ants from crawling on to trays, as ants are serious menace to silk worms. They are made of concrete or stone blocks 20 cm square and 7.5 cm high with a deep groove of 2.5 cm running all round the top. The legs of the rearing stands rest on the centre of well filled with water.

iv) **Rearing tray:** These are made of bamboo or wood so that they are light and easy to handle. These are either round or rectangular.

v) **Paraffin paper:** This is a thick craft paper coated with paraffin wax with a melting point of 55 o C. It is used for rearing early stages of silk worms and prevents

withering of the chopped leaves and also help to maintain proper humidity in the rearing bed.

vi) **Foam rubber strips:** Long foam rubber strips 2.5 cm wide and 2.5 cm thick dipped in water are kept around the silkworm rearing bed during first two instar stages to maintain optimum humidity. Newspaper strips may also be used as a substitute.

vii) **Chopsticks:** These are tapering bamboo rods (1cm in diameter) and meant for picking younger stages of larvae to ensure the hygienic handling.

viii) **Feathers:** Bird feathers preferably white and large are important items of silkworm rearing room. These are used for brushing newly hatched worms to prevent injuries.

ix) **Chopping** board and Knife: The chopping board is made up of soft wood it is used as a base for cutting leaves with knife to the suitable size required for feeding the worms in different instar stages.

x) **Leaf chambers:** These are used for storing harvested leaves. The sidewalls and bottom are made of wooden strips. The chamber is covered on all sides with a wet gunny cloth.

xi) **Cleaning net:** These are cotton or nylon nets of different mesh size to suit the size variations of different instars of the silk worm. These are used for cleaning the rearing beds, and at least two nets are required for each rearing tray.

xii) **Mountages:** These are used to support silkworm for spinning cocoons. These are made up of bamboo, usually 1.8 m long and 1.2 m wide. Over a mat base, tapes (woven out of bamboo and 5-6 cm wide) are fixed in the form of spirals leaving a gap of 5-6 cm. They are also called chandrikes. Other types of mountage such as centipede rope mountage, straw cocooning frames etc. are also used.

xiii) **Hygrometers and Thermometers:** These are used to record humidity and temperature of the rearing room.

xiv) **Feeding stands:** These are small wooden stands (0.9 m height) used for holding the trays during feeding and bed cleaning. Other equipments like feeding basins, sprayer, and leaf baskets may also be required.

Rearing Practices:

Silkworms must be reared with utmost care since they are susceptible to diseases. Therefore, to prevent diseases, good sanitation methods and hygienic rearing techniques must be followed. The appliances and the rearing room should be thoroughly cleaned and disinfected with 2-4% formaldehyde solution. Room temperature should be maintained around 25 0 C.

Procurement of quality seeds:

The most important step in silkworm rearing is the procurement of quality seeds free from diseases. Seeds are obtained from grainages, which are the centers for production of disease free seeds of pure and hybrid races in large quantities. These centers purchase cocoons from the certified seed cocoon producers. These cocoons are placed in well-ventilated rooms with proper temperature (23-25^{o} C) and humidity (70-80 %), and emergence of moth is allowed. Grainage rooms may be kept dark, and light may be supplied suddenly on the expected day of emergence to bring uniform emergence. Emerging moths are sexed and used for breeding purposes to produce seed eggs. Three hours of mating secures maximum fertilized eggs. The females are then made to lay eggs on paper sheets or cardboard coated with a gummy substance. Egg sheets are disinfected with 2% formalin, and then washed with water to remove traces of formalin and then dried up in shades. The eggs are transported in the form of egg sheet. However, it is easy to transport loose eggs. To loosen the eggs, the sheets are soaked in water. The loose eggs are washed in salt solution of 1.06-1.10 specific gravity to separate out unfertilized eggs and dead eggs floating on surface. Prior to the final washing, the eggs are disinfected with 2% formalin solution. Eggs are dried, weighed to the required standard and packed in small flat boxes with muslin covers and dispatched to buyers.

Brushing:

The process of transferring the silkworm to rearing trays is called brushing. Suitable time for brushing is about 10.00 am. Eggs at the blue egg stage are kept in black boxes on the days prior to hatching. The next day they are exposed to diffused light so that the larvae hatch uniformly in response to photic stimuli. About 90% hatching can be obtained in one day by this method. In case of eggs prepared on egg cards, the cards with the newly hatched worms are placed in the rearing trays or boxes and tender mulberry leaves are chopped into pieces and sprinkled over egg cards. In case of loose eggs a net with small holes is spread over the box containing the hatched larvae and mulberry leaves cut into small pieces are scattered over the net. Worms start crawling over the leaves on the net; the net with worms is transferred to rearing tray.

Preparation of feed bed and feeding:

After brushing, the bed is prepared by collecting the worms and the mulberry leaves together by using a feather. The bed is spread uniformly using chopsticks. The first feeding is given after two hours of brushing. Feed bed is a layer of chopped leaves spread on a tray or over a large area. The first and second instar larvae are commonly known as chawki worms. For

chawki worms, paraffin paper sheet is spread on the rearing tray. Chopped mulberry leaves are sprinkled on the sheet and hatched larvae are brushed on to the leaves. A second paraffin paper sheet is spread over the first bed. In between two sheets water soaked foam rubber strips are placed to maintain humidity.

The 4^{th} and 5^{th} instars are reared in wooden or bamboo trays by any of the three methods: viz., shelf-rearing, floor-rearing and shoot-rearing. In shelf rearing, the rearing trays are arranged one above the other in tiers on a rearing stand which can accommodate 10 -11 trays. This method provides enough space for rearing, but it is uneconomical as it requires large number of laborers to handle the trays. Chopped leaves are given as feed in this method. In floor rearing, fixed rearing sheets of 5-7x1-1.5m size are constructed out of wooden or bamboo strips in two tiers one meter apart. These sheets are used for rearing. Chopped leaves are given as feed. This method is economical than the first one because it does not involve much labour in handling of trays. Shoot-rearing is most economical of the three methods. The rearing sheet used is one meter wide and any length long in single tier and the larvae are offered fresh shoot or twigs bearing leaves. This method can be practiced both outdoors and indoors depending upon the weather. Each age of the silk worms could be conveniently divided into seven stages. First feeding stage, sparse eating stage, moderate eating stage, active eating stage, premoulting stage, last feeding stage, moulting stage. The larvae have good appetite at first feeding stage and comparatively little appetite at sparse and moderate eating stages. They eat voraciously during active stage to last feeding stage after which they stop feeding.

Bed Cleaning:

Periodical removal of left over leaves and worms' excreta may be undertaken and is referred to as bed cleaning. It is necessary for proper growth and proper hygiene. Four methods are adopted: conventional method, husk method, net method, and combined husk and net method.

Spacing:

Provision of adequate space is of great importance for vigorous growth of silkworms. As the worms grow in size, the density in the rearing bed increases and conditions of over crowding are faced. Normally it is necessary to double or triple the space by the time of moult from one to other instar stage, with the result that from the first to third instar the rearing space increases eight fold. In 4 th instar, it is necessary to increase the space by two to three times and in 5 th instar again twice. Thus, the rearing space increases up to hundred folds from the time of brushing till the time of maturation of worms.

Mounting:

Transferring mature fifth instar larvae to mountages is called mounting. When larvae are fully mature, they become translucent, their body shrinks, and they stop feeding and start searching for suitable place to attach themselves for cocoon spinning and pupation. They are picked up and put on mountages. The worms attach themselves to the spirals of the mountages and start spinning the cocoon. By continuous movement of head, silk fluid is released in minute quantity which hardens to form a long continuous filament. The silkworm at first lays the foundation for the cocoon structure by weaving a preliminary web providing the necessary foot hold for the larva to spin the compact shell of cocoon. Owing to characteristic movements of the head, the silk filament is deposited in a series of short waves forming the figure of eight. This way layers are built and added to form the compact cocoon shell. After the compact shell of the cocoon is formed, the shrinking larva wraps itself and detaches from the shell and becomes pupa or chrysalis. The spinning completes within 2-3 days in multi-voltine varieties and 3-4 days in uni- and bi-voltine.

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Begum N., Kiran B. R. and R. Purushothama (2018): Mulberry Cultivation Practices and Diseases: An overview, Technical Research Organization India, Vol. 5 (2), 61-68.

Buckner M. C. (1884): Silk Culture, Manual with Complete Instructions. Singh Tumul: Applied Zoology, Sericulture.

		
Black-Boxing, Eggs Hatching	Chawki Rearing	Bed Cleaning
		
Rearing Trays/ Racks	Feeding of silkworms	
		
Traditional Chandrika	Recently in use Chandrika, Cocoon harvesting.	