SERICULTURE

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Introduction to Sericulture

What is Sericulture?

Sericulture is the process of cultivating silkworms and extracting silk from them. The caterpillars of the domestic silkmoth (also called 'Bombyx Mori') are the most commonly used silkworm species in sericulture. Other types of silkworms (such as Eri, Muga, and Tasar) are also cultivated for the production of 'wild silks'.Sericulture is an agro-based industry. It involves rearing of silkworms for the production of raw silk, which is the yarn obtained out of cocoons spun by certain species of insects. The major activities of sericulture comprises of food-plant cultivation to feed the silkworms which spin silk cocoons and reeling the cocoons.for unwinding the silk filament for value added benefits such as processing and weaving.

What is Silk Made Up Of?

Silk is a fibre made up two different proteins – sericin and fibroin. Approximately 80% of silk fibre is made up of fibroin, which is concentrated at the core. This core is surrounded by a layer of sericin (which makes up the remaining 20% of silk).The presence of pigments (such as xanthophyll) in the sericin layer of the fibre imparts colour to the silk.

Where do we find Silk?

Geographically, Asia is the main producer of silk in the world and produces over 95 % of the total global output. Though there are over 40 countries on the world map of silk, bulk of it is produced in China and India, followed by Japan, Brazil and Korea. China is the leading supplier of silk to the world.

India is the second largest producer of silk and also the largest consumer of silk in the world. It has a strong tradition and culture bound domestic market of silk. In India, mulberry silk is produced mainly in the states of Karnataka, Andhra Pradesh, Tamil Nadu, Jammu & Kashmir and West Bengal, while the non-mulberry silks are produced in Jharkhand, Chattisgarh, Orissa and north-eastern states.Silkworm larvae are fed mulberry leaves, and, after the fourth moult, climb a twig placed near them and spin their silken cocoons. The silk is a continuous-filament fiber consisting of fibroinprotein secreted from two salivary glands in the head of each larva, and a gum called sericin, which cements the two filaments.

History of sericulture

Silk production has a long history. Silk was discovered by Xilingji (Hsiling-chi), wife of China's 3rd Emperor, Huangdi (Hoang-Ti), in 2640 B.C. While making tea, Xilingji accidentally dropped a silkworm cocoon into a cup of hot water and found that the silk fiber could be loosened and unwound. Fibers from several cocoons could be twisted together to make a thread that was strong enough to be woven into cloth. Thereafter, Hsiling chi discovered not only the means of raising silk worms, but also the manners of reeling silk and of employing it to make garments. Later sericulture spread throughout China, and silk became a precious commodity, highly sought after by other countries. Demand for this exotic fabric eventually created the lucrative trade route, the historically famous Silk Road or Silk Route named after its most important commodity. This road helped in taking silk westward and bringing gold, silver and wool to the East. With the mulberry silk moth native to China, the Chinese had a monopoly on the world's silk production. After 1200B.C. Chinese immigrants who had settled in Korea helped in the emergence of silk industry in Korea. During the third century B.C. Semiramus, a general of the army of Empress Singu-Kongo, invaded and conquered Korea. Among his prisoners were some Sericulturists whom he brought back to Japan. They helped in the establishment and growth of sericulture industry in Japan. Another story is that a Chinese princess married an Indian prince. She carried silkworm eggs/mulberry cocoons in her elaborate head dress. She disclosed the secret of raising silkworms thus, silk production spread in India. In 550A.D. moth eggs and mulberry seeds were smuggled from China by two Nestorian monks, sent by Emperor Justinian-I and silk production began in Byzantium. The technique of sericulture spread throughout the Mediterranean countries during the 7 th century AD and then to Africa, Spain and Sicily. During latter part of the 19th century, modern machinery, improved techniques and intensive research helped the growth of sericulture industry in Japan. At present, Japan, China, Korea, Italy, Soviet Union, France, Brazil and India are the chief silk producing countries in the World.

Types of Silkworm and Silk:-

Types of silk:-

Moths belonging to families Satumidae and Bombycidae of order lepidoptera and class Insecta produce silk of commerce. There are many species of silk-moth which can produce the silk of commerce, but only few have been exploited by man for the purpose. Mainly four types of silk have been recognised which are secreted by different species of silk worms.

1. Mulberry Silk:-This silk is supposed to be superior in quality to the other types due to its shining and creamy white colour. It is secreted by the caterpillar of Bombyx mori which feeds on mulberry leaves.

2.Tasar Silk:- It is secreted by caterpillars of Antheraea mylitta, A. paphia, A. royeli, A. pernyi A. proyeli etc. This silk is of coppery colour. They feed on the leaves of Arjun, Asan, Sal, Oak and various other secondary food plants.

3.Muga Silk:- It is obtained from caterpillars of Antheraea assama which feeds on Som, Champa and Moyankuri.

4. Eri Silk:- It is produced by caterpillars of Attacus ricini which feed on castor leaves. Its colour is also creamy white like mulberry silk, but is less shining than the latter.

Types of Silkworms:-

1. Mulberry Silkworm-

Bombyx mori or the Mulberry silkworm is completely domesticated insect.B. mori which is originated from the original Mandarina silkworm, known as Bombyx mandarina Moore.The adult moths of B. mori is seldom, fat and are primarily concerned with reproduction. Their larvae are voracious eaters. They feed on the leaves of mulberry treesBombyx mori produces cocoons with continuous silk filament and therefore can be industrially reeled to produce raw silk.Some moths are single brooded or univoltine and others are many brooded or multivoltine.
Owing to domestication, a large number of strains have evolved out, which produce cocoons of various shapes, sizes, weights and colours ranging from white to yellow.

2. Tassar Silkworms-

The tassar silkworms belong to the genus Antheraea and they are all wild silkworms. There are many varieties such as the Chinese tassar silkworm — A. pernyi G.Tassar silk occupies the third position; next to mulberry and eri silk. China is the biggest tassar silk producer of the world; followed by India.Traditional tassar silk of India is the one produced by the tropical tassar silkworm, Antheraea mylitta D. Its distribution extends along the tropical forest belt of India starting from West Bengal in the east, extending upto Karnataka in the South-East through Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh and Maharashtra.Tassar silkworm is polyphagous, feeding on about two dozen host plantsThe Indian tassar silkworm — A. mylitta Dury. The Japanese tassar silkworm — A. yamamai Guerin.

3. Muga Silkworms-

The muga silkworms (Antheraea assama) also belong to the same genus as tassar worms but produce an unusual lustrous golden-yellow silk thread which is very attractive and strong.

The primary food plants of A. assama Westwood are Som (Machilus bombycina) and soalu (Litsaea polyantha) leaves which are Assammese names. Muga silkworms are wild in nature, muga moths (muga is an Assamese word meaning brown or amber) are distributed from Western Himalayas to Nagaland, Cachar districts of Assam of south Tripura. But the sericulture practice is confined to the Brahmaputra valley of Assam and Foot hills of East Garo hills of Meghalaya. Ideal temperature for muga silkworm growth is 24-30°C and humidity 75-85%.This silk is a traditional costume during the marriage ceremonies and festive occasions, the ladies garments 'Mekhala and Chadhar' made of muga silk are a priced commodity in Assam.

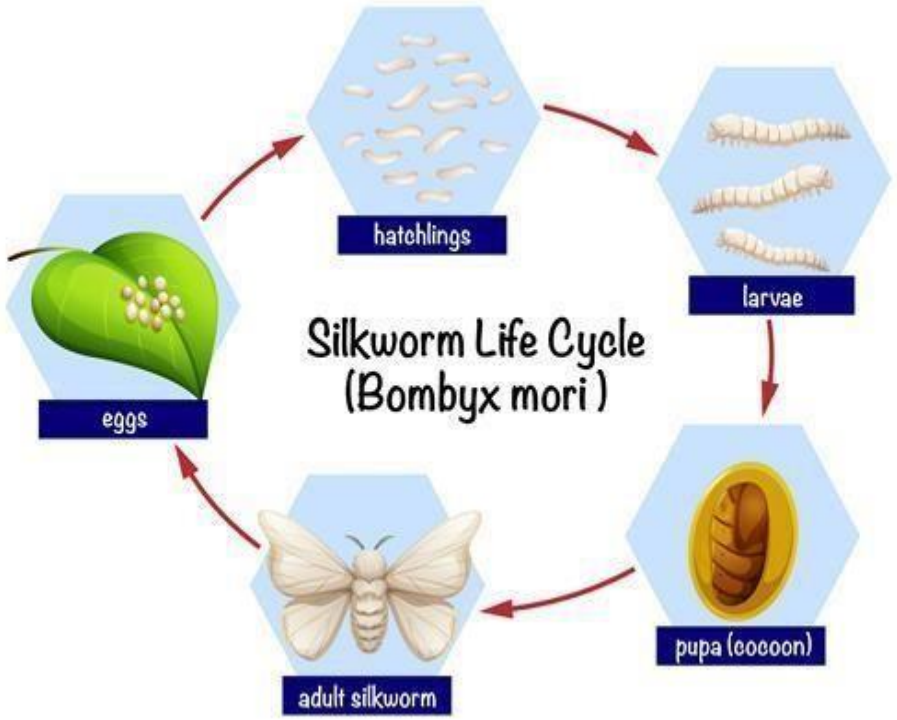
4. Eri Silkworm-

Eri silkworms Samia cynthia ricini (Huts) belong to family Saturniidae. The local name eri derives from its primary food plant 'era' (castor), so commonly known as castor silkworm is a

domesticated and reared on castor oil plant leaves so as to produce a white or brick-red silk popularly known as ert silk.The distribution of eri silkworm in North eastern India is mostly confined to the Brahmaputra valley and the surrounding areas extending to the foot hills of Meghalaya, Mizoram, Nagaland, Manipur and Arunachal Pradesh upto about 3000' altitude. Manipur are predominantly eri growing areas of this region.Both male and female have brown, black and green coloured wings with white "crescent markings and wooly white abdomen". The male is smaller than female bearing bushy antennae and narrower abdomen.

The Life Cycle of Silkworm

The life cycle of a silk moth begins when a female silk moth lays eggs. These eggs hatch into caterpillars or larvae, which are commonly known as silkworms. The silkworms feed on mulberry leaves and go through several stages of growth. During the pupa stage, the silkworm spins a protective cocoon around itself. Inside the cocoon, the silkworm swings its head and spins a fiber made of protein, forming the silk fiber. The cocoon acts as a protective covering for the pupa. Silk threads, also known as yarn, are obtained from the cocoon of the silk moth.



Silkworm Lifecycle:

1. **Egg stage:**

- An egg is the first stage of the life cycle of the silkworm.
- The egg is laid by a female moth which is mostly the size of small dots, usually in clusters on surfaces such as leaves or twigs.
- A female moth lays more than 350 eggs at a time.
- The eggs are tiny, ranging in size from 1 to 2 millimeters, and have a yellowish or whitish color.
- They are covered with a protective coating called sericin, which helps keep them safe until conditions are favorable for hatching.
- The incubation period for the eggs lasts about 10 to 14 days, depending on the temperature and humidity.
- In the springtime, the eggs hatch due to the warmth in the air.
- This procedure happens once in every year.

2. **Larva Stage:**
   - Once the eggs hatch, tiny silkworm larvae or caterpillars emerge.
   - These larvae have a characteristic appearance with a small head, soft body, and numerous tiny hairs covering their skin.
   - At this stage, the silkworms have a strong appetite and they feed on mulberry leaves and consume a large amount of these leaves for around 30 days before going to the next stage.
   - The larvae undergo several molting stages, shedding their skin to accommodate their growing bodies.

3. **Pupa Stage:**
   - After completing their final instar, the silkworms enter the pupa stage.
   - The pupa is the resting/ motionless or transitional stage of development.
   - Inside the pupa, major changes occur as the silkworm undergoes metamorphosis to transform into an adult silk moth.
   - During this stage, the silkworm spins a protective cocoon around itself using silk threads produced from special glands in its head.
   - The cocoon serves as a shield and provides a safe environment for the pupa to undergo its transformation.
   - In this stage, people kill the pupa by plunging the cocoon into boiling water and unwind the silk thread.

4. **Cocoon Stage:**
   - In this stage, silkworms spin a protective cocoon around itself.
   - It is the size of a small cotton ball and is made of a single thread of silk.
   - The silkworm completes the construction of its cocoon within a few days.
   - The cocoon is oval-shaped and consists of a single continuous silk filament, which can measure up to 900 meters long.
   - The silk filament is made up of two proteins: fibroin, which gives the thread its strength, and sericin, a gummy substance that holds the fibers together.
   - The silk fibers produced by the silkworm serve as the raw material for silk production.
   - The cocoon provides protection to the developing pupa from predators and external


conditions.

5. **Moth Stage:**
   - Inside the cocoon, the pupa undergoes complete metamorphosis, transforming into an adult silk moth.
   - When the transformation is complete, the adult moth secretes a special enzyme to dissolve a portion of the cocoon, creating an exit hole.
   - The silk moth emerges from the cocoon through this hole, usually during the night.
   - The adult silk moth has a short lifespan, ranging from about 5 to 10 days.
   - The primary purpose of the adult silk moth is to reproduce, and it does not possess functional mouthparts or a digestive system.
   - These stages encompass the remarkable lifecycle of a silkworm, showcasing their ability to produce silk and undergo metamorphosis.
   - The female moth lays eggs after mating and thus the life cycle of silkworm begins again.


MORICULTURE:

Sericulture is dependent on moriculture. The cultivation of mulberry plants to obtain feed for silkworms and to obtain silk is called moriculture. The first time mulberry plant cultivation was carried out was in 2800 BC by the chin–nong. The raw silk industry is based on moriculture and sericulture. To increase silk production and cocoon production moriculture is an important process. Moriculture techniques have been improved with time to reduce production costs in sericulture. Approximately 4,00,000 hectares of farmland is used for the cultivation of mulberry plants. Each hectare of the land yields approximately 12000 – 15000 kg of mulberry leaves. Presently, the production of mulberry leaves has been increased due to advanced techniques of cultivation of mulberry plants. Morus alba, Morus indica, Morus latifolia, Morus nigra are the main four species of mulberry plant which are found in India.

OPTIMUM CLIMATIC CONDITIONS FOR MORICULTURE:

Mulberry plants may thrive under a wide range of climatic conditions. 24^0 to 28^0 temperature is suitable for optimum growth of mulberry plants. Although they give average yield at 18^0 - 24^0 temperatures as well. It grows well in places that have an annual rainfall of 600 – 2500 mm. It requires 350m3/ha water every ten days. Sunshine is the controlling factor of the growth of mulberry plants. It requires 9-13 hours of sunshine per day.

SOIL CONDITIONS FOR MORICULTURE:

Clayey and loamy soils are suitable for mulberry plants. Soil should be deep, fertile and porous with good water holding capacity. The ideal pH for its best growth is 6.2 – 6.8. Land preparation for mulberry plant cultivation involves

deep ploughing up to a depth of 30 – 35cm. Cultivation of Kanva – 2 of Morus indica is common in India for moriculture. Apart from Kanva – 2, S-36, S-54 etc. are also belongs to M. indica and are used for moriculture.

SPACING OF MULBERRY PLANTS :

The spacing of mulberry plants depends on the soil conditions. For black and heavy soils, 90 × 90 cm spacing. While for sloppy soil of hilly areas 120 × 60 cm spacing.

HARVESTING OF MULBERRY LEAVES FROM THE PLANT :

Let the mulberry plants grow up to an optimum extent. After their optimum growth, mulberry leaves can be harvested and can be used as feed for silkworms. Mulberry leaves must be harvested at the right time as fully grown mulberry leaves contain less moisture than partially grown leaves. Leaf picking and branch cutting are the methods that are used in the harvesting of mulberry leaves. Another well-known harvesting method of mulberry leaves is whole shoot harvesting.

FERTILIZERS USED IN MORICULTURE:

It requires two doses of fertilizer in one season. Suphala fertilizer is used after two months of planting the mulberry saplings. During this time, weeding is also done. The second time weeding is done after 2 – 3 months of planting.

PRESERVATION OF LEAVES:

Mulberry leaves must be kept in a basket full of moisture. The basket should be lined with a clean and wet cotton cloth. It should also be covered with a wet and clean cloth. When preservation of mulberry leaves is done in bulk then preservation chambers are used. Moist and green mulberry leaves are suitable for feeding the silk moths. The leaves should be heaped loosely and periodically turned. By doing this aeration is provided to leaves for better preservation. Optimum temperature and humidity are required for the preservation of mulberry leaves.

PROCESSES OF SERICULTURE

1. Harvesting process

Introduction of harvesting:

When the mature larva is placed in the mountage, it will spin a cocoon by ejecting a silk filament from its silk gland through an opening (spinneret). Silk filament is protein in nature,which hardens in contact with the air. You know the mature silkworm larva will take 3-4 days to spin a cocoon. After complete ejection of silk and formation of cocoon, metamorphosis takes place and the larva transforms into pupa. In between, there is pre-pupal stage. This transient phase is very delicate. Normally, within 10 days, the pupa again undergoes metamorphosis and emerges as a moth by piercing the cocoon.

Time of harvest :

Harvest is commonly used to mean gathering or collection of ripen crops, especially in agriculture produce. In sericulture, harvest signifies to the collection and gathering of produce cocoons from spinning tray or mountage. After spinning a cocoon, the larva undergo metamorphosis (complete change in morphology) and transforms into pupa. For completion of spinning and metamorphosis, about 5-6 days are required and you have to allow the larva for this process. While harvesting, it may also be considered that during summer, the process is faster, where as in cooler months, it is slower. After pupation, when the integument of the pupa turns brown and hard on the 5th day, the cocoon may be harvested. The safest method is checking the condition of pupa by slit open a few pupa, pre mature collection of cocoons are harvesting may lead to loss of silk content of the cocoon due to incomplete spinning or killing the delicate pre-pupa or pupa within the cocoons. Killing of

pre-pupa or tender early pupa inside the cocoon will lead to stained cocoons, rendering it unfit for reeling.

To avoid this, harvest cocoons at 6th day after completion of full 5 days in mountage, counted

from the last day of mounting. The pupa will be hard and cocoon shell will be dry. This condition will be suitable for safe handling and transportation of cocoon. Cocoons release moisture even after completion of spinning. Delayed harvest will lead to weight loss of cocoons. So, you should stick to the time of harvest.

METHODS OF HARVEST:

Methods for harvesting of silk cocoons varies, depending upon the mountage(spinning tray)

used. Whatever the methods of harvest, first you remove litters and left-over of leaves, dead

or un-spun larva, naked pupa (without cocoon), flimsy and melted cocoons from the mountage. Flimsy and melted cocoons may spoil the good cocoons by spilling stain.

Mounting Methods

Different Types of Mountages Used:

Mountages The most important device that helps or supports the silkworms (larvae) for

comfortable spinning their cocoon is called cocoonage or mountage. Mountages play a vital role in quality cocoon production. Farmer's depending upon their resources use different

types of materials available locally for making mountages. Types of material used, finishing

of mountages, space available for spinning determines both the quality and quantity of the

cocoons. Nearly 2 % of mature larvae make naked cocoons for want of proper mountages or cocooning space. To avoid formation of naked or deformed cocoons, ripe worms are picked from the rearing platforms and released on an appropriate mountages. It is used to enable the ripe worm to spin cocoon.

Mounting Methods

1.Chandrika:

The most, common form of mountage in India is “Chandrika”. It is a rectangular bamboo mat
on which a spiral bamboo tape is tied. The chandrika measures 1.8 m X 1.2 m. The tape is
about 4-5 cm. Broad and space between the spirals is about 4-5 cm. It became more popular than any other mountage because of the following advantages.

- Easily manufactured in the villages by bamboo weavers.
- Can be stored easily.
- It provides easy passage of air for quick drying of excreta of spinning worms and avoids staining.
- Easy to transport.
- Easy to disinfect.
- Low cost and light weight.

2. Screen-type Mountage:

It is made of bamboo or wooden or plastic reapers on which, instead of spiral bamboo tape, longitudinal strips with triangular peaks are placed. The screen can be folded and stored.This mountage can be kept clean and well- ventilated and hence, cocoons spun on this mountage are of good quality. It is more durable than chandrika. But occurrences of double cocoons are frequent in it.

3. Plastic Mountage:

Like Chandrika, but is made from plastic instead of bamboo and hence, more durable, easy to clean, not prone to rodent attack, and produce lesser number of double cocoons. Once invested, further maintenance, care or expenditure are not incurred. But these mountages are costly than Chandrika. The cocoons produced on these mountages are more flimsy and not of uniform size and hence not frequently used by farmers.

4. Japanese low Cost Mountage:

In this modified Japanese mountage, a wooden frame of 4 longitudinal rods is attached by means of cross-spokes at two ends to a central axis. Each rod has a number of pegs placed at

equal distances. These pegs are connected by long threads of twisted rice straw in a regular pattern like that of charpoy.The size of frame and the number of pegs can be modified according to the requirement of the rearer. This mountage is cheap, more durable and make less chances of disease spread.

5. Bamboo Strip Mountage:

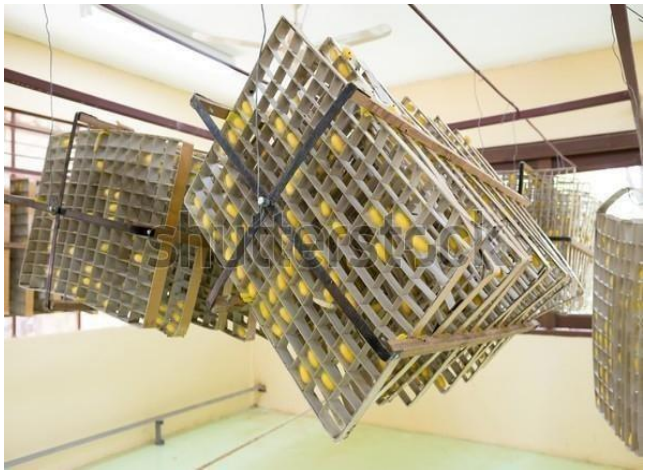
Made of bamboo stirps that are either nailed on wooden reaper or placed in grooves of wooden reapers. Several such frames are placed one above the other with the lower one keeping on four uniform bricks or wooden blocks. This mountages are cheap, durable, easy to handle, and harvest the cocoons.

6. Bottle Brush Mountage:

This recently introduced mountage consists of a thick coconut or jute fibre rope into which 6-9 sticks (midrib of coconut leaves) are inserted very closely.These are used by the worms as support. The worms spin their cocoons in the space between the sticks. This mountage is very cheap; can be made easily and occupies little space compared to Chandrika.

7. Rotary mountage:

It has pieces of cardboard to form 13 rows, consisting of 12 sections and each and amounting to 156 sections. Ten pieces are put into frame. When this frame is hung up with wire holding at by ends, the frame can be turned around two axes. This frame produces fewer spoiled cocoons and raises the reliability of cocoons. Good cocoon percentage is more than 80. It is the best type and suitable for large scale silkworm rearing because it does not only lead to increased cocoon quality but also saves labour in mounting and harvesting.



2. Drying process of cocoon:

Cocoon drying, adept person all know, the purpose is to prevent the cocoon living pupa transferred during storage, silkworm legacy parasitic fly eggs out of larvae and pupae of decay and damage the cocoon layer, at the same time also make cocoon layer after heat treatment appropriate change outer soluble properties of sericin, raised strong cocoon cooking resistance, protection of non-broken cocoon silk reeling and storage.

To obtain the silkworm cocoon with higher drying quality, a lot of manufacturers also tried a lot of methods really, but always in the traditional method in the circle straight dry method and dry method. But no matter which kind has the fatal weakness to be able to dry fresh cocoon at a time, although simplified the operation process, reduce the chance of cocoon damage, but easy to cause fresh cocoon backlog. Dry again for the first time to fresh cocoon baking onto a baking rate at about 60% of semi-dry cocoon, by using low temperature drying for a second time to dry, this method can improve the utilization of drying uniformity and drying equipment, is also the current commonly used methods for many factory, but there are certain problems of temperature and humidity control does not reach the designated position, pupa body humidity is higher, is not conducive to the late of silk reeling.

In fact, the silkworm cocoon is mainly composed of cocoon layer and pupa body. The weight of cocoon layer in general fresh cocoon only accounts for 18%-24%. Fresh cocoons contain a lot of water, usually 100 kilograms of fresh cocoons baked to the appropriate dry cocoon to remove about 60 kilograms of water. Under normal circumstances, the moisture content of fresh cocoons is about 13%-15%, and that of pupae is about 73-77%. So, silkworm cocoon drying is mainly to remove the water in the pupa body, and the cocoon layer only lost a small amount of water. The traditional methods are not nearly as sophisticated.

Before baking silkworm cocoons with a heat pump dryer, the amount of cocoons laid according to the thickness of laid cocoons, generally not more than two half cocoon horizontal height is appropriate, the use of vertical penetration air circulation dryer to not more than three high is appropriate. The main processing conditions of drying silkworm cocoons are temperature, humidity, wind speed, cocoon amount and drying time. Must conform to the law of water evaporation at each stage of drying, such as temperature should be gradually reduced from high to low, humidity gradually increased from low, wind speed gradually reduced from large to small.

The drying process of silkworm cocoon is mainly divided into three stages: preheating, constant drying and decelerating drying:

1. Preheating stage: the fresh cocoon heating, the heat energy through the cocoon layer into the cocoon chamber to kill the pupa body, pupa body water into the evaporation period. At this stage, the temperature has to rise gradually, but rapidly.

2. At the stage of constant drying, the water evaporation of pupae is the most and the evaporation rate is the fastest. During this period, the diffusion rate of water in the chrysalis is in equilibrium with the evaporation rate on the surface of the chrysalis. The temperature of the chrysalis is lower than the air temperature in the drying chamber, and the temperature of the chrysalis is lower than the temperature of the chrysalis, until the diffusion rate of water in the chrysalis gradually falls behind the evaporation rate on the surface of the chrysalis.

3. The drying phase in which the moisture in the cocoon gradually decreases and the evaporation rate correspondingly slows down. During this period, the temperature of the cocoon gradually rises close to that of hot air. When the inside of the pupa begins to

evaporate, the slowing down and drying turns from the first stage to the second stage until the drying ends.

3. COCOON BOILING

The sericin or the silk gum present on the cocoon filament keeps them together or the silk gum present on the cocoon filament keeps them together. (or) The silk gum present on the cocoon filament keeps them together compactly in the shell. This is softened with hot water or steam, so that the filament can be wound on the reel without breaks or entanglement. This process is called cocoon cooking wound on the reel without breaks or entanglement. There are different methods of cooking to suit the different reeling systems. Important are different methods of cooking to suit the different reeling systems.

Cooking for float reeling

Generally cooking for float reeling is followed both in small and big In India, The cooking for float reeling is divided into two types namely (open pan cooking) ,and (three pan cooking).

OPEN PAN COOKING

This method consists in cooking cocoons in ordinary open pans or vessels made of either earthenware or copper sheet with sheet with tinning inside the vessel. Water is poured into the vessel and brought to boiling by application of direct heat from the fire below the basin.

When the water begins to boil a handful of cocoons is put into the boiling water and kept in water.

When the cocoons appear dull in color and water for a few minutes by using a perforated ladle Somewhat translucent, they feel soapy to touch and the filaments easily come off when pulled. This method of cooking, though simple, is technically defective. The outer layers of the cocoon in contact with hot water get cooked earlier than the middle or inner layers This results in unnecessary dissolution softening of the gum which causes the filament to come off in lump and also spoils the cohesion, luster and cleanness of the reeled silk. To come off in lump and also spoils the cohesion, luster and cleanness of the reeled silk.Whereas, if the cocoons are removed for reeling soon after the outer layers are cooked, reeling becomes difficult when the middle and inner layers are reached.

In either case wastage of silk increases.

However, the defect of under cooking is overcome to some extent by keeping the reeling water at a high temperature, which adds to the cost of reeling besides causing other inconveniences to the reeler. These defects of the common open-pan system of cooking are reduced to some extent in cooking basins provided with an automatic brushing device. In this method when the brush is lowered into the basin after the exterior of the cocoons is cooked, the brush fits snugly into the basin and keeps the cocoons well pressed down in the boiling water. This enables cooking to be continued under covered conditions when the brushing is in progress, thereby forcing the boiling water to infiltrate through the shell layers, and soften and loosen the layers evenly throughout. As cooking and brushing are done in the same small basin containing a small quantity of water, the dirt and deleterious substances released from the cocoons make the water dirty with suspended impurities very soon, and the cooking operative has to keep draining the water regularly and adding freshwater to the basin.

This naturally increases the consumption of water and steam for heating the water. Increased consumption of water and steam becomes a serious problem where good reeling water and boiler fuel are scarce and costly. Due to the smallness of the size of the cooking basin only small quantities of cocoons can be cooked at a time with the result that the capacity of the basin to supply cooked cocoons for reeling becomes limited. This limitation has to be compensated by increasing the number of cooking units and employing more cooking operatives. All this involves considerable extra expenditure on equipment, labor and space. Lastly, as cooking of cocoons even of the same batch is done in several basins in small quantities by different operatives, there are bound to be variations in the degree of cooking or in the quantity of waste removed from cocoons in the several basins. Thus, this type of cooking is not conducive to standardization of cooking and removal of waste, and therefore, offers no scope for standardization of the economics of cooking operation.

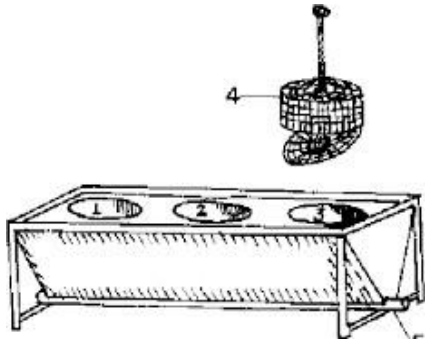
The only advantage of importance in this system is that the cooking operations are done in front of the reeler himself who can give timely instructions and guidance to the cooker regarding the degree of cooking required, and the cooker can easily manipulate the operations to suit the requirements of the reeler.

Cocoons are two of type colors

1. Yellow cocoons

2. white cocoons

THREE PAN COOKING :



The deficiencies of the open pan type cooking have been overcome to a considerable extent. Totally different from adopting a system of cooking totally different from that of the basin type. Three fairly large sized porcelain basins fitted in a row on equipment having three fairly large sized porcelain basins fitted in a row on a platform or table. The basins are provided with The basins are provided with water and steam connections. The accessory equipment consists of water and steam connections. Holding the cocoons, a wire mesh disc of a special design with a long handled brass wire. An open shelf is provided as an integral part of the table in front of the basins for keeping the accessories. Towards the end of the table a platform for keeping the trough which receives the accessories. In addition to these, the cooking unit is served by trolleys for carrying small wooden tubs with water. cocoons from the cooking unit to the reeling basins. The Water in the receiving trough and in the cocoon carrier basins is kept at 40ºC-45ºC. A required quantity of cocoons is taken and placed in the wire cage and after securely fastening the cage it and placing It is in the wire cage and after securely fastening the cage it is immersed in the first pan for about 60 seconds. and expelled. The cocoon cage is briskly lifted out of this pan and immersed in the second pan containing water at 65ºC for 30 or 40 seconds. Here the air inside the cocoons contracts and C for 30 or 40 seconds. Contracts and water from the basin is sucked in. Hot water permeates as a result of the first dip. In this process water from the basin is sucked in.

The cocoon shell layers are loosened and the hot water entering through the shell softens and shells the sericin later and water partly files the cocoon cavity. From the second pan the cocoons are discharged into the third pan

having water at 90 or 95ºC, and the cocoons are kept immersed by pressing down with the specially designed wire mesh disc. From the third pan the cocoons are transferred using long handled perforated ladles to the cocoon-receiving trough for onward supply in small buckets to the reeling basins for brushing and reeling. The process is made continuous by having two or more sets of the accessories and charging the vacant basins with cages with freshly filled cocoons as quickly as possible.

Cocoon cooking for sunken reeling

Cocoon Cooking Machine

Cocoonhopper part, Soaking part, High temperature permeating part, low temperature permeating part, Cooking part, Adjusting part, Low temperature finishing part, Cocoon outlet.

The six different processes or treatments to the cocoons passing through the six chambers of the machine are as follows:

FIRST CHAMBER

This is called the "Dipping" or "Wetting" chamber. It contains water at 40°C to 42°C where the cocoons are treated for about 30 to 50 seconds. The surface layers of the cocoons which will be in direct contact with hot water swell slightly due to wetting.

SECOND CHAMBER

This is the steaming or steam blasting chamber. The wetted cocoons coming in from the first chamber are exposed to the action of steam at about 90°-

95°C at proper steam pressure. The effect of this treatment is that the air inside the cocoon cavity is heated up to cause its expansion and partial replacement. As the hot dry steam is likely to make the sericin layers stiff and slightly less soluble, the optimum duration of treatment is limited to 60 seconds.

THIRD CHAMBER

This is the permeating or infiltration chamber and contains water at 40°-60°C. Due to the lower temperature, a partial condensation of the steam occurs in the cocoon cavity and the cocoon sucks in water thereby uniformly wetting all the layers of the silk in the shell, without dissolving the sericin. Treatment time is 30 seconds.

FOURTH CHAMBER

This is the steam cooking chamber in which the cocoons from the third chamber are subjected to steam treatment for 118 to 120 seconds keeping the temperature and pressure at 95°C to 98°C and 0.33 kg per cm3 respectively. This treatment causes the sericin to swell and soften the silk layers, and the steam to fill up the cocoon cavity.

FIFTH CHAMBER

This is the cocoon boiling and adjusting chamber and is very important because it is in this chamber that the steam contents of the cocoon cavity is replaced by water by gradual condensation of steam in the cocoon obtained by gradual cooling of the water from 98° to 60°C. Accurate maintenance of the reducing temperature - gradient is most important because too sudden cooling causes the cocoon to collapse or buckle. Actual time for the operation depends upon the compactness and other qualities of the shell. Weaker cocoons naturally require a prolonged gradient in temperature adjustment, and therefore take longer time.

SIXTH CHAMBER

This is the finishing chamber containing water at 50°-60°C. In this chamber water easily enters and fills up whatever space is still left in the cocoon cavity

leaving only about 3% or less of air space. Cocoons in this condition after 10 or 11 minutes are automatically discharged into a receiving trough containing hot water at 40°-50°C for transfer to the next process of brushing. The cocoons discharged from the boiling machine are filled with water and therefore sink in reeling water during the reeling operations. Sometimes certain chemicals are also used in the infiltration chamber toenhance reliability.

In that event the degree of boiling according to the quality of cocoons is adjusted. Generally the fiber swells and the surrounding area is loosened. The swelling or softening can be accelerated with the aid of swelling agents of the non-ionic or anionic type to improve the unwinding ratio of the filament. These agents are selected according to the hardness of the cocoon shell. Optimum dosages are arrived at after trials with the quality of cocoons available in different regions and seasons.

The main advantages of this method of cocoon boiling for the sunken system of reeling are:

1. Degree of cooking is uniformly achieved in all cocoons and in all layers.
2. Reliability is improved and enables reeling of 40 to 50 ends by one reeler thus increasing the output per reeler.
3. Only nine to ten trained workers are required for supplying cooked cocoons to about 400 multi-end basins, whereas in the ordinary type a minimum of 200 cookers would be required. This economy in labor requirements is of special importance in countries where labor is scarce and costly.
4. The percentage of wastage is reduced and standardized.
5. As reeling is done in tepid or lukewarm water, steam consumption for heating reeling water is considerably reduced and therefore, water and fuel economy is attained. Using less steam in the reeling hall reduces mill dampness and vapor formation in summer and winter. Reduced mill' dampness considerably prevents occurrence of such defects as hard gum spots, ribbing and plastering defects and improves ventilation and visibility.

6. Low temperature of reeling water does not injure the fingers and palm of the reelers and, therefore, does not in any way impair their reeling efficiency.
7. Due to non dissolution of sericin and avoidance of over-softening of the sericin, cohesion of' reeled silk is very good.

The modern concept of rational reeling is to unwind the filament at a slow speed to avoid excessive tension and to provide sufficient opportunity to maintain the requisite number of cocoons at each end. In other words, slow reeling over a number of ends ensures higher productivity and greater evenness and cleanliness standards for the raw silk.

CHEMICAL POWDERS :

- Cocoon Boiling is used in some chemical powders ,FIBROIN,SILK SERICIN POWDER.

SILK SERICIN POWDER

4.REELING PROCESS

Introduction of reeling:

Silk reeling is a process of production of silk thread by unwinding the filaments of required number of cocoons. Silk reeling is closely related to agro based cocoon raw produced by farmers .The cocoon is spun by silkworm by feeding on Mulberry host plant.This edition is confined to Mulberry silk which shares a major chunk of total silk production.There are other three types of silks classified as wild silks as originally they were a forest produce which were later on partially domesticated.

Raw material

Cocoon is the raw material for Silk reeling produced by sericulture farmers.It is a heterogeneous material influenced by a combination of multiple factors such as soil characteristics, plantation techniques, variety of food plants,Race ofsilk worms ,lrrigation facilities, Rearing techniques, Geographical conditions etc.

SEQUENCES OF OPERATIONS IN MULBERRY SILK

1. COCOON MARKETS
2. COCOON DRYING/STIFLING
3. SORTING OF COCOONS
4. COCOON MIXING
5. COCOON COOKING
6. REELING
7. RE-REELING
8. LACING AND SKEINING
9. BUNDLINGS.

MULBERRY SILK REELING

Reeling is a process where the raw silk filaments from cocoons are combined and wound on to a reel to make silk thread of standard sizes. The reeling process demands trouble free running without much breaks &with minimum wastage. Mulberry silk reeling on Multimedia reeling machine.

Types of reeling:

1. Charaka
2. Cottage Basin
3. Multi end reeling machine
4. Automatic Reeling

1. Charaka

Charaka is a crude & traditional system of reeling which is widely employed for producing coarse variety of silk yarn and Dupion yarn mainly utilizing defective Cocoons.

2. Cottage basin

It is an improved version over charaka with gadgets like button, croissure wheels and jetteboutte. Cooking and reeling basins are separated and an operator will look after 6-8 ends/basin. The production ranges from 0.8 kg-1.0 kg/basin depending upon theDenier of years reeled.

3. Multi end reeling machine

It is an improved version over Cottage basin. The production ranges from 0.7-1.2 kg/basin depending upon denier of the yarn reeled. One operator looks after 10 ends/basin It has features like button, croissure wheels, jetteboute, Individual reel stop motion & planetary traverse.

4. Automatic reeling

It is the ultimate version in silk reeling .Most of the operations such as cooking& brushing, cocoon feeding to reeling basins, Denier maintenance are automatic. Oneoperator can look after more than 40 ends .In Indian conditions there is a 50% saving of labour besides production of highly quality 2A grade mulberry silk.

5. Spinning:

The process for producing single yarn out of discontinuous filament of cocoon is known as Spinning. The process by which silkworm produce cocoons is also spinning. Eri cocoons are spun since they are opening mouthed and not composed of continuous filament.

Eri cocoons spinning are simple and the cocoons are spun using 'Takli' in almost all the production areas, however the spinning activities are largely concentrated in Palasbari, Bijoynagar, Goalpara, Kokrajhar and Udalguri. Of late, the Department of Sericulture, Govt. of Assam and Central Silk Board, Govt. of India intensified the Eri spinning activities after popularisation of the latest interventions. i.e. CSTRI spinning wheel and Ambar Charka spinning wheel. The large quantities of the Silk yarn produced in the state is utilised within the production state and small quantity of Eri yarn is sold outside the state. 'Takli' the age-old device for Eri spinning is still in vogue. About 57% spinners are engaged in spinning of yarn on 'Takli' and there is demand for such yarn or products in domestic as well as international market. For increasing the productivity of 'Takli' type yarn, an improved Flier spindletype-spinning machine has been developed by Hindustan Machineries, Bhagalpur which is being evaluated for final recommendation. This machine can be used to meet the demand of 'Takli' type yarn suited for weft. The machine also can be used for wet spinning to produce yarn suited for warp purpose. The productivity of this device is 60-100 gm per day as compared to 40 gm per day on Takli.

6. Twisting

- Twisting is the process of reeling the bundles of yarn to skein lacing. It can be achieved by winding two strands of silk into multiple threads. These multiple spools are again used to prepare the warp.
- Silk is rarely used directly for weaving. It undergoes the process of twisting/doubling and twisting depending on the type of fabric being produced.
- The first level of twist inserted to the thread is referred to as primary twist and the second level of twist is referred to as secondary twist. The twisting machines used for silk are up twisters.
- The doubling bobbins are placed on the spindles rotating at very high speed of about 8000 to 10000rpm.

- The yarn passes through the traveller or flyer guide and the traverse guide on to the perforated bobbins placed on the take up roller.
- The flyer also acts as a tensioning device and facilitates to impart uniform twist especially higher levels of twist. The tendency of ballooning more so in the case of coarse denier yarn is counteracted by the use of flyer.
- The twist applied to the thread depends upon the relation between the speed of rotation of the spindles and the winding speed of the take-up bobbins.

- The twist level can be altered by altering the speed of the take-up roller.
- It is necessary to frequently check the speed of rotation of the spindle, since variation in spindle speed would result in twist variations.
- Tachometer/stroboscope can be used for the purpose. The tension at which threads are being wound must also be checked in all parts of the frame, as sunless equal tension is maintained during twisting it will produce saw-thread.
- The twist in the yarn is defined by the number of turns per unit length of the yarn viz twists per meter (TPM) or Twist Per Inch (TPI) and the direction of twist. There are two possibilities of the direction of twist namely clockwise and anticlockwise designated as “Z” and “S” Twists respectively.
- The tenacity of the raw silk slightly increase upto certain level of twist and exhibits a slow but continuous decrease in tenacity with increase in twist.
- The rate of decrease in tenacity with increasing twist is higher as the number of plies increase.
- Twisting affects the brilliancy of a thread.
- As the twist increases, the luster of the thread decreases and the thread becomes opaque.
- This is due to the roughness of the thread‟s surface caused by twisting, the ridges of the spirals making shadows with loss of reflected light.
- Twisting further has the effect of shortening the thread used. The shortening is very little for fine deniers and for limited number of twist, but becomes significant for coarse deniers and as the number of turns increases.
- The shortening also affects the denier of the thread, which increases in proportion to the reduction in length.

7. WEAVING

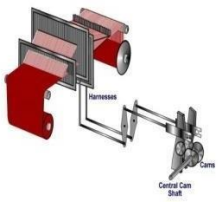
Forming a woven fabric requires five basic loom functions or motions: shedding, filling insertion, beat-up, let-off, and take-up. The first three motions take place in a set time interval and follow one another sequentially. Because these motions cannot happen simultaneously, conventional weaving is a single-phase process. Some machines can insert a number of picks almost simultaneously into a number of shed openings and beat each pick into the fabric. However, these multiphase (multished) machines have limited design potential and generate more lint when weaving spun yarns.

Shedding

This loom function separates all the warp yarns into a weave shed (opening) formed between a top shed (yarns that are raised) and a bottom shed (yarns that are not raised). Each weft yarn is inserted into the opening created by shedding of the warp yarns. Devices called harnesses contain a certain number of heddles through which warp yarns are drawn. Harnesses are raised and lowered to produce a particular woven design. There are three general methods of shedding, each with specific design capabilitie.

Cam Shedding:

Cam shedding typically uses 6 to 8 harnesses, though sometimes up to 12. As illustrated in, each harness is controlled by a rotating cam that forces the connected harness to move up and down in a prescribed manner to produce a particular fabric design. The profile or shape of each cam and its position on the camshaft dictate the movement of the connected harness. With cam shedding, designs are limited to basic weaves such as plain weave, simple twill weaves, and common satin weaves.

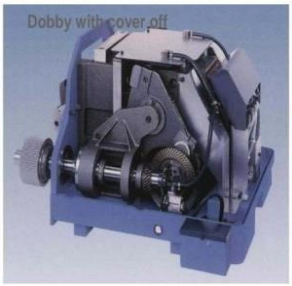


Dobby Shedding:

Dobby shedding typically uses 12 to 32 harnesses, which allows for a broader range of woven designs than with cam shedding. In addition to the basic weaves, dobby shedding makes it possible to weave small geometric figures, spot weaves, and more complex pattern stripes. Many machines with dobby shedding use plastic sheets with punched holes to direct the harnesses to be lifted in a certain sequence to produce a given design. A punched hole allows a pin to penetrate the sheet and initiate lifting of the associated harness. The weave design is thus controlled by the positioning of the holes in the pattern sheetshows a weaving machine using this type of dobby shedding.

Today, many weavers are investing in electronic dobby shedding machines that work in a much simplified manner, with no punched sheets. Connected with a computer-aided design system, these machines can quickly download and weave a developed design.

electronic dobby shedding machine:



Jacquard Shedding:

Instead of using harnesses to control the weave design, Jacquard shedding employs draw cords that drop down from a Jacquard head; each cord is connected to an individual heddle or a small group of heddles. This type of control makes it possible to form large design repeats and very intricate designs. A given Jacquard machine will have a certain number of hooks that

control the lifting of warp yarns. Having more hooks makes it possible to weave larger design repeats and more intricate designs.

Filling Insertion:

The filling, or weft yarn, can be inserted into the woven fabric by various methods. The oldest method, using a shuttle, has been replaced today by various shuttleless methods, which include rapier, projectile, air jet, and water jet filling insertion.

Shuttle Weaving:

Shuttles typically are inserted at the rate of 180 to 220 times per minute, referred to as picks per minute. The shuttle contains a quill on which a small amount of filling yarn is wound. The yarn unwinds from the quill as the shuttle goes back and forth through the separated warp yarns. A fresh quill of yarn is inserted just before the current quill is completely empty. Some shuttle machines are still in operation, weaving vintage denim and specialty fabrics. shows a shuttle with an empty quill inserted. The shuttle is tapered on each end for easy entrance into and exit and out of the weave shed. shows a shuttle machine manufactured in the late 1940s, with elements made
of iron, wood, and weather

weaving Shuttles

shuttle Loom

Rapier Filling Insertion:

Rapiers are rigid bars or flexible tapes with an attached gripper system to grip the yarn and insert it across the warp shed. The grippers typically are opened and closed with the aid of cams or springs. Most rapier weaving machines use a left-hand and a right-hand rapier. across the weave shed, where it meets the other rapier (the taker), which enters the

weave shed from the opposite direction, and the weft yarn is transferred from the giver to the taker. Each rapier then retracts from the weave shed to complete the process. The insertion process is typically repeated 350 to 600 times per minute, depending on machine width and model.

At least one manufacturer still produces single-rapier machines, which insert the rapier across the complete width of the fabric and return it empty beforeinsertion of the next weft yarn. This makes for a simpler operation and requires less critical timing, because successive picks are not exchanged from one rapier to another. Because rapier machines can insert a wide range of yarn types, from steel wire yarns to all kinds of novelty yarns, rapier filling insertion is the most flexible insertion method. Rigid rapier machines are excellent for weaving rip-stop fabrics, in which several yarn sare inserted simultaneously to help prevent the propagation of tears in the fabric. Rigid rapier machines and the rounded pipe-like devices at the front of each machine are where the rigid right-hand rapiers are recessed after leaving the weave shed.

1. Rigid rapier machines with Jacquard shedding

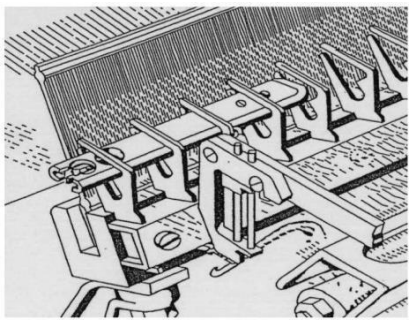
2. Rigid rapier machine with selection of 12 weft yarns

3. Double rigid rapier machine

Projectile Filling Insertion :

Projectile weaving machines contain a gripper that holds the filling yarn as the projectile is shot across the weave shed. A torsion bar stores up energy as it is twisted; when the energy is released, a connected lever strikes the projectile, propelling the yarn across the machine. A given machine will contain several projectiles, typically one per 10 inches of machine width. Projectiles are returned to the picking side of the machine via a type of conveyor-belt system; at any one time, several projectiles will be on the belt. Projectile filling insertion machines typically run at 300 to 550 insertions per minute. With fewer moving parts, they require less maintenance than rapier machines. Double-width projectile machines can make two separate fabrics with the same set of projectiles, thus doubling the speed of weaving. Projectile machines can produce denim-weight fabrics, as well as shirting weight.

Projectile filling insertion:



Air Jet Filling Insertion:

Air jet weaving machines use a burst of compressed air from an air nozzle to initially propel the filling yarn across the weave shed. Because the air disperses very quickly, additional relay air nozzles are evenly spaced across

the width of the weave shed to allow for weaving of wider fabrics. Air jet machines use a special profile reed to create a tunnel configuration through which the air and filling yarn travel across the weave shed. Air jet weaving machines can insert relatively coarse yarns, such as yarns for heavy bottom-weight denim; however, yarns any heavier than that would be difficult and more costly to weave, because of the high air pressures required. These machines can also weave finer spun yarns, but not ultra-fine yarns that might be blown apart. Spun yarns and textured filament weft yarns run well on these machines, but not slick flat filament yarns, because of their low surface friction. Air jet machines have lower maintenance requirements and fewer replacement parts than do rapier and projectile machines. Insertion rates ranging from 600 to 1200 per minute are typical for air jet machines.

The layout of the main nozzle and relay nozzle :

Water Jet Filling Insertion:

In water jet weaving, only hydrophobic fibers and yarns can be used, such as polyester, nylon, and olefin fibers. Most of the fabrics woven on these machines are made of filament yarns, which are less absorbent than spun yarns. A vacuum slot on the front of the machine front helps to remove any residual water from the fabric. All machine parts must be made of noncorrosive materials. Water jet weaving machines have insertionrates of 800 to 1200 picks per minute. The fabric most commonly made on water jet machines is mattress ticking.

PRODUCTS OF SERICULTURE

- The main product in silk industry is the production of thread obtained from the cocoons. In addition the silk industry can produce a number of byproducts like -

1. Mulberry:

I. Neutraceutical compounds in leaves:

Tea made from mulberry leaves is popular in China, Japan and Korea; it is beneficial for diabetic and hypertensive patients. DNJ, GBBA present in mulberry leaves reduces glucose level and blood pressure.

II. Antioxidants in mulberry fruits:

Ripe mul•berry fruits are used to make jam, jelly, pickle and wine.

III. Fuel and compost making from mulberry:

- Mulberry waste wood is a good source of cellulose for paper and chipboard industries.
- Mulberry shoots can be used as staking material for climbers of vegetable, ornamental or fruit crops and mushroom cultivation.
- Hard woods from mulberry are used for mak•ing hockey sticks and cricket bats.
- The fruits are edible; can also be used in the manufacture of alcoholic drinks
- The stem in the trees is white in colour, soft and pliable. It is in great demand in the manufacture of sports goods specially cricket bats. Many agricultural implements can also be fashioned out of the stem. The wood pulp of the stem is a good raw material for the manufacture of quality paper.
- Mulberry leaves constitute a good cattle feed. It is known that this feed increases the milk yield.

IV. Various parts of the plant body have a high medicianl value and are used in the Ayurvedic system of medicine.

i. The fruit is aromatic, cooling, laxative, removes thirst and good in the treatment of fevers.
ii. Bark is anthelmentic and purgative.
iii. Leaves in the form of decoction are used to gorgle in the treat•ment of inflammation of the vocal cards.
iv. Roots are anthelmentic and astringent (acts as a binding agent) and useful in the treatment of diahhroea.
v. There are four species of mulberry – Morus acedosa, M.alba, M. indica and M. nigra. All these species are of medicinal value.

2. Silkworm Larva:

1. Products from silkworm faeces:

In China, chlorophyll, phytol, carotene, and pectin are extrac•ted from silkworm faeces and used in food, che•mical and pharmaceutical industries.

2. Silkworm litter is also used as fodder and compost material

3. Pupa:

Oil extracted from silk moth pupa has numerous industrial applications like manufacturing soaps. After oil extraction, oil cake can be used as moulding material in bakelite industry. Silkworm pupa can also be used as feed for fowl, fish and pig as it is rich in protein.

A fungus Cordyceps sinensis cultured on pupae/moths, by use of recombinants have anti-tumour and anti-ageing properties.

4. Waste Silk:

Waste silk which cannot be reeled or spun is used to make silk film or silk powder which is used as feed additive for cosmetic products. Sericin can be used for the preparation of skin care items as it can provide excellent protection against ultraviolet rays

5. Silk Moths:

Silk moths are used as feed for livestock. Moths are also used for preparation of fungal medicine.

Silk filaments obtained from the cocoon of the silk worm have been used for textile production since sericulture was originally developed in china many centuries ago.

6.Silk worm faces:

The excreta of silk worms find a number of uses. It can be used in the production of vitamins (K and E), in the manufacture of acid resistant plastic sheets etc. The faces is also a good organic manure and can be added to the cattle dung to produce gobar gas. Manufacture of garlands – The remains of the cocoon after the removal of silk threads can be fashioned into garlands. These silk garlands are manufactured in Channapatna of Bangalore district.

Advantages of sericulture

The following points highlight the top eight advantages of sericulture. The advantages are:

1. **High Employment Potential**
2. **Provides Vibrancy to Rural Economy**
3. **Low Gestation, High Returns**
4. **Women-friendly Occupation**
5. **Ideal Programme for the Weaker Section of the Society**
6. **Eco-Friendly Properties**
7. **Scope for Professional Training**
8. **Facilities for Seri-Culturists**

1. High Employment Potential:

Only sericulture can generate vast employment. No other industry generates this kind of employment. Hence, it is used as a tool for rural economic reconstruction.

2. Provides Vibrancy to Rural Economy:

It is estimated that about 57% of the gross value of silk fabrics flow back to cocoon growers, who in general are rural people with share of income to different groups [56.8% to cocoon growers; 6.8% to the reelers, 9.1% to the twisters; 10.7% to the weavers; 16.6% to the trade]. Thus, large amount of income from silk industry goes back to villages from the cities.

3. Low Gestation, High Returns:

Land and rearing space) for mulberry cultivation and silkworm rearing Investment of only Rs. 12,000 to Rs. 15,000 (excluding cost of in one acre of irrigated land can generate net income levels up to Rs. 30,000/acre/ annum.

Mulberry takes only six months to grow for starting silkworm rearing and once planted it can support five crops in one year under tropical condition. Depending on the management, rearing at least for 15 years can be continued in the same land.

4. Women-friendly Occupation:

Different activities of sericulture starting from mulberry garden management, leaf harvesting and silkworm rearing even reeling and weaving can effectively be supported by women workers. In India, it has been found that over 60% of sericulture employees constitutes the women folk.

5. Ideal Programme for the Weaker Section of the Society:

Low land holders even can start sericulture. Silkworm rearing in 3/4 acres of mulberry garden can support a family of three without hiring labour. Moreover, vast areas of tasar food plantation are available in different forests of India; if judiciously exploited for rearing tasar silkworm, these can offer a great supplementary employment to tribal Indians.

6. Eco-Friendly Properties:

- **Soil preservation:** Being perennial plant with green foliage, mulberry contributes to soil preservation and provides vast green covers.
- **Manures:** Wastes from silk worm rearing can be recycled for mulberry garden preparation as manures.
- **Fuel source:** Dried mulberry twigs and branches can be used as fuels by the farmers, thus in turn can reduce the pressure on nearby vegetation or forest.
- **Pollution control:** Being an agro-based industry, it requires minimum use of fuel machinery, thus reduces air pollution.
- **Integrated farming:** With other plantations like flower, vegetables, mulberry can be cultivated as intercrop, thus same land can be used for various productions.
- **Uses of land:** Besides cultivation lands, water shade areas, hill slopes, vacant lands, etc. can also be used for the deep-rooted mulberry plants.

7. Scope for Professional Training:

Sericulture departments of various states arrange for training on different aspects of sericulture to the farmers with monthly stipend and field training. At national level, the Central Silk Board (CSB) organises three kinds of programmes. The first is open to all, the second to in-service personnel and the third to the farmers. Short term courses. Intensive Training Programmes are also organised by CSB from time to time. The International Centre for Training and Research in Tropical Sericulture (ICTRETS), Mysore conducts three courses on tropical sericulture at international level. In the vocational scheme, sanctioned by UGC, students can take sericulture as their subject of choice. Thus, sericulture is providing a wide scope for choosing profession to all sorts of people in the society.

8. Facilities for Seri-Culturists:

Besides providing field and educational trainings, Regional Extension Centres and Technical Service Centres of both State and Central Sericulture Boards supply advanced-staged larvae to the rearers; rearing appliances and other raw materials like mulberry samplings are supplied at nominal cost to the rearers. Incentive bonus is offered to bivoltinerearers. Crop insurance schemes have been offered specially to bivoltine farmers to protect against any failure. In remote rural areas, farmers are supplied with pamphlets or other essential details of methods of rearing, use of bed disinfectants, insecticides, etc.

Disadvantages of sericulture:

1. Drawbacks: Sericulture must be done in closed premises; workers must work in poorly ventilated premises. This creates respiratory problems for these workers. Dead silkworms are handled by the workers with their bare hands which leads to various diseases and infections.
2. Cost: Silk is a high-end fabric that can be expensive to produce, which can drive up its cost for consumers.
3. Delicacy: Silk is a delicate fabric that requires special care to prevent damage, such as hand-washing or dry-cleaning. Stains: Silk is prone to staining and may be difficult to clean if spills or stains occur.
4. Time-consuming: Silkworm farming is a time-consuming process, requiring close monitoring of the silkworms growth and development, as well as the maintenance of their environment.
5. Disease prone: Silkworms are susceptible to various diseases, which can cause significant losses and reduce profitability.
6. Depleting Water Table: Sericulture in India is practiced in select areas that depend largely on rain. Hence, water resource for irrigation has been a major concern and depleting water table is a big threat for the industry.
7. If the garment is worn, it wears out quickly and is highly susceptible to damage from perspiration, salt, and tears; if stored away, it becomes brittle and begins to shatter along lines of wear at an expedited rate.
8. Sericulture uses various techniques which can be harmful to farmers, one by-product which is released during the rearing process is carbon monoxide that can cause skin allergies, irritation and respiratory problems.
9. Silk protein itself has excellent biocompatibility and biodegradability, but compared with its excellent biological properties, its mechanical properties are often not ideal, with the disadvantages of low mechanical strength, poor gel quality, low molding efficiency, insufficient water retention performance, poor.
10. The disadvantage of silk fibroin is the high brittleness, which makes it difficult to handle as a scaffold biomaterial, especially when implanted in load-bearing sites [16,17]. In addition, some findings show that some

synthetic materials may decrease mechanical properties very early during degradation [18,19].

11. During a process where cocoons are kept in hot water to loosen the silk fibres. During this workers have to keep their hands directly into the water to check the cocoons which will lead to secondary infection.
12. Workers have to work for longer periods of time, like 12-16 hours a day. This will result is severe back pains and also in legs.
13. People who do not have proper knowledge will face difficulty in handling the silkworms.
14. A major disadvantage is that the silk produced by a diseased silk worm can be disastrous and can cause huge loss. When the cultivation is practiced of this kind the fertility of soil is lost.
15. common problems faced by the Indian silk industry are – Price fluctuation, Absence of proper market, Lack of transport facilities, Absence of storage facilities, Poor information on market trend, Lack of finance, High cost of production and low productivity, lack of technology penetration, prevalent rural nature of the …
16. The pebrine disease can infect the eggs, resulting in their death before the hatching of the larvae. Any larvae affected by this disease develop dark spots and become lethargic. Viral infections in the larvae may result in the shrinkage of their bodies.
17. Cost: On top of being one of the costlier fabrics, silk fabric is also costly to maintain. Dry cleaning services are not very easy on the pocket and this fabric requires special attention and care.
18. Sun Damage: Although silk fabric is pretty strong and durable, long exposure to sun rays can cause the fibre to weaken.

DISEASES OF SILKWORM / SILK MOTH

Diseases of silkworm are a big challenge for the rearers. Due to prolong domestication, silkworm develops less immunity and less adaptability for which they are often attacked by different agents. Although some attempt has been made to develop disease resistant silkworm variety, but only a limited success is obtained till date. In spite of taking many efforts on the rearing environment, silkworms are vulnerable for infection of the following agents or pathogens-

1. Protozoa
2. Bacteria
3. Viruses
4. Fungi

1. Protozoan Diseases

A) Pebrine-

This is one of the most virulent protozoan disease. The disease is caused by protozoa- Nosema bombycis. NIK-2r, NIK-3h and NIK – 4m are the three most virulent strain of this pathogen found in India. The protozoa complete its life cycle through two stages- infective spore stage and vegetative stage.

Symptoms-

Symptoms exhibited by the different stages of life cycle of silkworms are:

Egg:-

1. Infected egg exhibit less attachment with the egg cards due to improper deposition of glue.
2. Eggs turn pale yellow and may fail to hatch.

Larvae:-

Primarily infected larvae normally die before exhibiting any prominent symptoms, while secondary and tertiary infected larvae shows symptoms like loss of appetite, unequal body growth, clean worm symptom due to irregular and incomplete moulting**.** Infected worm also shows some piper like black spots on the body, irregular brown patches resulted due to dead hypodermal cells, spitting or wasting of silk instead of spinning cocoon, passing of soft faeces and generally die after spinning pupating .

Pupa –

Live infected pupa if present inside cocoon or if they infected at the pupal stage only they show black colour, swollen body with black spote on either sides of the abdomen.

Adult moth:-

i) Infected adult moth show black spots on the abdomen, deformed antennae, unstretched and discoloured wing.

ii) Adult female usually laid eggs in irregular loose heaps. Body scales also fall off easily.

Mode of transmission:-

The disease is transmitted to silkworm in three different ways.

i) Oral- The leaves in the rearing bed normally get contaminated with the spores liberated through the faeces of infected worms or dead larvae. So, when such food is consume by healthy larvae, they get infected. Contamination may also occur at the time of oviposition or after oviposition.

ii) Direct contact- Infection may occur through the skin of larvae in the rearing bed when contacted with the Nosema spores contained in the faecal matter or dead tissues.

iii) Transovarial- when infection occurs in the 5th instar larvae the adult moth immerges normally from the pupa. Under that situation the spores of Nosema Sporulate within the oocyte and pass on to the egg. Thus the eggs acquires infection from the mother and hatched into primary infected larvae. However, most of these infected larvae grown up to 3rd instar only. These larvae again act as the source of secondary infection through dead larvae and contamination by faecal matter. Secondarily infected larvae exhibit pebrine symptoms, unable to spin healthy cocoon and produce tertiary infection to 5th instar larvae.

Detection of pebrine-

Disease can be detected by keen observation to the rearing bed, the symptions and by microscopic observation of the homogenate, fluid from the body and faecal pellets, where the presence of the spores of nosema can be detected.Nowadays,by advance immune- enzymatic method presence of pebrine spores can be detected quickly.

Control measure:

Following techniques are adopted generally to get-rid of Pebrine:

1. Only disease free layings are allowed for rearing in the grainages.
2. If diseased larvae detected in the rearing bed they should be removed immediately and burnt.
3. All rearing appliances including the rearing room should be dis infeted with 4-5% formalin or bleaching powder. For rearing accessories instead of routine formalin benomyl/ Bavistin/ Bengard etc. can be used.
4. Disease resistant races (eg. Nistari) can be considered for rearing.

2. Bacterial Diseases

Most common bacterial diseases are

a) Bacterial Flacherie

Silkworm suffering from this disease exhibit diarrhea and vomiting. It is caused by Bacillus bombycis, B.sotto, Streptococcus bombycis, Pseudomonas aeroginosa etc.

Symptoms-

symptoms include:

i) Lack of eppetite. Diarrhoea and vomiting occur as common symptoms.
ii) Growth stunted and shrinkage of the body observed after moulting.
iii) Skin become loose and soft and exhibit sluggish movement.
iv) Body colour become dull to black-brown.
v) The larvae show signs of pain and convulsions and ultimately die.
vi) Body turns black and emits foul smell.

Mode of transmission

i) Oral transmission- After taking contaminated leaves by the larvae from the rearing bed bacterial growth occur in the gut of larva and consequent deposition of lactate, acetate etc. reduces the gut permeability and lower the pH and infection spreads all over the body of the larvae. Larvae release stoolwithbacterialspores and then next set of infection starts.

ii)Rearing environment – Environmental physical factors like temperature and humidity of the rearing room also plays a vital role in disease transmission. Humid environment in the room may enhance the spreading of Flacherie bacteria.Detection of flacherie bacteriaHistopathological analysis of gut can detect the bacterial infection by the detection of cylindrical or goblet and Diplococcus infection respectively. Control measures:

1. Through maintaining optimum humidity and temperature in the rearing room.
2. Providing healthy and disease free leaves to the rearing bed.
3. Disinfection of the rearing room and the rearing appliances with 2% formalin should be done regularly.

b) Septicemia-

It occurs due to infection of haemolymph by bacteria. It mainly causes by the infection of Bacillus, Streptococcus and Staphlococcus bacteria. Transmission of the disease occur through intake of contaminated leaves and wounds in the skin.

Symptoms-

i) Body exhibit softening.
ii) Body colour changes to brown.
iii) Larvae release liquid excreta.
iv) Loss of clasping power and death occurs frequently.

Control measure- Proper sanitation an hygiene should be maintain in the rearing room. Infected larvae should be immediately removed from the bed to prevent spreading of the disease. Handling of larvae should be done carefully to reduce skin wounds.

c) Sotto-

This disease is caused by some bioinsecticidal bacteria. For eg, Bacillus thuringiensis , which is widely use as a bioinsecticide release some endotoxin thuricide. When the larva consume the toxin two types of affects occur. In one type the larvae of B. mori stop feeding, haemolymph urn alkaline and papalysis occurs within 60-80 minutes of intact. In another type lepidopteran larva only show rapid inhibition of feeding.

Symptoms- Loss of appetite, sluggish movement, shrinkage of skin, diarrhea, Loss of clasping power of prologs, Body turns black after death and foul smell emit from the body.

Control measure- Cleaning of rearing room with hot water to inactive the toxins, immediate removal of the infected or dead larvae for the rearing bed, bacterial spores should be destroyed by exposing to 2% formaldehyde for 3hrs or 1000C for 5minutes.

d) Court disease-In this bacterial disease the affected dead larvae turn flaccid and the colour changes to crimson red. This disease is also commonly known as Rrangi due to this formation of colour. Causative bacteria- disease is caused by the infection of bacteria Serratia marcescans and S.piscavotar following the primary infection with Streptococcus faecalis . Infection occur through oral route or the skin wound.

Control measure- maintenance of the hygienic rearing room, removal of dead or infected larvae, cleaning of appliances with 2% formaldehyde are the measures for the diseases.

3. Viral diseases

1.Grasserie-

Symptoms-Thisdiseaseischaracterized by the jaundice like symptoms which are collectively known as Grasserie- orPolyhedrosis. Other symptoms includes symptoms includes

i) Loss of appetite

ii) Formation of loose and shiny white skin with swellings in the inter segmental zones.

iii) Release of milky white of yellowish fluid from the body containing polyhedral.

iv) Infected larvae turn restless and do not undergo moulting.

v) Translucent cephalothorax and opaque mid gut observed due to accumulation of polyhedral in the cytoplasm. Causative organism- nuclear polyhedrosis of B. mori is caused by Nuclear Polyhedrosis Virus strain Bm (NPV Bm). This DNA virus multiplys only in the nucleus of the host cell. the virus embedded in a proteinaceous mayrix called PIB (Polyhedral Inclusion Bodies). In midut polyhedrosis , the RNA Smithia virus form polyhedra in cytoplasm in case of midgut cytoplasmic polyhedrosis or in nucleus in case of midgut nuclear plyhedrosis.

Mode of transmission

1. Orally through contaminated leave with PIB from dead larvae or their
2. excreta.
3. High temperature and Humidity may enhance the transmission of latent stage of virus to virulent stage.
4. Blocking of spiracle by some agents like dust , exposure to formalin etc. may
5. enhance the spreading of the disease.
6. Skin wound also enhance the disease.
7.

Control Measure

1. Maintenance of hygienic environment, proper ventilation in the rearing room.
2. Sterilization of the rearing room with 2% formaldehyde or Bleaching powder or Resham Keed Ouzhad (RKO) or Labex.
3. Immediate removal of dead or infected larvae from the rearing bed.
4. Oral administration of nalidixic acid, P- aminobutyric acid etc. or topical application of imanine can control NPV to some extant.

b) Infectious Flascerie-

Infecious flasceri Virus(IFV) causes a type of flascerie of the silkworm,. This virus enter to the body of animal through the oral route along with the leaves. Vomiting and shrinkage of the body along with appearance of transparent body are the symptom of this disease.

The disease can be control by the following measures :

1. Feeding the larvae with healthy and hygienic leaves.
2. Maintanence of proper hygiene of the rearing room.
3. Disinfection of rearing appliances with formalin.

c) Gattine- This disease is also known as Clear head disease as the ffacted worm shows transparent, particularly the anterior part of the body. Causative organism is primarily some virus while Streptococcus bombycis act as the secondary agent. Loss of appetite and Supplying of proper healthy leaves, hygiene in the rearing room and Disinfection of rearing appliances are the measures to be taken for the controlling of the disease.

4.Fungal diseases

a) Muscardine- In muscardine the body of the larvae get mummified due to deposition of calcium oxalate . Hence the disease is also called as 'calcino'.Symptoms includes- Sluggish movement of the larvae, loss of appetite, vomiting , shrinkage of body with loose cuticle are observed. Larvae infected at the early stage do not spin, but those infected late may spin cocoon where the pupa die inside. Dead larvae generally covered with the spores of the infected fungi or may be mummified with white powdery material.Causative fungi is different muscardine. Depending on the colour of theconidiospores name of muscardine is different.

Name of muscardine

1. White muscardine
2. Black muscardine
3. Yellow muscardine
4. Brown muscardine
5. Red muscardine

Causative fungi

Beauveria bassiana,
Metarrhizium arisopliae.
Poecilomyces farinosus
Aspergillus flavus and
A. oryzel Sorosporella uvella

Mode of transmission- All types of muscardine infection occurs through contaminated leaves, through skin and spiracles. The fungal spores germinate after falling on the silkworm skin and gradually penetrate the cuticle by mechanical and enzymatic forces.

Control measures

1. Proper light, humidity and aeration should be maintained in the rearing room. Any factors that may help the growth of fungi should be avoided.
2. Temperature should be kept above 220C.
3. Infected larvae should be remove immediately and buried in a deep pits.

4. For the preparation of bed 0.45 formalinised husk can be use for 1st and 2nd instars, 0.5% for 2nd and 3rd instars. 0.6% for 4th instars and 0.8% for for 5th instars.
5. During moulting after every cleaning operation dithane-M45and kaoline can be applied to prevent the germination of fungal spores if any.
6. For every 100layings, 3-4kg of Resham Keed Ouzhad (RKO) can be spread after each moulting and 30 minutes before the larvae resume feeding.
7. Laabex, a mixture of lime and bleaching powder has anti-muscardine and grasserie effects, also improve larval growth.

Parasites of Silkworm

Uzi fly larvae:

Uzi fly deposit their eggs on the lepidopteran larvae. Two well known Indian variety of this fly are Tricholyga bombycis and Exoristasorbillans.

Mode of transmission-

After 2-3 days of ovi position, the leg less maggot penetrates into the body of the silkworm larvae by making a hole in the cuticle. The maggot then consume the larval tissues and complete the instars and come out from the body of the host for pupation. The host larvae dies in the process.

Symptoms-

Infected larvae shows black spots o the body, which are actually the entry points of maggot. Larvae loss body weight due to loss of tissue. Exhibit sluggish movement and stop feeding.

Control measure –

I. Uzinet(a nylon net of fine mesh) can be use to prevent the entry of Uzi fly to the rearing room.
II. Uzicide or Vijeta can be spread on rearing tray to kill the uzi eggs without hampering the normal growth of the silkworm larvae.
III. Reproductive potential of uzi fly can be prevented by introducing radiation exposed sterile fly.
IV. Biological control can be applied by introducing natural predators like spider in the field.
V. Uzi larvae and pupae found in the rearing room should be collected and destroy by putting them into hot water.

Beetles, Ants and Straw mites also produce damage to the silkworm industry.

Precauctions of sericulture

- No control measure for the disease has yet been evolved. The elimination of diseased eggs during grainage by microscopic examination and diseased larvae during rearing is the only preventive measures against the disease.
- Preventive measures can be taken in case of indoor operations of the cultural process, but in outdoor rearing of muga worm, the infection may come from extraneous sources.
- Follow the scientific inspection method of individual mother moth testing for detection of pebrine in egg production.
- Practice disinfection of grainage appliances before and after every grainage operation with 2% formalin.
- Ensure use of microscopically tested disease free disinfected eggs only.
- Practice surface sterilization of the eggs with 2% formalin for 5 minutes.
- Maintain hygienic conditions in egg production room and rearing sites.
- For basic stock maintenance, follow cellular method of rearing.
- Practice disinfection of rearing appliances before use.
- During rearing, test the faecal matters, unequal/lethargic/unsettled/irregular moulters periodically. If pebrine spores are detected, reject the entire infected crop.

- Ensure the measures for destruction of diseased silkworm larvae/cocoons/moths/eggs.

- Silkworms prefer a dry, cool, airy place. Keep their house away from direct sunlight and clean it out daily removing droppings and old leaves as Silkworms will suffocate if they are buried under rotting leaves. Placing a sheet of newspaper on the bottom of their enclosure will make cleaning much easier.

- Provide requisite spacing, good ventilation, good quality mulberry leaf, Maintain the recommended temperature and humidity. Practice hygienic measures during silkworm rearing. Identify and pick out infected larvae in the early stages and ensure destruction of diseased silkworm

- Three precautions to be taken during sericulture are: - The eggs should be stored below the temp 18°C for long term. - Clean and dry mulberry leaves should be fed to larvae. - A few cocoon of good quality should be kept as seed.

- Rear silkworms under optimum temperature and humidity. Avoid injury to the larvae. Apply recommended bed disinfectant as per schedule and quantity. Feed Amruth as per schedule to control flacherie disease.

- Prune the Affected Branch – Silkworms won't kill off a branch, but sometimes the easiest way to get rid of them is to prune the branch where the nest is built. Use Insecticide – If your trees are being overrun by hungry silkworms or you have a number of young saplings, it's time to consider using insecticide.

- Disinfection of tools and appliances of the rearing house by 2% formaline is essentially necessary to control the pebrine disease. But the measures cannot be applied in case of outdoor of the disease can be minimized except local occurrence.

People economics of sericulture:

1. Sericulture is an important labour intensive, agrobased industry providing gainful employment to unemployed in the rural and semi-urban areas and facilitates economic development and improvement in the standard of life of the people.
2. Sericulture industry provides employment to approximately 8.7 million persons in rural and semi-urban areas in India.
3. The income generated with these values would be approximately Rs. 28,000/- per year.
4. Developments were made in irrigation, crop-raising and breeding, building and handicrafts. Trade and commerce also flourished, and the Silk Routes became an increasingly important part of economic and cultural life, whilst coinage from this time serves as an indication of the political structure of the Kushan Empire.

Establishment Cost of Mulberry garden:

Mulberry plant has a bushy structure having life span of 15 years. Raising of mulberry garden is the basic need for rearing of silk cocoon. Since, mulberry garden and rearing ofcocoon are two aspects of silk production, proper care of mulberry garden is very necessaryfor getting fresh, ample and continuous feed to larvae in the form of mulberry leaves in orderto get fabulous silk cocoon production and to earn greater profit. This refers to the cost involves in establishing mulberry garden. It includes expenditure on different input uses during establishment period of garden.

Establishment cost of rearing house:

This refers to the cost involved in establishing the rearing house. It includes the expenditure on different equipment uses during the establishment of rearing house. Rearing of silkworm is important to produce raw silk.In this process, silkworms are reared atappropriate temperature and humidity to get silk threads from cocoons. This rearing process is important to produce desirable quality of cocoon.

Maintenance Cost of Mulberry garden:

It includes the expenditure incurred on the inputs used for the maintenance of mulberry garden. Maintenance cost starts after the establishment of mulberry garden after six months.

Maintenance and rearing cost of silk cocoon:

Once the mulberry garden is established it is to be maintained every year, the expenditure involved in this operation is treated as maintenance cost. Side by side the DFLs are also to be needed to rear in rearing house for produced silk cocoon. The silkworm rearing activities end up with the production of cocoons. This is carried out as an indoor activity. Cocoon production in silk industry is the main produce from which silk yarn is produced. Silk cocoon grower also earned income from by-produce i.e. manure.

PROBLEMS FACED BY FARMERS IN PRODUCTION OF COCOON:

- Inadequate knowledge about improved method of rearing.
- High cost of establishment of rearing unit.
- Unavability of timely labour.
- Lack of market information.
- More transportation cost for transport of cocoon to distance market.

Silk Samagra Scheme for Development of Sericulture:

Under the Central Sector Scheme Silk Samagra an Integrated Scheme for Development of Silk Industry (**ISDSI**) implemented by Government of India through Central Silk Board (**CSB**) with a total outlay of Rs. 2161.68 crore for three years (2017-18 to 2019-20) for the overall development of silk industry in the Country with an objective to scale up production by improving the quality and productivity.

The scheme comprises four major components

(i) Research & Development, Training, Transfer of Technology and Information Technology Initiatives.

(ii) Seed Organizations

(iii) Coordination and Market Development and

(iv) Quality Certification Systems (QCS) / Export Brand Promotion and Technology Up-gradation.

1.Features of the Scheme

All the four major components of Silk Samagra are interlinked with each other and aimed at a common goal.

The main objective of the scheme is to maintain Breeders stock, Breed improvement through R&D Projects, Development of mechanized practices, Technology translation through Sericulture Information Linkages and Knowledge System **(SILKS)** Portal, Mobile Application for Stakeholders and for seed quality monitoring, develop technology packages, impart training on improved technology programmes to Stakeholders, and transfer technology to the field through front line demonstration, produce Basic & Commercial Seed of the improved Silkworm breeds developed by the Research Institutes, encourage Private Partnership in Seed sector, and Maintain & Certify the quality standards set by the R&D units for Silkworm Seed, Cocoon, Raw Silk and Silk products covering the entire Silk value chain.

Major Interventions:

1. Research & Development:

Race improvement through development of improved host plant varieties and improved disease resistant Silkworm breeds through collaborative research with reputed National Research organizations like **IITs**, **CSIR**, **IISc** and International research institutes on Sericulture.

2. Seed organisation:

Seed production units will be strengthened to bring in quality standards in production network, besides increasing the production capacity to cater to the increased silk production target, promote adopted seed rearers to generate quality seed cocoons, Private Graineurs to produce quality seed and Chawki Rearing Centres **(CRCs)** with Incubation facilities to produce and supply chawki worms,

3. Quality Certification /Brand Promotion:

Promote Indian silk through quality certification by Silk Mark not only in the domestic market but also in the Export market. Besides, emphasis has been given for use of Silkworm by-products (pupa) for Poultry feed, Sericin for Cosmetic Applications and Product Diversification into non-woven fabrics, Silk Denim, Silk Knit etc. for value addition.

The scheme also comprises of various beneficiary oriented components to support Mulberry, Vanya and Post Cocoon Sectors.

These interventions cover the major areas

(a) Development and expansion of host plant,

(b) Strengthening and creation of Silkworm seed Multiplication infrastructure,

(c) Development of farm and post-cocoon infrastructure,

(d) Up-gradation of reeling and processing technologies in Silk, and

(e) Capacity Building through Skill development / Enterprise Development Programme.

The above scheme interventions are expected to increase /improve the production and productivity of silk.

The details of expected outcome of the scheme are as under:

- Increase the Silk production from the level of 30,348 MTs (Metric Tonne) during 2016-17 to 38,500 MTs by end of 2019-20,
- Increase the production of Bivoltine Import Substitute Silk to 8500 MTs from 5266 MTs in 2016-17
- Increasing Vanya Raw Silk production to 11,500 MTs from 9075 in 2016-17 MTs.
- To produce International Grade Silk of 4A and above to minimize the import to bare minimum.
- To generate additional employment to about 15 lakh person by reaching 100 lakh persons by end of March,2020 from the level of 85.10 lakh persons in 2016-17.
- 82562 villages under 455 districts in 26 silk producing states have been covered under the scheme **"Silk Samagra".**

The details of funds sanctioned/ allocated and utilized under **"Silk Samagra"** scheme during the years 2017-18, 2018-19 and 2019-20 in the country.

Sericulture is an agro-based cottage industry having huge employment and income generating potential in rural and semi-urban areas. It is estimated that sericulture industry provides employment to approximately 91.20 lakh persons (including 3.40 lakh persons in the State of Tamil Nadu) in rural and semi-urban areas in the country as of March-2019. Of these, a sizeable number of workers belong to the economically weaker sections of society, including women. This is mainly due to implementation of Government schemes and efforts made by State/ Central Government.

The main aim of **"Silk Samagra"** Scheme is to empower downtrodden, poor & backward tribal families through various activities of sericulture in the country including women. Women constitute over 60% of those employed in down-stream activities of sericulture like mulberry garden management, leaf harvesting and silkworm rearing etc. Even silk reeling industry including weaving is largely supported by them.

An average of 30% women beneficiaries are being covered under the **"Silk Samagra".** Women SHGs are involved in implementation of various beneficiary

oriented components under "**Silk Samagra"** specially group activities. Through beneficiary oriented components of the scheme, support has been extended under Tribal Sub Plan **(TSP)** to take up sericulture activities by tribal for their livelihood. The scheme as employment provider tool improved the living standards and economic conditions of the downtrodden, poor, backward & tribal families by supporting to take up various sericulture activities for their livelihood.

Silk production

- The raw silk production in India amounted to about 35 thousand metric tons in fiscal year 2022, an increase from the previous fiscal year.

Top Silk Producing States in India

- Karnataka, Andhra Pradesh, and Assam are the top three silk-producing states in India.
- This article will throw light on the top silk-producing states of India and cover some interesting facts related to sericulture.

Silk Producing States of India:

The top 10 silk-producing states of India are listed below:

● Karnataka

● Andhra Pradesh

● Assam

● Tamil Nadu

● Meghalaya

● Jharkhand

● Manipur

● West Bengal

● Maharashtra

● Chhattisgarh.

Silk Production Centres of States:

There are important silk production centres in different states, which are given below:

Karnataka:

- The important silk production centres of Karnataka are Kollegal, Melkote, Molakalmuru, Ilkal, Anekal, and Bengaluru.

Andhra Pradesh:

- The important silk production centres of Andhra Pradesh are located in Dharmavaram, Pochampalli, Venkatagiri, and Narayanpet.

Assam:

- Sualkuchi is the main silk production centre in Assam.

Tamil Nadu:

- The important silk production centres of Tamil Nadu are Kumbakonam, Thanjavur, Kanchipuram, Arni, and Salem.

West Bengal:

- Birbhum, Murshidabad, and Bishnupur are the silk production centres in the state of West Bengal.

Chhattisgarh:

- Raigarh, Chanderi, and Champa are the important silk production centres in Chhattisgarh.

Silk Production Centres in the Other States:

The important silk production centres in other states are given below:

- In Bihar, the important silk production centre is located in Bhagalpur.
- In Gujarat, the silk production centres are located in Cambay and Surat.
- In Uttar Pradesh, the silk production centre is located in Varanasi.
- Paithan is the silk production centre in Maharashtra.
- In Jammu & Kashmir, the silk production centre is located in Srinagar.

Sericulture in India:

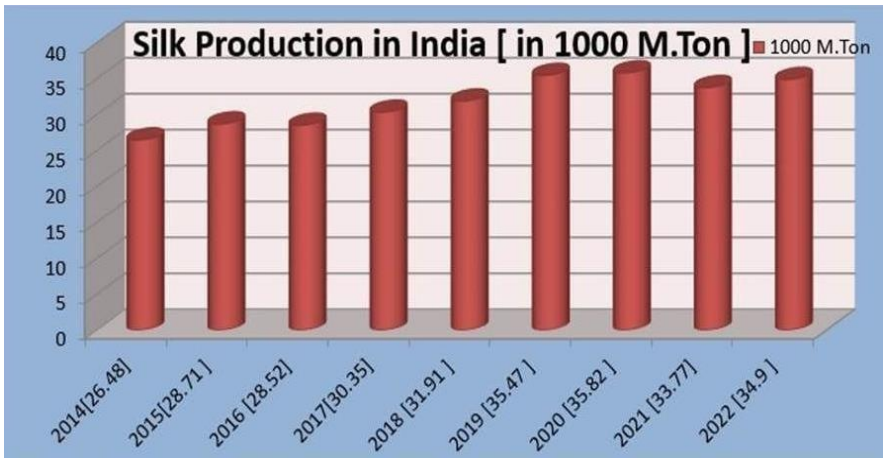
- Karnataka is the highest producer of silk in India. The important silk production centres of Karnataka are Kollegal, Melkote, Molakalmuru, Ilkal, Anekal, and Bangalore.
- Karnataka, Tamil Nadu, Andhra Pradesh, Assam, and Uttar Pradesh are some of the states of India which are famous for producing silk. In Uttar Pradesh, Varanasi is famous for its silk. In Tamil Nadu, Kanchipuram is famous for its silk.
- China is the world's largest producer of silk. India is the second-largest producer of silk in the world.
- Assam is the largest producer of Muga silk.
- The best all-season natural silks of India are Mulberry silk, Banarasi silk, Muga silk, Chanderi Silk, Baluchari Silk, etc.

Silk production in India:

- India is the only country where all types of silks are produced main of them being
- mulberry, tropical Tasar, Oak Tasar, Eri and Muga.
- Out of which much is known for its unique yellow glitter and is a prerogative to India. In India, mulberry sericulture is the major component, and it is practised in the five states, namely Andhra Pradesh, Assam, Karnataka, and West Bengal, Jharkhand, Tamil Nadu.
- Northeast region is the only unique that produces four varieties of silk which are Mulberry, Oak Tasar, Muga and Eri.
- India's total silk production out of which 18% is contributed by the northeast region.
- India is the second-largest producer of silk in the world.

Graph of the silk production:

Volume of raw silk production in India from 2014 to 2022


Silk Production in India [in 1000 M.Ton]
1000 M.Ton
40
35
30
25
20
15
10
5
0
2014[26.48]
2015[28.71]
2016 [28.52]
2017[30.35]
2018 [31.91]
2019 [35.47]
2020 [35.82]
2021 [33.77]
2022 [34.9]

Conclusion

India is the unique country of the world where all 4 varieties of silk namely mulberry, muga, tasar and eri are produced. Sericulture has been identified as an occupation of low investiment, employment creating and income generating. Favourable climatic conditions and participation of large number of women in sericulture industry will lead the development of silk industry to a greater height.

Sericulture offers self-employment opportunities to educated unemployed youth in different sectors. Many by-products can also be produced from sericulture activities. Moreover, Mulberry and silkworm have pharmaceutical values in the world.

Thus it is concluded that silk a lustrous, precious natural fibre is popular for its highest position among all fibres as Queen of fibres and requires careful processing so as not to affect its feel and appearance.

TOPIC NAME	REFRENCES
1. INTRODUCTION OF SERICULTURE	SH.S.D.PATERIYA
2. HISTORY OF SERICULTURE	FROM INTERNET
3. TYPES OF SILK AND SILKWORMS	FROM INTERNET
4. LIFE CYCLE OF SILKWORM	NEHA DHYANI
5. MORICULTURE	VEDANTU
6. PROCESS OF SERICULTURE	
A) HARVESTING	MR.YOGESH, V.GIRI
B) COCOON DRYING	FROM INTERNET
C) COCOON BOILING/ COOKING	H.B.MAHESHA
D) REELING	TEXTILU COMMITTE
E) SPINNING	FROM INTERNET
F) TWISTING	FROM INTERNET
G) WEAVING	MICHEL SIMDT
7. PRODUCTS OF SERICULTURE	FROM INTERNET
8. ADVANTAGES OF SERICULTURE	TIPPU SULTAN
9. DISADVANTAGES OF SERICULTURE	FROM INTERNET
10. DISEASES IN SERICULTURE	FROM INTERNET
11. GOVERNMENT SCHEMES	PIB (PRESS INFORMATION BUREAU)
12. PEOPLE ECONOMICS IN SERICULTURE	FROM INTERNET
13. PRODUCTIONS OF SERICULTURE	BYJUS
14. PREVENTIONS IN SERICULTURE	FROM INTERNET
15. CONCLUSION	FROM INTERNET

THANK YOU

This book will gives a clear information on concept of Sericulture.

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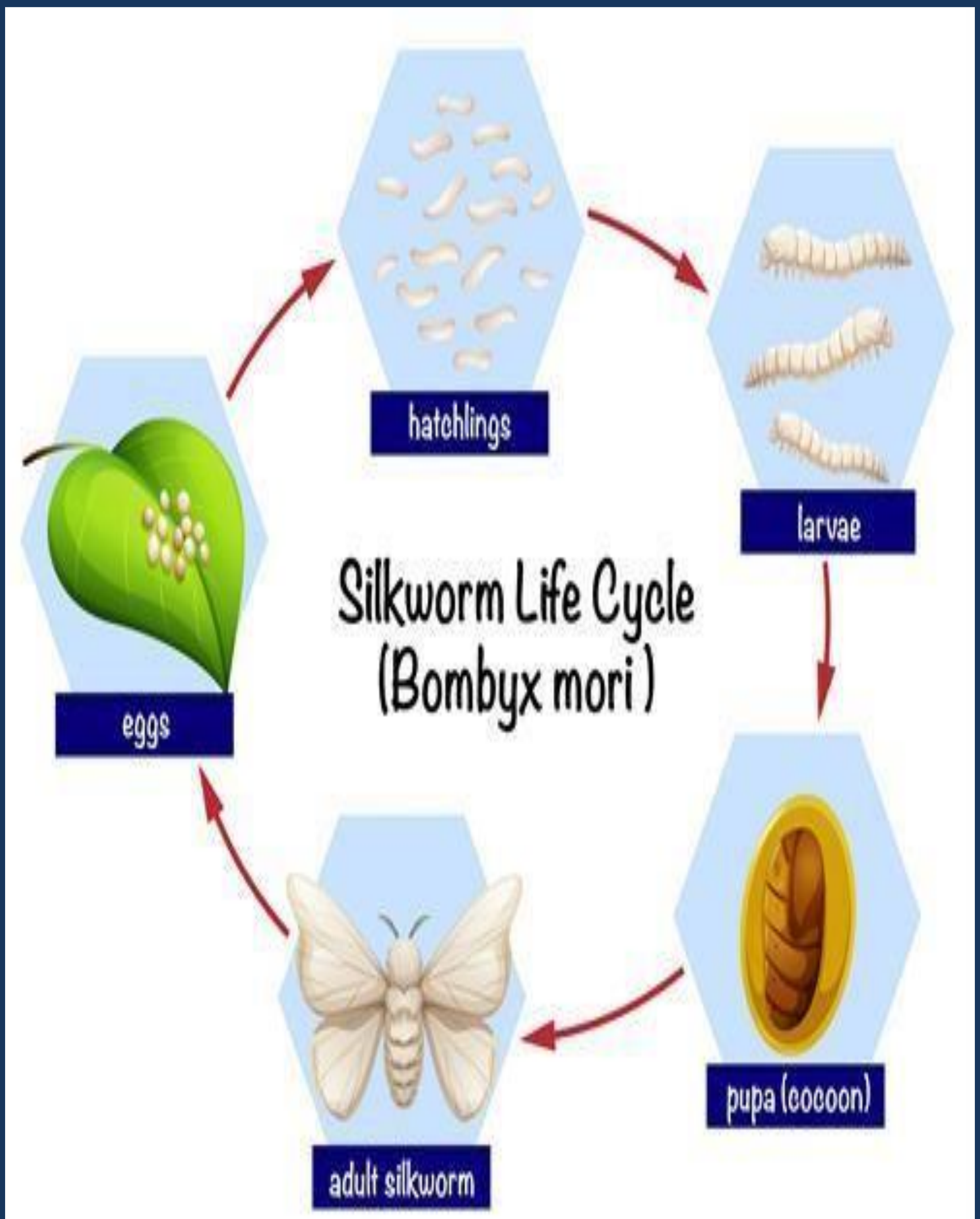
THANK YOU



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