

ANIMAL PRODUCTION

Level-II

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standard**



Module Title: - Performing Sericulture Development

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Introduction to the Module

This module covers the knowledge, skills and attitude required to raise sericulture. It requires the ability to prepare and handle materials, tools and equipment for sericulture work activities and clean up on completion of work.

The reduction of rural poverty continues to be a paramount goal of the developing countries as the majority of the poor population still resides in the countryside. The World Bank, for example, estimates that more than 70 % of the world's poor live in rural areas. So far, various strategies have been pursued to address this concern and among the major ones is rural employment creation. The agriculture sector, however, has been contending with a number of factors that have limited its potential for generating new jobs in rural areas. Those factors may include the small land holding size, insufficient capital and investment incentives, the inadequate farm infrastructure, limited market and stagnant prices of agricultural products. It is therefore necessary to focus on a broader spectrum of the rural economy.

Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen, and inherent affinity for dyes, high absorbance, light weight, soft touch and high durability and known as the “Queen of Textiles” the world over. On the other hand, it stands for livelihood opportunity for millions owing to high employment oriented, low capital intensive and remunerative nature of its production

The Regional Agricultural & Rural Development Bureaus are responsible for the development of sericulture in their respective regions. The bureaus plan activity programmes, provide training and extension services, supervise and render technical assistance to the extension staff and farmers. Of all the regional bureaus the SNNP bureau of Agriculture & Rural Development has become a pioneer region to organize trainings both for development agents and farmers, supplying required equipment for silk rearing house, provide financial assistance for construction of rearing houses

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LG #33

LO #1- Identify the morphology and characterize the physiology of silk worms

Instruction sheet 1

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying materials, tools, equipment and PPE
- Implementing Grainage seed production and hibernation of silkworms eggs
- Carrying out acid treatment of diapausing eggs activities
- Studying the Life cycle of silkworms and Identifying the morphology
- Carrying out comparative mulberry and non-mulberry silkworms
- Identifying silk glands, reproductive system, respiratory system and nervous system

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify all required materials, tools, equipment and Personal Protective Equipment
- Implement and identify grainage seed production and Hibernation of silkworms eggs considerations
- Carry out acid treatment for diapausing eggs activities
- Identify and study the life cycle of silkworms and the morphology
- Carry out Comparative study of mulberry and non-mulberry silkworms and identify digestive and excretory systems
- Identify silk glands, reproductive system, respiratory system and nervous system

1. **Learning Instructions:** Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information sheet-1

1.1. Identifying required materials, tools and equipment's

- **Definition of terminologies**

Sericulture: is the practice of rearing silk worms for the production of raw silk.

Silkworms: is the larva of a moth (*Bombyx mori*) that spins a cocoon of fine, strong, lustrous fiber that is the source of commercial silk.

Mulberry: is a plant/tree of genus *Morus* having edible fruit that resembles blackberry and the leaf are the most important feed for mulberry silk worm.

Chop sticks: These are two thin sticks of bamboo (17.5 cm and 20 cm) which taper to a point. At the thick end the two are connected by a small thread, and these are used like forceps for picking worms.

Paraffin paper: Thick craft paper coated with paraffin wax is used to prevent evaporation of moisture and to maintain high humidity in the rearing trays of young silkworms

Rearing trays: These are placed one above the other in the rearing stand to accommodate large number of silkworms.

Rearing bed: is the chopped leaves placed on the trays with worms

Cocoon: is silky envelope spun by the larvae of silkworm to protect pupas.

Silk: a fabric made from the fine threads produced by silkworm.

Mounting: is transferring mature silkworms from rearing beds to montages to start spinning. Spinning starts 8 days after worms get into fifth (5th) stage.

Incubation: is an important step for rearing. Incubation also: seed warming” by which the developing silkworm eggs (embryos) are provided with proper environmental condition so that the embryos can develop normally and the eggs hatch uniformly.

Sorting: Selecting of normal cocoons from these defectives for more processing.

Reeling: - The removal of silk yarn from the cocoons.

Re-reeling: is making raw silk skeins of standard size and weight and is done to get a firm and strong yarn.

Feathers: Bird's feathers are used for brushing newly hatched larvae from the egg card into the rearing tray.

1.1.1. Appliances used for feeding

Feeding also needs some separate equipment's which should be safe to use.

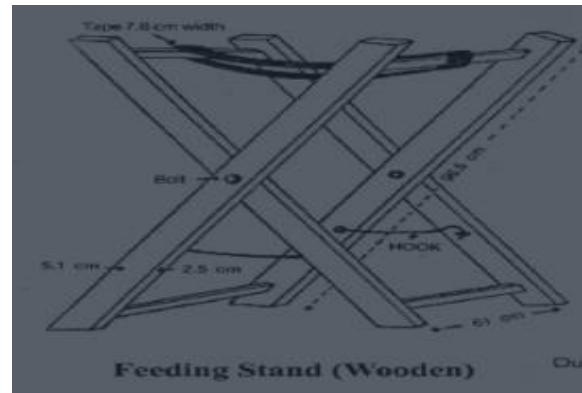
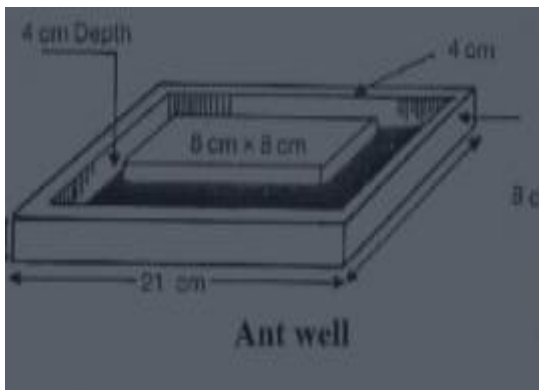
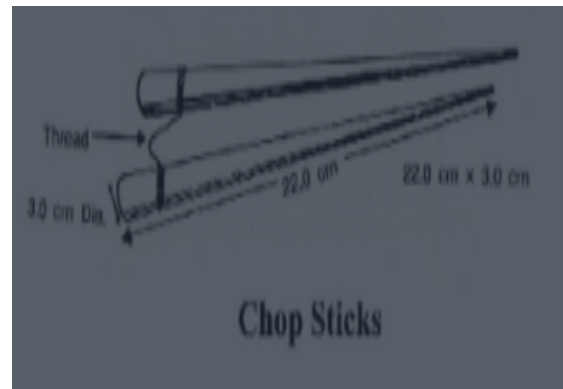
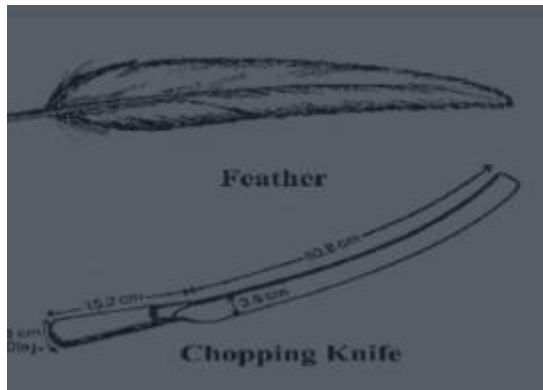
- **Leaf baskets:** These are bamboo baskets of convenient size used for collecting and transporting of leaves from the field to the rearing house.
- **Leaf chamber:** A chamber, the sides and bottom of which are made of strips of wooden reapers, is used to store harvested mulberry leaves. Wet gunny clothes is placed as a lining.
- **Chopping board:** This is a rectangular board made of soft wood used for cutting mulberry leaves.
- **Chopping knife:** Sickle like knives with broad and sharp blade are needed for chopping leaves.
- **Mats:** These are placed below the chopping boards prior to chopping and is used to collect cut leaves.
- **Feeding stand:** A folding stand on which the trays removed from the stand are placed, one at a time for feeding and bed cleaning.

1.1.2. Tools and equipments used for grainage activities

For sericulture farming to be continued grainage activities need to be practices to give disease free larva to produce cocoon in the later time.

Table 1.1. Grainage equipment for 5000 DFL production capacity

Item	Quantity
Tray racks	20
Wooden tray stands	8
Wooden stools or benches	10
Refrigerator	2
Ventilator	1
Incubator	1
Acid treatment bath	1
Humidifiers	4
Room heater	4
Moth-crushing equipment	10
Hydrometers	2
Hygrometers	4
Thermometers	2
Egg cabinet	1
Seed cocoon bins	20
Cellules	3000
Sprayers	1
Gas masks	2
Washing trays	2
Tinner	1



Figs.1.1. Different tools used for sericulture farm activities

1.2. Implementing Grainage seed production and hibernation of silkworms eggs

1.2.1 implementing Grain age seed production

Silkworms feed on mulberry leaves. Hence the rearing of silkworms involves cultivation of mulberry trees, which provide a regular supply of leaves. Worms are introduced through DFLs (Disease Free Layings, i.e. eggs) procured from a quality centre called grain age.

Silkworm rearing- has two branches- Grain age technology (egg production) and Silkworm rearing (larval stage management)

1.2.2.Silkworm Egg Production

- Silkworm egg is also called “Seed”. Seed production in Sericulture refers to:

1. Reproductive seed (Pure breed egg)
2. Industrial or commercial seed (Hybrids)

To produce quality hybrid eggs, sound organization of pure breeds is essential .In, 3 system of seed production at P3, P2, and P1 Grain ages exists.

Rearing of pure breeds is difficult, especially that of bivoltines as they are susceptible to diseases. Pure breeds are reared in separate zones called “Seed Areas”, where specialized sericulturists rear silkworms with meticulous care under hygienic conditions to produce seed cocoons.

Seed cocoons are sold at premium price, 1 1/2 - 2 times the price of commercial cocoons.

- **Seed Areas are categorized into**
 1. Multivoltine seed area
 2. Bivoltine seed area
- Both seed Areas produce eggs in 3 Stages or Levels of Seed Production i.e.
 - a) **P3 –Grand parent** of hybrid is rearing and eggs are produce (Breeding Stations) and it is called Basic or Nucleus seed.
 - b) **P2- Parent of hybrid** is rearing and eggs are produce (Government Institutes/ State departments
 - c) **P 1 – Hybrid egg production**, silkworms are rearing and hybrid cocoons are Produce (commercial cocoons or Industrial cocoons.

1.2.3. GRAINAGE is an establishment where disease free laying (DFL) or eggs are produced.

Grainage Technique

- **For sericulture industry to be profitable, two things are important:**
 - The race of silkworm reared should be superior and spin commercially good quality cocoons.
 - Healthy and hygienic rearing must be carried out by providing optimum conditions and quality leaves.

The function of producing disease free laying of silk- worms, called 'Industrial seeds' of known pure breed on hybrid, is carried out in special centers called grainage. Each grainage caters to the need of Seri culturists of a given area. Generally grainges are government owned organizations. But licensed private owners may also supply seeds. For example a grainage managed by an NGO is a great service to Seri culturists operating on small and marginal farms. .

A. Procedures in a grainage

- Rearing of parental seed cocoons,
- Seed cocoon preservation,
- Separation of sexes,
- Moth emergences,
- Pairing and oviposit ion,
- Methods of industrial egg production, and

Mother moth examination which may be individual moth examination, sample moth examination and mass moth examination

1.2.4. Identifying of Hibernation of silkworm's eggs

-Hibernation of silkworm's eggs

Silkworm eggs are of two types i.e. hibernating and non-hibernating eggs. Further processing of the eggs depends upon whether they are of the diapausing or the non-diapausing type. Univoltine races lay only diapausing eggs. Multivoltine races lay only non-hibernating eggs while the behavior of the eggs of the bivoltine is intermediate. Except multivoltine, uni and bivoltine race eggs are hibernating eggs which require special treatment to make them hatch.

These eggs are stored till the next season or awakened from diapause artificially. The eggs stored are taken out and subjected to incubation to achieve uniform hatching on a desired day. This can be achieved by exposing the eggs to certain range of environmental conditions. The incubation of egge is one of the essential parameter in silkworm rearing.

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1.3. Carrying out acid treatment of diapausing eggs activities

1.3.1. Acid treatment for diapausing eggs activities

Before or when symptom of diapauses begins to appear in the hibernating eggs, are treated in hydrochloric acid to stop them from entering in to diapauses .it is the common method .Egg treating in about 20 to 24 hours after laying when kept at 25c⁰.it is important the treating temperature to the younger eggs. Hydrochloric acid must be pure, and free from impure

1.3.2.Silk worm rearing techniques

The silkworm rearing involves the common operations such as disinfection, hatching, brushing, maintenance of optimum temperature and humidity in rearing beds, feeding, bed cleaning, spacing, and care during molting, mounting of mature worms for spinning and harvesting of cocoons.

The details of the operation vary from place to place to suit local conditions of environment and according to local tradition of rearing. These operations are briefly explained one by one as follows.

1.3.3.Disinfection

It is a preliminary operation and the following points are kept in mind before selecting the disinfectant and the method of its application.

- The disinfectant must be effective against the pathogens of silkworm diseases.
- Its application must be simple, easy and less time taking.
- It must be harmless to man and domestic animals.
- It must be cheap and easily available.

Physical methods of disinfection include, sun-drying, steaming and hot air sterilization. Among the chemical methods, chemical like paraformaldehyde, sodium hypobromide, iodine, idoform, alcohol have been tried for disinfection. The most popular chemical disinfection methods used by commercial rearers are following.

- Spraying with 2% formalin.
- Spraying with chlorkalk solution.
- Fumigating with formaldehyde gas.

Table 1.2. Different concentrations of formalin are used for different disinfection purposes

Sl.No	Purpose	% used	Remarks
1	For routine disinfection	1-2 %	Rearing room & appliances
2	After pebrine infection	4-5 %	Rearing room & appliances
3	During muscardine infection	0.7-0.8 %	Sprayed on the worms

Chlorkalk is a white powder containing Ca, Cl and water. The advantage of using chlorkalk is that it is cheap, harmless to man, his animals. 55 grams of chlorkalk is dissolved in 95 cc of water and left undisturbed. Clear supernatant solution is used for disinfection. 220 cc. is needed for spraying 10 m² area.

Regarding fumigation by formaldehyde gas 35 gram of formalin gas is obtained by evaporation of 92 cc of 35% formalin. The doors and windows are closed at right before fumigation and kept closed for 24 hours.

1.3.4. Prepare for egg laying

After mating the females will lay eggs on the paper, making them easy to collect. The eggs will remain viable for a year with minimal care. Seal them in a labeled zip bag and put them in the refrigerator (not the freezer!) as soon as all the moths have died. If you don't refrigerate the eggs, they will still hatch, but over an extended period of time instead

- **Incubation of silkworm's eggs**

Incubation room, chamber must be clean and should possess required chemicals, disinfectants, equipment's. Non-hibernating eggs and after acid treatment requires 80-85% humidity and 24-25⁰ C temperature right from the beginning.

- Cold stored eggs are gradually brought to normal room temperature.
- Temperature, humidity, light are equally important during incubation of eggs.
- Eggs are kept under a photoperiod of 16 hours daily until 30-40% of the eggs reach blue egg stage.
- Blue egg stage eggs are kept in dark/black boxes for more uniform hatching on the next day.
- Hatching can be delayed at blue egg stage by cold storing for about a week at 9⁰C.

- Incubated eggs are handled properly for good hatching percentage.

Silkworms are reared in well ventilated rearing shed following shoot rearing method.

1.3.5. Hatching

Hatching (coming out of the larvae from the egg after breaking the shell) is a photoperiodic response and begins in the early morning with sunrise and continues till noon. The newly hatched larvae are black and bristly and are called ants. Eggs after reaching blue egg stage are kept in black box/paper/cloth and kept in dark. In this way early maturing embryos are prevented from hatching and late maturing embryos are given time to develop and catch up with the early maturing ones. Thus all the eggs reach to blue egg stage. The eggs hatch out in response to phototropic stimulus. This method favors hatching more than 90 percent. If hatching is not uniform and only 50-60 percent of eggs hatch on the first day, brushing can be postponed to next day as well. If necessary hatched worms can be separated and kept in tissue paper and stored in fridge at 10⁰ C. When the second batch hatch hour the refrigerated eggs are mixed and brushed together. Even blue egg stages can also be preserved at 5⁰C for 2-3 days.

Silkworm eggs are available loosely and on egg cards. The newly developed larvae breaks out the egg shell and comes out, and is called hatching. The hatched larvae are collected and reared. The newly hatched larvae are black, hairy and look like small ants and are called “ants” or “kego” is always better to brush the larvae in the morning. The eggs exposed in early hours or hot hours results in irregular hatching. Generally brushing should not be delayed. If necessary, can be postponed to next day. When hatching is irregular. Brushing should be completed in the morning/ cool hours of the day. Freshly emerged larvae can also be preserved at 7- 10⁰C for one day.

A. Hatching percentage

The ratio between hatched eggs and total eggs in a laying is called “hatching percentage”. The hatched eggs, unfertilized or dead egg number is counted individually for calculating the percentage. This can be done using a color ink pen and later it is calculated using the following formulae and method.

Hatching percentage = Total No. of eggs hatched / Total No. of eggs x 100

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B. Brushing

The process of separating the newly hatched larva from their egg shell and transferring them to the rearing bed is called brushing. When the eggs hatch, the emerged larvae are to be collected for rearing. This process of separating kego/ants from egg shell is called “brushing”. It means placing of mulberry leaves on a frame to attract the larvae so that they will be separated from their shells. The optimum time for brushing is around 10am when the humidity is 85-90% and temperature 27⁰C. Normally hatching starts at 5-6 am when the eggs are exposed to early sun rays. Uniform hatching can be expected by 7-8 am. After 2 hours the newly hatching worms develop appetite and begin to crawl. Thus the suitable time for brushing would be 10am but once again it depends upon the weather conditions. The best time for brushing is 10 A.M. when the peak of hatching has occurred. Unhatched eggs are transferred back to the hal box and brushed the next day.

Before brushing, rearing facilities should be prepared according to the number of silkworms to be reared. Tender mulberry leaves should be chopped to 3-5 mm size. When the worms crawl over into the tray worm bodies should be disinfected for disease prevention by using a fine-mesh sieve to dust a fine powder of formalin (3%).

C. Brushing the loose eggs in egg boxes

This is done when 75% of the eggs have reached the blue egg stage (blue eggs are hatched eggs). The hatched larvae crawl up through the holes of perforated paper spread over the box, to eat the chopped pieces of leaves which are spread over. When a large number of larvae have crawled up, the larvae along with the chopped leaves are tapped.

D. .Brushing from egg cards

The various brushing methods adopted are

i. Feather method:

This is a popular method in India. Egg card is held vertically above the rearing bed and by gentle strokes of feathers the larvae are pulled out.

ii. Husk method:

Powdered husk is sprinkled over the freshly hatched larvae on the egg card. Place few leaves on the center of the husk sprinkled. The larvae crawl up the layer of husk to reach the leaves which are placed over the center of the husk. As the larvae crawl up the layer of husk themselves and are brushed by feather along with husk, the chances of injury are less.

iii. Cloth/paper/net method:

This is an adaptation from the method used for loose eggs. A cloth/paper/net with meshes is placed above the egg card and fresh chopped leaves are spread over it. After half an hour, larvae attached to the underside of net and those that have crawled on to the leaves are transferred to the bed gently.

- **Maintenance of optimum conditions for rearing**

Table 1.3. The optimum temperature and humidity for different instars

No.	Instars	Temperature	Humidity
1	1 st instar	26-28°C	85%
2	2 nd instar	26-28°C	85%
3	3 rd instar	24-26°C	80%
4	4 th instar	24-25°C	75%
5	5 th instar	23-24°C	70%

1.3.6. Feeding

The quality of the cocoons harvested, depends mainly on the quality of leaves fed during rearing. Feeding must satisfy both the appetite of the larvae and its nutritional requirements. The first deals with the amount and frequency of feeding of each instar and the second with the quality of leaves.

A. Quality and frequency of feeding.

The appetite increases with the age of the larvae. Of the total ingestion during the entire larval period, nearly 85% is taken during IV and V instars. The amount of food given also depends on the races. Uni and bi voltine require more than multivoltine.

Table 1.4. The amount of leaves to be supplied for 50 DFL'G (disease free laying's) or 20,000 loose eggs

No.	Age/ instar	Uni or bi voltine race	Multivoltine & bivoltine in tropics
1	1 st	1-2 kg	1-2 kg
2	2 nd	5-6 kg	2-3 kg
3	3 rd	20-55 kg	15-20 kg
4	4 th	80-90 kg	35-50 kg
5	5 th	450-475 kg	300-325 kg
	Total	550-600 kg	350-400 kg

Insufficient amount of leaves leads to unequal among the worms and overfeeding is uneconomical.

B. Frequency of feeding:

This varies from time to time and from place to place. In shoot and floor rearing three feedings per day are sufficient. The current practices is to maintain the frequency of feeding to 4 feedings per day. Maximum amount should be given during the active feeding stage and no feeding during the moulting stage.

C. Quality of leaf:

Leaves should be placed from well-maintained mulberry plants which have received adequate fertilizers and irrigation. Too coarse or too tender leaves are less suitable. Young worms require tender leaves rich in water, sugar, protein and minerals with little starch and coarse fiber while late age worms/require mature leaves with less of water and more crude fiber)

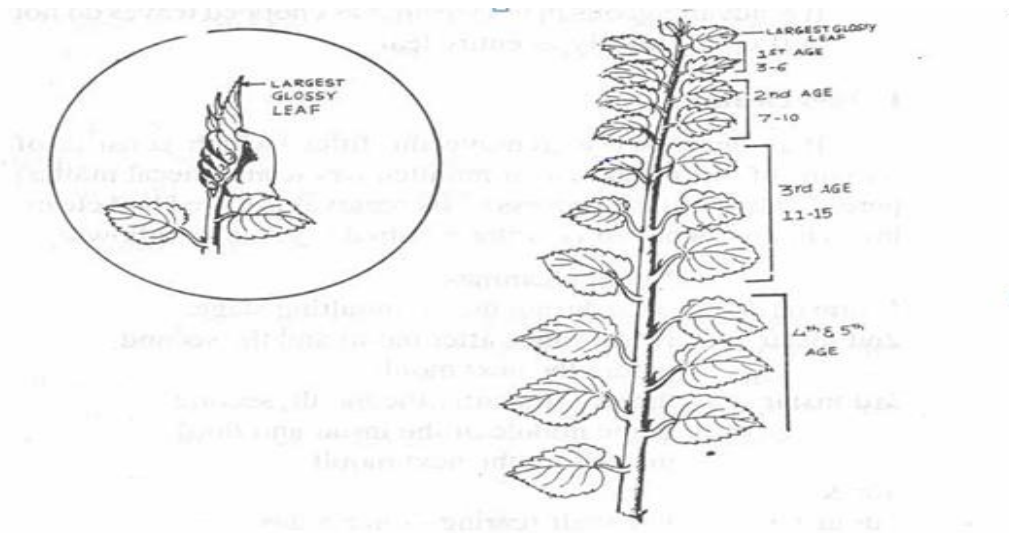


Fig.1.2 selection of leaves for rearing

D. Preparation of leaf for feeding:

To enable the larva to feed easily, young worms have to be given chopped leaves. For mature worms entire leaf collected by leaf picking may be given. The main advantage of chopped leaf feeding are:

- It facilitates the even distribution of leaves in the rearing bed or tray.
- It enables precise regulation of the amount of leaves supplied per feeding.
- It prevents the bed from getting too damp in wet weather.
- It is advantageous in hot weather as chopped leaves do not curl up as quickly as entire leaf.

E. Bed cleaning

It is necessary to remove the litter (which consists of remains of leaves, exuvia of moulted larvae and fecal matter) periodically, and the process of its removal is called bed cleaning. The frequency of clearing required is given as follows.

F. Number of cleanings.

- 1st instar -once during the premoulting stage.
- 2nd instar -twice -once after moult and the second before the next moult.
- 3rd instar -thrice -first after the moult, second in the middle of the instar and third just before the next moult.
- 4th & 5th instar -For shelf rearing -once a day. For floor rearing -once for each instar.

Regarding methods of cleaning, three methods can be adopted. These are

1. Cleaning with husk

A thin layer of husk is sprinkled evenly and completely over the bed just before feeding in the morning. The first feeding of chopped mulberry leaves is sprayed over the layer of husk. The worms crawl through the layer of husk to get the fresh leaves. At the time of second feeding the food is spread on a second tray and the worms on the leaves above the husk are gently swept by a brush to the second tray. The litter in the old tray is removed. For the first two instars, powdered husk is used instead of entire one. Recently use of charred husk or formalinized husk is recommended as an anti-muscardine measure.

2. Cleaning with net

A nylon or cotton net with a mesh of suitable size is spread completely over the rearing tray to be cleaned and fresh chopped mulberry leaves are spread over the net. Worms crawl through the meshes and feed on the leaves. After the second feeding the net is removed and worms and fresh leaves on it are transferred to the fresh rearing tray. The advantage of this method is that it is simple and requires less labor.

The recommended mesh size for the different instars is

- 1st and 2nd instars 2 mm²
- 3rd instar 10 mm²
- 4th and 5th instals 20 mm²

3. Combined net and husk method

A thin layer of paddy husk is first sprinkled over the bed and a net of suitable mesh size is superposed on it. Two successful feedings are given on the net after which the worms on the net are transferred to another tray. This method combines the cleanness of the husk method with the case of transference of the net method. It requires less skill and care in manipulation than the husk method but is more expensive than either, and also has the same inconvenience with regard to spacing as in the case of net method.

I. Spacing

Silkworms develop very rapidly from age to age and increase several times their original weight and size in each instal. The rate of increase varies from hatching to 1st instar, 4 to 5 times each at 2nd instar and 3rd instar, 25 times each at 4th and 5th instars. The total increase in weight from hatching to the end of the 5th instar will be from 7000-10,000 times.

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Table 1.5. The theoretical spacing to be provided for different ages of silkworms of 50 laying or 20,000 loose eggs

Sl.No	Uni&bivoltine age	At the beginning of the stage (m ²)	At the end of the stage(m ²)
1	1 st	0.2	0.8
2	2 nd	1.0	2.0
3	3 rd	2.0	4.5
4	4 th	5.0	10.0
5	5 th	10.0	20.0
Multivoltine and bivoltine in tropics			
1	1 st	0.2	0.5
2	2 nd	0.5	1.5
3	3 rd	1.5	3.0
4	4 th	3.0	9.0
5	5 th	9.0	18.0

Normally the practical rearer is advised to double or triple the space from the 1st instar to 3rd instar and to increase the space by 2 or 3 times in the 4th instar and again by 2 times in the 5th instar. Totally the space is increased by 80-100 times from hatching to the final instar.

Spacing should not be given during the moulting period and it is done either independently or along with bed cleaning.

II. Care during molting

Molting occurs four times during the larval life. It is a sensitive period lasting for 15-30 hours, during which the worm does not feed but wriggles out of the old skin and comes out with a new and soft skin. Care during molting is stopping and resuming feeding at appropriate time that ensures uniformity in growth. So also keeping the bed dry and taking antimuscardine measures during moulting reduces the chance of contraction of diseases during this sensitive period.

1.3.7. Mounting

For providing optimum spinning condition, the ripe worms are transferred to special devices called 'Mountage'. The process of transferring the ripe worms to the mountages or cocoon ages or encabanages is called mounting. Mounting is the final and most important busy operation in silkworm rearing. The final instar larva after attaining full growth, selects a suitable place exudes

silk through its spinner- et and spins a cocoon around itself and transforms into a pupa inside it. The pupa after metamorphosing into a moth comes out by piercing open the cocoon. The aim of sericulture is to rear silkworms and provide them with optimum conditions so that they spin a good cocoon with high silk content and to harvest them before moth emergence.

1. Characteristic features of a ripe worm

The final instar larva after full growth stops feeding and is ready to spin the cocoon. At this stage it is called the ripe worm. This stage is attained after 5-7 days of feeding in 5th instar for multivoltine and bivoltine in subtropical regions. The ripe worm is readily distinguishable by its translucent colour as it does not feed and gut does not have any green color in it. The body shrinks in length.

2. Process of spinning

This process takes place about one to two days in multivoltine and two to three days in uni/bivoltines. The fibre from the two silk glands come out through the spinneret independently and are called brins. The secretion of the two glands cements the two brins into a single threads called bave.

3. Methods of mounting

a. Hand picking this method has an advantage that only ripe worms will be picked the worms will be more uniformly distributed in the mountages and injured and diseased worms can be easily recognized and removed.

b. Net method: Nets are spread over the rearing beds and ripe worms alone crawl on the nets, and the nets along with the ripe worms are removed and shaken on the mountages, Handling is avoided in this method and it requires less labor.

c. Branch method: This is similar to net method and here small branches are spread above the rearing bed. In shoot rearing, the early ripening larvae (10-20%) are hand-picked and the rest are shaken off the shoot and transferred to mountage.

d. Free mounting: This method is not popular in India. The early ripening larvae are hand-picked but the majority are allowed to crawl themselves on to the mountage which are placed above the rearing bed. Free mounting undoubtedly saves labor and causes minimum injury to the worms but has the disadvantage that uniform distribution is not achieved on the mountages.

4. Population density in mounting

The ripe worm ordinarily requires an area which is the square of its body length for spinning its cocoon. Too wide a spacing is uneconomical for the following reason.

- The silkworm wastes too much silk for spinning the preliminary web.
- Extra mountages and extra labor are required.

Too close a spacing is also uneconomical and results in the formation of double cocoons (which are unreliable) is very high. The optimum density for chandrika, the popular Indian mountage is 50 worms per 0.1 m².

5. Precautions to be taken during mounting

- Only ripe worms should be mounted. As all worms do not ripe uniformly, they must be picked and mounted.
- Temperature around 24°C is optimum for spinning. Violent fluctuations of temperature during spinning leads to uniformity of the filaments spun and flaccid cocoon.
- A humidity range of 60-70% is ideal for spinning. By adequate ventilation, extra moisture must be dried. Too high a dryness prevents the worms from spinning.
- The worms must be disturbed during spinning as it causes suspension of spinning and braking of thread.



Fig.1.3 Mating of Moths



Fig.1.4 "Kego" newly hatched larva



Fig.1.5 Mountages for spinning

The worms have to be picked up and transferred to a mountage for spinning cocoons.



Fig.1.6 brushing of silkworm



Fig.1.7. Brushing newly hatched larva



Fig.1.8. Silkworm bedding



Fig1.9 Silk cloth



Fig.1.10 Hand Made raw Silk thread

-https://youtu.be/_F-QCPkITc0 (on 2/09/2022) Hatching eggs video address

-https://www.youtube.com/watch?v=rDMD_tH8lFI (on 2/9/2022)

-<https://youtu.be/0uaTBkU-JV4> (sericulture housing 2/09/2022)

6. Harvesting

The aim of silkworm rearing is to harvest the cocoons produced and sell them to the reeling agencies.

(a) Timing of harvesting: Harvesting must be done after the pupal cuticle hardens and before the adult emerges. Tropical multivoltine and bivoltine races pupate on the 3rd and 4th day and temperature uni and bivoltines on the fourth or 5th day of spinning. The recommended time of harvesting is 5th day of spinning for tropical races and 7th or 8th day for temperate races. Delay in harvesting beyond the recommended day may lead to the formation of pierced cocoons by the emergence of parasitic ozify maggots or by moth emergence. Too early harvesting leads to inside soiled cocoons due to putrefaction of pupa injured by harvesting.

(b) Method of harvesting: Normally cocoons are harvested by hands. Harvested Cocoons are cleaned by removing any fecal pellets on them and sorted according to sizes. Defective cocoons are separated.

1.4. Carrying out comparative mulberry and non-mulberry silkworms

1. Life cycle. A silkworm starts its life as a tiny egg laid by the female moth. The egg is just about this size: . The egg, laid in the summer or early fall, remains dormant until the warmth of spring stimulates it to start developing. When silkworms first hatch in the spring, they are tiny—3 mm or so (about 1/8")—and hairy. They require young tender mulberry leaves during their first few days. As they grow, they can eat tougher leaves, and late in their development they will eat any mulberry leaf you can supply.

The life cycle of both Mori & Eri silkworms have four stages: egg, larva, pupa encased in cocoon and adult moth. A complete life cycle of eri-silkworm lasts about 44 days in summer and 85 days in winter. Both Mori & Eri silkworm are reared indoors. Rearing of eri can be started when castor leaves are available aplenty.

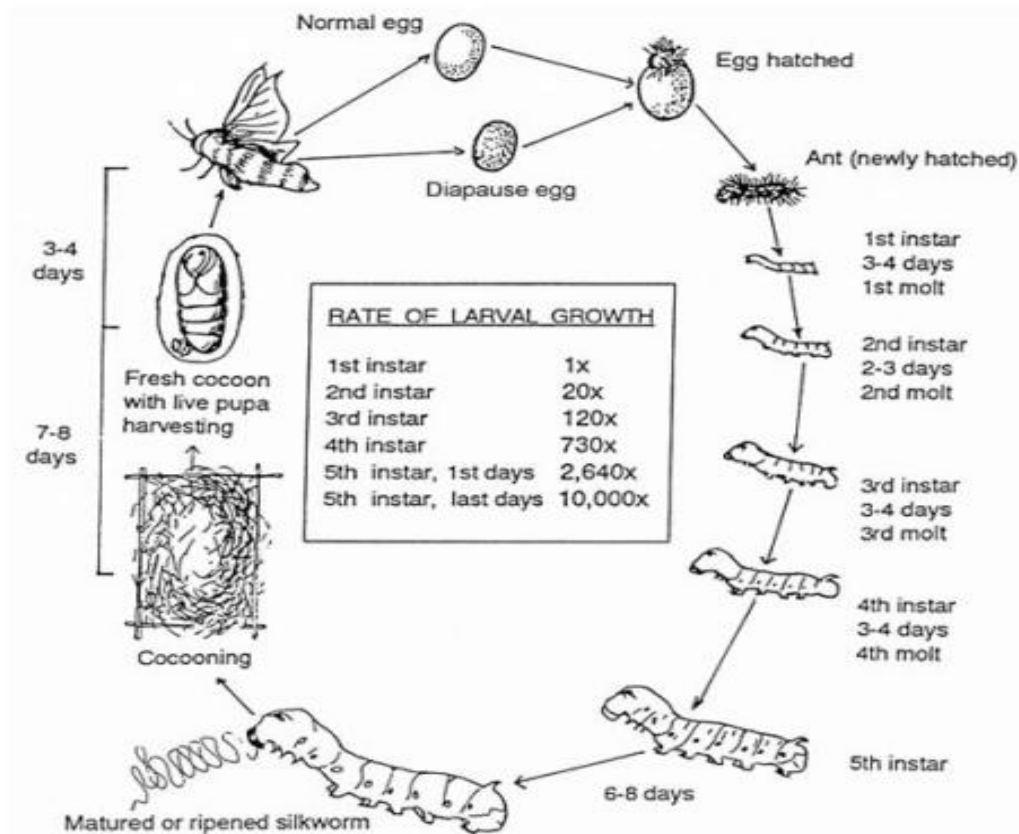


Diagram 1.2 showing lifecycle of silk worm

Note:

- Larval duration for eri takes 26-32 days. It starts at hatching of eggs and goes to the 4th molt stage.
- The duration is generally longer for uni and bivoltine races of mulberry silkworms, but shorter for multivoltine ones & for Eri silkworms, 18-23 days.

The larvae advance through five stages of growth, called instars. The silkworm literally outgrows its skin five times, and molts its outgrown skin. With the first molt the silkworm loses its hairy exterior, and for the rest of its larval life its skin is soft and smooth.

Silkworms grow rapidly, eventually reaching the size of your ring finger. Then they spin beautiful oval white or yellow cocoons in which they pupate. After 2–3 weeks the creamy-white adult moths emerge from the cocoons. They clamber around, vibrate their wings rapidly, and mate, but they don't fly or attempt to escape from their container. During the adult phase of the

life cycle, the silkworm moths do not eat or drink. After mating, the female lays a profusion of eggs, and the moths die.

Males and females look slightly different, and students will be able to tell them apart with a little practice. The female has a larger abdomen. The male has a much larger pair of antennae, which look like long rakes or comb-shaped eyebrows. Have four stages

2.Larva Silkworm larva is delicate at first and should not be handled for the first 2 weeks except with a tiny paintbrush. By the time the larvae are 2 cm (1") long; students can carefully pick up and gently hold them. The larvae seem to survive better if they are kept together in a single culture early in life—later they can be kept in pairs or small groups

3.Plan for spinning get a medium-size corrugated cardboard box and a couple of paper egg cartons. Open the egg cartons and attaches them to the inside walls of the box. The silkworms will spin in the depressions in the egg cartons. The silkworms must all be in this box for spinning their cocoons. The time for this will be signaled by the first larva that starts to spin, either in your class habitat or, more likely, in one of the group habitats.

4. Prepare for silkworm moths. Once the larvae spin cocoons, they require no further care. The moths will emerge in a couple of weeks and can be handled by students. They do not eat or drink—they mate, lay eggs, and die.

5. Prepare for mating and egg laying Get a large flat box, or cut a taller one down to about 10 cm (4"). Line the bottom with paper. As the adults emerge, move them to this new box. The moths will stay in the open box. The females will lay eggs on the paper, making them easy to collect.

6. Collect eggs. The eggs will remain viable for a year with minimal care. Seal them in a labeled zip bag and put them in the refrigerator (not the freezer!) as soon as all the moths have died. If you don't refrigerate the eggs, they will still hatch, but over an extended period of time instead.

1.4.1. Taxonomy of silk worm

Taxonomic classification of silkworms

Silkworm belongs to phylum – Arthropods

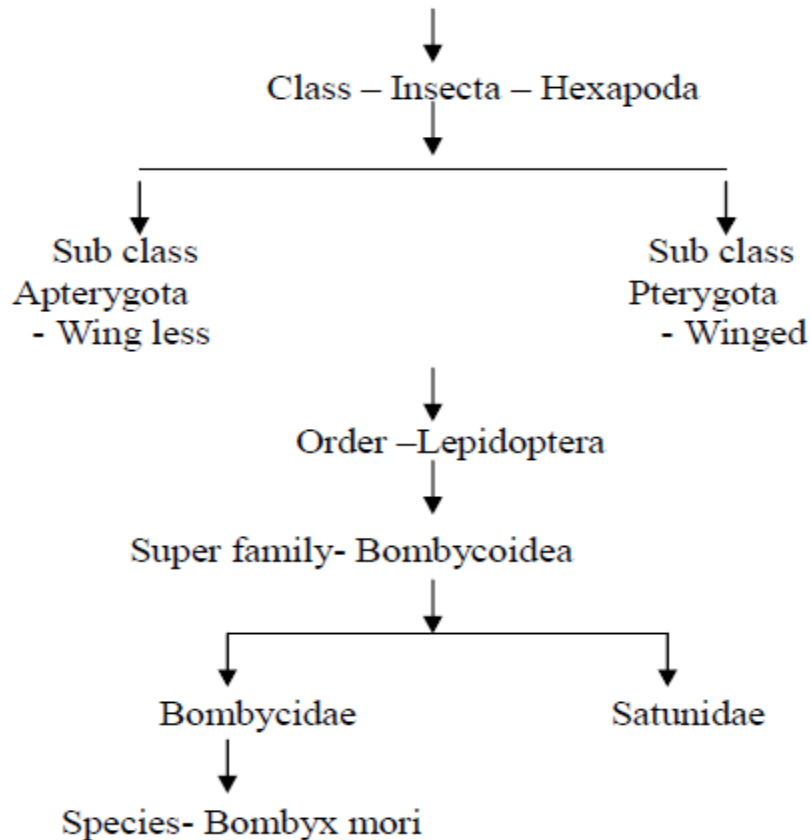


Diagram 1.3. Taxonomic classification

- *Bombyx mori*-Domesticated mulberry silkworms
- *Bombyx mandarina*- wild ancestor to silkworms
- **Satunidae**-family
 1. *Antherea perini* – Chinese tasar silkworms
 2. *Antherea mylitta* – Indian tasar silkworms
 3. *Antherea yamami* – Japanese green tasar silkworms
 4. *Antherea assama* – Indian (Muga) worms
 5. *Philosamia recini* – Eri silkworm
 6. *Eriogyna* – Fish line silkworms - was used to make ropes around fishing areas in earlier times

1.4.2. Morphology of silkworms

- Morphology of silkworms:-refers to the external body structures of silkworms at different Stages
- **Studying the life cycle of silkworm duration at each stage.**

Mulberry silk worm passes through four morphologically different stages in its life cycle i.e. egg, larva, pupa and adult .Among these four stages, larval stage is the only feeding and active stage.

The duration of each stage varies according to

- The race
- The climatic conditions and
- The quality of the food given.

Table 1.6. Duration of different stages of life cycle in different races of mulberry silk worm

SN	Particulars	Uni/ bivoltine	Multivoltine
1	Egg	11-14 days (after break of diapause)	9-12 days
2	Larva	24-26 days	20-24 days
3	Pupa	12-15 days	10-12 days
4	Adult life span	6-10 days	3-4 days

A. Adult

It is blackish gray in colour and distinguishable into head, thorax and abdomen. The head is triangular in shape with conical abdomen. Thorax has four longitudinal black bands on the dorsal side, while the first abdominal segment is black and rest grayish yellow. The life span of adults varies with sex and season. **Males survive for about 10-18 days.** And females live 2-3 days longer than males. Survival period is long during summer. Males are longer (12 mm) than females (10mm). **Male has external genitalia covered with** brownish orange hairs on the ventral side of the abdominal tip. The bristles on the lateral region of abdomen are more dense in male, while they are restricted to last two segments in females. The width of the fronts of the male fly is narrower than that of female.

Generally males strike the resting and walking females. Mating strike is followed by agitated state of the female before successful general contact. This permuting period prolongs for about 4-6 hours.

The polygamous adults mate 1-2 times after emergence and 3-7 times within 24 hours in the entire life. Mating occurs during early morning or late in the evening, with a duration ranging from half an hour to two and half hours. But it requires a minimum of one hour mating for full fecundity and maximum hatchability.

Female fly starts egg laying 44-45 hours after emergence. The fly prefers to lay egg on late instar (3rd instar onwards) because of relative area of the silkworm body. After repeated survey the fly settles down on the host for ovipositor. Under normal condition 1-2 eggs are laid per larva. The eggs are laid at intersegment area. A single female lays about 300-1000 eggs over a period of above 9- 25 days. Initially few eggs are laid which gradually increases to reach the peak between fourth and seventh day after emergence. But egg laying decreases with advancing age. Female fly lays eggs throughout its life.

B. Egg

The eggs are creamy white measuring 0.45-0.56 mm in length and 0.25-0.30 mm in width with along shape. Depending on the environmental conditions the eggs hatch in about 2-5 days after laying. The newly hatched maggot penetrates into the silkworm body.

C. Maggot

The maggot hatches out through operculum of egg shell which generally faces the silkworm body. The maggot penetrates into the silkworm which is surrounded by a sheath formed by granulocytes and proliferating tissue at the site of the wound. With the growth of maggot the size of the sheath increase and becomes thick and black which finally seen as a black lesion or scar on the silkworm body. This is a good identification of infestation

The first and second instars maggots are yellowish white in color measuring 0.7-1.5 mm and 2.75 mm width and length respectively. The third instars maggots are creamy white measuring 1.3-1.6 cm in length.

Maggots have eleven body segments and pass through three instars. The first two instars develop just below the skin but final instars maggots move into the body cavity and grow in size. After a

lapse of 5-8 days the mature maggot escapes by piercing the host integument by its prothoracic hooks. The maggot feeds on the body tissues of silkworm and the host dies by the time maggot escapes.

D. Pupa

Maggots pupate in about 10-20 hours in the darker area in and around the silkworm rearing house like rearing beds, crevices, corners, below ant wells and rearing stands or in the superficial soil. The body becomes motionless and shrinks before pupation. Pupae are oblong in shape, reddish brown to dark reddish brown in colour, with eleven segments and measures 0.9-1.2 cm in length and 0.4-0.6 cm in width. It takes 10-12 days to metamorphose into adult which emerges out.

- Identifying the morphology of silkworms in accordance with cocoon yield and quality.
- Comparative studying of mulberry and non-mulberry silkworm's lifecycle stage for management.

The life cycle of both Mori (mulberry) & Eri (non-mulberry) silkworms have four stages: egg, larva, pupa encased in cocoon and adult moth. A complete life cycle of eri-silkworm lasts about 44 days in summer and 85 days in winter. Both Mori & Eri silkworm are reared indoors. Rearing of eri can be started when castor leaves are available aplenty.

Note: · Larval duration for eri takes 26-32 days. It starts at hatching of eggs and goes to the 4th molt stage. The duration is generally longer for uni and bivoltine races of mulberry silkworms, but shorter for multivoltine ones & for Eri silkworms, 18-23 days.

- **Identifying features Appearance (Morphology)**

- Larvae are worm-like with a short anal horn.
- Three distinct body parts: head, thorax, abdomen
- Adult has four wings covered with scales

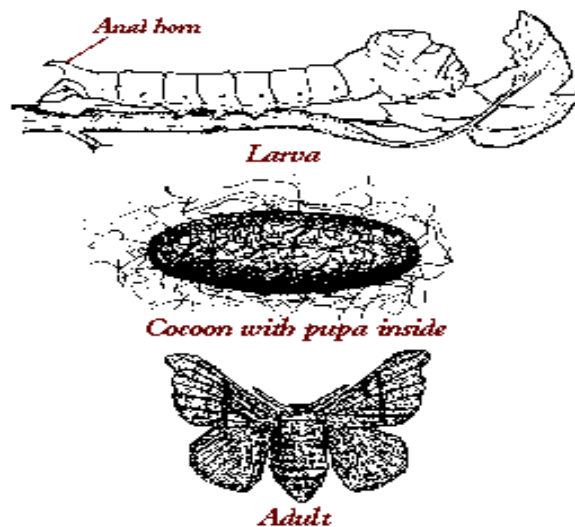


Fig.1.11 Showing larvae, pupa and Adult of silk worm

E. Adult Males and Females

Adult moths have creamy white wings with brownish patterns across the front wings. The body is very hairy and the wingspan is about 50 mm. Adult females are larger and less active than males. Male moths actively crawl around looking for females. They will copulate for several hours.

1.5. Carrying out comparative mulberry and non-mulberry silkworms

I. Mulberry silkworm

Mulberry silkworm is biologically named as *Bombyx mori*, which is obtained originally in China. This is the most widely cultivated silkworm species over the world. The fiber from these silkworm species is ranked as 1st grade as compared to other silkworm species. These silkworm species can be categorized in to three groups based on their generation per year: univoltine, bivoltine, & multivoltine. Univoltine & bivoltine groups carry out only one & two generations per year respectively while multivoltine ones carry out many generations (at least 4-5) per year.

II. Eri Silkworm

Eri silkworm is biologically(scientific name) is *Philosamia ricini* and it is adomesticated. It belongs to the family Satuniidae under order Lepidoptera and class Insecta. It is multivoltine breed having five to six cycle in a year. The commonly occurring wild eri silkworm is *Philosamia cynthia*, which is either bi or trivoltine in nature. Both moths differ slightly in

markings and in the amount of white scales in their abdomen. Whereas the cocoon of *Philosamia ricini* is loose and white, that of *Philosamia cynthia* is compact and light brown.

Both hybridize freely. It is reared on Castor and Tapioca leaves. It produces a white or brick-red Silk. The cocoons are very weak and pediculate. The Eri silkfilament is neither continuous nor uniform in thickness, thus cocoons cannot be reeled. Therefore the moth emerged from cocoons are used for to extract silk by process of spinning but not reeling. So the pupae are not killed, so called as ‘ahimsa silk’

1.6. Identifying silk glands, reproductive system, respiratory system and nervous

1.6.1. Identifying silk glands and reproduction

- **Silk gland** (where biosynthesis of silk is developing): These are transformed labial glands ,ectodermal in origin,cylindrical and tubular with characteristically branched nuclei. Silk glands are paired and situated on ventro- lateral sides of digestive system.

Silk glands are divided into three distinct regions- Anterior, middle and posterior.

- **Anterior region-** is a straight tube opening at the into a duct and posteriorly into the middle region.
- **Middle region** -is the largest of the three regions and have three definite flexions or curves. Middle region is again divided three functionally different sections-Anterior, middle and posterior, all of which synthesis “ Sericin”.
- **Posterior region-** of silk gland is highly crooked and curved and responsible for synthesis of “Fibroin”.

The wall of silk gland is composed of three layers namely tunica propria, the gland cells and tunica intima’ A pair of small glands known as Fillipi’s or Lyonnet’s glands is situated at the junction of the two anterior regions. A viscous fluid is secreted by these glands, and it is assumed to lubricate passage of silk.

Fibroin and Sericin are the silk proteins in filament produced by ripe worms which spin the cocoons. Middle gland synthesizes Sericin protein and posterior gland synthesizes Fibroin, anterior gland serves as a passage for silk to reach “spinneret” from where silk is thrown out. In the silk glands, silk is synthesized in liquid form, but when thrown out of the body, on contact

with air it solidifies. Silk produced by each half of the gland is called Brin, which is thrown out as a single thread called Bave.

Silk glands are very well developed functional only when silkworm has stopped feeding and ripe or mature.

1.6.2. Identify Digestive systems

Well developed in larval stage, rudimentary in adult. Larval stage is the only feeding stage in the life cycle of Bombyx mori. It's a straight tube from mouth to anus, also called Alimentary canal and consists of three parts namely 1) Foregut or Stomodeum 2) Midgut or Mesenteron 3) Hindgut or procyodeum.

1. Foregut; composed of mouth cavity, pharynx and esophagus which is narrow interiorly and widens at posterior end. Cardiac or Stomodeal valve is located at the end of Foregut, which helps in retaining the chewed leaf bits for some time and prevents regurgitation from midgut to foregut.

2. Mid gut: Long, wide cylindrical tube, narrow at posterior end. Digestion and assimilation of food takes place in this region. The inner wall has peritrophic membrane which protects from mechanical damage of food particles(chewed mulberry leaves)

3. Hindgut: made up of small intestine, colon and rectum. The Pylorus valve is situated near the anterior end of small intestine. It guards and regulates the passage of digested food from midgut to hindgut. Also absorption of moisture from food takes place and elimination of digested food resulting in fecal pellets which are hexagonal and black

- **Excretory systems**

excretory system has 3 pairs of malpighian tubules which arise at junction of small intestine and colon. These tubules are aligned on the digestive system, the ascending tubules run towards anterior side, turn back and open into the rectum. This arrangement is called cryptonephric, conservation of moisture in food takes place and nitrogenous compounds are excreted as uric acid.

1.6.3. Respiratory and nervous system

A. Spiracles are responsible for breathing.

- Air enters into body through tiny holes spiracles
- Use to avoid water loss
- A cavity atrium or entrance is present
- Air passage is controlled by Valves
- Surrounded by peritreme

B. Nervous system:-

In insects it serves as an elaborate (complex) connecting link between the sense organs and the effectors' organs (muscles and sometimes glands).

C. Mate and monitor reproduction of moth

Once the moths emerge, **their sole mission is to breed and lay eggs**. They cannot fly, do not eat, and they do not drink. Females are larger than the males and have very round abdomens which are full of yellow unfertilized eggs. Males will frantically flap their wings and spin in circles once they sense the presence of a female; flapping continues until they meet and the male attaches to the female. Most pairs typically copulate for over 12 hours.

Males are persistent and if given the chance will attempt to continuously mate. In order to let the female lay her eggs, separate the pair and place the females in a separate container, a paper lined container is ideal for her to lay her eggs on. She will lay between 100-400 yellow eggs. If the eggs are fertilized, over the next few days the eggs will change from yellow to black. If they are not fertile they will remain yellow.

Self check 1	Written test
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Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I. Choose the best answer

- The disinfectant that is cheap, harmless and white powder containing Ca, Cl and water is:-
A. Formalin B. potassium permanganet C. Chlorkalk D. formaldehyde
- The kind of acid used for treating diapausing egg is :-
A. Sulphuric acid B. Hydrochloric acid C. Acetic acid D. all
- The biological name Philosomia ricini belongs to
A. Eri silk worm B. Muluberry silk worms D. Muga Silk worms

Part II. Give brief answer for the followings

- List down at least ten necessary materials used in sericulture development activity?
(10 points)
- Define the following terms (6pts.)
a) Sericulture
b) Cocoon
c) Re-reeling
- Worms are introduced through DFLs (Disease Free Layings, i.e. eggs) procured from a quality centre called _____ (2pts)
- Write the procedures in Grainage
- What are the two types of silk worm eggs? (4pts)
- Write the life cycle of silk worm? (10pts.)
- Define and explain the morphology of silk worms. (10pts.)

Note: Satisfactory rating – 10 points

Unsatisfactory - below 10 points

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You can ask your teacher for the copy of the correct answers.

Operation Sheet -1

1. 1. Performing Incubation of silkworm's eggs






A. Identify Materials required

- **Wear PPE**
- Tray racks
- Feed(mulberry/caster leaf chopped)
- Egg box and egg tray
- Fridge
- brush
- Bedding
- Acid treatment bath
- paper cover/newspaper
- Thermometre
- Hydrometer

B. Procedure

- **Wear PPE**
- Store eggs cold
- Treat seed (wash with acid HCL)
- Adjust Temperature, humidity, light are equally.
- Eggs are kept under a photoperiod of 16 hours daily until 30-40% of the eggs reach blue egg stage.
- Blue egg stage eggs are kept in dark/black boxes for more uniform hatching on the next day.
- Hatching can be delayed at blue egg stage by cold storing for about a week at 9⁰C.
- Incubate it on plastic tray covered with paper
- Incubated eggs are handled properly for good hatching percentage
- feeding

Table 1.1. The following are some of personal protecting materials

No	Materials	Description
1		Body safety cloth (tuta): - This cloth is a type of cloth which covers all the body part except the head and the fingers. It is used to protect the body from dirty.
2		Sun hat:- is the material, that is used to protect head from direct sun radiation
3		Eye protecting device: - it is used to protect the eye from different damage
4		Boot:- it is used to protect leg from sharpen and other damaging
5		Hand glove: - which is made of leather or strong flexible plastic rubber, it is used to cover fingers to protect from sharpen materials.

1.2. Technique of Harvesting /Collecting cocoon

A. Materials required

- PPE
- Basket
- tray
- storing container
- sorting tool
- Jar and seed

B. Procedure

- Wear appropriate PPE
- put on sorting tool
- collect and sort cocoon manually or using tool
- store in dry place
- Killing the cocoon by drying in the sun
- cleaning of working area

LAP TEST-1	Performance Test
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Name..... ID..... Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hour. The project is expected from each student to do it.

Task-1.Perform Incubation of egg

Task-2.Perform cocoon production activities

Task-3 Perform collection of cocoon from the mount age

LG #34	LO #2 Prepare materials, tools and equipment for sericulture development activities
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Instruction sheet 2

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying materials, tools and equipment
- Conducting check on all materials ,tools and equipments and reporting faults
- Using correct manual handing techniques
- Selecting and checking suitable PPE
- Providing **OHS** requirement

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify required materials, tools and equipment .
- Conduct Checks on all materials, tools and equipment, and report to supervisor.
- Use correct manual handling techniques when loading and unloading materials.
- Select and check Suitable PPE
- Provide Work support according to OHS requirements

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 2

2.1. Identifying materials, tools and equipment

A. Material are

- ✓ White birds feather
- ✓ Local montages
- ✓ Karaka (egg card and egg case)
- ✓ Disinfecting materials
- ✓ Nylon string
- ✓ Plastic tube for watering
- ✓ Chopsticks
- ✓ Pegs
- ✓ Empty sacks
- ✓ Plastic bag for seedlings
- ✓ Paper bags
- ✓ White birds feather
- ✓ Local montages
- ✓ Disinfecting materials
- ✓ Cleaning supplies/detergents
- ✓ Log sheet (record book)
- ✓ Lumber and plywood
- ✓ Hard card board
- ✓ Bamboo basket
- ✓ Markers
- ✓ Cheese cloth
- ✓ Black sheet cloth
- ✓ Bamboo tray
- ✓ Hand washing tray/towel
- ✓ Paraffin paper
- ✓ News paper
- ✓ Karaka (egg card and egg case)

B. Tools and equipment needed for sericulture

- ✓ Refrigerator
- ✓ Balance
- ✓ Brushes
- ✓ Ruler
- ✓ Stirrer
- ✓ Beaker
- ✓ Petri-dish
- ✓ Dropper
- ✓ Graduating cylinder
- ✓ Test tubes
- ✓ Buckets,
- ✓ Rearing and feeding stand
- ✓ Cleaning net
- ✓ Pruning scissor
- ✓ Measuring tape
- ✓ Thermometer(dry and wet bulb)
- ✓ Humidity recorder with chart
- ✓ Hammer, Saw, Nail
- ✓ Forceps
- ✓ Hand lens
- ✓ Egg counter
- ✓ Chopping knife and Chopping board

- ✓ Wheelbarrows
- ✓ Shovel, spades, forks, rakes and hoes
- ✓ Tray(rearing/feeding and seed)

Modern Montage

- ✓ Refrigerator
- ✓ Ventilator
- ✓ Foot cleaning tray
- ✓ Water bath
- ✓ Centrifuge
- ✓ Incubator
- ✓ Stop watch
- ✓ Basin stand
- ✓ Hygrometer

- ✓ Hand sprayer
- ✓ Hydrometer
- ✓ Leaf chamber
- ✓ Electric heater or charcoal
- ✓ Rearing and feeding stand
- ✓ Ants well
- ✓ Feeding basin
- ✓ Hygrometer
- ✓ Mounting board
- ✓ First aid kit
- ✓ Ants well
- ✓ Feeding basin

2.2. Conducting Checks on all materials, tools and equipment, and insufficient or faulty items

2.2.1 Check all materials, tools and equipments with insufficient or faulty items

• Check all materials, tools and equipments

Finding the right materials, tools and equipments among different items is the most critical aspect in sericulture development activity. All the items should be checked before utilization for their

- safety; right material,
- no damage and
- Appropriate amount for a specific activity.

2.2.2. Reporting insufficient or faulty items

Damaged, broken, and material which are not fit for sericulture development activity should be identified and reported to the responsible person in time.

2.3. Using correct manual handling techniques

2.3.1. Use correct manual handling techniques during loading and unloading

Loading and unloading facilities are a critical in the process of transport. When loading materials care should take not to break and make damage the items. Appropriate handling of materials, tools and equipments to minimize damage self, others, load and vehicle. Suitable training will normally need to be given on correct lifting, Loading & techniques of materials & silkworms cocoon.

During loading and unloading of materials, tools, equipment, silkworms cocoon and eggs the following points should be considered:

- they should be healthy and in good condition while transporting
- Separate different developmental stages (eggs, larvae, pupa, and adult) during transport.
- Isolate diseased or suspected larvae during transportation.
- Heavier materials should be loaded at the bottom of the transport materials
- Flammable material should be given a precaution.
- When loading different material the same material should be loaded at the same sides

2.3.2. Procedures for loading & unloading materials:

- Properly design/select loading/unloading areas
- Clean areas regularly to remove potential sources of pollutants.
- Reduce exposure of materials to rain.
- Inspect equipment regularly
- If possible, conduct loading & unloading in dry and cool weather.

2.4. Selecting and checking suitable personal protective equipment

- **Select suitable personal protective equipment.**

There are different types of materials, tools and equipments and supplies to perform different activities in sericulture development activity. Therefore, identifying, selecting, using and preparing facilities, supplies according to the working activity are very important aspect in sericulture work.

Personal protective equipment include

- Overalls
- Gloves
- Safety goggles

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- plastic boots/shoes
- Sunhats
- Respiratory mask
- Helment
- Aprons,

Protective clothing should be selected to prevent skin contact with virus-contaminated materials or environments. Consideration should be given to the type of work being performed by the worker when selecting personal protective clothing

2.5 OHS Hazards in sericulture development activity

Personnel working in the sericulture development activity are permanently exposed to hazards. These have either a physical, chemical or biological nature. Proper management is needed to avoid accidents and to keep the staff motivated..

According to the International Labor Organization (ILO), health hazards in sericulture development activity working environments are categorized as accidental, physical, chemical, and biological. Here are just a few examples for each category mentioned by this organization

2.5.1. Physical

- Exposure to high wind.
- Long-time exposure to heat and cold.
- Injuries resulting from lifting and moving of silk worms, feed plants (bags), egg and larvae collection.

2.5.2. Chemical

- Respiratory problems resulting from exposure to dust, which is composed of feathers, dander, micro-organisms, etc.
- Respiratory, skin, and eye diseases due to exposure to gaseous chemicals.(e.g. NH₃, H₂S, CO₂, CO, and CH₄).
- Exposure to disinfectants, detergents, formaldehyde and pesticides.

2.5.3 Biological

- Zoonotic infections. These diseases are transmitted between birds and humans & they also are transmitted from animals to humans and include bacterial, viral, fungal, and parasitic diseases.

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2.5.4 OHS requirements

Work task is provided according to Occupational Health and Safety (OHS) requirements. This may include:

- Using of relevant protective clothing and equipment,
- Use of tooling and equipment,
- Creating conducive working environment and safety handling of material,
- Using First aid kit to provide aid services
- Hazard control and hazardous materials and substances.etc,
- Following Occupational health and safety procedure designated for the task
- Checking and fulfilling required safety devices before starting operation

Self check : 2	Written test
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Name: _____ **Date:** _____

Directions: Answer all the questions listed below.

Part I. Choose the best answer (1pt. each)

- Which of the following is procedure of loading & unloading materials?
 - Properly design/select loading/unloading areas
 - Clean areas regularly to remove potential sources of pollutants.
 - Reduce exposure of materials to rain.
 - Inspect equipment regularly
 - All
- Personnel working in the sericulture development activity are permanently exposed to:-
 - OHS
 - hazards
 - sanitation
 - loading un loading

Part II.Short answer Questions (reduce)

- List down 10 materials and tools used to run sericulture development activities? (5pts)
- What are the points that should be considered during loading and unloading of materials, tools, equipment, silkworms cocoon and eggs ?(10pts.)
- List down PPE used in sericulture development activity (6pts)
- List down the three types of hazards (3pts)
- Write the Occupational Health and Safety (OHS) requirements in work place.(7pts)

Note: Satisfactory rating 12 points and above Unsatisfactory - below 12 point

You can ask your instructor for the copy of the correct answer

Operation Sheet -2

2.1. Performing Identification of tools and equipments of sericulture farm

2.1 Techniques/Procedures/Methods of

A. All Tools and equipments put

- Prepare PPE
- White birds feather
- Local montages
- Karaka (egg card and egg case)
- Disinfecting materials
- Cheese cloth
- Black sheet cloth
- Bamboo tray

B. Procedures/Steps/Techniques

- Wear PPE
- Display tools and equipments
- Identify tools and Equipments
- Determine its use

LAP TEST-2	Performance Test
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Name..... ID..... Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hour. The project is expected from each student to do it.

Task-1. Perform **identification of tools and equipments in sericulture farm**

LG #35	LO #3. Undertake Sericulture development work
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Instruction sheet 3

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- undertaking Seri-culture development activities
- Carrying out Interactions with stakeholders
- Reporting problems or difficulties

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- undertake seri-culture development activities .
- carry out Interactions with other staff, in Seri-culture development areas, owners, stakeholders and customers
- Report problems or difficulties in completing work to supervisor

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 3

3.1. Seri-culture development activities

Introduction

Ethiopia's bimodal rainfall pattern, ambient temperature and other agro-ecological factors provide a fertile ground for mulberry and castor seed cultivation and silkworm production. Mulberry commonly grows in urban and per urban areas where people cultivate for its fruit and life fencing. Castor tree is very common plant growing widely in compounds of rural and urban areas of the country. It also grows on wastelands, grave yards, along the road, sewerage and waste

disposal areas. Sericulture development by both eri and mori silkworms although old agricultural practice in East Asian and European countries has been introduced into the country very lately. It was initiated by Melkasa Agriculture Research Centre 20 years ago.

However, the technology has been disseminated to beneficiaries since 2001. The SNNP Regional Bureau of Agriculture & Rural Development is the first to promote sericulture technology to the rural poor farmers among all the regions. Other regions namely Amhara, Oromiya and Tigray are undertaking preliminary operations by their own initiative since a year. Apart from these, interested individuals in and around urban and per urban areas of Awassa, Nazareth, Addis Ababa, Debrezeit and Bahir Dar are involved in the development programme.

Sericulture is a sideline activity by the farming community and integrated farming by investors. Considerable quantity of dried cocoons has been produced both by farmers & investors in the last 2 years. According to the recent report over 3000 kg of dried cocoon is collected out of which over 95% of the product is marketed to Addis. However, the quality of the cocoon in certain cases is inferior due to lack of knowledge and experience in producing & handling of cocoons.

3.1.2. Sericulture extension

The extent of sericulture extension unlike crop & livestock extension is a relatively new activity in the country. Currently, MOARD has developed a package on sericulture development aimed at promoting cocoon production, mulberry cultivation and at encouraging land owned or landless

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farmers to participate in sericulture activities. Many farmers both in food secured and insecure areas are expected to benefit from the extension package in the coming few years.

The objectives of the sericulture extension package include:

- To strengthen knowledge & skills of farmers.
- To generate income through production and sales of cocoon.
- To supply raw silk to the local textile industries.
- To generate foreign exchange earnings through export of cocoon & silk products.

The aforementioned objectives would be attained by cultivating mulberry trees as food plant for mulberry silkworms, rearing of silkworms, mounting and harvesting of cocoons, sorting of cocoons for reproduction and production etc. The package due attention mulberry silk farming because cocoon quality is higher, commands higher price and more profitable than the sericulture.

3.1.1. Undertake feed plant propagation

- **Mulberry Planting and Cultivation Practices**

The silkworm *Bombyx mori* L. is monophagous insect which feeds merely on mulberry leaves. Since mulberry leaves is the primary sources of silkworm feeding, planting and cultivation of mulberry trees represent a prerequisite for a successful silkworm rearing, silkworm egg production and for the entire operation of sericulture.

I. Planting

There are two ways of establishing mulberry plantation: replanting an existing field or establishing a new plantation. In the following paragraph, we will emphasize on practices used to establish new plantation.

Planting practices depends very much on factors such as climatic and soil conditions in a given area. In any cases, the following factors must be taken into account:

- Land selection and cultivation
- Planting distance
- Planting pattern

For a higher productivity of a mulberry field, it is recommended to select suitable and fertile land. The following factors must be taken in consideration in the selection of land for a mulberry farm:

- A sunny, flat place. In addition, it is preferable to establish the farm at a location close to silkworm rearing units.
- A place with a thick and soft surface soil. Extremely dry or wet land must be avoided.

Land cultivation is performed to prepare the ground for mulberry plantation and it depends on the types of soil and on the topography of the chosen site for the establishment of a mulberry garden. Another important factor to be taken into account during land preparation is the mulberry root system. The root system of the mulberry tree variety dictates the initial trenches for the saplings in order to ensure a healthy development of the mulberry.

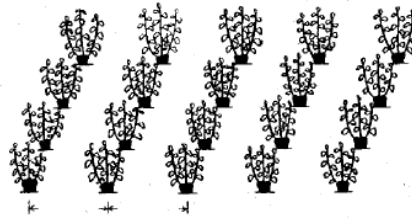
The **planting distance** is decided according to the inter-ridge distance and the interplant distance. The most common spacing systems are the pit and the row systems. The former allows greater density of planting and higher productivity while the latter permits mechanical operations.

Planting pattern in temperate climate is dictated by mulberry varieties, types of soil and cultivation practices etc. According to Lim et al. (1990) there are three basic planting patterns (**Fig. 3.1**):

- Single rows in high plant density, 1.5-1.8X0.5-0.8m (about 9,000 trees/hectare).
- Rows with paired plants, wide ridge 1.8 m, narrow ridge 0.6 m X 0.5 m (about 16,000 trees/hectare).
- Single rows in lower density, 2.5X1.5 m (about 2,500 trees/hectare).

According to the depth of the planting is decided according to the distance of upper part of the growing roots of the young trees from the ground surface. The depth of planting can be adjusted according to various conditions.

(a) Single rows in high plant density



(b) Rows with paired plants

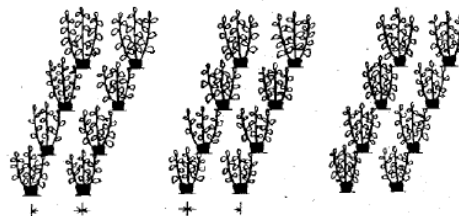


Fig. 3.1. Field arrangement of the mulberry trees

II. Cultivation practices

Once a mulberry plantation is established, the following cultivation practices are recommended:

- Tillage- weeding
- Irrigation
- Pruning
- Fertilization
- Pest management

A. Tillage-Weeding

Mulberry tree has a deep root system and therefore good soils conditions are prerequisite for its continuing productivity. Tillage is considered to be one of the common practices for improving soil conditions. Tillage affects mulberry productivity in the following manner:

- Air and water permeability and supply are improved.
- Soil temperature is raised whereby the function of roots is activated
- The insoluble nutrients are made soluble and the soil fertility is improved.

- The soil is soft, which encourages the growth of the roots and regeneration of a large number of new roots.
- Weeds on the soil are removed and damage from pests is minimized. For weed control, chemical, mechanical and cultural methods are applied. The question as to the method to use can only be answered with local land conditions.

Usually deep digging is carried out three times in a year-in spring, in summer and in winter. In spring it is carried out before budding. In summer it is carried out at a shallow level soon after the summer pruning and in winter, in November-December after the shoots are bundled. This is to allow the soil around the stump to mix with the soil in the space between the ridges to protect the fine roots from cold air and also to kill the pests and pathogens which may be hiding in the stumps. Digging at 30-40cm depth during summer helps to reduce the various soil-borne pathogens causing root rot, stem cancer and root knot diseases in mulberry. Soil solarization increases the temperature in the soil by 8-10 °C which helps in destruction of pathogenic fungi, bacteria and nematode in the soil. However, an excessive soil tilling, attempted in summer when the plant grows fast, will cut the small roots spreading in the surface soil of the ridge, thereby seriously affecting the growth of mulberry plants. For heightened soil fertility and improved productivity of a mulberry farm, it is required that a sufficient amount of humus is contained in the soil and that the humus can be easily decomposed at all times. For an increased amount of humus, the soil needs a sufficient supply of organic materials every year. If compost is available, a 20 cm deep groove in winter in the center of the ridge is cut, the compost is applied and has been covered with soil. Furthermore, if cut-down weeds or pasture is available, the green grass (1.5 to 2Kg, in fresh weight) is spread on the surface of the ridge as thick as 3 cm to 5 cm. Especially in locations with little rain and the land gets dry, the above mentioned spread of organic matters has great effects to prevent drought damage.

B. Irrigation

Water uptake is a vital condition for mulberry tree and any shortage of water in the soil will jeopardize the growth rate of the plants. Both extreme wet and dry soils are harmful to the mulberry growth. Basically an average daily rainfall of 5 mm is required to maintain normal growing. There are two water conservation methods:

- **Direct and indirect.**

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✓ **Direct method**

includes drip irrigation, sprinkler and furrow methods. Since sprinkler is ideal but costly method and furrow method is of low cost but some water is wasted, the most effective method is drip irrigation.

✓ **Indirect method**

includes mulching of the soil surface in order to reduce evaporation and the organic matter will increase the water holding capacity of the soil by enhancing aggregation of soil particles.

C. Pruning

Pruning is the process of maintaining the size and the spreading of the mulberry tree at more or less uniform level. This is performed by cutting the branches at regular intervals. It is a pruning technique that maintains the shape of the plant.

Depending on the density of planting, three types of cutting are distinguished: **low cutting** (plant cut at a level less than 0.5 m from the ground), **medium cutting** (plant cut at a level between 0.5 and 1.5 m) and **high cutting** (plant cut at a level more than 1.5 m). For example for a mulberry plantation of 2.000 trees per hectare (2.5 X 2 m), the most suitable type of cutting is the medium cutting. Furthermore, pruning creates an environmental condition unfavorable to the pathogen and eradicating or reducing the amount of a pathogen in the plant/field. Generally, the disease incidence is high in plants pruned at ground level (low cutting) than medium cutting. About 21-25% of reduction in disease severity was observed under medium cutting over the low cutting. This is due to easier contact of pathogens or overwintering stage of pathogen present in soil/debris through the cut ends of plant and creation of more favorable microclimate under the canopy .

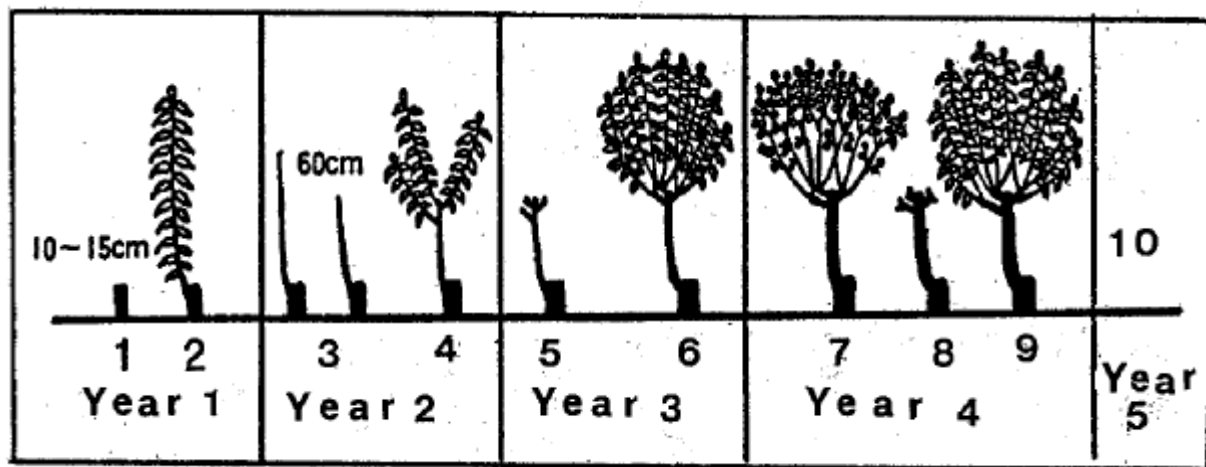


Fig.3.2. Medium cutting of pruning, 1. Planting, 2. Late fall, 3. Spring cutting, 4. Late fall, 5. Spring cutting, 6. Late fall, 7. Spring, 8. Summer cutting, 9. Late fall, 10. Same as in the 4th year .

Low-cut pruning is desirable for warm regions and regions where the soil is shallow and the underground water rich. In the regions where the soil is deep and the underground water poor, high-cut pruning is desirable. High-cut pruning is also applied in cold regions where there are chances of snow damages. Furthermore, it is better to adopt medium-cut or high-cut pruning in regions where there are frequent floods and heavy rains.

In dried mulberry fields, pruning is usually carried out in June, following the low-cut pruning method. In some cases, a second pruning is operated, cutting the branches in 1/3 of their length. The total leaf production is then reached the 30% of the leaf production produced during the first pruning in June.

In irrigated mulberry fields, at the end of May until middle June, pruning is operated by low-cut pruning method, In order to operate a second silkworm rearing, another low-cut pruning is carried out at the end of August until the beginning of September.

Other authors have classified pruning methods in spring and summer cuttings, fist-style and non-fist style cuttings. According to this source, spring cutting is carried out after planting mulberry for 1 or 2 years and at time on full grown plants.

In our project **the medium cutting (figure 3.1.2.)** was performed. The plants were cut at a level of 0.8 m) The detailed specifications for each partner are analyzed in Task A 2.1a (Partner practices).

D. Fertilization

Fertilization increases the quantity and improves the quality of leaves. Furthermore it improves the plant growth by assisting in developing resistance in mulberry against certain foliar diseases. The type and the quantity of fertilizer depends very much on the soil fertility and on the irrigation. As the plants do not grow well on strong acid or strong alkaline soil, it is necessary that the acid soil is ameliorated with some lime and the alkaline soil with acid fertilizer in order to neutralize alkalinity. When we have many rearings per year, fertilization should be frequent. Usually, for a medium fertile soil, the average quantity of fertilizers is 230 kg of N, 150 kg of P and 170 kg of K per hectare, applied in three doses.

In a separate report the details of mulberry fertilization are discussed.

E. Pests and diseases

In temperate climates mulberry trees have few pests. References on pests are from non European countries. A number of pests and diseases can cause damage to mulberry tree. The noxious insects of mulberry tree include Coleoptera, Lepidoptera, Hemiptera, Thysanoptera, etc. According to their feeding habitat and damage, mulberry insect pests can be classified into three categories:

- Insect which feed on leaves and young shoots
- Insect which harm the branches and trunks
- Insects which harm the roots

In addition to insect pests, many wild rodents of the family Muridae may cause damage to mulberry trees especially on the base of branches.

In mulberry diseases are included fungal, bacterial, viral diseases, diseases caused by nematodes and non-infectious (or physiological) diseases. According to the symptom location, these diseases can be classified into:

- Root diseases
- Stem diseases

- Leaf diseases
- Diseases attacking the whole trees

Application of more phosphatic fertilizer induces increased tolerance against many foliar diseases of mulberry. Application of green manure and compost help in multiplication of antagonistic fungi and bacteria in the soil which suppress the pathogenic fungi and bacteria in addition to improving the plant growth. Principal disease controlling factors are:

- Selection of mulberry varieties resistant to diseases
- Cultivation practices
- Field maintenance
- Soil conditions
- Meteorological conditions.

D. Propagation

Mulberry can be propagated by seeds (sexual propagation) or cuttings (asexual propagation).

1. Sexual propagation

In sexual propagation, mature seeds are collected, washed and dried. An area under shade is dug, manured and prepared for seedling nursery. Then viable seeds soaked in hot water for a day to soften a hard testa for easy and successful germination are sown in rows. Seedlings are thinned when they grow to a height of 3.5 to 5 cm. They would be subject to sun light during cool hours. Transplanting is done with a distance of 22.5 cm three months after sowing. These seedlings grow for one to two years are then transplanted to field or used for grafting.

2. Asexual propagation

This can be done by cutting, grafting or budding.

- **Cutting:**

cuttings are most commonly used in the asexual propagation of mulberry. Nutritious, high yielding, fast growing, pests, diseases and drought resistant leaf cuttings should be used.

Properly matured and thick shoots with active and well-developed buds are cut from selected varieties. Cuttings taken from parts with high carbohydrate content root more readily and profusely than cuttings from parts rich in nitrogen. Tender portions from upper and over-mature

parts at the base need to be rejected. Cuttings of 7-10cm long, slant cut with three to five active buds, should be produced.

Size of direct field plant or nursery bed must be determined before cuttings are planted in slanting position at a distance of 7-15 cm. After 8 months, cuttings are transplanted to the field depending on the type of the plants to be raised.

Roots of cuttings are formed either naturally or artificially. For poor rooting plants, certain growth regulator hormones are applied to stimulate rooting. These hormones include

Indole Acetic Acid (I.A.A.), Indole Butyric Acid (I.B.A.), Naftalin Acetic Acid (N.A.A.), and Dychlorophenoxy Acetic Acid (D.A.A.).

Chemicals like restone and seradin are also used.

- **Grafting:**

Grafting is inserting rooted plant in to the same or allied species to bring about organic uniformity or union between the two species and finally make them grow as one. The branch that is inserted is known as scion and the plant in to which another plant is inserted is stock. The stock is usually an indigenous plant that is well acclimatized to the local conditions. Selection of stock and scion is very important. Grafting, thus, facilitates the propagation of a variety which has desirable qualities which can not be propagated by other methods. There are three types of grafting: shoot grafting, root grafting and bud grafting.

- **Budding:**

Budding involves removing one bud from stock and putting in to another stock. It is used only when the material is scarce. Patch budding, t-budding and ring budding (flute) are the types of buddings. In addition to grafting and budding, **air and ground layering** are used to propagate mulberry plants.

- **Polyploidy:**

which is the result of mutation, also helps to produce mulberry plants; some of which are drought and disease resistant and high yielding varieties.

Mulberry field can be managed by weeding, intercropping, irrigation and mulching. The plants can be top pruned at 1m, medium pruned at 50 cm or low pruned at ground level.

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A. Quality of mulberry leaves

Growth of silkworms depends on the quality of leaves fed to them. The leaves which are best relished and utilized by the worms are those containing more moisture, protein, sugars and carbohydrates. These nutrients can be obtained in young, succulent, and under 2½ months old plant leaves. It is advisable to harvest leaves at optimum stage of development and maturity. Furthermore, for vigor and proper development of worms, over matured and yellowing leaves are very poor in quality and can spell danger to the rearing if mixed with succulent leaves and therefore be picked up at the time of feeding. Irrigation, nitrogen fertilization, close spacing and pruning help mulberry plants grow vigorously, and leaves harvested from such plants are nutritious and uniform in quality.

B. Leaf harvesting

Mulberry leaf is harvested from trees or bushes in the plantations, and is stored carefully to keep it fresh for silkworms. There are three methods of harvesting leaves: individual leaf picking, branch cutting, whole shoot harvesting. In individual leaf picking, individual leaves are picked from the plant, where in the other methods, the branches and entire shoots are cut and fed to the worms. These methods help to train the bushes. Leaf quality is affected by withering. It is important to harvest leaves during cool hours and preserve them with care. As the nutritional requirement of young silkworms is different from requirement of old ones, tender leaves near the tip of branches are fed to young worms while mature leaves are fed to old worms.

After each harvest, the plant is allowed to stay 35 to 45 days with out picking leaves. Cultivation operations like digging, fertilizer application and weeding have to be done repeatedly after each harvest. Farm Yard Manure (FYM) is applied at least twice a year. The suitable time for harvesting leaves from the garden is either in the morning (till 10:00 AM) or late in the afternoon (from 4:00 PM-6:00PM).

C. Leaf preservation

It is important not only to produce highly nutritious and succulent leaves but also to preserve them fresh till they are consumed by silkworms. After harvest, moisture loss is very rapid, and this affects the edibility or palatability of leaves for silkworms.

To increase relative humidity in the rearing house and prevent withering of leaves, sprinkling water in the rearing house; using ventilators and fans; soaking sacks in water filled pails and hanging them on the windows are advisable. Fresh & succulent leaves harvested from the plants should be collected in wet sacks or in bamboo baskets lined inside and covered with wet unstitched sack materials. These leaves are transported to the rearing house where they should be immediately preserved under a wet cloth which should be kept wet all the time by sprinkling water on it repeatedly at intervals. Leaves preserved as such remain fresh with high moisture and protein content and are easily digestible to worms.



Fig.3.4. Showing mulberry plant



Fig.3.5. showing castor plant

3.1.2.Castor (Recinusus Commnis):

Types and sowing methods

Castor may be grown as an annual or perennial plant. Its leaves are commonly seen with two colors: pale green and violet. Both are equally suitable for feeding eri silkworms.

June-October and March-April are preferred sowing seasons for castor. Sowing may be done in any area where rainfall has become scanty. Land preparation including manuring should be done beforehand.

A. Germination of seeds and

growth of castor plants are greatly influenced by heat, light, moisture and aeration. Under optimum condition of heat, light, moisture and aeration, seeds generally germination within 7-10 days. Germination, however, takes longer time when temperature is low and moisture is less. So, it has to be cultivated like any other garden plants. Seeds are sometimes broadcast at rate of 9-10 kg per acre.

But the best method is to sow 2 seeds in a hole, either 0.9-1.2m or 1.5-1.8m apart in rows. A stick, about 1½ inch thick and 8 inches long, may be used to drill holes and for sowing seeds.

The first thinning operation is undertaken when the seeds are broadcast, and the spacing is adjusted to 0.9- 1.2m between plants. In the case of perennial plants, another thinning is done when the spacing is adjusted to 1.5-1.8m between plants. If, for some reason, germination is not as expected or the new plants appear weak, they should be uprooted and fresh healthy seeds should be sown in their places. The objective of thinning is to cultivate the healthiest plants and give proper spacing among plants. To feed worms, leaves should be harvested from healthy plants. Dry leaves and twigs must be removed and plots should be weeded frequently to keep them clean.

B. Soil and manure

For good cultivation of castor trees, light clay soil is required. However, light sandy soil is always preferable to clay soil for better production. Since potash in the soil is necessary, it is replenished by adding ash of burnt weeds, leaves, stalks and stems. Cultivation of leguminous plants like sunhemp, acacia, cowpea, mung, and matakalai may be done before planting castor to incorporate nitrogen and humus in the soil. Castor and mustard oil cakes may be used as manure. A dose of lime is necessary when any manure with oil contents is used every two or three years. Well-decomposed FYM is the best and the cheapest organic manure in some places.

Inorganic fertilizer may be applied by top dressing either at the beginning or at the middle of cropping. Green manure may also be applied when the plants have grown two to three feet high.

C. Variety and Spacing

Selection of suitable varieties is essential for successful rearing of silkworms. Castor having non-powdery stems and leaves are better than those with powdery stems. However, short life plants cultivated for seeds may not be much suitable for rearing silkworms as there may be shortage of leaves at peak rearing period.

Varieties less susceptible to wilt and root rot disease and tolerant to jassids should also be selected. Spacing of 1.5 m x1.5 m or 2.0 m x 2.0 m is also practiced on hilly lands and slopes

where perennial castor plants are cultivated. Such spacing facilitates cultivation of cereals or vegetables as an intercrop along with castor.

D. Seed harvesting

Castor seeds do not become ready for harvesting simultaneously. This is because all the capsules on the fruiting branch or spike do not mature uniformly. So, the crops should be harvested when a few fruits or capsules show signs of drying. In some regions, the whole spike or fruiting branch of castor plant is stripped off when most of them dry. This method is not good because a large number of premature and partially dried fruits or capsules are harvested with the ripe fruits. Therefore, the quantity and quality of the produce is reduced. Kernels of immature fruits are light in weight and poor in oil content. Experiments show that seeds from mature capsules yield 5% more oil than seeds from immature capsules. Mature capsules shed their seeds if harvest is delayed until the fruits are fully dried on the plants. If castor seeds are collected when they are dry, more labor will be required for frequent pickings, and cost of collection will be quite high. So, the solution to this problem is to grow strains whose seed maturity comes at one time. Even then, it will be economical to harvest the crop only when the fruits in the spike are ripe. More quantity of matured and better seed is obtained in this way.

3.1.3. Food plants of Eri silkworm

Being polyphagous, eri silkworm feeds on several varieties of feed plants, which are mainly of Euphorbiaeace family. Among these are castor or era, Kesseru, tapioca/cassava, gulancha phool/champ, barkesseru, and papaya. The most important ones are castor (*Ricinus communis*), kesseru (*Heteropanax fragrans*), payam(*Evodia flaxinifolia*) and tapiopa/cassava (*Manihot utilissima*). Castor is the best among these feed plants. Eri silkworms reared on castor leaves yield large cocoons rich in silk content.

Castor and kesseru grow wild around villages or near rearers' houses in many areas. Thus, a rearer often collects leaves from scattered castor plants or kesseru trees.

- **Silk worm feed plant and their production agronomical practices**

Mulberry (*Morus* in Latin) is the main feed plant of *Bombyx mori* L. It is a diploid with 28 chromosomes and grows as a bush in tropical countries. There are over 200 species of mulberry

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varieties. Today mulberry is universally distributed between 230 south and 450 north of the equator. Thus it is produced in China, Korea, Japan, India, Russia, France, Latin, America and Africa.

Mulberry is the basic food for silkworm, and the bulk of silk goods in the world is produced from mulberry silkworms. Therefore, producing mulberry leaves on scientific basis is essential for organizing sericulture on sound economic lines. Under intensive cultivation practices in tropical countries, leaves of about 30 tons per hectare can be harvested per year.

Studies of 200 varieties on ecological aspects and adaptability, which have been included under breeding programs, have helped in selecting varieties suitable to different agro-climatic tracts; and studies on horticultural aspects of the plant have helped in adapting various training, pruning and other plant regulatory practices to make the plants grow as bushes, middling or trees for leaf production. It has been found that irrigation, fertilization and proper cultural practices such as weeding, inter-cultivation, and mulching influence mulberry production. As there are some pests and diseases of mulberry leaves, insecticides and fungicides that are harmless to silk worms could be used.

3.2. Carrying out Interactions with owners and stakeholders of sericulture

- **Sericulture package dissemination system**

The following systems are expected to lead to better acceptance of the technology & increased production.

1. Provision of training

Training is one of the limiting factors for the promotion of sericulture development. There is no formal training centre for sericulture except non- formal training that hold at Melkasa Agricultural Research centre and 6-10 hours lecture in ATVET Colleges. Short-term training, which lasts from 20-30 days, will be organized for training of trainers to implement the package. The training would be practical oriented and skill development. Such training will be provided to Wereda experts. The Wereda expert's in turn are expected to train the beneficiaries.

II. Organize awareness creation forums

A forum such as field or farmers day would be organized at farmers silkworm rearing houses or demonstration farms. The forum is expected to be appropriate media to transfer the necessary knowledge & skill to needy farmers.

III. Strengthening of extension services

The extension services on sericulture like other agriculture extension activities will be centering the Farmers Training Centers (FTC's) Modules of the package would be developed to effect the services. Subsequent training and/or in-service training will be organized to the DA's to capacitate them with skill that will enable them technically assist the farmers.

IV. Provision of input

Inputs that are required for rearing silkworms will be made available for purchase from suppliers and/or for home construction provided that prototypes are ready for use. Silkworms can be obtained from the nearest demonstration centers or from Melkasa Agriculture Research Centre. Mulberry cuttings of indigenous type for the time being can be obtained from residents in urban and per urban areas and also from the nearby mulberry farms of investors. New varieties of Mulberry and hybrid silkworms can be supplied to the producers from Alage ATVET starting early 2006.

V. Market development

Market as in other agricultural programmes is a key factor to sericulture development. Market will be facilitated to encourage the farmers to produce cocoons in a sustainable way. The government is committed to sponsor the purchase of cocoons from framers until the private sectors involve into the trading and processing businesses. Purchasing of cocoons will be managed both by the agricultural & Rural Development Bureaus or by the Regional Commission of Cooperatives or by any representative organ of the government. Beside these, government affiliated NGO's will also be involved to encourage the producers.

VI. Provision of credit

Credit will be facilitated for mulberry cultivation, construction of silkworm rearing houses, purchase of rearing equipment and tools and also for marketing the commodity. Smallholder farmers will be served through micro financial institutions or from other source. Grace period should be given to the farmers to start back payments mainly because they are new to the technology and lack experience and stills for quick production of the item and generate income

3.3. Reporting problems or difficulties in completing work

After completing any work directed by supervisor any work outcome and work problem have to be reported to supervisor.

Sericulture development activity should be reported daily, weekly, monthly and yearly to the concerned body as well as for documentation. It is important source of information and advice from someone who has collected and studied the farm profitability, in order to make decisions and take actions. Reports should be clear, understandable, and meaningful. The outcome measurement process have gone well, poorly reported information will discourage use or provide misleading information.

Some of the report in Sericulture rearing farm includes

3.3.1. Monitoring Equipment

- Occupational Safety Procedures
- First Aid Availability
- Significance of Training
- Documenting Injuries
- Safety Procedure Awareness
- Risk assessment

3.3.2. Occupational Safety Procedures

The purpose of occupational safety procedures is to help with the prevention of injuries, illnesses and deaths that occur at the workplace. If employees are aware of safety procedures, they will keep themselves and others in the workplace from being hurt. An employer must post the safety procedures in the workplace, as well as ensure every employee has read the safety procedures before beginning their jobs.

A. Monitoring Equipment

Before an employee operates machinery, the machinery must be in good working condition and clean. If the machine is not functioning properly, this puts the employee's safety in danger, as does un-cleaned equipment that can cause germs and bacteria to spread throughout the workplace. If the machinery in the workplace is used to make products for clients, the germs

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from the equipment could cause safety issues with the customers that use the products as well, leading to a possible lawsuit for the employer.

B. First Aid Availability

Employees suffer from small injuries while on the job daily. The injury could require a bandage or some type of over-the-counter medication to relieve the temporary pain. An employer should keep a first aid kit for employees somewhere in the workplace. When an employee suffers from a minor injury, he should be able to ask his manager for the first aid treatment kit.

C. Significance of Training

Training is a required safety procedure for employees. Those employers that do not provide training for employees using equipment or other safety procedures such as emergency exits and where to go in case of tornadoes, hurricanes or other dangerous conditions. An employer should generally document that training has been provided to employees, to show compliance to Occupational Health and Safety procedures were followed.

D. Documenting Injuries

Whenever an employee is hurt on the job, an employer must document the injury. Even if the injury is not severe, it must be documented in compliance with occupational safety procedures. The time length varies for how long employees have to keep the safety or injury forms on file in the employee's file.

3.3.3. Safety Procedure Awareness

It is a safety procedure for all employers to make employees aware of their safety rights. This can be done by passing out literature or copies of OSHA's policies and procedures. Copies only have to be given to employees if the employee makes the request. However, the employer must post a visual sign for all employees to see somewhere in the workplace at all times. If an inspector from OSHA inspects the business and the posting is not visible, the business can be given a citation and have to pay a penalty.

3.3.4. Risk assessment

A risk assessment procedure helps in identifying the risks to health and safety to a person. The risk may arise out of any work-related activities or other factors. The process involves an

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assessment of the potential health hazards that are duly identified and consequent evaluation of the extent of the risk. This is done by making a feasible judgment of the nature of the harm that can be caused by the health hazard, while at the same time, taking into account the necessary control measures. The risk assessment plans identify a clear system that assesses all risks to health and safety, systematically, and then specifies the circumstances under which the different elements of the procedure are to be used.

The risk assessment procedure applies exclusively to occupational health and safety risks. As an initial step, the process must ensure that all the significant risks and related hazards are addressed. The following step involves in identifying the victims who are likely to be affected by the impending hazards. Risk assessment analysis takes into account all the aspects of work, including routine and non-routine activities that may cause a health risk, and reviews them. The procedure also analyses non-routine operations, for instance, maintenance, for obvious safety reasons.

Risk assessment training is beneficial for equipping the assessor with first hand knowledge about how to address a risk situation and bring the control measures into effect. A risk assessor is directly responsible for the supervising the activities in the affected area. This requires him to be adequately familiar with all the aspects of the work and the prevalent risk, for which he needs to have a sound knowledge of the area, or the assessment process and the task to be assessed. Sufficient risk assessment training is therefore required to come to help when the need arises for practical knowledge.

There are different types of risk assessment including physical hazard risk assessment, fire risk assessment, lone working risk assessment, manual handling assessment, display screen equipment assessment, and work equipment risk assessment. The risk assessment analysis may need to reviewed under certain circumstances like any kind of changes in the process or task, or location. There may also be a change in the personnel who is responsible for the execution of the procedure, or a alteration in the knowledge of risk. The process of risk assessment, thus, demands immediate attention to the risk factor, addressing it and controlling it successfully.

Self check 3.	Written test
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Name: _____

Date: _____

Directions: Answer all the questions listed below.

1. What do you think is the reason for less intensification of sericulture activity?(5pts)
2. What is the reason for an employer must post the safety procedures in the workplace, as well as ensure every employee has read the safety procedures before beginning their jobs?(5Pts.)
3. what is the significance of training in the aspect of sericulture development? (5Pts.)

Note: Satisfactory rating – 7 points and above

Unsatisfactory - below 7 point

You can ask your instructor for the copy of the correct answer

LG #36	LO #4. Treat plant pests, diseases and disorders and carry out post treatment operations
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Instruction sheet 4

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Recognizing , recording and selecting of feed plant pests, diseases and disorders treatment methods
- preparing and applying treatments to feed plants
- cleaning and maintaining equipment, disposing wastes and recording

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Recognize , record and select feed plant pests, diseases and disorders treatment methods
- prepare and apply treatments to feed plants
- clean and maintain equipment, dispose wastes and record

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information sheet 4.

4.1. Recognizing, recording and selecting of feed plant pests, diseases and disorders treatment methods

4.1.1. Recording

Recording of every farm activities that could be recorded daily, weekly, monthly or yearly as well as when required are needed to be recorded on already prepared format or file. **these recordings could** be given to the supervisors, interpreted or filed as a document and could be used for further activities of the farm. Good recording system is the mirror of the farm so the farm worker need to give attention to the recording besides of production activities.

N.B. The recording type could vary depending the type and condition of disease

4.1.2. Prepare and apply treatment of insect disease of Insect pests of mulberry

Table 4.1. pests of mulberry plant

Sl. No.	Common Name	Scientific Name
1	Pink mealy bug	<i>Maconellicoccus hirsutus</i>
2	Jassid/leaf hopper	<i>Empoasca flavescens</i>
3	Termite	<i>Odontotermes</i> sp.
4	White grub	<i>Holotrichia</i> spp.
5	Mite	<i>Tetranychus</i> sp.

1. Pink mealy bug



Fig.4.1. Pink mealy bug

Type of damage

- Nymphs and adults suck the cell sap from tender leaves and buds.
- Nutritive value of leaves, leaf yield and plant height are drastically reduced.

Symptoms

- Malformation of the apical shoots, retarded growth, wrinkling and curling of the affected leaves, become dark green in colour.
- Leaves become pale yellow on severe infestation.
- Affected portions become brittle.
- Symptoms are collectively called as Tukra (Bushy top) disease

Management

- Cutting the affected shoots and burning
- Spraying Fish Oil Rosin Soap (FORS) @ 40 g/l or dichlorvos 76 WSC @ 2 ml/l, (safe waiting period: 15 days)
- Releasing *Cryptolaemus montrouzieri* @ 750 beetles/ha and *Scymnus coccivora* @ 1000 beetles/ha.

2. Thrips



Fig.4.2 Thrips

Type of damage

- Injure the epidermal tissues of leaves and desap.
- Early maturity, depletion of moisture, reduction in crude protein and total sugars.
- Leaves become unfit to rear silkworm.

Symptoms

- In early stage of infestation streaks are observed on leaves.
- In advanced stages, the leaves become yellowish brown on maturity.

Management

- Spraying dichlorvos 76 WSC @ 2 ml/lit.

3. Leaf Webber



Fig.4.3. Leaf webber

Type of damage

- Larvae defoliate the mulberry plants.
- Reduction in leaf yield.

Symptoms

- Cause damage by folding the leaves and by webbing the tender shoots.
- Larvae web the leaves together and feed from inside on soft tissues, and skeletonize them.
- Grown up caterpillars feed voraciously on tender leaves.
- Apical tips are preferred for feeding, resulting in stunting. Also, apical shoots are destroyed due to egg laying.
- Quality of leaf and yield is severely affected.

Management

Table 4.2. Integrated management

Sl.No	Component	Days after pruning
1	Flood irrigation	0
2	Release of pupal parasitoid, Tetrastichus howardi @ 20,000 / ac.	1
3	Release of egg parasitoid, Trichogramma chilonis @ 2cc / ac.	10
4	Spraying of dichlorvos @ 1ml /l.	30
5	Mechanical clipping and burning of affected shoots	40

4. Termite/White ant



Fig.4.4 Termite/White ant

Type of damage

- Workers of the colony cause the damage. Termites form an earthen sheath on the stem and feed on the bark and kill the plant.
- Drying of plants and reduction in leaf yield.
- Mulching with dry twigs favours the populations build up in endemic areas.
- More damage is seen in red loam and sandy soil.

Management

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- Location and destruction of termite colonies by removing queen termite
- Treatment of mounds with 50 ml chlorpyrifos 20 EC.
- Swabbing or drenching of established plants at the base with 50 ml chlorpyrifos 20 EC.

Mulberry disease

4.1.3. Diseases and nematodes of mulberry

Table 4. 3. -Showing disease of silk warm feeding plant and its cause

Sl. No	Disease	Causal organism
1	Leaf spot	<i>Cercospora moricola</i>
2	Powdery mildew	<i>Phyllactinia corylea</i>
3	Root rot	<i>Macrophomina phaseolina</i> <i>Fusarium solani .oxysporum</i>
4	Root knot nematode	<i>Meloidogyne incognita</i>

1. Leaf spot

Symptoms

- Brownish circular or irregular leaf spots in the initial stage, enlarge, coalesce and form shot holes in later stage
- Severely affected leaves become yellowish and fall off prematurely

Management

- Spraying carbendazim @ 500-625 g/ha



Fig. 4.5. showing Powdery mildew on leaf of mulberry

2. Powdery mildew

Symptoms

- Initially, white powdery patches on lower surface of leaves are seen which later cover the entire leaf surface.
- Later turn black to brown in colour.
- Infected leaves turn yellow and fall off.
- High humidity (>70%) and low temperature (24-26oC) favour outbreak of the disease.

Management

- Providing wider spacing
- Growing resistant varieties like MR1, MR2 and China White
- Spraying Carbendazim @ 500-625 g/ha
- Releasing yellow lady bird beetles and white spotted lady bird beetles, since they feed on the mildew fungus.

3. Root rot



Fig.4.6. showing root rot from the plant

Symptoms

- Occurrence mostly seen in summer
- Initial stage, leaf blade turn to wilt and then spread to entire plant
- Later stage, black fungus are appear on branches and stem
- Spread through soil and water

Management

- Application of farm yard manure @20tonnes as basal
- At root surface pour copper oxy chloride(2gm/lit of water)
- Prevent the spread of disease to other healthy plant by basin irrigation
- Uproot the died plants
- Application of Trichoderma viride @ 25gm/plant
- Application of Bacillus subtilis @ 25gm/plant at the time of planting or pruning

4. Root knot nematode

Symptoms

- Growth and yield of plants affected.
- Stunted plants, marginal necrosis and yellowing of leaves, necrotic lesions on the root surface.
- Formation of characteristic knots or galls on the roots.
- Wilting of plants.

Management

- Deep ploughing in summer
- Applying neem cake @ 1000 kg/ha
- Applying Carbofuran 3G @ 30 kg/ha/year in four split doses
- (safe period is 50 days)

4.2. Preparing and applying of treatments

Many pests are effectively checked by dusting 10% DDT or BHC, or spraying 0.03% endrin with calcium erseinate, 0.1% malathion and 0.05% parathion insecticides. In early stages of infection, egg masses and caterpillars should be collected and destroyed. When the insecticides are used, leaves should be cleaned by washing thoroughly before feeding them to worms. Other control measures include ploughing the soil to expose and kill the pupae, handpicking and

destroying moths, trapping and destroying caterpillars by digging trenches around and across infected field. Seedlings blight, rusts, alternaria blight, and cercospora leaf spot are the diseases affecting castor leaves.

4..3. Cleaning equipment, disposing wastes and maintaining records

Tools and equipments should be properly maintained and kept clean after completion of work and stored at convenient place. When equipments are not functional it should be get maintenance services.

- **Definition:**

Maintenance is the preservation or safeguarding of machinery, property & equipments according to the manufacture’s manual so that the service life of machineries & equipments is prolonged and operate in environment friendly condition.

- **The importance of maintenance**

Maintenance is important to make sure the constant production of high quality of production.

- You can take the regular maintenance services from your service supplier.
- A regular maintenance service will reduce production losses and increase constant production.

Maintenance Procedure:

In order to maintain any given machinery one has to know the procedures to be performed during maintenance. The maintenance process involves:

- Identifying the main parts of machines & equipments
- Identifying machines & equipments which need maintenance
- Prepare tools & equipments needed for maintenance
- Identify OHS , hazards & risks involved during maintenance
- Prepare personal protective equipments to avoid or minimize those risks

In order to carry maintenance activities accurate, timely and relevant information about the equipments & machineries are necessary. Hence, maintenance activities are only possible if regard is given to manufacturer’s manual.

Self check : 4	Written test
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Name: _____

Date: _____

Directions: Answer all the questions listed below.

Part I. choose the best answer

1. preferred sowing seasons for castor plant is
A. April - June B. June-October C. March-April D.B&C
2. The resting stage of buds under extreme weather conditions is Known as
A. Harvesting B. Inoculation C. flossing D. dormancy
3. what is the preservation or safeguarding of machinery, property & equipments that is used to prolong their life time?
A. Maintenance B. Management C. Pest treatment Cleaning

Part II. Write short answer for the following

1. What is the advantage of recording and reporting of activities in sericulture farm?(4pts.)
2. Write rain fall and agronomic requirements of mulberry plantation briefly.(10 Pts.)
3. What are the two major types of Mulberry propagation?(2Pts.)
4. Write at least 5 types of mulberry and caster plan diseases (10 Pts.)
5. Write at least 3 treatment dusts used to treat pests of the plant? (6pts.)

Note: Satisfactory rating – 5 points and above Unsatisfactory - below 5 point

- You can ask your instructor for the copy of the correct answer

Operation Sheet -3

1. 1. planting mulberry/caster plant






A. Material required

- PPE
- Hoe
- spade
- nylon string
- meter
- Pegs
- planting seed/vegetative part

B. Procedure for planting

1. Site selection
2. Land preparation
3. Measuring land
4. using method of planting
5. Planting/layering
6. weed control
7. Observation of diseases & pests

Table The following are some of personal protecting materials

No	Materials	Description
1		Body safety cloth (tuta): - This cloth is a type of cloth which covers all the body part except the head and the fingers. It is used to protect the body from dirty.
2		Sun hat:- is the material, that is used to protect head from direct sun radiation
3		Eye protecting device: - it is used to protect the eye from different damage
4		Boot:- it is used to protect leg from sharpen and other damaging
5		Hand glove: - which is made of leather or strong flexible plastic rubber, it is used to cover fingers to protect from sharpen materials.

LAP TEST-3	Performance Test
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Name..... ID..... Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hour. The project is expected from each student to do it.

Task-1. Perform establishing of mulberry or caster plantation activities.

LG #37	LO #5- Treat moth, pupae, larvae , egg pests, diseases and carry out post treatment operations
Instruction sheet 5	
<p>This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> Recognizing, recording & selecting treatment method of egg, larvae, pupae and moth pests Treating egg, larvae, pupae and moth pests and diseases Cleaning equipments, disposing wastes and maintaining records <p>This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> recognize, record and select. egg, larvae, pupae and moth pests and diseases, prepare and apply treatments for egg, larvae, pupae and moth pests and diseases Clean equipment and dispose waste and maintain record 	
Learning Instructions:	
<ol style="list-style-type: none"> 1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 4. Accomplish the Self-checks 5. Perform Operation Sheets 6. Do the “LAP test” 	

Information sheet 5.

5.1. Recognizing, recording and selecting egg, larvae, pupae and moth pests treatment

Treating silkworm diseases, pests and predators

Introduction

One of the major constraints in silk production is the diseases in silkworm rearing. Most Seri culturists do not disinfect the rearing house at all. As the disinfectant Formalin cause discomfort to the residents. Silkworm bed cleaning practices involving cleaning with hand helps in contamination. Diseased larvae are not picked and even if picked, most farmers do not discard them but rear in separate tray forming a source of infection in the rearing house. The bed refuse are transported in baskets or gunny bags that are sometimes also used for transportation of mulberry leaves to feed silkworms. While transportation, the bed refuse and diseases silkworms are dropped on the way to litter pit. In some cases the bed refuse is transported directly to the mulberry field which itself gets contaminated.

5.1.1. Recognizing Major diseases of silk worm

- Diseases are the behavioral and physiological changes induced by pathogens in an organism.
- All diseases have specific symptoms and characteristics.
- Silkworms are also affected by various types of diseases caused by protozoa, fungi, bacteria and viruses.
- Since they cause substantial financial loss to the industry, their prevention and control assumes utmost importance.

5.1.2. Identifying microbial diseases

1. Pebrine disease:

Pebrine is caused by *Nosema bombycis*, which is a protozoan. The disease is transmitted through contaminated leaves or from mother moths through eggs. It is the most serious disease in silkworms as it is highly infectious and infects the young silkworm larvae causing considerable loss.

Symptoms:

The symptoms of this disease are observed in all life stages viz. (namely), egg, larva, pupa and adult.

A. Symptoms of egg stage:

- Poor egg number.
- Reduction in size and weight.
- Lack of adherence of substratum, disuniform with more of dead and unfertilized eggs.
- Irregular hatching

B. Symptoms at larval stage:

- Loss of appetite, retarded growth and dis uniformity in size
- Irregular mounting.
- Heavy mortality after 2nd moult if infected at egg stage.
- Larvae shrink in size and vomit gut juice.
- Dark brown or black spots may be seen sometimes on the body.

C. Symptoms at the pupalstage:

- Pupa looks floppy and swollen.
- Irregular black spots on the body.
- Heavy mortality at pupal stage

D. Symptoms at the moth stage:

- Improper development of moth.
- Deformed wings and distorted antennae.
- Poor mating and egg laying.
- Scale of wings and abdominal area come off easily

Control measures of pebrinedisease:

- Follow strict mother moth microscopic examination method to produce disease free laying's. Individual moth examination to group moth examination for industrial seed must be resorted to, in order to eradicate pebrinizedlayings.
- Periodical microscopic examination of silkworm larvae during rearing. If pebrine spores are detected, the whole lot should be discarded /rejected.

- Carry out surface sterilization of disease free layings by dipping egg cards in 2% formalin solution for 10 minutes followed by washing in running water.
- Follow strict disinfection of rearing room, appliances and surroundings of rearing area.
- Maintain strict sanitation and hygienic conditions during rearing.
- Apply bed disinfectant as per recommended schedule and quantity. Infected silkworm feces and bed refuse are important source of infection and should be disposed of to prevent cross infection and spread of disease.

2. Grasserie disease:

Grasserie is a viral disease in silkworm caused by Nuclear Polyhedrosis (NPV), Cytoplasmic polyhedrosis (CPV) and infectious flacherie. Nuclear polyhedrosis (NPV) is a major viral disease in silkworm. It is caused due to the presence of high temperature, high humidity and feeding of poor quality mulberry leaves. It is highly infectious.

Symptoms:

In the early larval stage of infection, it is difficult to detect the disease. Microscopic examination of larvae may indicate the presence of polyhedral bodies. As the disease advances, the larvae loose appetite and skin becomes shiny before moulting. The inter-segment membrane becomes swollen. The haemolymph or body fluid becomes turbid white. Microscopic examination shows presence of large number of polyhedral bodies.

Grasserie larvae

Control measures for grasserie:

- Rear the larvae under clean and hygienic condition.
- Thorough disinfection of rearing room, appliances and surroundings.
- Ensure proper disinfection of egg surface.
- Incubate eggs under hygienic conditions. Avoid touching with hands.
- Provide suitable and timely feed during rearing.
- Maintain proper spacing and adequate ventilation.
- Pick out diseased, weak and injured larvae and destroy them properly.
- Apply bed disinfectants as per recommended schedule and quantity.

3. Flacheriedisease: caused by bacteria or virus individually or in association.

- Depending on symptoms and cause they are called as bacterial flacherie disease, septicemia, sotto disease, etc.

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- The disease may occur due to fluctuations in temperature, humidity and feeding poor quality mulberry leaves.

Symptoms

- Larvae becomes sluggish and loose appetite.
- Body shrinks, becomes soft and flaccid.
- Growth is retarded, becomes dull and vomits gut juice.
- Loose clasping power of prolegs.
- Body ferments, turn to different color and oozes out foul smell.

Control measures for flacherie:

- Raise only healthy and strong silkworm races.
- Maintain proper temperature (22-25°C) and humidity (80-85%) during incubation of eggs.
- Attend thorough disinfection of rearing room, appliances and surroundings.
- Take strict hygienic measures during rearing.
- Isolate infected larvae from the healthy one immediately and destroy by burning or dumping deep in the soil.
- Provide quality leaves for feeding and maintain proper spacing and ventilation.
- Maintain proper temperature and humidity during rearing

4. Muscardine (Fungal disease): Muscardine is a fungal disease in silkworm. Various types of muscardine diseases have been reported i.e. white, green, yellow etc.

- The white muscardine in silkworm is caused by a fungus, *Beuveriabassiana*.
- The disease is caused due to body contamination by the fungus. The fungus grows well under low temperature.

Symptoms:

- The larvae loose appetite, become sluggish, ceases to move and finally die.
- The dead larvae become harder and mummified.
- The body after death is covered with white mycelia. Conidia develops in the body.
- Finally whole body of dead larvae looks chalky white.
- The pupa and moth are also infected by white muscardine disease. In heavy infection, pupal body gets covered with conidia.

Control measures for muscardine disease:

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- Infected larvae should be picked up and burnt.
- Maintain good ventilation and proper humidity in rearing room.
- Regulate humidity by dusting lime at the time of each moult and in between.
- Apply bed disinfectants as per recommended schedule and time.
- Provide quality leaves and maintain proper spacing during rearing. Avoid dusty leaves.
- Follow strict disinfection of rearing house, rearing appliances and surrounding area.
- Practice proper disinfection of silkworm egg surface.
- Maintain hygienic conditions during rearing.
- As a specific measure, dust Diathene M-45 in Kaolin or Captan in slaked lime on silkworm body immediately after every moult as per following schedule.

I-II instar -1% dust

III-V instar-2% dust

- Apply formalin chaff to silkworm body. The formalin chaff is prepared by partially burning paddy husk and mix formalin of 0.6% to 0.8% concentration (0.6% for chawki and 0.8% for late stage) in the ratio of 10:1. The chap is sprinkled uniformly on the silkworms 30 minutes before feeding.

5.1.3. Identifying Pest and predators

A. Uzi Fly, Exoristabobmycis:

- The Uzi Fly, Exoristabobmycis is a serious endo-larval parasitoid of the silkworm. The loss estimated from this fly is 10-20%.
- The pest occurs throughout the year. Its incidence is high from August to November.
- Presence of black scar on the body of parasitized silkworms and maggot emerge hole in cocoon indicate the uzi infestation.
- The silkworms parasitized in early instars are killed before attaining spinning stage, while those parasitized in the late fifth instar spin cocoons of weak built and from such cocoons uzi maggots emerge by piercing, thus rendering cocoons unfit for commercial reeling.

Management:

1. Physical Method:

- Collect and destroy the uzi infested silkworms and uzi maggots and pupae.
- Keep the rearing house floor free from cracks and crevices.
- Uzi infested larvae spin cocoons a day or two earlier than other silkworms and such cocoons are flimsy and bad quality.
- Fixing wire mesh or nylon mesh to the window of the rearing house with an arrangement to construct anteroom would physically prevent uzi fly entering the rearing house.

II. Chemical methods:

A.Uzi Powder:

It is an ovicidal dust formulation. It is dusted on the body of silkworms on the 2nd day during III instar, 2nd and 4th days during IV instar and 2nd, 4th and 6th days in V instar. Uzi powder should be dusted after bed cleaning and silkworms should be fed half an hour after dusting. 4-5 kg uzi powder is required for 100 dfls.

B.Uzitrap:

It is a chemo trap used for attracting and killing the adults. Dissolve one tablet in one liter of water and the solution should be poured in light colored flat trays or plates and placed near the windows of the rearing house. Uzi flies are attracted and get trapped in the solution. 12 tablets are required for 100dfls rearing.

C. Uzicide:

It is an ovicidal formulation. It is sprayed on the body of silkworms starting from 2nd at in III instar through 4th or 6th day of V instar on alternate days except during moulting. Uzicide should be sprayed after bed cleaning or 2-3 hours after feeding. Silkworms should be fed half an hour after spraying uzicide. 4 to 5 liters is required for rearing 100 dfls.

Biocontrol Agent:

Nesolynx thymus is aecto-pupal parasitoid to kill the pupae. One lak hadult females should be released in 3 doses corresponding to IV and V instars and within one or two days after cocoon harvest at 8000, 16000 and 76000 adults, respectively. The parasitoids are released immediately after sunset in the rearing house, places of mountage storage, near mountages with spinning worms and also near the manure pits.

B. Insect Pests of Grainages:

- A number of insects are known to attack B. mori in grainages. Dermestid beetles and earwigs cause heavy loss in grainages.
- The most important pest is Dermestesater beetles which are omnivorous.
- They attack and feed on eggs and silk moths, besides boring into cocoons to feed on pupae within the cocoons. They also feed on dead organic matter.
- The predatory earwigs, Labia arachidis attack gravid females placed on the egg sheet for oviposition. They cut open the abdominal region of the moths and the injured moths die before egg lying.

Management:

- The grainage premises and place of storage of cocoon should be kept clean.
- The pest insects should be collected using a vacuum cleaner and destroyed by burning
- The pierced cocoons should be thoroughly sundried before storing them in airtight bags.
- The pierced cocoons (PC) should be shifted from the grainages as and when they are available and stored in place away from the grainages.
- Fix wire mesh to the doors and window of the grainage.
- Use of plastic cocoon storing trays reduced the incidences of pests.

Chemical Control:

- Dusting of bleaching powder (36% chlorine) on the floor near the walls @ 200g/sq.ft.
- The cocoon storage bags should be dipped in 0.028% deltamethrin solution (1 part of deltamethrin in 100 parts of water), followed by shade drying.
- Spray 0.028% deltamethrin solution on floor and walls of PC storage rooms.
- Dust 5% malathion on PC, before storing them (5kg dust to cover 50kg PC)
- Dip wooden trays harbouring the pests in 0.076% DDVP solution for 2-3 minutes. After 10 days, wash them thoroughly, sundry and use.
- Spray stands and room with 0.076% DDVP solution.
- Days, wash them thoroughly, sundry and use.
- Spray stands and room with 0.076% DDVP solution.

Treatments may include use of

- Insecticides and fungicides,
- Dips and release of biological agents,
- pheromone traps, baits, and hormones

Constraints in management of diseases in silkworm rearing

- The major constraint in silkworm disease management is the need for a disinfectant suitable to the infrastructural facilities available with Seri culturists. Formalin was used as a disinfectant in sericulture for the past several hundred years.
- The unsuitability of the disinfectant under the infrastructural facilities available with Seri culturists and its hazardous nature has been responsible for improper disinfection and hygiene.
- Recently disinfection with bleaching powder solution was introduced as a disinfectant in sericulture. While the disinfectant eliminated the constraints associated with formalin, its high corrosiveness, unsuitable nature and unsure of quality lead to the similar situation as formalin

5.1.4.Integrated silkworm disease management

- Comprehensive integrated steps can result in prevention of silkworm diseases. Prevention is better than cure is the correct approach for controlling silkworm diseases. The following preventive measures will result in controlling silkworm diseases:
- Follow strict disinfection of rearing houses, rearing equipment and surrounding areas.
- Rear only disease free laying's. Infected laying should be isolated through strict moth examination and discarded.
- Control mulberry pests (alternate hosts of muscardine causing pathogens) in the field and provide disease free and quality leaves according to age of silkworms.
- Maintain strict sanitation and hygienic conditions during rearing.
- Enhance vigor of silkworms by providing suitable and timely feeding. This will enhance resistance against disease.
- Isolate sick and diseased worms and dispose of properly.
- Maintain appropriate spacing during rearing.
- Isolate infected material/equipment and follow strict disinfection.

- Feces (silkworm litter) and bed refuse should be disposed of properly by burying it.
- Adjust the humidity of rearing room and trays. Dust lime at the time of each moult.
- Apply bed disinfectant (Vijetha/Labex/RKO) as per recommended schedule and time.
- Intensive rearing management and close monitoring is essential

Self-check 5	Written Test
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Name: _____ Date: _____

Directions: Answer all the questions listed below.

Part I. choose the best answer for the following questions

- Which of the following is protozoa disease of silk worms?
A. Pebrinedisease B. grasseriedisease C. Muscardine D. Flacherie disease
E. None
- Pest and predators
A. Nesolynx thymus B. Dermestid beetles C. Uzi Fly D. all
- Which of the following is used as treatment for **pebrinedisease** of silk worm disease?
A. Apply Diathene M-45 B. apply 2% formalin solution for 10 minutes C. UZy Dust

Part II. Write the short answer for the following questions

- List major silk worm diseases; pest and predators? (6pts)
- List and discuss Control measures of pebrine disease? (6pts)

Note: Satisfactory rating - 12 points Unsatisfactory - below 12 points

You can ask you teacher for the copy of the correct answer

LG #38	LO #6 Handle and Clean materials, tools and equipment
Instruction sheet 6	
<p>This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> • Handling waste materials • Handling and transporting materials, tools and equipment • Maintaining clean and safe work site • Recycling , storing, disposing disposable materials • Reporting work outcomes <p>This guide will also assist you to attain the learning outcomes stated in the cover page.</p> <p>Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> • Waste materials produced during work are handled according to supervisor instructions. • Materials, tools and equipment are handled and transported according to industry guidelines. • Clean and safe work site is maintained while working • Materials are returned to store or disposable materials are disposed. • Work outcomes are reported to supervisor, feedback on performance is sought and any required improvements are noted for future action 	
Learning Instructions:	
<ol style="list-style-type: none"> 7. Read the specific objectives of this Learning Guide. 8. Follow the instructions described below. 9. Read the information written in the information Sheets 10. Accomplish the Self-checks 11. Perform Operation Sheets 12. Do the “LAP test” 	

Information sheet : 6

6.1.Handling Waste material produced during work

Waste materials and debris produced during rearing silk worm includes:-

- Litter, sick and dead silkworms
- Dead larvae and pupae
- Broken and wasted rearing and farm items
- Plant debris
- Plastic, and paper-based materials
- Moulded skins

These needs day to day cleaning from the rearing room and storage in a designated area to sort out for recycling, re-using, returning to the manufacturer, or disposed of according to enterprise work procedure.

6.2.Handling and transporting Materials, tools and equipment

Materials used for raising sericulture activity have to be handled and transported safely. Any sericulture farmer has to do this task safely because any damage will create inconvenience on the next use of the equipment, and also it will cause injury to silkworms.

All the materials and equipment used in sericulture farming should be handled and transported accordingly.

6.2.1.Good handling measurements of materials tools and equipments are:-

- Provide sanitation services to the working devices after and before work
- Maintaining identification and selection of functional equipment from non-functional ones.
- Apply the kaizen principle according to the sericulture farming disciplines
- Use safe and well organized storage for tools, equipment and materials.
- Use recommended transportation system as the transported materials nature.

Make of care during loading and unloading of materials, equipment and tools

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6.2.2. Handling materials, tools and equipment

Materials will be stored for varying periods of time before an entry control is performed or at different stages of the production process.

Stores should be safe from a health and safety point of view, the material should bear clear identification, and **means of transport** (e.g. boxes, pallets) should be standardized and reusable. Chemical reaction of the material with the environment (rust is a very common one) should be avoided, as well as leaks and spillages. The respective training of transport and warehouse workers is indispensable. Special precautions have to be taken in the case of hazardous materials. Information on how to do this can be found in a useful guide entitled Storage of hazardous materials, issued by the UNEP Industry and Environment Office.

Materials management, often called logistics, holds the responsibility for the transport of materials in many companies.

6.2.3. Transport distances

Depending on the more or less favorable layouts of plants, number of handlings of a material in successive production stages, means of transport (energy consumption, noise and exhaust emissions, electric fork-lift versus diesel fork-lift) and type of **transport containers** play an important role in environment-friendly materials management.

A relatively new task for materials management is the handling of all kinds of wastes and not just the traditional selling

6.3. Cleaning and maintaining work site

Work site have to be clean and safe for efficient work of employee. So any sericulture farmer or employee in sericulture farm has to keep sanitation of his/her work site which mean that he/she has to clean the work area after completing his/her task by doing these he/she can keep healthy himself/herself and staff members.

The work site should be clean and safe to conduct effective sericulture development activity.

The work area:

- Should be free from contaminants/chemicals
- Should be free from any obstacles causing injuries, death and etc
- Should be with the recommended temperature
- Should be well ventilated/ not suffocated

- Free from dirty or disposals wastes
- Far from noisy and disturbance
- Free from predators
- Remove the unhealthy larvae
- When the silkworms are moved off, the beds must be cleaned.

6.4. Recycling , storing, disposing disposable materials

Sericulture emerged as an important economic activity, becoming increasingly popular in several parts of the country, because of its short gestation period, quick recycling of resources.

- **Handling Waste material produce during working.**

One of waste material in the livestock farm is manure of the animal, So this waste product have to be removed from our farm in different way. The main objective of manure handling is to prevent surface and ground water pollution. Biological and chemical treatments of animal wastes are too expensive for farmers to use. Generally, the wastes must be held in some way until they can be properly disposed of on the land.

- **Selecting a system of Manure Handling**

An animal feeding operation refers to facilities that house livestock for production purposes. The Environmental Protection Agency (EPA) specifies the conditions and/or factors that must be taken in to account when planning and selecting Livestock waste handling systems.

Solid system uses several types of floors, depending on the way in which the manure is to be handled. Housing that uses a solid system may have concert floors, dirt floors, slotted floors, or solid floors with gutters. Those buildings with liquid systems may use solid concrete floors that are flushed with water. Slotted floors are also used with liquid.

Liquid system use pits, lagoons, or storage basins for storing and handling manure. Pits are pumped out & the manure is spread on the liquid in the farm. Storage basins may be above or below the ground. Above ground system is more expensive to build than underground basins so that the manure can be hauled to the field.

Every waste material must be handled in a safe manner and avoided from farm area as soon as possible.

6.5. Reporting Working outcomes

Report may be defined as a formal statement describing a state of affairs or what has happened. It has detailed description of a problem or a situation, findings of an investigation and recommendations or actions taken. Or we can say that it is submitted by a lower authority to a higher authority and it is a back bone of communication. The quality of organizational decision depends on the quality of information reported and organized. Report should be objectively and timely. Because, report enable managers to evaluate progress and plan the future. Detailed report is precious formal document prepared and presented by the workers to the higher management concerning the works on operation or completed. The report may contain the following.

- The report that represents the result of technical, economical and financial feasibility of the program or project.
- Report serves as the basis on the basis of which the concerned government body gives clearance /sanction of the planned works.
- Report serves as guide for the starting and implementation of the planned activities.
- Report is helpful in achieving the time and cost limits in the completion of the planned activities.
- Report is helpful in obtaining technical and financial assistance from different cooperative organizations and bodies.
- **Report reflects commitment of the organization /group of the planned work performers.**

I. Report includes the following:-

- General information about the work
- Background of the participants of the work
- Details of the work or project Capacity
- Process Technical arrangement
- Raw materials and tools
- schedule of implementation
- attitude of beneficiaries
- participation of stakeholders
- Cost estimated and used
- Means of finance
- Cash flow details
- Economic consideration
- Local, regional and federal government clearance

II. Types of Reports

Reports could be oral or written. On which oral report is face to face communication which is informal and time saving. On the other hand, written report is formal and relatively more accurate and precise. On the basis of format and procedure; adopted reports may be formal or informal.

- **Informal report** is report of person to person communication where as
- **Formal report** is presented in prescribed form and procedures.

III. Guide Lines for Writing Report

- **Report should include the following:**

- A. General information:-analysis of the organization which the work (project belongs) and it deals with the past performance. Description of the culture, attitude, participation, economic condition, environmental, terrain, climate condition and the local resources found are stated well. Role of the public sector, community, local government, civic organizations, allocation of investment, choices of technique etc
- B. Preliminary analysis of alternatives:-This should contain present data on the gap between demand and supply of the out puts which are to be produced. Sustainability of the project and options should be put in the report.
- C. Project description: - on population, water, land, air, flora, fauna, effects arising out of the project and other environmental effects, equipment, operational requirement.

Self check : 6	Written test
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Name: _____

Date: _____

Directions: Answer all the questions listed below.

Part 1. Write brief answers for the following questions

1. Write waste materials and debris produced during rearing silk worm includes? (5pts)
2. Write briefly good handling measurements of materials tools and equipments? (5Pts.)
3. what are the two main types of reports?(4pts.)

Part II. Choose the best answer

1. Face to face communication which is informal and time saving is
A.. oral report B. written report C. secondary report
- 2.

Note: Satisfactory rating – 5 points and above

Unsatisfactory - below 5 point

You can ask your instructor for the copy of the correct answer

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