

INTENSIVE BIVOLTINE SERICULTURE TECHNOLOGY PACKAGE



CENTRAL SERICULTURAL RESEARCH & TRAINING INSTITUTE

[ISO 9001 : 2015 Certified]

CENTRAL SILK BOARD

Govt. of India: Ministry of Textiles,
BERHAMPORE – 742 101, WEST BENGAL

December,2015

English

© CSR&TI, Berhampore, WB, December,2015

Published

Dr. Kanika Trivedy
Director
CSR&TI, Central Silk Board
Berhampore, West Bengal

Compiled & Edited

Dr. A. K. Saha
Dr. A. K. Verma
Dr. N. Suresh Kumar
Dr. S. Roy Chowdhuri
Dr. U.K. Bandyopadhyay
Dr. J. Sarkar

Technical Assistance

Mr. Subrata Sarkar
Smt. Subhra Karmakar (Mustafi)
Mr. Sanjib Roy

Cover design & DTP

Mr. Tapas Kr. Maitra
Computer Cell, CSR&TI

CONTENTS

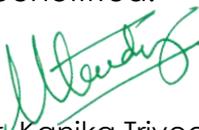
Contents		Page No.
1.	Rearing House	1
2.	Recommended Hybrids and Rearing schedule	2-5
3.	Hygiene and Disinfection	5-9
	A. Room disinfection	6-7
	B. Bed Disinfection	8
	C. Hygiene	9
4.	Incubation of Eggs	9-11
5.	Black boxing of Eggs	11-13
6.	Young Age Rearing	14-20
	A. Brushing	14-15
	B. Preparation of Chawki Bed	15
	C. Mulberry leaf quality, harvest and preservation	16
	D. Size and requirement of mulberry leaves	16
	E. Frequency of feeding	17
	F. Bed Cleaning	17
	G. Spacing/ Bed area	17-18
	H. Moulting care	18
	I. Environmental conditions for young silkworms	18-19
	J. Chawki rearing management	19-20
	K. Importance of chawki rearing	20
7.	Late age silkworm rearing	21-31
	A. Characteristics of late age silkworms	21
	B. Methods of late age rearing	21
	C. Environmental Conditions	22
	D. Quality of mulberry leaves	23
	E. Leaf preservation	23
	F. Feeding frequency	23-24
	G. Quantity of mulberry leaves required	24
	H. Bed Spacing	24
	I. Bed Size	24
	J. Recommended gap between trays/ dalas	24
	K. Bed cleaning	25
	L. Larval Protection	25
	M. Care during moulting	25
	N. Mounting of Cocoons	26-27
	O. Identification of matured larvae	27
	P. Picking of matured larvae	27
	Q. Mounting methods	28-29
	R. Mounting Environment	29
	S. Mounting Density	29-30
	T. Harvesting of Cocoon	30-31
	U. Disinfection after rearing	31

PREFACE



The tradition of sericulture of its region is primeval. Due to continuous effort of CSR&TI, Berhampore, since 1943 the age old the traditional sericulture activity has transformed into an industry in the Eastern (5 states) and North-Eastern (7 states) regions. Silk has been intermingled with the life and culture of the North-Eastern states and have a rich and complex history in silk production. Sericulture stakeholders especially sericulture farmers of these regions are benefitting by adoption of improved technologies & innovations percolated through the extension networking of this premier institute. A North-Eastern state of India comprises of Assam, Sikkim Tripura, Manipur, Nagaland, Mizoram and Meghalaya is practicing mulberry silkworm rearing. Due to small land holdings and other resource constraints, improved technology adoption by these seri-farming families is slow. Despite these hurdles, coordinated efforts of Central Silk Board and State Sericulture Departments accelerated the development further, which has been visualized with a gradual shift from rearing Multi x Bivoltine hybrids to Bivoltine breeds/hybrids. The bivoltine silkworm breeds/hybrids with rearing technologies developed by this premier Institute, their dissemination and wide adoption in the field has added a new dimension in sericulture industry. The Bivoltine promotion through Cluster Promotion Programme (CPP) to this effect has further accelerated the development of silk production in this region from an average quality cocoon production of 42 kg/ 100 dfls to around 50 kg/ 100 dfls in bivoltine. As a result sericulture has emerged as a profitable avocation to other agriculture crops.

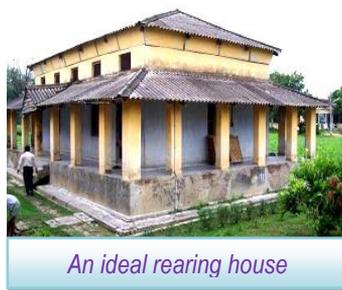
For long, West Bengal and Eastern part of the country were known as non-congenial zone for bivoltine sericulture due to climatic hazards but overcoming all those, bivoltine sericulture has been gaining momentum now. Our efforts of publishing the book will only be fulfilled if then persons directly/ indirectly involved with the sericulture industry especially the farmers get benefitted.


(Dr. Kanika Trivedy)
Director

Sericulture is one of the important sources of income for the rural populace, in India. It being the agro-based labour intensive industry a large number of farming families are involved in sericulture. It is the complex structure of silkworm host plant management i.e. mulberry (*Morus* spp.) cultivation and silkworm (*Bombyx mori* L.) rearing, production of cocoons and silk. Mulberry silkworm (*Bombyx mori* L.) being monophagous, it solely depends on mulberry for its food. Besides, management of silkworm rearing is important for successful production of cocoon and thereby quality silk production. The factors influence the rearing silkworm (*Bombyx mori* L.) and its management practices need proper care. Among, various factors, quality silkworm layings, inculation of silkworm eggs, disinfection, maintenance of hygiene and rearing environments, quality of mulberry leaf, disease and pest management, mounting etc. are important for silkworm rearing and its success.

Rearing House:

- Well ventilated rearing space of 200 sq.ft. (Tray rearing) / 300 sq.ft (Shelf rearing) is required to rear 100 dfls'.
- A rearing house should be established nearer to the mulberry garden that reduces the excess expenditure for man power, transportation, communication as well as it provides better management.
- It should be established in a comparatively high land and in considerable distance from any stagnant water.
- Importance should be given for the placement of the house facing in north and south to avoid the temperature of direct sunlight and for adequate cross ventilation.
- A false ceiling is acceptable in winter to maintain the optimum temperature of the rearing house while the ceiling may be released during summer.
- Utilization of natural resources like, woods, bamboo and other available materials are suitable for silkworm rearing than brick buildings.



An ideal rearing house

Recommended Hybrids and Rearing schedule for States in Eastern and North Eastern region:

Eastern region:

1. West Bengal

Silkworm Breed and Rearing Brushing Schedule

Season	Hybrids	Bivoltine hybrid	Brushing schedule
Falguni	Bivoltine/ Cross Breed	SK6 x SK7/ Nistari x (SK6 x SK7)/ M.Con.1 x B.Con.4/ M.Con4 x B.Con.4	26th-30 th January
Baisakhi	Cross breed	Nistari x (SK6 x SK7)/ M.Con.1 x B.Con.4/ M.Con4 x B.Con.4	28-30 th March
Jaistha	Cross Breed	Nistari x (SK6 x SK7)	20-22 nd May
Sravani	Multi x Multi	Nx M12(W) / N x M.Con.4/ M.Con.1 x M.Con.4	20-23 rd JUne
Bhaduri/ Aswina	Multi x Multi	Nx M12(W) / N x M.Con.4/ M.Con.1 x M.Con.4	4 th – 6 th Aug. 23 rd -25 th Aug.
Agrahayni	Bivoltine/ Cross Breed	SK6 x SK7/Nistari x (SK6 x SK7)/ M.Con.1 x B.Con.4/M.Con4 x B.Con.4	31 st Oct. – 5 th Nov.

2. Odisha

Silkworm Breed and Rearing Brushing Schedule

Season	Hybrids	Bivoltine hybrid/ Cross Breed	Brushing schedule
Spring	Bivoltine	SK6 x SK7/CSR2 x CSR4/ FC1 x FC2	20-25 th Feb
Rainy	Cross Breed	PM x CSR2	20 – 25 th Aug.
Autumn	Bivoltine	SK6 x SK7/CSR2 x CSR4/ FC1 x FC2	20-25 th Oct.



3. Bihar**Silkworm Breed and Rearing Brushing Schedule**

Season	Hybrids	Bivoltine hybrid/ Cross Breed	Brushing schedule
Spring	Bivoltine/ Cross Breed	SK6 x SK7/ PM x CSR2	Last week Feb-1 st week March
Rainy	Cross Breed	PM x CSR2	1 st Aug.
Autumn	Cross Breed	Nistari x (SK6 x SK7) / M.Con.1 x B.Con.4 / M.Con4 x B.Con.4	1 st Oct

4. Jharkhand**Silkworm Breed and Rearing Brushing Schedule**

Season	Hybrids	Bivoltine hybrid/ Cross Breed	Brushing schedule
Spring (March- April)	Bivoltine/ Cross Breed	SK6 x SK7 / Nistari x (SK6 x SK7) / M.Con.1 x B.Con.4/ M.Con4 x B.Con.4	28 th Mar – 1 st April
Rainy (July – Aug)	Multi x Multi	Nx M12(W) / N x M.Con.4/ M.Con.1 x M.Con.4	31 st July - 3 rd Aug
Autumn (Sept- October)	Bivoltine/ Cross Breed	SK6 x SK7/Nistari x (SK6 x SK7)/ M.Con.1 x B.Con.4/ M.Con4 x B.Con.4	28 th Sep. – 1 st Oct

5. Chattishgarh**Silkworm Breed and Rearing Brushing Schedule**

Season	Hybrids	Bivoltine hybrid/ Cross Breed	Brushing schedule
Spring	Bivoltine	SK6 x SK7	25 th Feb.
Rainy	Cross breed	PM x CSR2	15 th Aug.
Autumn	Bivoltine	SK6 x SK7	20 th Oct.

North-Eastern region:**1. Assam & BTC :****Silkworm Breed and Rearing Brushing Schedule**

Season	Hybrids	Bivoltine hybrid	Brushing schedule
Spring (Mar-Apr)	Bivoltine	SK6 x SK7	8-10th March
Summer	Cross breed	PM x (SK6 x SK7)	10-12th April
Autumn (Sep-Oct.)	Cross breed	PM (SK6 x SK7)	12-15th September
Late autumn (Nov)	Bivoltine	SK6 x SK7	2nd - 5th November



2. Meghalaya :

Silkworm Breed and Rearing Brushing Schedule

Season	Hybrids	Bivoltine hybrid	Brushing schedule
Spring (Mar-Apr)	Bivoltine	SK6 x SK7 ; B. Con.1 x B. Con.4	22-25 th March
Autumn (Sep-Oct)	Bivoltine	SK6 x SK7; B. Con.1 x B. Con.4	22 th – 24 th Sep.

3. Manipur :

Recommended hybrids:

Improved cross breeds N x (SK6 x SK7), M.Con.1 x B.Con.4,	Bivoltine hybrid SK6 x SK7, CSR2 x CSR4, B Con.1 x B. Con 4
Additionally, rearing of Chinese x Japanese hybrid is in vogue during March - April	

Rearing seasons:

Spring : March -April	Summer: June - July	Autumn September - October
Favourable for bivoltine rearing. The crop is practiced in the valley and hills regions.	Adverse due to moderate temperature, high rain fall and humidity. Farmers prefer to rear improved cross breeds.	Favourable for bivoltine rearing. The crop is practiced in the valley and hills regions.
Recently an early spring crop (in valley; D/B: last week of February) and early late autumn crop (in lower hills; D/B: 2 nd week of October) has been introduced.		

4. Mizoram :

Silkworm hybrids

Multi x Bi hybrid	Bivoltine hybrid
M.Con.1 x B.Con.4, M.Con.4 x B.Con.4, N x (SK6 x SK7), M6DPC x (SK6 x SK7)	SK6 x SK7, B.Con.1 x B.Con.4, CSR2 x CSR4

Season of Silkworm rearing

Spring March -April)	Summer (May-June)	Autumn (Nov.–Dec.)
March – April is most favorable commercial seasons for bivoltine silkworm rearing. The crop is practiced in the valley and hills regions.	Is partially favourable for silkworm rearing due to moderate temperature rain fall and humidity. During this season, farmers prefer to rear multi x bi hybrids.	Is the most ideal season for commercial silkworm rearing can be exploited for bi x bi due to congenial environmental conditions



5. Nagaland :

Silkworm hybrids

Multi x Bi hybrid	Bivoltine hybrid
M.Con.1 x B.Con.4, M.Con.4 x B.Con.4, N x (SK6 x SK7), M6DPC x (SK6 x SK7)	SK6 x SK7, B.Con.1 x B.Con.4, CSR2 x CSR4

Rearing Seasons

Spring (March-April)	Summer (May-June)	Autumn (Nov – Dec.)
March – April is most favorable commercial seasons for bivoltine silkworm rearing. The crop is practiced in the valley and hills regions.	Is partially favourable for silkworm rearing due to moderate temperature rain fall and humidity. During this season, farmers prefer to rear multi x bi hybrids.	Is the most ideal season for commercial silkworm rearing can be exploited for bi x bi due to congenial environmental conditions

6. Sikkim:

Silkworm Breed and Rearing Brushing Schedule

Season	Hybrids	Bivoltine hybrid	Brushing schedule
Spring (Apr-May)	Cross breed	SK6 x SK7	22-25 th April
Autumn(Sep.- Oct.)	Cross Breed	SK6 x SK7	22 th – 24 th Sep.

7. Tripura :

Silkworm Breed and Rearing Brushing Schedule

Season	Hybrids	Bivoltine hybrid	Brushing schedule
Spring (Mar-Apr.)	Bivoltine	SK6 x SK7	8-10 th March
Summer	Cross breed	PM x (SK6 x SK7)	10-12 th April
Autumn (Sep.-Oct.)	Cross breed	PM (SK6 x SK7)	12-15 th September
Late autumn	Bivoltine	SK6 x SK7	2nd - 5 th November

Hygiene and Disinfection:

Proper disinfection is one of the key factors in determining the success of sericulture and also essential in the prevention and control of silkworm diseases. Generally annual 5 crops in West Bengal and 3-4 crops in Eastern and North-Eastern regions are in practice of which spring and autumn are considered as favourable seasons. Like other insects, silkworms are prone to diseases and pest. Therefore, it is essential to control the diseases for successful crop harvest. For silkworm rearing the common disinfectants used are -

- Bleaching powder
- Slaked lime
- Chlorine dioxide (Sanitech) etc.
- Gharsodhan



Disinfectant:

- Rearing room & appliances disinfection: 5% Bleaching powder, Sanitech, Gharsodhan etc.
- Bed disinfection: Labex, Resham Kit Ousadh (RKO), Sericillin, Vijetha etc.

A. Room disinfection:

Disinfection of the rearing house is done 4-5 days before starting the rearing operation. Bleaching Powder Solution (5%) is used as disinfectant for silkworm rearing. 5% Bleaching powder solution in 0.3% slaked lime solution can be prepared as mentioned below:

Total quantity of disinfectant (lit)	Bleaching powder (kg)	Slaked lime (kg)	Water (Lit)
1	0.05	0.003	1
2	0.10	0.006	2
3	0.15	0.009	3
4	0.20	0.012	4
5	0.25	0.015	5
10	0.50	0.030	10
40	2.00	0.120	40
50	2.50	0.150	50
100	5.00	0.300	100

Preparation procedure of 5% Bleaching powder solution

- Dissolve 60 g of slaked lime powder in 20 lit. of water (0.3%).
- Dissolve 1 kg of bleaching powder solution in 0.5 lit. of slaked lime solution and make a paste.
- Dissolve 60 g of slaked lime powder in 20 lit. of water (0.3%).
- Pour the above bleaching powder paste to rest of the slaked lime solution and shake thoroughly.
- Cover the bucket with a lid and keep the mixture undisturbed for 15 minutes to settle down the un-dissolved matters.



Preparation of Bleaching Powder paste & mixing the paste with water

Application

- Use a sprayer machine for spraying the solution in the rearing room and its appliances.
- Rooms are not necessary to be made air-tight.
- Clean and wash the machine immediately after disinfection so that the corrosive actions of bleaching powder are avoided.



Quantity required

- 2 litres per sq. m floor area or 185 ml / sq. ft. floor area.
- For disinfection of rearing appliances inside the rearing house, 25% extra of the total quantity of disinfectant solution are required.
- Disinfecting the rearing appliances outside of the rearing house, 10% to the total quantity of disinfectant solution are required.

Example

- Say the area of the rearing room is 20' x 15' i.e. 300 sq. ft. = 28 sq.m
- Quantity of Disinfectant solⁿ. required for the room is 28 x 2 lts.= 56 litres
- Disinfectant solution required for appliances is 56 x 25/100 = 14 litres
- Disinfectant solⁿ required for outside rearing house is 56 x 10/100 = 5.6 litres
- Total quantity required is 56 + 14 + 5.6 = 75.6 lts or 76 litres

Advantages

- Bleaching powder is effective even when rooms are not air-tight.
- Effective at ordinary room temperature.
- Harmless to human beings and domestic animals.

2.5% Sanitech Solution

- Add 500 ml sanitech solution to 50g activator crystals to activate the Chlorine dioxide.
- Leave the preparation for 5 min. to allow complete dissolution of the crystals till colour changes to yellow.
- Mix 500 ml of yellow coloured sanitech solution with 19 lit. of water.
- Dissolve 100g of slaked lime in 0.5 lit of water in a clean container and mix this solution with 19.5 lit of solution.
- Stir the solution thoroughly. This solution (500 ppm chlorine dioxide + 0.5% slaked lime) can be used to disinfect the rearing house and tools.



B. Bed Disinfection

Commonly used bed silkworms disinfectants are Vijetha, Labex, Sericillin, RKO etc.

LABEX

Composition: 97% lime and 3% bleaching powder

Preparation procedure:

- Mix required quantities of pulverized slaked lime and bleaching powder thoroughly.
- In case slaked lime is not available, ordinary lime is procured and water is sprinkled on the lime and left overnight. This converts the lime (CaO) into slaked lime [Ca (OH)₂].
- The slaked lime is then dried and powdered and sieved through fine wire-mesh to obtain fine powder. The mixture contains 1% active chlorine.

Application

- Dust the powder uniformly on the silkworm bed @ 3-4 g / sq.ft. of bed area once after each moult i.e., half an hour before resumption of the next feeding and once more on 4th day of Vth instar immediately after bed cleaning and half an hour before next feeding.
- About 4 kg of labex is required for rearing of 100 DFLs.
- It inactivates all diseases caused by fungi, bacteria, viruses, protozoan etc.



Dusting of LABEX

Precautions

- After opening the packet, the mixture should be consumed within two months as long storage causes quality deterioration.
- Persons dusting labex should take adequate care to prevent its inhalation.

Formalin Chaff

- Formalin chaff is used for control of muscardine disease.
- Formalin solution of required concentration depending on the silkworm instar (0.4% for I & II; 0.5% for III; 0.6% for IV and 0.8% for V) is mixed with burnt paddy husk in the ratio of 1:10 by volume and then it is sprinkled evenly on the larvae and covered with a paraffin or double fold news paper.



- After half an hour the paper cover is removed and feed is given.
- Formalin chaff application should not be done when the larvae are preparing for moult and under moult.
- Application of formalin chaff can be done before brushing on the newly hatched larvae and after each moult half an hour before resumption of feeding.
- The frequency of application of formalin chaff should be increased depending on the incidence of disease.

C. Hygiene

- Before entering the rearing house, hands should be washed with 2% bleaching powder solution.
- Foot mat soaked in 5% bleaching powder and 0.3% slaked lime solution should be placed at the entrance.
- Immediately after bed cleaning room should be swept and cleaned with bleaching powder solution.
- Crevices of rearing room should be closed to check the entry and accumulation of litter along with the pathogen.
- Paraffin paper should not be reused after one rearing.
- Diseased / un-equal worms should be picked up and disposed into 5% bleaching powder in a basin.
- Polythene sheet should be spread in the rearing room for the collection of bed refuse.
- Rearing wastage should be disposed off in a pit far from the rearing house.



Washing of hands before entering the rearing room

Incubation of Eggs

Incubation is the process of preserving silkworm eggs under optimum temperature, humidity and photoperiod conditions to facilitate proper development of embryo and ensure uniform hatching. Incubation is done -

- To ensure proper development of the embryo.
- To ensure more than 95% hatching in a single day
- To maintain voltinism of a race
- To maintain vigour of the larvae
- To ensure quality and quantity of cocoon.



Duration of Incubation

Incubation of eggs begins from the day of oviposition. Normally 10 days are required from egg laying to hatching, which however may vary from 9 to 11 days according to temperature and humidity. In case of preserved eggs the incubation time is 7-9 days only.

Transportation of Silkworm eggs

- Utmost care should be taken during transportation of silkworm eggs.
- Ideal time for transportation is within 4 day of development of embryo.
- It is always better to transport the egg during cooler hours of the day
- Optimum temperature and aeration is to be provided during transportation.
- Eggs are to be carried in suitable eggs carrying box / cage.
- Improper transportation of eggs may leads to increase in the incidence of dead eggs and irregular hatching.

Surface Sterilization

- Egg should be dipped in 2% formalin solution for 10-15 minutes.
- If eggs are not properly sterilized, the larvae become weak and die due to diseases and form the source of secondary contamination for other larvae.
- Silkworm eggs can be safely surface sterilized on any day of development except during pin head and blue egg stage.
- In case of eggs in sheets, dip the sheets in 2% formalin solution for 10 minutes and wash in running water and dry in shade.
- In case of loose eggs they have to be taken out from the container, transferred into a cloth bag and dipped in 2% formalin solution, wash and dry in shade.

Incubation Procedure

- Incubation at 25°C temperature, 80% relative humidity and 16 hours of light per day is ideal for silkworm eggs.
- Wet foam strips may be used whenever Relative humidity falls below 70%.
- 16 hours light and 8 hours dark is ideal for incubation particularly in bivoltine eggs.



Incubation of card eggs



Loose egg Box



Incubation pot

Incubation in low cost incubation pot during summer

- It is a device consisting of two bucket shaped earthen pots.
- The inner chamber hangs inside the outer chamber from its rim. In between two chambers there is space or gap.
- Prior to incubation about 7-8 litres of water is poured inside the outer chamber and the inner chamber is placed within the outer one.
- In the incubation pot, about 400 dfls in sheets can be incubated at a time. In case of loose eggs the quantity will be more.
- It reduces the temperature by 6-7°C and increases the humidity by 40% from ambient condition which are nearer to the optimum.

Management during incubation

- Spread the eggs in a single layer for providing uniform temperature and humidity.
- It required, manipulate the temperature and humidity inside the incubation device or in the incubation room using heater, putting water container etc.
- Position of the eggs should be changed at regular intervals in all the directions in case of sheet eggs; in loose eggs position of eggs may be changed by shaking of the eggs for exposing uniform temperature and humidity.
- Keep the incubation room airy by opening door and window.
- Light should be cut off when eggs appear in the head pigmentation/ blue stage.
- The eggs should be refrigerated for one or two day for synchronization, if all the eggs do not uniformly develop.

Black boxing of Eggs

Irregular hatching of silkworm eggs is undesirable and imposes problems on the rearing management and uniform, hatching of eggs may be obtained by manipulation of temperature, light and humidity. The silkworm eggs are artificially confined to a dark phase or 'Scotophase' prior to hatching and the process is referred to as Black Boxing of Eggs.

Advantages

Development of eggs is observed faster in light than in darkness till head pigmentation stage. From the head pigmentation stage, conversely, darkness expedites the developmental process. By exploiting this developmental process, the early maturing embryo is prevented from hatching and the late embryos are given



time to develop and catch up with the early maturing worms. The next day they are exposed suddenly to diffused light so that the larvae hatch out most uniformly responding to the phototropic stimulus. By this method hatching percentage of 90 and above is attained.

Methods

- The egg sheets, packed in tissue papers or loose eggs are spread in single layer encircled by foam pads and finally covered by black cloth
- In case wooden trays and plastic trays are used, pile up the trays one over other and cover the whole assemblage with a double layered black cloth.
- For maintaining the ambient humidity, covers the assemblage with wet or dry cloths.
- Where bamboo trays are used they may be kept inside the rearing stand and the whole stand is covered with black cloth.
- For large scale black boxing, the entire incubation room can be made dark where light proof arrangements are possible. Black curtains are hung outside or inside the doors and windows to make the complete darkness.



Stage and duration of black boxing

- The eggs should be kept in darkness when majority of the eggs (80%) have reached pin head stage.
- This stage is identified as a small black dot in the eggs near the micropyle end and it appears normally on 7th – 8th days of incubation under optimum conditions.
- For multivoltine, 48 hours of black boxing is sufficient for synchronized and uniform hatching.
- For bivoltine, 72 hours is required as the change of eggs to head pigmentation stage is not clearly identified in majority of the eggs.
- Black boxing is required for only 36 hours when eggs are in blue stage.



Initiation of hatching

Exposure of eggs to light for hatching

On the day of hatching, the eggs are exposed to diffused light from a tube light, bulb or natural day light inside the incubation room. The eggs when exposed to light should be provided with optimum humidity and temperature. Hatching of larva is completed within 2½ hours.



Exposure to light

Precaution

- The intension of black boxing is not to postpone hatching but to synchronize the development of eggs or close the related age groups.
- Black boxing should not be practiced for all the laying when there are sharp differences in the developing laying
- Neither black boxing is any answer to eggs where there is a clear cut difference of 24 hours or more in oviposition time or release time from cold storage.
- Care should be taken not to expose the egg

Young Age Rearing

Mulberry silkworm is classified into two distinct phases i.e., Young age (chawki) and Late age for better management. Requirement of rearing appliances for CRC of 100 dfls are given below.

Rearing appliances	Quantity (No.)
Rearing Tray (3' x 2')	17
Rearing bamboo dala (6' x 4')/ round dala (5 ½ ft diameter)	4
Rearing stand / table	1
Foam strip (3' x 2" x 1.5")	68
Feather	2
Chop sticks (8" length)	2
Ant well,	6
Bed cleaning net (1 cm mesh)	30
Hygrometer	1
Chopping board	1
Chopping knife	1
Feeding stand	1
Leaf chamber,	1
Wash basin	1
Paraffin paper (3' x 100')	One roll

A. Brushing

- Brushing is the separation of newly hatched larvae gently and carefully from the egg sheets to rearing trays.
- Silkworm egg hatching generally starts in the early hours of the day after one or two hours of exposure to light in the morning and ideal time for brushing is at 9 AM to 10 AM.
- Tender mulberry leaves of suitable quality are selected, chopped at a size of 0.5 cm square and sprinkled in a thin layer on the newly hatched larvae. After 15 -20 minutes when all the larvae gather on the leaves, the egg sheets are turned upside down to transfer the worms along with the leaves on the rearing tray and the 1st feed is given to the larvae.



Newly hatched larvae



Sprinkling of leaves

- The rearing bed should be provided with wet foam pad around the bed and covered with another sheet of paraffin paper to complete the operation of brushing.
- Tapping of worms or direct brushing of larvae to rearing bed should be avoided. The use of chop sticks or feathers for stretching the rearing bed or making the rearing bed is advised
- Chop sticks or feathers should be used for stretching the rearing bed or making the bed.



Brushing with feather

Brushing of Loose Eggs

- After removing the loose eggs from the black box, they are kept in the rearing tray provided with paraffin paper.
- The eggs are then spread in the box by gently shaking.
- The cover cloth should be cut without damaging the eggs and kept turned up with the eggs and expose to required light.
- Cotton or nylon net (double) with proper mesh size should be spread on the worms before giving 1st feeding to the newly hatched larvae.
- Wet foam pad should be kept around the bed and the bed must be covered with another paraffin paper.
- Before the second feed, all the larvae which crawled up on the upper net are transferred to a rearing tray with a bottom paraffin paper.
- Then 2nd feeding and proper bed spacing should be given to them.



Spreading of two nets



Providing of leaf



Transfer of Chawki Bed

B. Preparation of Chawki Bed

- The rearing bed should be provided with wet foam pad in all the four sides and covered with paraffin paper to complete the operation of brushing
- During high humid seasons, wet foam pads may be avoided.



C. Mulberry leaf quality, harvest & preservation

- Quality of mulberry leaves plays a vital role for growth and development of the young silkworms.
- Tender mulberry leaves with 75 to 80% moisture and high nutrient content (protein 27%, carbohydrate 11%) are ideal for young age silkworms.
- A separate mulberry plot / garden is preferred. Requirement of FYM is 40 tones/ha/yr. and NPK @ 236: 180: 112 kg/ha/yr.
- If general mulberry plot is used, largest glossy leaf at the tip, 3rd to 5th leaves are ideal for first instar and subsequent 6-9 leaves for the second instar larvae and remaining tender leaves are suitable for third instar larvae.
- Plucked leaves should be kept in a basket or leaf chamber covered with wet gunny cloth.
- During dry seasons water should be sprinkled on the gunny cloth.



An ideal chawkli garden

Selection & Preservation of mulberry leaves

D. Size & Requirement of Mulberry Leaf

Since the worms are tiny in size, chopped leaves are spread uniformly on the worms in rearing bed so that the worms can have easy access to the leaves for feeding. It also helps in loosening and spreading the bed when the bed is required to be dried prior to feeding and also at moulting. But now it is recommended to feed different instars of worms with different sizes of chopped mulberry leaves are given below.

Size of Leaf for Chawki rearing

Instar	Size (cm ²)		Size (cm ²) during moult
	From	To	
I	0.50	2.00	1.00
II	2.00	4.00	1.50
III	4.00	Entire leaf	2.00



E. Frequency of Feeding

- Four times feeding per day at 6 AM, 10 AM, 4 PM and 8 PM should be given during both low and high humid seasons to avoid quick withering of cut mulberry leaves.

F. Bed Cleaning

- Young age silkworms are delicate and prone to diseases. Thus, maintenance of cleanliness in silkworm bed is a vital aspect to ensure hygiene in the rearing microclimate as well as for silkworm body.
- Time to time bed cleaning is essential to remove unused mulberry leaves and silkworm litters accumulated in the rearing bed.
- Cleaning is done by nylon net of mesh size one cm. sq. (1.00 cm²).
- Cleaning net is applied covering the full rearing bed just one feed before the cleaning time and the feeding is given above the net.
- At the time of next feed the net along with the larvae are transferred to another tray and fresh feed is given only after giving sufficient spacing.
- Cleaning schedule for young age rearing is given below.

Instar	Frequency	When to be done
I	Once	Before settling of 1 st moult, preferably on 3 rd day.
II	Two times	Just after 1 st moult Before settling of 2 nd moult, preferably 2 feedings before moult.
III	Three times	Just after 2 nd moult Before settling of 3 rd moult Middle of the 3 rd instar

G. Spacing or Bed Area

- Through optimum spacing at every stage of rearing, starting from brushing of the worms, vigorous growth, robust health and uniform development of the entire batch of worms are ensured.



- Optimum spacing for young age worms in their first three instars is as follows for 100 laying which contain an average of 400 eggs per laying.

Bed Spacing (Sq ft) for 100 dfls		
Instar	Multi x Bi	Bi x Bi
1 st	6 – 18 (1)*	8 – 21 (1)*
2 nd	18 – 54 (3)*	21 – 65 (3)*
3 rd	54-100(4) *	65-140(6) *

* No. of 6' x 4' Trays

H. Moulting Care

Silkworms take normally 12 - 14 feedings (4 feeding / day) to settle for 1st moult, 8-10 feedings for the 2nd moult and 14 – 18 feedings for 3rd moult. Moulting duration is 20 - 24 hours under optimum conditions. Following care should be taken for uniform:

- Size and quantity of leaves should be reduced just before settling for moulting.
- When about 90% of the larvae settled for moulting, feeding should be stopped.
- Slaked lime powder should be dusted to reduce bed humidity during seasons with high humidity.
- The rearing bed should be maintained as thin as possible to reduce bed humidity.
- During moulting, paraffin paper on the top of the silkworm bed and wet foam pads should be removed in case of Box Rearing.
- When around 90 to 95% silkworms are out of moult bed disinfectant like labex should be dusted.
- After half an hour of dusting, feeding should be given with tender leaves.

I. Environmental conditions for young silkworms

Temperature

The environmental factors like temperature, humidity, light and air have great influence on growth and development of silkworm. These factors directly or indirectly control the physiological activities of silkworm larvae. Hence, it is necessary to provide most favourable climate conditions to the silkworms at young stage.



Humidity

Humidity exerts a direct effect on water evaporation in the silkworm's body, regulation of the body temperature and metabolism. It also influences the withering rate of mulberry leaves, the worm's appetite and the sanitation of the rearing beds. In summer, high humidity will facilitate propagation of pathogens on the rearing beds, which increases the incidence of diseases.

Devices for enhancement of temperature



Circumferential Room heater



Hot air blower

Device for increasing humidity



Humidifier

Temperature and humidity requirement during young age silkworm rearing

Particulars	Instars		
	I	II	III
Temperature	27-28°C	26-28°C	26-27°C
Relative humidity	85-90%	85-90%	80%

Light

- For uniform development of the silkworms, direct or one-sided light on the rearing bed should be avoided.
- Silkworm prefers dim light of 15-30 lux and it requires a minimum 16 hours light per day.

J. Chawki Rearing Management

For Low Humid seasons

- **Box rearing method** (individual tray with bottom and top paraffin paper as well as wet foam pad in piled up condition) is recommended
- The top most trays should be a dummy tray without worms
- Paraffin paper cover should be removed and crisscross pattern of tray should be maintained half an hour before feeding and during moulting to allow aeration.

For High Humid seasons

- **Open type of shelf rearing** (individual tray in rearing stand with only bottom paraffin paper without paraffin cover and wet foam pad) is recommended.

K. Importance of Chawki rearing

- Practicing chawki rearing ensures healthy and robust silkworms which will spin successful cocoon crops in later stages with minimum of loss due to diseases.
- Practicing chawki rearing will help to reap bumper harvest of cocoons in the region (45 to 55 kg / 100 dfls).
- The cocoon of such bumper harvests are also superior in quality and therefore fetch much higher prices in market.
- Bumper harvest of cocoon will also mean more efficient use of leaf harvest (leaf cocoon ratio 18 to 16:1).



Late age silkworm rearing

Rearing of fourth and fifth instars larvae are called as **late age rearing**. Late age worms are more sensitive to high temperature, humidity and susceptible to diseases. During this stage, the larvae grow vigorously and feed maximum leaves. In this instars, silkworm larvae takes mature and nutritious mulberry leaves to build their physique for producing silk protein continuously.

A. Characteristics of late age silkworms

- Late age silkworms become weak when exposed to high temperature, much humidity, lack of aeration and other unfavourable environmental conditions.
- Larvae need more food than the young silkworms.
- Mulberry leaf quality and environmental factors play important role in crop success followed by the rearing technique, silkworm race or breed, silkworm eggs etc. Contribution of different factors for success of rearing are –

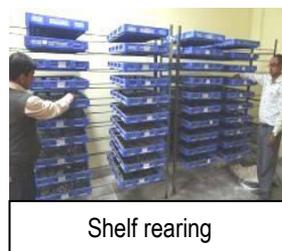
Items	Percentage contribution
Mulberry Leaf	38.20%
Climate	37.00%
Rearing Technology	09-30%
Silkworm Race	09.30%
Silkworm eggs	03-10%
Other factors	08-20%

B. Methods of late age rearing

Two methods are suitable for rearing of late age silkworms namely Shelf rearing and Shoot rearing.

Shelf Silkworm Rearing

- Silkworms are reared in bamboo trays which are arranged one over the other in tiers on rearing stands.
- Rearing stands are arranged in two rows parallel to the wall with adequate space in the centre, for removing the trays and for conducting the cleaning and feeding operations.
- Mulberry leaves are picked from the plants are cut to convenient size and fed to the silkworms.
- Usually 4 feeding are given in a day and nets are used for cleaning the beds.



Shelf rearing

- Labour required is high and has the advantage of accommodating more silkworms in a limited area.

Shoot Rearing

- Shoot rearing practices is suitable during unfavorable climatic condition from May –June and suitable parameters are given below.

Items	Quantity /parameters
Size of Rack	25' x 5'
No of tiers	4 tiers with a gap of 24"
Material for preparation	Bamboo/Wood
Preparation of Shelf	With Nylon rope & net
Time of shifting	Just after 3 rd Moults
Method of feeding	Entire shoot in two alternate direction
Feeding frequency	3 times /day
Bed cleaning	Ones in 4 th instar & twice in 5 th instar



Shoot rearing

C. Environmental conditions

- Environmental factors i.e., temperature and humidity, quality of leaf supply, techniques of rearing adopted, such as feeding, cleaning, spacing etc determine the success of silkworm crops.
- Temperature and humidity requirement during late stage silkworm rearing are-

Particulars	Instars	
	IV	V
Temperature	24-25°C	23-24°C
Relative humidity	75 %	70%

Temperature

- Temperature plays a very vital part in the growth of silkworms. It has direct effect on the various physiological activities.
- Optimum temperature should be maintained by using room heater or country chullah (smokeless).
- Doors and windows of rearing house should be closed during winter season from afternoon to the next morning.

Humidity

- Humidity plays a vital role in silkworm rearing.
- It influences directly on the physiological functions of the silkworm.



- It influences on the preservation and freshness of mulberry leaf in the rearing beds.
- High humidity affects growth of late age worms and create favourable environment for outbreak of diseases.
- Humidifier may be used to increase humidity.
- Use lime powder to reduce humidity.

Air Current, light and darkness

- Air current helps in providing fresh air required for silkworms besides, regulating the rearing room temperature and humidity.
- Growth of silkworms is correlated with movement of air current in silkworm rearing room.
- Light and dark periods of 16 and 8 hours respectively in late instars are desirable.

D. Quality of mulberry leaves

Mulberry leaves are the only source of nutrition for the silkworm. In silkworms, mature mulberry leaves are converted into silk protein – Silk. For production of 100 unit of silk substance, around 170 units of protein, 200 units of sugar, 23 units of fats and 7 units of organic salts are required. Protein rich and low moisture content leaves are most suitable for late age rearing. Leaves should be harvested after 50 -60 days from date of sprouting. In case of shoot harvest, it is essential to clip the terminal buds at least 7 days before feeding to worms of 4 -5th instars larvae. Yellow and over matured dried leaves should be avoided strictly.

E. Leaf preservation

- During **dry seasons**, water should be sprayed on covered gunny cloth. Leaves should be preserved for 2-3 feeding only.
- During **high humid seasons of June – September**, one day preserved leaf may be given.
- Do not store mulberry leaves inside the rearing room. Leaves should be stored in a separate disinfected room.



F. Feeding Frequency

- Favourable season: March - April & September -October (with low humidity)
4 times feeding at 6 AM, 10 AM, 4 PM and 9 PM.

- Rainy seasons: May-July (with high humidity) three times feeding at 6 AM, 1 PM and 8 PM keeping the same quantum of feeding.

G. Quantity of Mulberry Leaves Required

- Requirement of mulberry leaf (kg) for rearing of 100 dfls of are:

Instar	Multi x Bi	Bi x Bi
1 st	3.00	5.00
2 nd	12.00	15.00
3 rd	50.0	70.0
4 th	110	170
5 th	625	940
TOTAL	800	1200

H. Bed spacing

- Overcrowding of larvae leads to poor growth and development of worms and poor quality cocoons as well as low survival.
- Spacing between the worms as well as the trays should be maintained properly depending upon season to season.
- In summer months the spacing required is comparatively more than the winter.



I. Bed size

- Ideal bed size in sq.ft. for 40,000 larvae (100 dfls) is:

Instar	Multi x Bi	Bi x Bi
4 th	100 – 200 (9)*	140 – 270 (12)*
5 th	200 – 400 (17)*	270 – 540 (23)*

[*No. of (6' x 4') Dalas / Tray]

J. Recommended gap between rearing trays / dalas

- A gap of 9" between the rearing trays / dalas is recommended for better aeration instead of 6" gap which is now practiced by the farmers of West Bengal.

K. Bed cleaning

- Removal of unused mulberry leaves, fecal matter of silkworm, dead or unhealthy silkworms from rearing bed is known as bed cleaning.
- It plays a significant role for healthy growth and development of silkworm.
- Accumulations of unnecessary matters build detrimental micro-climate in the rearing bed and favours rapid multiplication of micro-organisms.
- Periodical bed cleaning is necessary to maintain hygiene.
- During late age rearing, the bed should be cleaned once in a day in the morning hours.
- Use cotton or nylon net is used for bed cleaning.
- The net is spread over the silkworms and leaves are served to the silkworms.
- At the time of next feeding, nets are lifted along with silkworms and transferred to a fresh cleaned tray.



Bed cleaning by using nets

L. Larval Protection

Silkworms' crop loss is recorded due to the outbreak of various diseases like infectious grasserie, bacterial flacherie, nuclear polyhedrosis etc. Occasional occurrence of muscardine and pebrine also cause significant loss. Labex dusting is most effective to control the silkworm diseases. It should be dusted after bed cleaning, half an hour before feeding. It should not be dusted during moulting period.



M. Care during moult

Prior to stopping the fed for moulting, the rearing bed should be spread to a thin layer to facilitate quick drying of leaf over in the tray and also to provide the desired low humidity. Lime powder may be applied during moulting to keep dry condition of the bed. Besides charred paddy husk can be applied for uniform moulting.

N. Mounting of Cocoons

Types of Mountages to be used

- Bamboo mountage and Plastic collapsible mountage is recommended.
- Post cocoon parameters are improved in collapsible mountage, durable, easy to disinfect, easy to handle, requires minimum space for use and preservation.

Bamboo Mountage:

- Bamboo mountages are traditional type of mountage.
- Bamboo strips are fixed in a spiral/circular fashion on the bamboo mats. 1.8 x 1.2 meters is ideal size of mountage and gap between the spirals should be 5 - 6 cm.
- Around 40 – 60 larvae per sq. ft. can be mounted.
- Two mountages can be placed one behind the other at 45° inclination during spinning stage to reduce areas.



Plastic collapsible mountage:

- Plastic collapsible nets are specially designed for mounting of spinning larvae.
- Height of the corrugation should be 6 cm and each mountage should have 11 corrugations.
- Ideal size of the mountage should be 60 x 90 cm, and can be placed in wooden rearing tray.
- Around 300- 400 larvae can be mounted on a mountages and old newspaper should be placed below the mountage to absorb the urination and to reducing humidity.
- Plastic collapsible mountages require less mounting space, easy for disinfection and cocoon harvesting with adequate aeration.



Rotary mountage:

- Rotary mountage consist of two components, wooden frame and card board mountage.



Card Board Mountage:

- Ten card board mountages are assembled in a checkered pattern and each card board mountage has 13 rows consisting 12 sections totaling to 156 sections.

- Each section of which provides shelter to a silkworm to spin its cocoon. 10 such pieces are assembled in a wooden frame. This is called as a set. Each set can accommodate 1560 silkworms. Standard size of cardboard moutage is 55 cm length, 40 cm width, width and 3 cm depth. This frame can be compactly folded when unused.
- 35-40 moutages are required to mount 100 Dfls larvae (40,000-45,000 larvae).

O. Identification of matured larvae

- After eating sufficient mulberry leaves in the 5th instar, on 6th-7th day, the silkworm larvae shrinks, body becomes translucent and reduced eating.
- The matured larvae raises its head, start moving around in search of a place for cocooning and passes soft litter.
- At this stage, the mature worms should be picked up and placed in the chandraki for spinning.
- Delayed identification and transfer leads to the formation of poor quality cocoon.



Ripened worms



Spinning in progress

P. Picking of matured larvae

Two methods are used for picking the matured larvae.

Manual picking method: In this method only matured larvae are picked by hand one by one and put into plastic basin. This method is time consuming and labour oriented.

Jobarai method: In this method when 5% of the worms are matured, net is spread over the rearing bed and shoots are fed. After 2-3 hours, the net is lifted along with the shoots and worms. Spread an old newspaper or polythene sheets on the floor. The shoots are taken out along with worms from the net and shoots are shaken gently over the newspaper/polythene sheet from a distance of 1 foot from the ground. This method should not be practiced when the batch is infected with diseases. This method is less time consuming and labour saving.

Q. Mounting methods:

Matured larvae can be mounted by three methods-

1. Keep the mountages horizontally on the floor.
2. Keeping the mountages vertically with the support of wall.
3. Combination of horizontal and vertical methods.

Horizontal method:

- In this method, assembled rotary mountages is placed horizontally on the floor over the old newspaper.
- Known number of larvae (1250-1300) taken based on weight/volume, are transferred equally in between card board frames from top of the mountage.
- Plastic comb can also be used by inserting it in between card board and fixed properly. 1250 larvae are taken in a long plastic/wooden board and transferred from top of the mountage and then comb is taken out.
- Every time same quantity/volume of larvae is mounted to maintain uniform number of larvae in all mountages.
- Mountages are kept as such for 4-5 hours before suspension from ceiling.
- Protect it from ant attacks.
- Mounting of 100 dfls need 400 Sq.ft. floor area.

Vertical method:

- Assembled mountages are placed vertically in such a way that hooks are facing upward on the floor over the old newspaper.
- With the help of hard card board piece, 125-130 matured worms are mounted in each piece card board frame and a total of 1250-1300 silkworms are mounted uniformly from top to bottom of the mountage.
- Mountages are left as such for 2-3 hours before suspending them from ceiling.
- 180 sq.ft. floor area is required to mount 100 dfls worms.
- This method is recommended where there is scarcity of space.

Combined method:

- Assembled rotary mountage are placed horizontally on the floor over the newspaper.
- 1250-1300 worms are taken in a plastic boat.
- Plastic comb is inserted between the card board frames.
- Larvae are transferred equally from the top of the mountage so that the larvae will rest on the branches of plastic comb.



- The moutage is lifted and kept in vertical position in such a way that hooks face upward and moutage is leaned against the wall.
- The plastic comb is slowly removed and the moutage is left as such for 2-3 hours.
- Afterwards the moutage is suspended from the ceiling with the help of iron hooks.

Suspension of rotary moutage from ceiling:

- Generally, matured silkworms take 2-3 hours to settle down in sections of rotary moutage.
- Rotary moutages should be placed at the same direction as of the wind and light. After 2-3 hours moutages should be suspended horizontally parallel to the ground with the support of iron hooks. While suspending the moutages, the unclimbed worms are collected and remounted.
- Depending on the height of the ceiling, 2-3 tiers of moutages can be suspended.
- After suspending, nylon net is tied or some matting materials like, gunny cloth/paddy straw/saw dust /old newspaper are spread on the floor below the moutages to absorb the urine passed by the silkworms and keep the mounting room dry and also to avoid damage to the silkworms in case of accidental fall.
- The mat is removed and cleaned as early as possible. Lime can be dusted on the floor to reduce the humidity in the mounting hall.

R. Mounting Environment

- 24 – 25°C temperature and 60 – 70% humidity suitable during spinning
- Proper aeration should be maintained during spinning room.
- Bamboo chandraki should place in the Varandah or under the shade in well ventilated condition.
- Direct sun light should be avoided.
- High temperature and high humidity adversely affect the reeling quality of cocoons

S. Mounting Density

- Proper mounting density should be maintained for quality improvement.
- 40 larvae / sq.ft. is recommended for bi x bi hybrid
- 50 larvae / sq.ft. is recommended for multi x bi hybrid
- 60 larvae / sq.ft. is recommended for multi x multi hybrid.





Optimum density



Crowded condition



Mounting under direct sunlight



Mounting in Verandah

T. Harvesting of Cocoon

- Cocoon should be harvested on 7 – 8th day of spinning for Bi x Bi and on 5 – 6th day of spinning for Multi x Bi hybrids.
- Premature harvesting of cocoon affects the quality. To confirm the completion of pupation few cocoon are cut open and checked.
- Defective cocoons such as deformed cocoons, flimsy cocoons and double cocoons should be removed.
- After harvesting cocoons should be deflossed.
- Cocoon should be preserve
- Keep thin layer before marketing.



Harvesting of cocoons



Deflossing of cocoons

U. Disinfection after rearing

- Waste material, diseased larvae, flimsy and melted cocoons should be collected and burnt after completion of each rearing.
- When harvesting is over, rearing room and appliances should be cleaned thoroughly with water followed by 5% bleaching powder solution.



Inside the rearing house



Outside the rearing house





Serving nation since 1943

Published by:

Dr. Kanika Trivedy, Director

C.S.R. & T.I., Central Silk Board

Berhampore - 742 101, Murshidabad, West Bengal