SERICULTURE TECHNOLOGIES DESCRIPTOR FOR EASTERN AND NORTH-EASTERN STATES

CENTRAL SERICULTURAL RESEARCH & TRAINING INSTITUTE
CENTRAL SILK BOARD : Ministry of Textiles : Govt. of India
Berhampore, Murshidabad, West Bengal

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TECHNOLOGIES

1. Mulberry variety: S1 (for irrigated & rainfed zones)

Advantages over the alternative technologies:

Leaf yield is around 3 folds more than the local variety Kajli.

Leaf yield: 28-29 mt/ha/yr (irrigated) & 9-11 mt/ha/yr (rainfed)

Best suited practices with the variety:

- Land should be prepared after soil testing; pH range of 6.5 to 6.8 is preferred.
- Plantation through saplings is preferable.
- Wider spacing of minimum 60 cm x 60 cm or more should be adopted.
- Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: Leaves are smaller in size but profuse in number. The variety fares well throughout the country.

States/ areas: Gangetic West Bengal, parts of NE states, Jharkhand, Bihar and Orissa

Salient features of the technology: Suitable for Gangetic alluvial soil under both Irrigated & Rainfed conditions; **Extent of coverage**: 7750 acres

2. Mulberry Variety : S1635 (for irrigated & rainfed zones)

Salient Features: Leaf yield is 44-45 mt/ha/yr (Irrigated) and 8-14 mt/ha/yr in rainfed conditions.

Advantages over the alternative technologies:

Leaf yield is around 50% more than S-1 variety.

Best suited practices with the variety:

- Land should be prepared after soil testing; pH range of 6.5 to 6.8 is preferred.
- Plantation through saplings is preferable.
- Wider spacing of minimum 60 cm x 60 cm should be adopted under irrigated condition.

- Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: Leaves mature a little early. But it fares well throughout the country.

States/ areas: Gangetic West Bengal, parts of NE states, Jharkhand, Bihar and Orissa.

3. Mulberry Variety : C1730 (for red & lateritic rainfed soil)

Salient Features: This variety is suitable for Red & Lateritic soil. The leaf yield is 15-16 mt/ha/yr.

Advantages over the alternative technologies:

Leaf yield is around 75% more over the local variety.

Best suited practices with the variety:

- The land should be properly prepared after soil testing; pH range 6.5 to 6.8 is preferred.
- Plantation through saplings is preferable.
- Wider spacing of minimum 90 cm x 90 cm must be adopted.
- Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: Suitable for low rainfall areas of lateritic and coarse textured soils.

States/areas: Low rainfall areas of West Bengal, Jharkhand, Bihar, Chhattisgarh, Orissa and Madhya Pradesh with lateritic soils.

4. Mulberry Variety: $BC_2$59 (for Hilly region)

Salient Features: Leaf yield is 9-10 mt/ha/yr at hills (Kalimpong) and 15-16 mt/ha/yr at foot hills.

Advantages over the alternative technologies:

Leaf yield is around 2 folds more than the local variety and 12% maore than Tr-10 variety.

Be**st suited practices with the variety:**

- Land should be prepared after soil testing.

- Plantation through saplings is preferable.
- Wider spacing of minimum 90 cm x 90 cm or more should be adopted.
- Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: Survivability is low in hills due to acidic nature of the soil.

States/ areas: Hilly areas of West Bengal, Sikkim and parts of NE States.

5. Mulberry genotype: C-2038 (for irrigated conditions)

Salient Features: Mulberry genotype C-2038 has been identified as highest yielder (55 mt/ha/yr) under irrigated condition, which out yielded S-1635 (45.0 mt/ha/yr) by 27%.

Advantages over the alternative technologies:

Leaf yield gain is around 1.25 folds more than the high yielding S-1635 variety.

Best suited practices with the variety:

- The land should be properly prepared after soil testing; pH range 6.5 to 6.8 is preferred.
- Plantation through saplings is preferable.
- Wider spacing of minimum 60 cm x 60 cm must be adopted under irrigated condition.
- Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: It fares well in irrigated condition.

6. Mulberry genotype: Tr-23 (for acidic soils of hills & foothills of WB)

Salient Features: Tr-23 is suitable for acidic soil of hills / foot hills specially of Darjeeling hills with an annual leaf yield of 15 mt/ha and 24.5 mt. at Kalimpong and Matigara (Darjeeling district) respectively.

Advantages over the alternative technologies:

Leaf yield gain is around 56% and 77% more than existing ($BC_2$59) variety.

Best suited practices with the variety: Land should be prepared after soil testing, Plantation through saplings is

preferable, Wider spacing of minimum 90 cm x 90 cm should be adopted under rainfed condition, Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: Suitable for acidic soils of hills and foot hills in West Bengal.

7. Mulberry genotype: C-2028 (as flood tolerant)

Salient Features: Tolerant to flood conditions in the low lying areas (water logging / stagnation of 4-6 weeks). Annual leaf yield of 35-36 mt/ ha. with higher survival (70%) and low rate of leaf senescence (19%) followed by S-1635 (26.2 mt/ha, 43% and 53%) and S-1 (22.9 mt/ha, 62% and 22% respectively).

Advantages over the alternative technologies:

Leaf yield gain is around 3-4 folds more than the local variety.

Best suited practices with the variety:

Standard package of practices for cultivation of the variety should be followed.

Limitations and environmental impact:

The variety fares well in the flood prone areas of Eastern and North-Eastern India.

States/ areas: West Bengal and other states in Eastern & North-Eastern India.

8. Nitrofert - a Nitrogen fixing bio-fertilizer (*Azotobacter chorococcum*)

Salient features of the technology:

Nitrofert is an eco-friendly biofertilizer containing free-living nitrogen fixing bacteria (*Azotobacter chrorococcum*). Efficient strains have been isolated from rhizospheric soil of the local mulberry gardens. Annual doses of 20 kg/ha in irrigated and 10 kg/ha in rainfed mulberry gardens are to be applied. This reduces application of inorganic Nitrogen by 50% of the recommended dose (336 kg in irrigated and 150 kg in rainfed gardens/ha/yr) without any adverse effect on leaf yield and quality.

Methodology: The cultured bacterial broth is mixed with powdered charcoal in 1:3 ratio and packaged in sealed plastic air tight bags. This is a commercially marketable product costing Rs 25/- per kg. A minimum population of 108 cells/g of carrier material is maintained in the product. Irrigation should be applied immediately after Nitrofert application to maintain soil moisture (35-40%).

- Nitrofert can be stored for a maximum period of 180 days in a cool and dark place but, fresh inoculum is preferred.
- A minimum of 10 days gap between the application of Nitrofert and chemical fertilizers should be followed.

Advantages over the alternative technologies: Reduces about 50% chemical nitrogenous fertilizers by applying @ 20 kg/ha/year for irrigated and 10 kg/ha/year for rainfed areas. Eco-friendly approach, reduces the cost of cultivation by Rs.960/-/ha/yr. Benefit – Cost ratio: Irrigated: 2.9:1, Rainfed: 2.6:1.

Limitations and environmental impact: Use of pesticides and contact with chemical fertilizers hamper bacterial growth of Nitrofert and its functioning.

Extent of coverage: Around 880 hectares of land supplemented since year 2000 amongst 5442 beneficiaries.

States/areas: West Bengal, Orissa, Bihar, Jharkhand, Madhya Pradesh and North-Eastern states of India.

9. Phosphofert (*Arbuscular mycorrhizal* fungi)

Salient features of the technology:

Phosphofert (*Arbuscular Mycorrhizal* fungi) biofertilizer is of fungal origin, obligate symbiont in nature, containing living mycelia and spores of AM fungi in rhizosphere soil which enhances phosphate mobilization, diffusion, absorption and uptake by plants especially in phosphate – deficient (below 20 kg available P/ha) and moisture stress soils.

Methodology: Garden soil is sterilized twice through autoclaving. The maize seeds inoculated with AM Fungi, *Glomus mossae* and *G. fascicula* are sown in the sterilized soil. The plants are taken care of to grow. The process of growing maize plants is repeated twice till the inoculated soil becomes enriched with the spores and mycelia to the population of 108 cells /g of soil. The spore-enriched soil is wrapped in air tight polythene bags for commercial sale @ Rs. 25/- per kg.

This can be stored in a dark and cool place upto six months but, fresh material is advised for field application.

- In established mulberry garden, apply 75-100 kg Phosphofert/ha/ in irrigated soil and in rainfed soil 40-50 kg /ha once in 4 years
- It is an eco-friendly approach, brings down the cost of cultivation by Rs. 2,325/- per ha/yr in irrigated & Rs. 390/- per ha/yr in rainfed mulberry gardens respectively
- Benefit – Cost ratio: Irrigated condition: 2.7 :1, Rainfed condition : 3.5:1

Advantages over the alternative technologies:

It reduces about 70% chemical phosphatic fertilizer by applying in the AM Fungi- inoculated mulberry saplings grown in nursery @ 200 kg/ha/year.

Limitations and environmental impact:

- Use of Phosphofert biofertilizer reduces the phosphate requirement in mulberry upto 70% both under irrigated and rainfed conditions.
- It enhances water and solute uptake, root proliferation, phosphate mobilization, plant growth, leaf yield and improves disease and drought tolerance of the plants.
- Phosphofert biofertilizer is environment friendly.

States/areas:

West Bengal, Orissa, Bihar, Jharkhand, M.P. and North-Eastern states of India.

Application method for optimum gain:

- Phosphofert and chemical fertilizer should not be used simultaneously; chemical fertilizer should be applied after 35-40 days of phosphofert application.
- During transplantation Phosphofert associated sapling along with 20 g of nursery soil should be taken for planting in each pit. Care should be taken to avoid damage of roots.
- Water stagnation in the field should be avoided.

Extent of coverage:

Around 224 hectares of land supplemented since year 2000 amongst 1612 beneficiaries.

10. Irrigation schedule for mulberry garden:

- Soils of mulberry growing areas of plains are sandy clay loam, where 15 days interval of irrigation during water stress condition (November – May) is recommended with 1.5–2.0 acre inch of water (1 acre inch = 22687 gallon, 1 gallon = 4.55 lit.).
- For efficient water conservation ridge and furrow system to be followed.

11. Fertilizer & FYM dosages for yield maximization:

Irrigated conditions:

NPK @ 336:180:112 kg/ha/yr; **FYM**: 20 mt/ha/yr; Cost of technology: Rs.16,222/-

Incremental benefit over farmers' practice Rs. 23,320/-

Benefit – Cost ratio : 1.44:1

Farmers' practice:

Cost: Rs. 15,542/- (Empirical application of more P & K and less FYM); **Gross income :** Rs.36,000(Local variety)

Rainfed conditions: NPK @150:50:50 kg/ha/yr; FYM:10 mt/ha/yr; Cost of taking up the technology : Rs.7154/-; Incremental benefit over farmers' practice: Rs. 11,800/-; Benefit Cost ratio : 1.65 : 1

Farmers' Practice: Cost : Rs. 7591/- (Empirical application of more P and K); Gross income : Rs.14,000/-

12. Ready reckoner for Soil-test based *Nitrogen fertilizer* application for mulberry

Salient features of the technology: Ready reckoners of Nitrogen fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values from 100 to 400 kg/ha available Nitrogen contents under irrigated Gangetic alluvial soil (West Bengal)and rainfed Red-laterite gravelly soil (West Bengal, Jharkhand, Orissa and Assam) were developed.

Methodology: Based on the relationship between biomass yield, added fertilizers and the amount of nutrient already present in the soil, information is generated on the efficiency factors for soil nutrient and fertilizers applied with reference to Nitrogen. Subsequently, the obtained data are subjected to Mitscherlich-Bray equation and developed Ready reckoners of nitrogen fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values of available Nitrogen contents under irrigated and rainfed zones.

For Irrigated condition		**For Rain fed condition**	
Soil test values (kg/ha)	Requirement (kg/ha/yr)	Soil test values (kg/ha)	Requirement (kg/ha/yr)
100	490	100	113
150	448	150	90
200	407	200	66
250	366	250	43
300	324	300	20
350	283	350	0
400	242		

Advantages over the alternative technologies: Mulberry cultivation can be done at reduced cost by utilizing optimum doses of nitrogenous fertilizer from the evolved ready reckoners and the soil fertility is maintained.

Limitations and environmental impact: No limitation and no adverse environmental impact.

States/ areas: Eastern and North-Eastern states (West Bengal- for irrigated as well as rainfed; Jharkhand, Orissa and Assam).

13. Ready reckoner for Soil-test based *Phosphatic* fertilizer application for mulberry

Salient features of the technology: Ready reckoners of Phosphorus fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values from 10 to 60 kg/ha available phosphate contents under irrigated (West Bengal) and rainfed (Jharkhand, Orissa and Assam) conditions have been developed.

Methodology: Based on the relationship between biomass yield, added fertilizers and the amount of nutrient already present in the soil, information is generated on the efficiency factors for soil nutrient and fertilizers applied with reference to Phosphorus. Subsequently, the obtained data are subjected to Mitscherlich-Bray equation and developed Ready reckoners of Phosphorus

fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values of available Phosphorus contents under irrigated and rainfed zones.

For Irrigated condition		**For Rain fed condition**	
Soil test values (kg/ha)	Requirement (kg/ha/yr)	Soil test values (kg/ha)	Requirement (kg/ha/yr)
10	356	10	75
20	287	20	57
30	218	30	40
40	150	40	23
50	81	50	5
60	12	60	0
70	0		

Advantages over the alternative technologies: Mulberry cultivation can be done at reduced cost by utilizing optimum doses of Phosphoric fertilizer from the evolved ready reckoners and the soil fertility is maintained.

Limitations and environmental impact: No limitation and no adverse environmental impact.

States/ areas: Eastern and North-Eastern states (West Bengal- for irrigated as well as rainfed; Jharkhand, Orissa and Assam).

14. Ready reckoner for Soil-test based *Potassic* fertilizer application for mulberry

Salient features: Ready reckoners of Potassium fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values from 100 to 500 kg/ha available Potash contents under irrigated (West Bengal) and rainfed (Jharkhand, Orissa and Assam) conditions have been developed.

Methodology: Based on the relationship between biomass yield, added fertilizers and the amount of nutrient already present in the soil, information is generated on the efficiency factors for soil nutrient and fertilizers applied with reference to Potash. Subsequently, the obtained data are subjected to Mitscherlich-Bray equation and developed Ready reckoners of Potassic fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values of available Potassic contents under irrigated and rainfed zones.

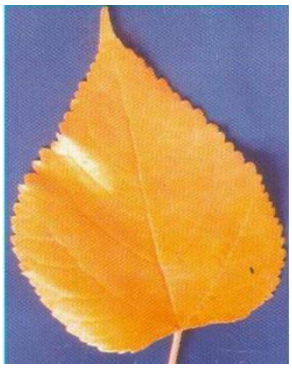
Advantages over the alternative technologies: Mulberry cultivation can be done at reduced cost by utilizing optimum doses of Potassic fertilizer from the evolved ready reckoners and the soil fertility is maintained.

For Irrigated condition		For Rain fed condition	
Soil test values (kg/ha)	Requirement (kg/ha/yr)	Soil test values (kg/ha)	Requirement (kg/ha/yr)
100	220	100	89
200	179	200	65
300	138	300	40
400	97	400	15
500	56	500	0
600	15	600	0
700	0		

Limitations and environmental impact: No limitation and no adverse environmental impact.

States/ areas: Eastern and North-Eastern states (West Bengal- for irrigated as well as rainfed; Jharkhand, Orissa and Assam).

15. Ready reckoner for Sulphur application in mulberry:



Salient features: A ready reckoner of Sulphur fertilizer application for targeted yield of mulberry by applying Sulphur (Ammonium Sulphate) @ 40 kg / ha/ year with a benefit cost ratio of 6.37:1 over control (No Sulphur) for irrigated Gangetic alluvial soil of Eastern India was developed.

Methodology: Based on the relationship between biomass yields, added fertilizers and the amount of nutrient already present in the soil, information is generated on the efficiency factors for soil nutrient and fertilizers applied with reference to Sulphur. Subsequently, the obtained data are subjected to Mitscherlich-Bray equation and developed Ready reckoners of Sulphur fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values of available Sulphur contents under irrigated and rainfed zones.

Soil test value of sulphur (kg ha^{-1})	Irrigated plains of West Bengal	Hills of West Bengal
5	94	34
10	76	28
15	59	23
20	42	18
25	25	12
30	8	7
35	0	2
40	0	0

Advantages over the alternative technologies:

Mulberry cultivation can be done at reduced cost by utilizing

optimum doses of Sulphur fertilizer from the evolved ready reckoners and the soil fertility is maintained.

Limitations and environmental impact: No limitation and no adverse environmental impact.

States/ areas: Eastern and North-Eastern states (West Bengal- for irrigated as well as rainfed; Jharkhand, Orissa and Assam)

16. Paired row system of mulberry plantation for better leaf production:

Salient features: Paired row system of plantation [(90 cm+120 cm) x 60 cm] was found promising and leaf yield is almost at par with existing recommendation (60 cm x 60 cm) although the number of plants/ha was double in 60 cm x 60 cm spacing (27,777) against (13,888) in paired row system. The paired row system was found promising in respect of sustainable leaf yield, better leaf quality, maximum leaf yield and net profit. Hence, this is recommended for sustainable quality leaf yield and additional profit with 4 suitable intercrops (Green gram, *Vigna radiata*; cowpea, *Vigna sinensis,* Toria, *Brassica campestris* and amaranth, *Amaranthus blitum*) and one green manure crop (sunhemp, *Crotalaria juncea)* under 5 crops schedule.

Advantages over the alternative technologies:

- ❖ The paired row plantation, provides, ample space and scope for availability of sunlight and aeration.
- ❖ This system provides scope for mechanization in cultural operations
- ❖ This system provides scope for intercropping, thus augmenting the economical returns of the stakeholders.

17. Morizyme – B : A Plant growth Regulator (PGR)

Salient Features: Farmers face severe leaf scarcity during the winter months i.e. November – February (late autumn / Agrahayani – November and Spring / Falgooni – February) because of stunted mulberry growth due to cold and low humidity (temperature 10-12° C & RH below 60%). But, these seasons are quiet congenial for silkworm rearing when leaf could more efficiently be converted into cocoons with high productivity and quality. To harness this by augmentation of silkworm rearing by way of increasing leaf productivity and

quality, a formulation for foliar application, Morizyme – B, a Plant Growth Regulator has been developed. Foliar application of Morizyme – B @ 0.1%, 15-20 days after pruning **increases mulberry leaf yield by 25-30%,** Leaf protein by 30% and Sugar by 31% during winter season.

Dose of Morizyme B: 0.1% aqueous solution (1 ml of Morizyme B in 1 liter of water)

Season: Jan.- Feb. and Oct. – Nov.

Application Schedule:

- First foliar spray: 15-20 days after pruning
- Second foliar spray: After 15 days of first foliar spray
- Spraying is to be done in the morning hours in the bright sunny day

Economics:

Cost of taking up the technology: Cost of Morizyme B: Rs. 327.00 /ha/crop.

Other cost is same as existing package

Mulberry leaf yield is increased by 25% over existing practice.

Additional benefit from the technology: Rs. 5278/- (120 kg cocoons at the rate of 40 kg/100 dfls from 300 dfls; value of cocoons Rs. 80/- per kg).

Benefit – Cost ratio: 1.45 : 1

Extent of coverage: Commercialized through NRDC, New Delhi.
Licensed to 4 entrepreneurs who are supplying the production in large scale. **1480 hectares** of mulberry plantation have been supplemented since year 2007 covering **22,200 farmers.**

Royalty received from NRDC for both Labex & Morizyme-B:

✓ Year 2008-09: Rs. 1,84,957/-

✓ Year 2009-10: Rs. 80,301/-

Advantages over alternative technology: New technology of its kind for mulberry.

18. Antitranspirant (KCl 1%): For increasing mulberry leaf yield under rainfed condition.

Salient features of the technology: Under rainfed sericulture, application of antitranspirants KCl (1%) on mulberry is found effective in respect of leaf yield (9.15 mt/ha/year) against control (8.36 mt/ha/year) with 9.5% yield gain over the control, besides, increase in plant water status. Economics worked out showed that KCl (1%) is profitable in return over the control to the tune of 6.2% for multivoltine and around 20% for bivoltine silkworm breeds.

Methodology: This formulation is prepared by dissolving the Potassium Chloride salt in clean water along with certain wetting agent and should be mixed thoroughly before spray. First foliar application of this formulation is given 20 days before taking up silkworm rearing followed by second application after 10 days of first spray. Spray should be done on the foliage thoroughly so that the leaves are fully drenched.

Advantages over the alternative technologies:

- Acts as water stress reliever by increasing leaf moisture and moisture retention capacity of mulberry leaf in water stress condition.
- Keep the leaves in turgid condition by reducing the loss of moisture through reducing transpiration.
- Leaf yield is increased up to 9.5%

Precautions:

- Always freshly prepared solution has to be sprayed.
- Care should be taken to prepare the solution in clean water
- Spray the formulation during morning hours of bright sunny day

If rain occurs within 7-8 hours after spray, repeat the spray on the next bright sunny day

19. Intercropping in Mulberry :

- Multiple cropping has been considered as the ideal practice for gaining additional income from mulberry cultivation.
- In this practice, the economic gain increases in a unit area of land through growing crops simultaneously or in combination of mixed crops in sequence.
- With space available in mulberry plantation during establishment period and thereafter upto 2-3 years may be effectively utilized through the cultivation of short duration, season specific and suitable intercrops with in mulberry plantation.

- With the intercropping, an additional income of Rs.6,139 during establishment period of mulberry and Rs.19,981 after establishment period can be generated at farmers' field.

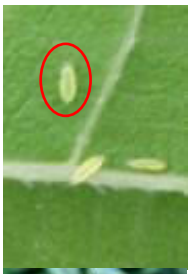
Intercrop Schedule:

Season	Establishment period	After Establishment period (up to 2-3 years)
October – December	Toria	-
January – February	Red amaranth	-
March – May	-	Green gram
June – August	-	Cow pea
September – November	-	Toria
December – February	-	Red amaranth

20. Forecasting for insect pests of mulberry in Eastern & NE India

In eastern and north-eastern India due to rich alluvial soil and well distributed precipitation mulberry grows luxuriantly and abundant foliage is available round the year except during the brief period of December – February due to cold spell. Incidence of insect pests is one of the major predicaments for cocoon production as foliage loss due to insect pests is about 11-25% depending upon the pest and severity. The problem has been aggravated with the expansion of HYV mulberry and monocropping in the traditional areas with higher doses of nutrients. In this region the major pests of mulberry are thrips, mealy bug, whitefly and root mealy bug (RMB) in Kalimpong and Sikkim hills. Region wise Forewarning calendars have been developed and appended herewith to create awareness amongst the farming community and extension functionaries to remain in preparedness for implementing appropriate management strategies.

21. **Management of Thrips** - a major pest of mulberry (*Pseudodendrothrips mori* Niwa)



Chemical Control: Spraying of 0.1 – 0.2% dimethoate (EC 30%) suppresses thrips population about 88-92% upto 14 days after spray.

Cost of taking up the technology: Rs. 595 /- per ha.

Additional benefit from the technology: Additional 200 M x Bi. Dfls can be reared with saved mulberry leaf (1600 kg)

Benefit – Cost ratio: 6:1

Botanical Control: 2% Pongamia oil is found effective. To prepare one liter solution, 20 ml of Pongamia oil is to be mixed with 1 ml of soap solution and nearly 1 liter of water (980 ml). For one hectare mulberry garden, 500 liters of solution need to be prepared. Accordingly, the solution has to be thoroughly mixed and applied during morning / evening hours. Application of 2% Pongamia oil reduces thrips infestation to an extent of 75% by 14th day of application with an increase in leaf yield to an extent of 27%. The safe period is 10 days for silkworm rearing. The Benefit – Cost ratio of the technology: 2.10 : 1.

22. **Management of Mealy bug -** a major pest of mulberry (*Maconellicoccus hirsutus* Green)

Chemical Control: Spraying of 0.1 – 0.2% dimethoate (EC 30%) suppresses 76% of Tukra infestation upto 14 days after spray.

Cost of taking up the technology: Rs. 595 /- per ha.

Additional benefit from the technology: Additional 50 M x Bi. Dfls can be reared with saved mulberry leaf (725 kg).

The Benefit – Cost ratio of the technology: 2.23: 1.

Botanical Control: For the management of mealy bug, 1.5% Pongamia oil is effective. To prepare one liter solution, 15 ml of Pongamia oil is needed to be mixed with 1 ml of soap solution in nearly 1 liter of water (985 ml). For one hectare mulberry garden, 500 liters of solution need to be prepared. Accordingly, the solution has to be thoroughly mixed and applied during morning / evening hours. Application of 1.5% Pongamia oil reduces mealy bug infestation to an extent of 75% by 14th day of application with an

increase in leaf yield to an extent of 16%. The safe period is 10 days for silkworm rearing.

The Benefit – Cost ratio of the technology: 2.34 : 1.

23. Management of whitefly – a major pest of mulberry

Dialeuropora decempuncta & *Aleuroclava pentatuberculata*

Chemical / Botanical Control:

Spraying of 0.1% dichorvos (EC 76%) reduced 85% population or 1% Neem oil suppresses 80% upto 14 days after spray.

Cost of taking up the technology:

Rs. 500 /- per ha. with dichlorvos (or) 1500/- per ha with Neem oil

Additional benefit from the technology:

Additional 200 M x Bi. Dfls can be reared with saved mulberry leaf (1630 kg).

The Benefit – Cost ratio of the technology:

6 : 1 (dichlorvos) and 2.4: 1 (Neem oil)

Mechanical Control:

Yellow colored sticky traps (size: 2'x1') @150/ha effectively reduces whitefly population (25%). For installation of traps, Rs.675 /ha (on the basis of depreciation cost of polythene sheet and bamboo sticks)

Additional benefit from the technology:

30% of the leaf yield can be saved.

The Benefit – Cost ratio of the technology: 1.7 : 1

Biological Control:

Release of *Brumoides suturalis* (Fabricius) (Coleoptera : Coccinellidae), a native predator @1250 pairs / ha suppresses whitefly population upto 23% within a period of 45 days after release.

24. Management of Brown Leaf rust (*Peridiospora mori*):

Brief description: Leaf rust is one of the important foliar diseases during winter season in the plains and the hilly region of India. The disease appears during the month of November in the plains and during September in the hills. It is characterized by appearance of small pinhead shaped pustules on lower surface of the leaves. Reddish brown spot also appear on upper surface of the leaves. Severely infected leaves turn yellow and margin of the leaves become dry. 5-10% leaf yield loss occurs due to the disease.

Methodology: Whenever leaf rust disease severity exceeds > 5 PDI, spray of 0.2% Copper oxychloride 50 WP [2.5 g/l of water] has to be sprayed on mulberry leaves. Spray should be done during early morning or afternoon and repeated after 10 days. Mulberry leaves can be used for silkworm rearing after 14 days of spray.

Advantages over the altenative technologies:

Foliar application of 0.2% Blitox reduces 80% leaf rust disease severity. Visit mulberry field regularly and observe lower surface of the leaves for disease. Spray should be done in adjacent fields simultaneously.

Cost of taking up the technology: Rs.800/ha/crop

Increase in leaf yield: saves 600 kg leaf/ha/crop to give cocoon yield (30 kg/ha/crop)

Additional benefit from the technology: Rs.2100/ha/crop

Benefit – Cost ratio: 2.63 : 1

Limitations and environmental impact: Higher concentrations may cause phytotoxicity on the leaves.

States/ areas: This technology has been disseminated to the field effectively. It is being widely used by the farmers in Eastern & North-Eastern India.

25. Management of Yellow leaf rust (*Aecidium mori*)

Brief description: In mulberry the symptoms appears as pin head size brown pustules appears on the leaves, which breaks through the host epidermis and scattered over the whole heat surface leaf vein, midrib, petiole, young shoot of the branches are also shows rusty symptoms. In the latter stage these rusty pustules appears as yellowish aeciospores. The

disease occurs during the winter and post winter month. The rust is found manifest itself on the lower surface of the leaves and the twig of plants in the form of yellowish patches. Leaves become yellow and premature fall. The pathogen obligate in favorable condition. Acediospore release from acediosporus and contact with host tissue and enter into leaves tissue through stomata. The hyphae go intercellularly in host.

Methodology: Foliar spray of 0.2% Mancozeb effectively controls the disease. It is being widely used by the farmers in Eastern & North-Eastern India.

26. Management of Leaf spot (Fungal) (*Myrothecium roridum*):

Brief description: *Myrothecium* leaf spot is one of the major diseases during monsoon in the Gangetic plains of West Bengal and North Eastern region. The disease appears during the month of July and continued up to the month of November. The disease is characterized small to medium sized irregular brown necrotic spots which appear on both surfaces of the leaves. Severely infected leaves turn yellowish and defoliate prematurely.

Methodology: Whenever the disease severity exceeds more than 5 PDI, spray of 0.1% Carbendazim 50 WP (2g / l of water) on mulberry leaves should to be done during early morning or afternoon and repeated after 10 days. Mulberry leaves can be used for silkworm rearing after 7 days of spray.

Advantages over the alternative technologies: The disease is effectively controlled by foliar spray of 0.1%Carbendazin (Bavistin) - a broad spectrum systemic fungicide which reduces 70-80% disease severity.

Limitations and environmental impact: Since Carbendazim has broad spectrum fungicidal activity, it should not be applied in VAM inoculated mulberry plants. Visit field regularly and observe upper surface of the leaves for the disease. Spray all adjacent fields simultaneously.

Cost of taking up the technology: Rs.700/ha/crop

Increase in leaf yield: saves 600 kg leaf/ha/crop to give cocoon yield (25 kg/ha/crop)

Additional benefit from the technology: Rs.1500/ha/crop

Benefit – Cost ratio: 2.14 : 1

States/ areas: This technology has been disseminated to the field effectively. It is being widely used by the farmers in Eastern & North-Eastern India.

27. Management of Bacterial Leaf spot (*Xanthomonus campestris* pv. *mori*)

Brief description: Bacterial leaf spot is one of the major diseases during monsoon in the Gangetic plains of West Bengal. The disease appears during the month of June and continued up to month of October. The disease is characterized by small water soaked spots on the lower surface of the younger leaves. The spot latter turns yellow, often shot holes appear due to shedding of necrotic zones. Severely infected leaves turn yellowish and defoliate prematurely.10-20% crop loss occurs due to the disease.

Methodology: Whenever bacterial leaf spot disease severity exceeds more than 5 PDI, spray of 0.01% agricultural antibiotic, *viz.* Plantomycin / Pushamycin (1g / l of water) on mulberry leaves should to be done during early morning or afternoon and repeated after 10 days. The leaves can be used for silkworm rearing after 7 days of spray.

Advantages over the alternative technologies: The disease is effectively controlled by foliar spray of 0.01% agricultural antibiotics like Pushamycin / Plantomycin which reduces 60-70% disease severity.

Cost of taking up the technology: Rs.600/ha/crop

Increase in leaf yield: saves 600 kg leaf/ha/crop to give cocoon yield (25 kg/ha/crop)

Additional benefit from the technology: Rs.1500/ha/crop

Benefit – Cost ratio: 2.5 : 1

Limitations and environmental impact: Don't use along with biofertilizer. Visit mulberry field regularly and observe top leaves for the disease. Spraying of all adjacent fields should be done simultaneously.

States/ areas: This technology has been disseminated to the field effectively. It is being widely used by the farmers in Eastern & North-Eastern India.

28. Management of Powdery mildew (*Phyllactinia corylea*)

Brief description: Powdery mildew is one of the major foliar diseases of mulberry. The disease commonly appears during winter season. It is characterized by white powdery patches on the lower surface of the leaves, which gradually covers whole leaf surface. 10- 15% leaf yield loss occurs due to the disease. The disease is effectively controlled by foliar spray of 0.1% Carbendazim (Bavistin) - a broad-spectrum systemic fungicide.

Methodology: Whenever disease severity exceeds > 5 PDI, spray of 0.1% Carbendazim 50 WP (2g / l of water) has to be done on mulberry leaves. Spray should be done during early morning or afternoon and repeated after 10 days. Mulberry leaves can be used for silkworm rearing after 7 day of spray.

Advantages over the alternative technologies:

Foliar application of 0.1% Carbendazim reduces 50 - 55% powdery mildew disease severity.

Cost of taking up the technology: Rs.1400/ha/crop

Increase in leaf yield: saves 600 kg leaf/ha/crop to give cocoon yield (30 kg/ha/crop)

Additional benefit from the technology: Rs.2100/ha/crop; **Benefit – Cost ratio:** 1.5 : 1

Limitations and environmental impact:

Since Carbendazim has broad-spectrum fungicidal activity, it should not be applied in VAM inoculated mulberry plants. Visit mulberry field regularly and observe lower surface of the leaves for disease. Spray should be done in adjacent fields simultaneously.

States/ areas: All over India.

29. Management of *Pseudocercospora* leaf spot *(Pseudocercospora mori)*

Brief description: *Pseudocercospora* leaf spot is one of the major diseases during post monsoon in the Gangetic plains of West Bengal and North Eastern region. The disease appears during the month of September and continued up to the month of November. The disease is characterized by small to medium sized velvety gray to black spots which appear on the lower surface of the older leaves. Latter, the spots cover whole lower surface. Severely infected leaves turn yellowish and defoliate prematurely.

Methodology: Whenever *Pseudocercospora* leaf spot disease severity exceeds more than 5 PDI, spray of 0.1% Carbendazim 50 WP (2g / l of water) on mulberry leaves should to be done during early morning or afternoon and repeated after 10 days. Mulberry leaves can be used for silkworm rearing after 7 days of last spray.

Advantages over the alternative technologies:

Carbendazim (Bavistin) - a broad-spectrum systemic fungicide and effective against most of the foliar fungal diseases. Carbendazim is having protective, curative and growth promoting property, it effectively controls the disease. Foliar application of 0.1% Carbendazim reduces 50 - 55% disease severity.

Limitations and environmental impact:

Since Carbendazim is having broad spectrum fungicidal activity, it should not be applied on VAM inoculated mulberry plants. Visit mulberry field regularly and observe lower surface of the leaves for the disease incidence. Spray all the adjacent fields simultaneously.

States/ areas: Eastern & North-Eastern region.

30. Management of Root knot (*Meloidogyne incognita*) disease

Brief description:

Root knot is one of the major diseases. It occurs mainly in sandy soils low in organic matter. The severity of the disease increases with increased age of the garden. The symptoms include stunted growth, poor and delayed sprouting, reduced leaf size and yield, chlorosis and marginal necrosis of leaves. The root system shows, galls/knots, reduced and stubby root system, necrotic lesions on the root surface and death of active rootlets. The estimated yield loss due to the disease is 15-30%. Infected plants become dry that leads to mortality.

Methodology:

Application of 1MT Neem oil cake /ha/yr in 4 split dose effectively reduces the root knot infestation

Advantages over the alternative technologies:

Neem cake is a broad-spectrum systemic action and effective against most of the diseases. Neem cake is having protective, curative and growth promoting property. The application of Neem cake reduces 60 - 70% disease severity

States/ areas: Eastern & North-Eastern region.

31. Forewarning Calendars for Mulberry diseases

Major foliar diseases of mulberry in the Eastern and North-eastern region of India are Powdery mildew (*Phyllactinia corylea*), leaf rust (*Peridiopsora mori*), bacterial leaf spot (*Xanthomonas campestris* pv. *mori*) and *Myrothecium* leaf spot (*Myrothecium roridum*), *Pseudocercospora* leaf spot *(Pseudocercospora mori*). Foliar diseases reduce 10-15% leaf yield and quality. Besides, feeding of diseased leaf affects cocoon productivity and quality. This huge loss in leaf and cocoon productivity and quality can be minimized by taking up appropriate disease management practices in time by FOREWARNING of mulberry diseases of Eastern and North-eastern India. Accordingly a Forewarning Calendar is prepared and appended herewith for guiding the farmers' community to remain in preparedness for implementing appropriate management measures.

Month-wise Ready reckoner for disease forewarning of Eastern and North Eastern India

Month	Week	Place	Action to be taken (*Application)*
January	III	Murshidabad (WB)	0.1% Carbendazim
	IV	Singhanpur (Chattisgarh)	0.2% Mancozeb
February	I	Koraput (Odisha)	0.2% Mancozeb
		Aizawl (Mizoram)	0.1% Carbendazim
		M.P.Raj (Jharkhand)	
March	I	Imphal (Manipur)	0.1% Carbendazim
	IV	Malda (WB)	0.1% Carbendazim
April	III	Agartala (Tripura)	0.1% Carbendazim
May	II	Birbhum (WB)	0.1% Carbendazim
	III	M.P.Raj (Jharkhand)	0.01% Plantomycin
	IV	Murshidabad (WB)	0.01% Plantomycin
		Birbhum (WB)	
June	I	Malda (West Bengal)	0.1% Carbendazim
	II	Birbhum (West Bengal)	0.1% Carbendazim
		Rangpo (Sikkim)	
	III	Malda (West Bengal)	0.01% Plantomycin
July	I	Jorhat (Assam) / Rangpo (Sikkim)	0.1% Carbendazim / 0.2% Mancozeb
	II	Dimapur (Nagaland)	0.1% Carbendazim
	III	Singhanpur (Chattisgarh)	0.2% Mancozeb
	IV	Koraput (Odisha)/ Dimapur (Nagaland)	0.1% Carbendazim / 0.2% Mancoze
August	I	Kalimpong (WB) / Jorhat (Assam)	0.1% Carbendazim / 0.2% Mancozeb
	II	Koraput (Odisha)	0.2% Mancozeb

	III	Murshidabad (WB)	0.01% Plantomycin / 0.1% Carbendazim
		Jorhat (Assam) / Aizawl (Mizoram)	
	IV	Imphal (Manipur) / Agartala (Tripura)	0.1% Carbendazim
September	I	Aizawl (Mizoram) / Imphal (Manipur)	0.2% Mancozeb / 0.1% Carbendazim
	II	Ranchi (Jharkhand)	0.1% Carbendazim
	III	Malda (West Bengal)	0.1% Carbendazim
	IV	Koraput (Odisha)	0.1% Carbendazim
October	I	Malda (West Bengal)	0.1% Carbendazim
	II	Koraput (Odisha)	0.2% Mancozeb
	III	Murshidabad (WB) / Ranchi (Jharkhand)	0.1% Carbendazim
November	I – IV	NIL	NIL
December	I – IV	NIL	NIL

Silkworm Hybrid:

32. Multi x Multi: N x M.Con.4

Recommended for unfavorable seasons in West Bengal (Jaishta, Shrabani, Bhaduri / Aswina commercial crops)

Yield : 35-40 kg/100 dfls

Shell percentage (%): 14.00-16.00

Filament length (m): 350-400

Renditta: 9.5-10.5

Incremental benefit % over control: 75%

Rearing condition: Temp.30-33°C, RH: 75-85% (June – Sept.)

33. Multi x Multi: M.Con.1 x M.Con.4

Recommended for unfavorable seasons in West Bengal (Jaishta, Shrabani, Bhaduri/ Aswina commercial crops)

Yield: 35-42 kg/100 dfls

Shell percentage (%): 15.00-16.00

Filament length (m): 350-450

Renditta: 9.10-10.0

Incremental benefit % over control: 75%

Rearing condition: Temp.30-33°C, RH: 75-85% (June – Sept.)

34. Multi x Bi: N x (SK6 x SK7)

Recommended for West Bengal: Agrahayani, Falgooni and Baisakhi and North-Eastern states: Spring, Summer & Autumn

Yield : 50-57 kg/100 dfls
Shell percentage (%): 15.00-16.00
Filament length (m): 650-700
Renditta: 8.5-9.0
Incremental benefit % over control: 25%
Rearing condition: Temp.25-30°C, RH: 75-85% (Oct. - April)

35. Multi x Bi: M.Con.1 x B.Con.4

West Bengal: Agrahayani, Falgooni and Baisakhi
North – eastern states: Spring, Summer & Autumn

Yield: 50-57 kg/100 dfls
Shell percentage(%): 17.5-18.00
Filament length (m): 700-775
Renditta: 8.0-9.0
Incremental benefit % over control: 25%
Rearing condition: Temp. 25-31°C, RH: 75-80% (Oct. - April)

36. Multi x Bi: M.Con.4 x B.Con.4

West Bengal: Agrahayani, Falgooni and Baisakhi
North – eastern states: Spring, Summer & Autumn

Yield: 50-55 kg/100 dfls
Shell percentage (%): 16.5-17.00
Filament length (m): 550-600
Renditta: 7.5-8.5
Incremental benefit % over control: 25%
Rearing condition: Temp. 25-31°C, RH: 75-80% (Oct. - April)

37. Bi x Bi: SK6 x SK7

(West Bengal: Seed crop seasons: Agrahayani, Falgooni and Baisakhi)
(North Eastern States: Spring and Autumn);

Parameters	Season	
	Unfav.	Fav.
Fecundity	473	525
Pupation rate (%)	80.5	90.5
Yield / 100 dfls	60.5	68.0

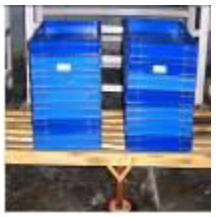
Cocoon weight (g)	1.316	1.453
Shell percentage (%)	19.3	20.7
Filament length (m)	884	910
Gain in cocoon yield over check	200 %	46.7%

38. Bi x Bi: B.Con.1 x B.Con.4

(North Eastern States: Spring and Autumn)
Yield/100 dfls: 55-67 kg
Shell percentage (%): 19.0-20.0
Filament length (m): 850-900
Renditta: 6.5-7.5
Incremental benefit % over control: 10%
Rearing condition: Temp. 24-26°C, RH: 75-80% (Oct. - March)

39. Season specific Rearing Package to enhance the cocoon productivity in all the commercial crop seasons

The season specific rearing package is helpful to the Sericultural farmers to harvest qualitatively & quantitatively superior cocoon crop in all the commercial crop seasons in spite of fluctuation in climatic conditions of this region. The technology is popularized at farmers' level in Malda, Murshidabad and Birbhum districts of West Bengal; Koraput districts of Odisha, Lohardaga and Pakur districts of Jharkhand and all the North Eastern states including Sikkim.



Advantages over alternative technology: Superiority of evolved package of practices with respect to both quality and quantity of cocoons in comparison to existing farmers' practice in both favourable and unfavorable crop seasons. BCR is 4:1 for favourable seasons and 3.6:1 for unfavorable seasons. The Benefit –Cost ratio of this technology is 2.28:1, 3.08:1,2.60:1 and 2.92:1 at kalimpong, Koraput, Ranchi and Jorhat respectively.

Salient features of the technology:

- During the favourable crops Box type with paraffin and during unfavorable seasons Open type with only paraffin in the base of rearing bed during chawki rearing is recommended
- During I stage, bed area should be 16-18 sq.ft. During II stage 18-54 sq.ft and during III stage 54-100 sq.ft. have to be provided
- 9'' gap between two rearing trays

- Normally 4 times feeding with a gap of 6 hours and 3 times feeding during June – September prevailing R.H. 80-95% by keeping the quantum of feed unchanged.
- 100-200 sq.ft and 200-400 sq.ft bed space with larval density of 200-400 and 100-200 for 100 dfls during IV and V instar is recommended.
- Plastic Collapsible mountage with 50-60 larvae/ sq.ft is recommended

40. Shelf rearing technology was found advantageous for silkworm rearing as labor saving approach at farmers' level:

- To overcome silkworm crop losses during unfavorable climatic conditions, Shoot rearing package was developed to manipulate the rearing environment
- Size of Rack: 25'x5'
- No. of tiers: 4 with a gap of 24''
- Material: Bamboo / Wood
- Preparation of Shelf: With Nylon rope & net
- Time of shifting: Just after 3rd moult
- Method of feeding: Entire shoot in two alternate direction
- Feeding frequency: 3times / day
- Bed cleaning: Once in 4th instar & twice in 5th instar
- Shoot rearing has been taken up at selected farmers of Jorhat and Golaghat area revealed an overall increase of 10% cocoon yield / 100 dfls (45 - 48 kg / 100 dfls; 41 - 42 kg/ 100 dfls).
- Through this technology a farmer can earn an additional income of Rs.1400 /100 dfls.

41. *Labex*: Silkworm bed disinfectant for control of major silkworm diseases

Brief description: Labex is an effective bed disinfectant, which is a mixture of two locally available chemicals. The formulation maintains 1% chlorine that inactivates all fungal, bacterial, viral and protozoan pathogens of silkworm. Mixture inactivates all disease germs of fungal, bacterial, viral and protozoan origin lying on the silkworm bed by oxidizing when it dusted and thus prevents secondary contamination. This product is patented with **IP No.200 199 (952/CAL/97)** and commercialized.

Methodology: Labex is to be dusted with the help of a muslin cloth on the silkworm bed @ 3-4 g per sq. ft. of bed area once after each moult i.e., 30 - 45 minutes before resumption of the next feeding and once more on the 4th

day of the fifth instar immediately after bed cleaning and 30-45 minutes before next feeding. This acts as a prophylactic measure. In case any disease symptoms are observed, the diseased larvae should be removed and dusting repeated every day till symptoms disappear. About 4 kg Labex is required for the whole rearing of 100 dfls.

Advantages over the alternative technologies: At farmers' level in Eastern India, use of Labex gained 2.7 to 4.8 kg more cocoons per 100 Dfls over untreated control rearing with Nistari. Application of Labex in North-Eastern states yielded a gain of 1.7 to 6.9 kg cocoons per 100 Dfls. Labex is cheap and most effective. It ranked first position in all India trial conducted by Central Silk Board, Bangalore.

Cost of the taking up the technology: Rs.81/100 dfls (Labex @ Rs.25/kg)

Impact of the cocoon crop: 4 kg cocoon gain / 100 dfls over control fetching Rs.320 (@Rs.80/-/kg of cocoon).

Additional benefit from the technology: Rs.239/100 dfls

Benefit – Cost ratio: 2.95 : 1

Limitations and environmental impact: After opening the packet, the mixture should be consumed within 2 months and any remaining powder should be stored in airtight plastic container since long storage will render it ineffective. As the contents include Bleaching Powder, it shows corrosive effect on metals. Person dusting the Labex should take adequate care to prevent its inhalation.

42. Sericillin as bed disinfectant for control of major silkworm diseases.

Salient features of the technology: 'Sericillin' is a synergistic composition for disinfecting silkworm body and silkworm bed, is a mixture of three chemicals. This powder formulation is found effective against Muscardine as well as it is equally effective against all common silkworm diseases such as Grasserie, Flacherie. This technology is under process of **patenting at NRDC, New Delhi (Ref No. IRP/11082-L/2012 dated 18.05.2012) and commercialization**.

Methodology: Sericillin is to be dusted with the help of a muslin cloth on the silkworm bed @ 3-4 g per sq. ft. of bed area once after each moult i.e., 30 - 45 minutes before resumption of the next feeding and once more on the 4th day of the fifth instar immediately after bed cleaning and 30-45 minutes before next feeding. This acts as a prophylactic measure. In case, any disease symptoms are observed, the diseased larvae should be removed and dusting repeated every day till symptoms disappear. About 4 kg Sericillin is required for the whole rearing of 100 dfls.

Advantages over the alternative technologies: At farmers' level in Eastern India, use of Sericillin gained 4 kg more cocoons per 100 Dfls over untreated control. Application of Sericillin in North-Eastern states yielded a gain of 3.00 – 7.90 kg cocoons per 100 Dfls. Sericillin is cheap and most effective. The added advantage of Sericillin is though it is highly effective against Muscardine it also suppresses the incidence of other diseases.

Limitations and environmental impact: After opening the packet, the mixture should be consumed within 2 months and any remaining powder should be stored in airtight plastic container since long storage will render it ineffective. Person dusting the Sericillin should take adequate care to prevent its inhalation.

Cost of the taking up the technology: 4 Kg of Sericillin / 100 dfls of rearing (cost of 4 kg. is 120/-)

Impact on the cocoon crop : 4 kg cocoons /100 dfls

Additional benefit from the technology: Rs.320/100 dfls (Benefit-Cost Ratio of 6.4:1)

States/ areas: Eastern and North- Eastern states.

43. 5% Bleaching powder solution for rearing room disinfection

Technology: Bleaching powder solution as effective room disinfectant

Salient features of the technology: The solution maintains approximately 1.6% of available chlorine, which inactivates all disease germs in the rearing room and appliances by oxidizing the essential amino acids. It can be used both in closed and open type of rearing houses, works at ambient temperature and action is very immediate.

Methodology: Aqueous solution of 5% bleaching powder is prepared by dissolving 5 g of bleaching powder per liter of water. First, a paste of the bleaching powder using water in a plastic container has to be made and then remaining water to be added to get required 5% concentration (1.5%Cl2). The container has to be covered with a lid and after sedimentation of un-dissolved materials; the solution has to be filtered using a muslin cloth. Spray of the solution has to be affected using a plastic sprayer. 50 liters of solution is required for disinfection of rearing room and appliances for 100 dfls.

Advantages over the alternative technologies: Field trial of 5% bleaching solution for three years showed that use of bleaching powder solution yielded an average of 4 kg additional cocoons/ 100 dfls over control.

States/ areas: This technology is being widely practiced by stakeholders in eastern & north-eastern India.

44. Integrated Management of Uzi fly

Salient features of the technology: Uzi fly is prevalent during summer and rainy seasons (April to September) in the Gangetic plains of West Bengal and North-Eastern states causing about 10 – 30% cocoon crop loss. Though farmers use fly proof netted doors and windows to prevent the entry of Uzi fly in the rearing house, but cannot fully control uzi infestation. When tested in the farmers' rearing houses, the technology enhances the cocoon production to the tune of 3-5 kg per 100 dfls.

Methodology:

- **Flytrap**, an electrical device has to be hanged in a corner in the rearing house.
- **2% Bleaching powder** solution has to be sprayed on silkworm larvae infested with Uzi eggs. It kills Uzi eggs on silkworm instantly.10- 12 litres of 2% Bleaching powder solution is required for rearing of 100 Dfls.

Advantages over the alternative technologies:

- **Mechanical control through flytrap –** It traps up to 50 % of adult flies inside the rearing house.
- **2% Bleaching powder solution -** When sprayed on Uzi-infested silkworms, it kills the Uzi eggs, thereby saves the cocoon crop up to 95%. Moreover, it also kills the disease causing germs that prevail in the rearing bed.
- With the application of this technology a cocoon yield gain 3kg – 5kg/ 100 dfls enhancement in cocoon yield (Rs.240/- to 400/-) was recorded.



Limitations and environmental impact: Both the technologies are environment friendly 2% bleaching powder solution has no deleterious effects on silkworm.

States /areas: Gangetic plains of West Bengal and North Eastern states.

MULBERRY CULTIVATION PRACTICES FOR IRRIGATED AND RAINFED CONDITION

Introduction

Sericulture is an agro-based labour intensive avocation in India. It is the complex structure of silkworm host plant management i.e. mulberry (*Morus* spp.) cultivation, rearing of silkworm (*Bombyx mori* L.), production of disease-free silkworm seeds and production of commercial cocoons and post cocoons aspects. For mulberry cultivation, activities involved are presented below:

Soils for Mulberry: Mulberry is tolerant to a wide range of soil conditions. It grows well on loamy soil of high fertility. In general, the soil for mulberry should be deep, well-drained, clay loam to loam in texture, friable, porous, fertile and with good water retention capacity.

Soil pH: Slightly acidic soils with a pH value around 6.8 which are free from injurious salts are ideal for good growth of mulberry plants. Saline and alkaline soils and also highly acid soils should be avoided and if not possible, should be suitably reclaimed.

Ready reckoner for soil ameliorants: Soils of mulberry growing areas can be rectified as required by plantation. Highly alkaline soil can be rectified by application of gypsum or sulphur, while acidic soil by application of lime. A ready reckoner for application of acidic or alkaline soils is given.

Requirement of limestone/gypsum for amelioration of acid/ alkali soils

pH	Quantity (tones/ha)	
	Lime	Gypsum
3.5	12.50	
4.5	8.75	
5.5	5.00	
7.4 – 7.8	-	2.0
7.9 – 8.4	-	5.0
8.5 – 9.0	-	9.0
9.1 & above	-	14.0

Soil Sampling: Soil testing is done to know the soil fertility status and other characteristics for proper establishment of mulberry garden. Small quantity of the huge and vast soil mass in the field is collected and used for soil testing.

Soil Sampling

Collection of Soil Sample: The entire field is to be traversed in a zigzag fashion and at least 20 spots/ acre have been selected randomly on traversed route for collection of soil samples. Grasses, stubbles, litters etc. present on the surface of each spot should be removed with the help of spade. Soil samples are collected at

surface to 30 cm depth for general testing and fertilizer recommendation. At each spot, a pit of 30 cm depth is made in the shape of 'V' using a spade and soil from each V-shaped pit may be collected by scrapping down the depth with the help of a dry twig. Soil samples should not be collected just after rains or irrigation, burning of crop residues etc.

Soil Testing

- ✓ Pack the soil sample bags along with relevant information in a clean dry bag.
- ✓ Write down the name and address of the soil testing laboratory where it is to be analyzed.
- ✓ Soil test is to be done once in 2-3 years.
- ✓ Before raising of plantation soil is to be tested for estimation of pH, organic carbon and NPK status.
- ✓ Fertilizers are to be applied on the basis of soil test results.

Mulberry varieties for different agro climatic conditions

High yielding, improved and suitable mulberry varieties developed for various agro-climatic conditions namely, irrigated, rainfed and flood prone areas of Gangetic plains and hills of West Bengal and entire Eastern & North-Eastern region are.

- **S-1** – A high yielding mulberry variety for irrigated and optimum rainfall areas
- **S-1635** – A high yielding mulberry variety for irrigated optimum rainfall areas
- **Tr-10** – A high yielding mulberry variety for sub-tropical hills of Eastern and North-Eastern India
- **$BC_2$59** – A high yielding mulberry variety for sub-tropical hills of Eastern and North-Eastern India
- **C-1730** – A high yielding mulberry variety for red & lateritic rainfed areas
- **C-2028** – A high yielding mulberry variety for flood prone areas of Gangetic plain

Mulberry Nursery Technique

Selection of site: A flat elevated land nearer to water source is preferred as a nursery site. Well-drained and loamy soil is ideal for nursery.

Land Preparation and Layout: The land should be deep-ploughed two times in both directions in the first week of October, leveled thoroughly. Nursery of 3.0 m × 1.2 m size is prepared with at least 5 cm elevation from the ground level. 30 to 45 cm wide drains, with slopes towards sub- and main drains should be maintained along the sides of all the nursery beds.

Prepared Nursery Bed

Nursery bed size: A bed size of 300 cm (L) × 120 cm (B) can accommodate 240 cuttings (row to row 15 cm and cutting to cutting in a row 10 cm distance) to raise saplings of 4-6 months old. The same bed can accommodate only 120 cuttings (row to row 30 cm and cutting to cutting in a row 10 cm distance) to raise saplings of 8-12 months old.

Preparation of Soil for Nursery:

- ✓ Loamy soil is ideal for nursery.
- ✓ Add 5 pans of FYM / Sericulture compost/ Vermicompost to each bed and mix thoroughly with soil.
- ✓ If the soil is clayey in nature, add 5 pans of sand per bed and mix thoroughly with soil.
- ✓ In the case of sandy loam soil, there is a possibility of termite infestation and thus, spray of 0.1% Chloropyriphos/ Dursban is required to drench the soil of nursery beds (2-3 litres/ bed) as a preventive measure.

Selection of Cutting:

Plants selected (any popular improved mulberry variety) for preparation of cuttings must be healthy and free from scale insect, tukra infestation etc.

- The shoots should be of 6 to 9 months old and should have attained a diameter of 10 to 15 mm.
- The stout lower portion and tender green upper portion of the shoots are not fit to be used as cuttings.
- The middle portion of uniform thickness must be used.

Preparation of cutting and storing

- Cuttings for raising 4-6 months old saplings should be of 15 to 20 cm long with 3 to 4 good active buds.
- For raising 8 to 12 months old saplings, cuttings should be of about 25 cm long. Sharp knife must be used to get clean cut ends without damaging the bark.
- Cuttings are to be planted immediately after preparation.
- If mulberry cuttings have to be transported over long distance or stored for 2-3 days, the same should be done carefully so that the cuttings do not dry.
- Keep the cuttings in wet gunny cloth, if they are not planted immediately after preparation.
- Prepared cuttings, if required to be stored, should be bundled with all buds in one direction and kept in wet sand bed with the buds pointing upwards under shade.
- It can be covered with a thin layer of hay. The sand bed and hay covering must be sprinkled with water daily to avoid drying of cuttings.
- Cuttings can be stored this way for 4-5 days.

Disinfection of Cutting: To avoid fungal attack, cuttings should be dipped in 0.2% Bavistin or 0.1% Dithane M-45 solution for 30 minutes.

Spacing: With the help of a thread each row is marked at a distance of 15 cm. In each row, small holes are made at 10 cm distance to insert cuttings by using pointed stick. Thus, in a bed size of 300 × 120 cm, a total of 20 rows and in each row 12 cuttings can be accommodated.

Cutting plantation: Nursery beds should be adequately watered and made wet one or two days earlier to planting. In each row small holes are made to insert cuttings by using pointed stick.

Depth of planting cutting: Cutting must be planted in the hole vertically exposing only one bud above soil.

Management of young saplings:

- Irrigation must be provided immediately after planting. Subsequently, irrigation is given once in 4 to 5 days in the case of sandy loam and red soil.
- Nursery beds must be kept free from weeds. At least two rounds of manual weeding are required, first after 25 to 30 days and second after 55 to 60 days of planting.
- Chemical fertilizers as 500 g of ammonium sulphate or 250 g of urea must be applied per nursery bed preferably after the second round of weeding when saplings attain 20 to 25 cm height in about 55 to 60 days after planting. Light irrigation is must after fertilizer application.

Plant Protection measures:

- Application of 0.1 % Bavistin twice at an interval of 15 to 20 days is recommended.
- To control thrips, spraying of 0.1% Rogor and to control mites, 0.1% Metasystax are recommended.
- The spray schedule is case to case basis subject to the occurrence of infestation.

Uprooting and Dressing of Saplings:

- Two or three days before uprooting of saplings, nursery bed should be adequately watered for easy removal.
- After uprooting, long time preservation of saplings should be avoided as far as possible and must be taken to the planting site immediately followed by planting in the pits already prepared for regular plantation.
- After uprooting, saplings are to be dressed maintaining the shoot height of 45 to 60 cm while root portion is dressed as per requirement.

Uprooting of Saplings

Transplantation: Mulberry is a perennial crop and produces leaves for more than 20 years. Hence, initial planting should follow the recommended package of practices for mulberry cultivation for better establishment.

Planting Season

- Planting seasons in hills and valley are different due to variation of soil characteristics, topography and agro climatic situations.
- Mulberry plantation can be established either by cuttings or saplings. Saplings are generally preferred due to their well-developed root system. Recommended seasons in different states are May-August and September-October

Land preparation

- Flat or slightly sloppy land is suitable for mulberry cultivation.
- If the place needs to be freshly prepared, land is cleaned by removing the existing plants along with their roots.
- Land should be ploughed deep (30 to 45 cm), followed by 2 to 3 times light ploughing to ensure fine tilth of soil. The land should be made free of weeds and leveled subsequently.
- If the land is thickly populated with trees in hill-area, the same is prepared after removing the trees, shrubs and other vegetation. Roots of the large trees are completely removed and the land is made into plot of convenient size through terrace system.
- pH of the soils should be carefully checked and if necessary, lime should be mixed with the soil of acidic reaction. Farm yard manure @ 20 mt t for irrigated and 10 t/ ha for rainfed conditions is applied.

Spacing for Mulberry plantation: Spacing of mulberry plantation is dependent on topography of the region. Generally, 60 cm x 60 cm for irrigated and 90 cm x 90 cm for rainfed conditions are recommended. Besides, bush plantation (90 cm x 90 cm) and tree plantation (180 cm x 120 cm) are recommended for valley and hilly regions.

System of planting: Mulberry plantation is developed by pit system. In pit plantation, pits of 30 cm × 30 cm × 30 cm size are prepared. One sapling is planted in each pit and soil is filled up. Small quantity of 5% Dursban powder may be mixed with soil to avoid termite attack. The rope should be arranged cross-wise and at each cross sapling to be put in the pit to make the plantation straight with uniform geometry. The root zone of sapling in the pit covered with soil and pressed firmly around the sapling so that the sapling should be in upright position. The plot should be irrigated just after plantation to avoid driage of the plants.

Pruning Schedule: Mulberry crop period continues for 65 to 70 days from the date of pruning. After establishment of one year first pruning should be given. It depends upon the silkworm crop schedule of the particular region. Generally rearing is initiated on 45th day after pruning and completed within 70th day. In irrigated conditions, 5 crop schedule and in rain fed condition, schedule of three crop harvest is followed.

Pruning: Pruning of mulberry plantation is dependent upon climatic conditions, nature of crop schedule, topography etc. Pruning is conducted two times in a year during December and July as given below in rainfed conditions. In irrigated condition, 5 times pruning is in practice.

Crop types	Pruning height above ground (cm)			
	Hills		Valley	
	December	July	December	July
High bush mulberry	120	150	120	150
Low bush	90	50	60	50

Pruning Appliance: Pruning should be done with the pruning secateurs, pruning saw and sickle.

Pruning by Secateurs

Pruning by Saw

Application of manure and fertilizers:

Organic manure has great role in improvement of soil properties. It improves structure of soil and thereby increases water retention capacity. It provides suitable environment for multiplication of microbes in the soil and makes the soils of mulberry garden healthier. Chemical fertilizer readily supplies essential nutrient elements to the mulberry plant for augmenting its growth and production. It should be applied in furrow and should be cover immediately.

Recommendation of chemical fertilizers for mulberry:

- Farm Yard Manure: Irrigated @ 20 t /ha/year; Rainfed @ 10 t/ha/year
- Chemical fertilizers: N:P:K@336:180:112 kg/ha/year (Irrigated)
  N:P: K @ 150:50:50 kg/ha/year (Rainfed)

Requirement of farm yard manure and fertilizer materials for different units of land area is furnished below:

Unit of land area	Dose of FYM (t/ year)	Dose of Urea (kg/ year)	Dose of SSP (kg/ year)	Dose of MOP (kg/ year)
Hectare	10	326	313	83
Acre	4	132	127	34
Bigha	1.3	44	42	11

Farm yard manure and nitrogenous fertilizer are prescribed to be applied in two equal split doses while phosphatic and potassic fertilizers are to be applied in a single dose.

Use of Soil Test Based fertilizer application - Ready Reckoner

Irrigated Gangetic alluvial soil

N		P_2O_5		K_2O	
Soil test values (kg/ha)	Requirement (kg/ha/yr)	Soil test values (kg/ha)	Requirement (kg/ha/yr)	Soil test values (kg/ha)	Requirement (kg/ha/yr)
100	490	10	356	100	220
150	448	20	287	200	179
200	407	30	218	300	138

250	366	40	150	400	97
300	324	50	81	500	56
350	283	60	12	600	15
400	242	70	0	700	0

Rainfed soils

N		P_2O_5		K_2O	
Soil test values (kg/ha)	Requirement (kg/ha/yr)	Soil test values (kg/ha)	Requirement (kg/ha/yr)	Soil test values (kg/ha)	Requirement (kg/ha/yr)
100	160	10	70	100	92
150	141	20	61	200	70
200	123	30	51	300	49
250	104	40	42	400	29
300	86	50	33	500	7
350	65	60	24	600	0

Maintenance of plantation from second year onwards: The production of quality cocoon largely depends upon availability of quality foliage. It needs regular cultural operations like weeding, loosening of soil around plants, training of branches, fertilizer and manure application etc., which are mandatory during the initial establishment period. From second year onwards, utmost care is to be taken for harvesting qualitatively and quantitatively superior leaves. A working calendar for the same is given below:

Use of Morizyme (Plant Growth Regulator) for improvement of productivity: For production of better leaf quality and increase in quantity during winter, the growth regulator Morizyme-B @ 0.1% should be sprayed twice in each crop, 1st spray after 25 days of pruning and 2nd spray after 32 days of pruning in sunny morning without rain at least for 6-7 hours.

USE OF BIOFERTILIZERS

Nitrofert - a Nitrogen fixing bio-fertilizer (*Azotobacter chorococcum*)

- It is an eco-friendly biofertilizer containing free-living nitrogen fixing bacteria (*Azotobacter chrorococcum*). Efficient strains have been isolated from rhizospheric soil of the local mulberry gardens.

- Annual doses of 20 kg/ha in irrigated and 10 kg/ha in rainfed mulberry gardens are to be applied.
- It reduces application of inorganic Nitrogen by 50% of the recommended dose (336 kg in irrigated and 150 kg/ha/yr in rainfed gardens without any adverse effect on leaf yield and quality.
- The cultured bacterial broth of minimum population of 108 cells/g of carrier material is maintained in the product.
- Irrigation should be applied immediately after Nitrofert application to maintain soil moisture (35-40%).

- A minimum of 10 days gap between the application of Nitrofert and chemical fertilizers should be followed.

Phosphofert (*Arbuscular mycorrhizal* fungi)

Phosphofert (*Arbuscular Mycorrhizal* fungi) biofertilizer is of fungal origin, obligate symbiont in nature, containing living mycelia and spores of AM fungi in rhizosphere soil which enhances phosphate mobilization, diffusion, absorption and uptake by plants especially in phosphate – deficient (below 20 kg available P/ha) and moisture stress soils.

- In established mulberry garden, apply 75-100 kg Phosphofert/ha/ in irrigated soil and in rainfed soil 40-50 kg /ha once in 4 years

DISEASES OF MULBERRY AND MANAGEMENT

Mulberry is prone to various diseases caused by fungi, bacteria, virus, mycoplasma and nematode. Three major diseases i.e., powdery mildew, fungal leaf spot, bacterial leaf spot, leaf rust are available in North Eastern states. Disease symptoms, causal organisms, and management practices, disease are discussed below.

Leaf spot

Causal organism: This disease is caused by the fungus called *Cercospora moricola* Cook

Symptoms: Leaf spot is characterized by irregular pin head size spots appear on the leaves in the beginning and in later stages these spots become enlarged coalesced and lead to formation of "shoot holes". Severally affected leaves become yellowish and fall off prematurely.

Peak season: The disease appears throughout the year but maximum incidence is found during rainy and winter seasons.

Management

- Avoid dense planting
- Collect and burn unused and infected leaves after pruning
- Foliar spray of 0.1 % Bavistin (Carbendazim 50WP) [2 g/l of water] at early stage of infection. Spray may be repeated after 10 days if required.

Save period: Leaves should be utilized for rearing 7 days after last spray.

Powdery mildew

Causal organism: This disease is caused by the fungus called *Phyllactinia corylea* (Pers) Karst

Symptoms: White powdery patches appear on the ventral surface of the leaves and cover the entire surface at a later stage. The patches turn yellowish brown to black colour. The diseased leaves look dry and fall off.

Peak season: The disease appears mostly in autumn (October-November) season.

Management:

- Foliar spray of 0.1% Carbendazim 50 WP (Bavistin), 0.2%, Karathane (Dinocap) and 0.2% wettable sulphur (Sulfex) have been found effective for the control powdery mildew. Spray the recommended fungicides 30 days after pruning as a preventive measure. While spraying the lower surface of the leaves should be thoroughly drenched.

Save period: Leaves can be used for silkworm rearing after 7 - 10 days after spray.

Leaf rust

Causal organism: Caused by the fungus called *Cerotelium fici* (Cast) Arth. and *Aecidium mori* Barclay

Symptoms: Small dark brown and circular red spots on both side of leaves and gradually the affected leaves become yellow and wither off.

Peak season: The disease appears mostly in autumn (October-November) season.

Management

- Avoid dense planting.
- Simultaneous pruning of all adjacent mulberry fields
- Collect and burn unused infected leaves after pruning.
- 0.2 % Copper oxy-chloride 50WP (Blitox) [4 g/l of water] or 0.02% Tridiamefon 25 WP (Bayleton) [8g / 10 litre of water] should be sprayed immediately after the appearance of disease symptoms. If required the spray may be repeated after 10 days.

Save period: Leaves may be fed to silkworm after 15 days of the last spray.

Sooty mould

Causal organism: A group of ascomycetes and deuteromycetes fungi

Symptoms: Thick black coating developed on the upper surface of the leaves. Nymphal stages excrete honew dew which attracts sooty mould fungus. It covers the upper surface as a black coating and impairs photosynthesis.

Peak season: The disease appears from August to December.

Management

- Foliar spray of 0.2% Monocrotophos on 15 th and 30 th day of pruning to control white fly infestation
- Spray 0.2% Indofil M-45 75 WP to check the growth of saprophytic fungi

Save period: 15 days safe period for feeding the leaves to silkworms.

Bacterial leaf spot

It appears during June and continues up to October. Maximum disease severity noticed during July-September.

Causal organism: Xanthomonas campestris pv. *mori*.

Symptoms

- Appearance of numerous small angular water soaked spots on lower surface of leaves which later turn brownish surrounded by yellow halo .
- Necrotic spot shed off and produce shot hole in the leaves. The young infected leaves curl outward and distorted.
- Highly infected leaves turn yellowish and defoliate prematurely.

Peak season: Maximum disease severity noticed during July-September.

Management: Foliar spray of 0.01% spray of Plantomycin / Pusamycin [1g/l of water] 20 -25 days after pruning during rainy season.

Save period: Spray may be repeats after 10 days, if required.

INSECT PESTS OF MULBERRY AND MANAGEMENT

There are a large number of insects which are harmful to mulberry plants. Some of the important insect pests are discussed here.

Mealy bug (*Maconellicocus hirsutus*)

Season of incidence: Peak infestation season is April -June

Nature of damage: Nymphs suck the plant sap from the meristematic region and affected apical shoots show retarded growth, thickening of affected leaves. Affected leaves become dark green, fattening of apical shoot, twisted and symptom is called as "TUKRA.".

Economic threshold level (ETL): The ETL for mealy bug is 10 individual per shoot.

Management Mealy bug colony:

- Cutting and burning the affected shoots
- Spray 0.2% Rogor within 20 days of developing the new shoots
- Released predator *Pullus bourdillioni* Kapoor @ 600 pairs/acre

Whitefly (*Dialeuropora decempuncta*)

Season of incidence: Peak infestation season is August -November

Nature damage: Nymph and adults suck the plant sap causing chlorosis, yellowing and curling of leaves. The honey dew secreted by the nymphs serve as a medium for growth of sooty mould which in turn causes serious damage to the mulberry plants during September to November**.**

Economic threshold level (ETL): The ETL for white fly is 10 individual per shoot

Management:

- Keep the mulberry garden free from weeds
- Erect 40-50 yellow trap made of polythine sheets (Size: 1.5 m x1m) coated with sticky oil in per acre mulberry garden
- Spray 0.2 % Monocrotophos or 0.1% Dichlorovos to control the white fly (safe period 15 days) after release predator
- *Coelophora unicolor* as biological control agent for white fly.

Thrips (*Pseudodendrothrips mori* Niwa)

Season of incidence: Peak infestation period start from April to May and August-November

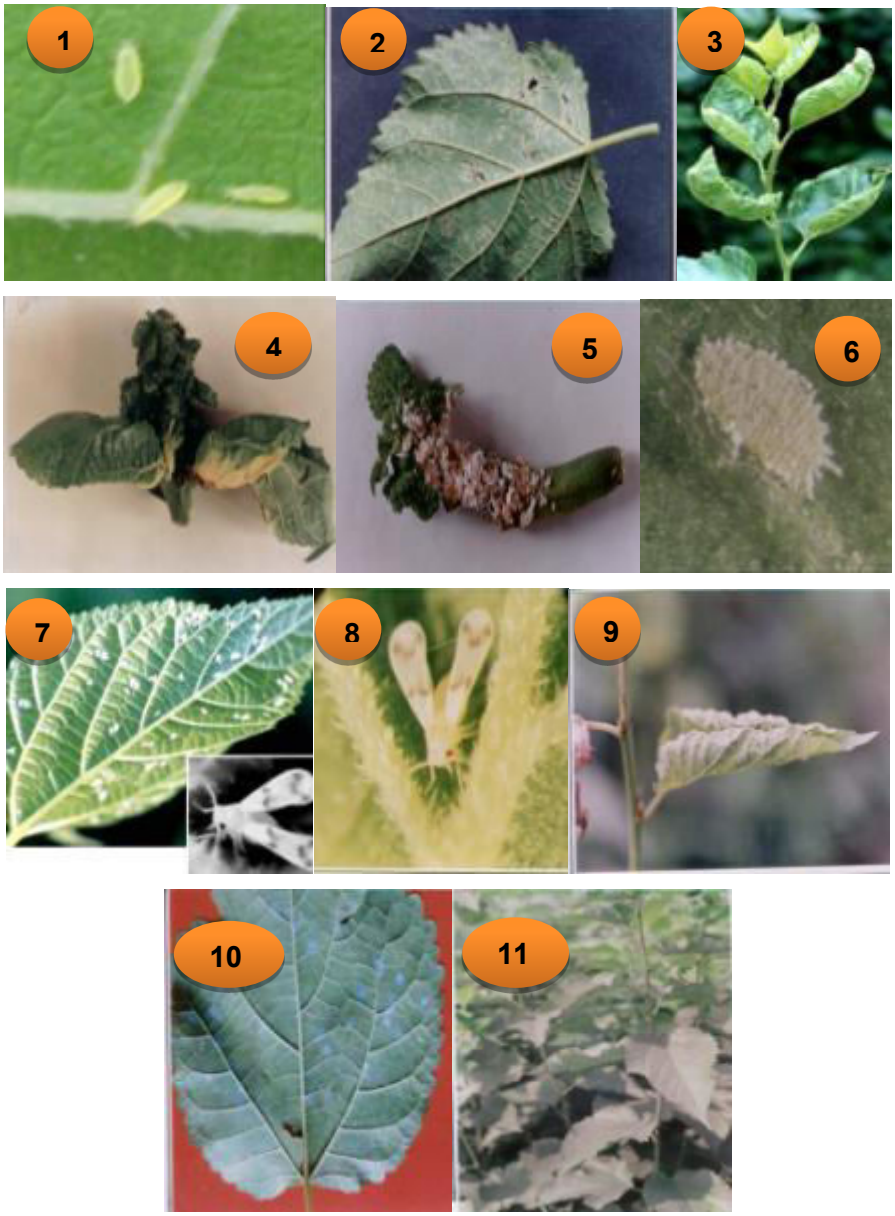
Nature of damage: The infestation of thrips causes depletion of moisture and yellowing leaves. The leaves become boat shaped in advanced stage of infestation and pre maturely fall.

Economic threshold level (ETL): The ETL for white fly is 20 individuals per leaf

Management:

- Keep the mulberry garden free from weeds
- Erect 40-50 yellow trap made of polythene sheet (Size: 1.5 m x 1 m)
- Spray 0.1-0.2 % Dimethoate to control the pest

- Release predator *Micraspis discolor* as biological control agent of the pest



1. Nymphs of thrip	2. Yellow blotches due to thrips infestation	3. Thrips infested plant showing boat shaped leaves
4. Tukra infested shoot	5. Tukra infested shoot showing mealy bug colony	6. Adult mealy bug
7. Adults of whitefly on the lower surface of top leaf	8. Adult whitefly (Microscopic view)	9. Leaf curl symptoms
10. Leaf showing nymphs of whitefly	11. Sootymould infested mulberry plant	

Economics of Sapling Rising in the Nursery (1 Acre)

Details of Recurring Expenditure

#	Particulars	Amount (Rs.)
1	Land preparation by Tractor (4 times cris-cross ploughing)	1000
2	Removal of Weeds 100 Mandays @ Rs.200/-	20000
3	Nursery bed preparation (700 Nos.; bed size 3 m × 1.2 m) 100 Mandays @ Rs.200/-	20000
4	Cost of FYM (10 t @ 950 per/ t)	9500
5	Cost of Planting material (4.25 t cutting) @ Rs.1700/- per t	7225
6	Transportation of planting materials	1000
7	Preparation of cuttings: 3000 cuttings/ man-day (56 man days @Rs.200/-)	11200
8	Planting of cuttings: 2000 cuttings/ man day (84 man days @Rs.200/-)	16800
9	Cost of Irrigation during planting of cuttings	3000
10	Hand Weeding 4 times (monthly once) [10 MDs each time× 4 times = 40 man days @ Rs.200/-)	8000
11	Cost of Urea : 4 kg (@1%, 400 liters/ acre)	24
12	Cost of Pesticides	300
13	Spraying of Urea, fungicides: 10 man days @ Rs.200/-	2000
14	Uprooting of Saplings @ 2000 saplings / man day (84 man days @ Rs.200/-)	16800
	Total	**116849**

Details of Non-Recurring Expenditure

#	Particulars	Amount (Rs.)
1	Cost of Spade (10 Nos.)	1000
2	*Dao* (10 Nos.)	500
3	*Khurpi* (10 Nos.)	200
4	Measuring Tape (100 ft)	250
5	Iron buckets 10 litre capacity (2 Nos.)	500
6	Sprayer (1 No.)	1500
7	Digging Fork (10 Nos.)	500
	Total	**4450**

The appliances can be used at least for 5 years, therefore the cost of Rs.4450 is divided by number of years = Rs.890

- Total Expenditure = 116849 + 890 = Rs.1, 17,739
- Total Cuttings planted = 1, 68,000 (240 per bed × 700 beds)
- Saplings expected to be available after 25% mortality = 1, 26,000 Nos.
- Expenditure of 1, 26,000 saplings = Rs.1, 17,739
- Cost of Each Sapling = Rs.1.07
- Selling price of 1, 26,000 Saplings @Rs.2.50 = Rs.1, 89,000
- Net Profit = Rs.315000- Rs.1, 17,739 = Rs.1, 97,261

Sericulture Economics

Sericulture is one of the important economic venture where minimum investment fetches maximum return. It is estimated that annually one farmer can earn Rs 9252.00 utilising all the resources, engaging family labours in 1 acre of land. Details Economic of Mulberry sericulture are given below:

Table 1: Initial establishment cost of 1 acre mulberry plot.

Sl.	Item	Quantity	Rate (Rs)	Amount (Rs)
1	Ploughing & leveling of land	2 times by tractor	500	1,000
		14 mandays	180	2,520
2	Weed removal after plough	6 mandays	180	1,080
3	Cost of cowdung	4 t	800	6,400
4	Application of cowdung	6 mandays	180	1,080
5	Cost of mulberry twigs	1.2 t	1700	2,040
6	Mulberry cutting preparation	6 mandays	180	1,080
7	Plantation of cutting	12 mandays	180	2,160
8	Application of irrigation	8 mandays	180	1,440
9	Weeding (thrice)	40 mandays	180	7,200
10	Miscellaneous			500
	Total establishment cost			**26,500**

Table 2: Annual expenditure for 1 acre of mulberry plot from 2nd year

Sl.	Item	Quantity	Rate (Rs)	Amount (Rs)
1	Part of initial cost			-
2	Repayment of bank interest		8% pa	2120
3	Digging & weeding	40 mandays	180	7,200
4	Cost of cowdung	4 t	950	3,800
5	Cost of Nitrofert	8 kg	30	240
6	Cost of Phosphophert	30 kg/4 years	30	225
7	Cost of urea	65kg	8.5	552
8	Cost of SSP	125 kg	7.5	937
9	Cost of MOP	34 kg	18.5	629
10	Application of items at 4 to 9	8 mandays	180	1,440
11	Leaf harvest (7200kg)/prunning	32mandays	180	5,760
12	Miscellaneous			500
	Total annual expenditure			23,403

An expenditure of Rs. 23,182 has to be incurred to produce 7200 kg of mulberry leaf in a year, and hence its cost of production is Rs. 3.20 per kg of mulberry leaf.

SILKWORM REARING PRACTICES

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, inculcation 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.

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

a). 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 sol^{n}. required for the room is 28 x 2 lts.= 56 litres
- Disinfectant solution required for appliances is 56 x 25/100 = 14 litres
- Disinfectant sol^{n} 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.

b). 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 line 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.

a). 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 4^{th} 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.

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 refuge.
- 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.


Black boxing in Plastic Tray

Black boxing in Rearing Dala

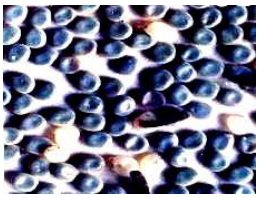
- For large scale black boxing, the entire incubation room can be made dark where light proof arrangements are possible. Black curtains are hung outside or inside the doors and windows to make the complete darkness.

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 7^{th} – 8^{th} 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.

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

Initiation of hatching

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') Rearing bamboo dala (6' x 4')/ round dala (5 ½ ft diameter)	17 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

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.

Newly hatched larvae

- 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.

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

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.

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

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

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.

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 cm^2).
- 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 Ist moult, preferably on 3rd day.
II	Two times	Just after 1st moult Before settling of 2nd moult, preferably 2 feedings before moult.
III	Three times	Just after IInd moult Before settling of 3rd moult Middle of the 3rd instar

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.

Optimum spacing

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

** No. of 6' x 4' Trays*

Crowded condition

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.

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

Circumferantial 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	27-28ºC	26-28ºC	26-27ºC
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.

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.

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.

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%

Rearing House

- 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.

An ideal rearing house

- 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.

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

Shelf rearing

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 3rd Moult
Method of feeding	Entire shoot in two alternate direction
Feeding frequency	3 times /day
Bed cleaning	Ones in 4th instar & twice in 5th instar

Shoot rearing

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	24-25ºC	23-24ºC
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 in stars are desirable.

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.

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.

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.

Quantity of Mulberry Leaves Required

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

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

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.

Bed size Silkworms

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

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

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

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.

Bed cleaning


Bed cleaning by using nets

- 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.

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.

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.

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 mounatge 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 mountage is 55 cm length, 40 cm width, width and 3 cm depth. This frame can be compactly folded when unused.
- 35-40 mountages are required to mount 100 Dfls larvae (40,000-45,000 larvae).

How to identify the matured larvae:

- After eating sufficient mulberry leaves in the 5th instar, on 6th-7th day, the silkworm larvae shrinks, body becomes translucent, raises its head and passes soft litter. These are the indications that larvae are ready for mounting.

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 labouur saving.

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

Suspension of rotary mountage from ceiling:

- Generally, matured silkworms take 2-3 hours to settle down in sections of rotary mountage.
- Rotary mountages should be placed at the same direction as of the wind and light. After 2-3 hours mountages should be suspended horizontally parallel to the ground with the support of iron hooks. While suspending the mountages, the unclimbed worms are collected and remounted.
- Depending on the height of the ceiling, 2-3 tiers of mountages 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 mountages 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.

Mounting Environment:

In mounting room, 24-25°C temperature, 65-70% relative humidity and good ventilation has to be provided. High temperature and high humidity adversely affect the reeling quality of cocoons. Therefore, sufficient ventilation and aeration must be provided.

Time of cocoon harvesting:

Cocoons are harvested 6-7th days after mounting when pupation is completed. To confirm the completion of pupation few cocoon are cut open and checked.

Removal of flimsy cocoons, un-spun and dead worms:

After taking out the cardboard frames from the wooden frame, hold the cardboard frame to light. Thin settled cocoons, dead worms and un-spun larvae have to be removed and properly disposed off.

Cocoon harvesting:

- Card board frame is inserted in specially designed wooden cocoon harvester.
- With the help of pusher, cocoons are pushed out.
- Card board frame is taken out from the harvester frame and folded in such a way that pushed out cocoons are hanging down wards and cocoons are collected.

Identification of matured larvae

- Matured larvae can be identified by seeing translucent body, decreased body size, soft feces and reduced eating. The matured larvae start moving around lifting head and thorax in search of a place for cocooning.
- 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

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 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.

Mounting under direct sunlight

Mounting in Verandah

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.
- 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

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.

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ISO 9001:2015 Certified

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