

TECHNOLOGIES

Brief Description of Technologies Developed

I. Mulberry varieties

High yielding, improved and suitable mulberry varieties developed for various agro-climates: irrigated, rainfed and flood prone areas of Gangetic plains and hills of West Bengal and entire Eastern & North-Eastern region are as under. **Mulberry leaf productivity in last over six decades increased from 8 - 10 mt (Kajli/ Bombai local) to 40 - 45 mt (S-1635) per hectare per annum.** The variety S-1635 has been found best in All India Coordinated Experiment on Mulberry (AICEM Phase-I) programme and hence, recommended as **National check variety** by the Mulberry Variety Authorization Committee (MVAC) constituted by the Central Silk Board and some more still higher yielders are in pipe line.

1. **S-1** - A high yielding mulberry variety for irrigated and optimum rainfall areas
2. **Tr-10** - A high yielding mulberry variety for sub-tropical hills of Eastern and North-Eastern India
3. **BC₂59** - A high yielding mulberry variety for sub-tropical hills of Eastern and North-Eastern India
4. **S-1635** - A high yielding mulberry variety for irrigated optimum rainfall areas
5. **C-1730** - A high yielding mulberry variety for red & lateritic rainfed areas
6. **S-146** - A high yielding mulberry variety for sub-tropical areas of Northern region
7. **C-776** - A high yielding mulberry variety for saline soil
8. **C-2028** - A high yielding mulberry variety for flood prone areas of Gangetic plain
9. **C-2038 (RG-120)** - A high yielding mulberry variety for irrigated areas

II. Soil Science & Chemistry

10. Recommendation for **Chemical fertilizers** (NPK) and **Farmyard manure** (FYM) for mulberry cultivation under irrigated and rainfed conditions
11. Technology for **Soil-test based** targetted yield approach for fertilizers application for mulberry

III. Agronomy

12. Use of **Nitrofert biofertilizer** (*Azotobacter chroococcum*) in mulberry cultivation
13. Use of **Phosphofert** (Arbuscular Mycorrhizal Fungi) in mulberry cultivation
14. **Vermicomposting** of serifarm residues

IV. Mulberry Physiology

15. Improvement of mulberry leaf production through foliar spray of **Morizyme -B**, specially for winter season

V. Mulberry Disease and Pest Management

16. Control of **Powdery mildew** (*Phyllactinia corylea*)

17. Control of **Leaf rust** (*Peridiopsora mori*)
18. Control of **Bacterial leaf spot** (*Xanthomonus campestris* pv. *mori*)
19. Control of **Fungal leaf spot** (*Myrothecium roridum*)
20. Control of *Pseudocercospora* **leaf spot**
21. Control of **Whitefly** (*Dialeuropora decempuncta*, Quaintance & Baker, and *Alleuroclava pentatuberculata*)
22. Control of **Thrips** (*Pseudodendrothrips mori*, Niwa)
23. Control of **Mealy bug** (*Maconellicoccus hirsutus*, Green)

VI. Silkworm races

24. **N x M12 (W)** - A productive Multivoltine hybrid
25. **N x YB** - A productive Multivoltine x Bivoltine hybrid

VII. Silkworm Physiology & Rearing Technology Innovation

26. **Incubation pot** for better hatching in dry summer
27. **Silkworm egg carrying box**

VIII. Silkworm Disease and Pest Management

28. **Bleaching powder solution** as effective room disinfectant
29. **Labex** - A Silkworm Bed-Disinfectant
30. Integrated **Management of Uzi Fly**

IX. Reeling & Spinning

31. **Designing of reeling machine**
32. **Cocoon drying chamber**

Technology - 1

Technology: S-1- A high yielding mulberry variety for irrigated and optimum rainfall areas

Year of release: 1970

Salient features of the variety:

Name of the variety	S-1
Parentage	Selection of an exotic variety Mandalaya of Burma
Breeding methods used	Clonal selection
Ploidy level	Diploid (2n = 28)
Shoots per plant	12-14
Phyllotaxy	2/5
Leaf lobation	Homophyllous, entire
Leaf shape	Ovate
Leaf apex	Acuminate
Leaf surface	Leaves are thick, smooth and glossy
Leaf colour	Dark green
Flowering season	January - March, thoughout the year is also found
Sexuality	Monoecious
Colour and taste of sorosis	White and sweet to taste
Rooting at 90 th day (%)	90%
Leaf yield (mt/ha/year)	Irrigated - 28 to 30 mt; Optimum rainfall condition - 13 to 15 mt
Soluble protein (mg/g fr. wt.)	32
Soluble sugar (mg/g fr. wt.)	44.27
Moisture (%)	82.7
Resistance to diseases	Moderately resistant

Advantages over the alternative technologies: Leaf yield is around 3 folds more than the local variety Kajli.

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 or more must 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 fairs well through out the country.

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

Technology - 2

Technology: Tr-10 – A high yielding mulberry variety for sub-tropical hills of Eastern and North-Eastern India

Year of release: 1978

Salient features of the variety:

Name of the variety	Tr-10
Parentage	T-4 (an induced tetraploid) x Philippines
Breeding methods used	Crossing
Ploidy level	Triploid ($2n = 3x = 42$)
Shoots per plant	12-14
Phyllotaxy	1/3
Leaf lobation	Homophyllous, entire
Leaf shape	Ovate
Leaf margin	Dentate
Leaf apex	Acuminate
Leaf surface	Leaves are thick , slightly rough
Idioblast frequency (No. / mm ²)	18.71
Leaf colour	Dark green
Flowering season	January – March
Sexuality	Dioecious, female but occasionally sterile male flowers appear
Colour and taste of sorosis	Black and sour to taste
Rooting at 90 th day (%)	70 -75%
Leaf yield (mt/ha/year)	18 to 20 mt
Soluble protein (mg/g fr. wt.)	31.28
Soluble sugar (mg/g fr. wt.)	33.76
Total chlorophyll (mg/g)	1.64
Moisture (%)	79.58
Moisture retention (%)	54.71
Resistance to diseases	Moderalety resistant

Advantages over the alternative technologies: Leaf yield is around 2 folds more than the local variety.

Best suited practices with the variety:

- ❖ The land should be properly prepared after soil testing.
- ❖ Plantation through saplings is preferable.
- ❖ Wider spacing of minimum 60 cm x 60 cm or more must be adopted.
- ❖ Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: In hills due to acidic nature of the soil, survivability of the variety is low

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

Technology - 3

Technology: BC₂59 – A high yielding mulberry variety for sub-tropical hills of Eastern and North-Eastern India

Year of release: 1980

Salient features of the variety:

Name of the variety	BC₂59
Parentage	Matigara local (<i>M. indica</i>) x Kosen (<i>M. latifolia</i>), Backcrossed with Kosen twice
Breeding methods used	Backcrossing
Ploidy level	Diploid (2n = 28)
Shoots per plant	7-8
Phyllotaxy	½
Leaf lobation	Homophyllous, entire
Leaf shape	Ovate
Leaf margin	Serrate
Leaf base	Cordate
Leaf apex	Acute
Leaf surface	Leaves are thick , smooth
Leaf colour	Dark green
Flowering season	January – March
Sexuality	Monoecious male, but female flower also occurs
Colour and taste of sorosis	Black and sour to taste
Rooting at 90 th day (%)	65 - 70%
Leaf yield (mt/ha/year)	20 to 22 mt
Soluble protein (mg/g fr. wt.)	21.29
Soluble sugar (mg/g fr. wt.)	28.16
Moisture (%)	76.62
Resistance to diseases	Moderately resistant

Advantages over the alternative technologies: Leaf yield is around 2 folds more than the local variety.

Best suited practices with the variety:

- ❖ The land should be properly prepared after soil testing.
- ❖ Plantation through saplings is preferable.
- ❖ Wider spacing of minimum 60 cm x 60 cm or more must be adopted.
- ❖ Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: In hills due to acidic nature of the soil, survivability of the variety is low

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

Technology - 4

Technology: S-1635 – A high yielding mulberry variety for irrigated areas

Year of release: 1995

Salient features of the variety:

Name of the variety	S-1635
Parentage	Open pollinated hybrid of a variety CSRS-II
Breeding methods used	OP selection
Ploidy level	Triploid ($2n = 3x = 42$)
Shoots per plant	12-14
Phyllotaxy	1/3
Leaf lobation	Homophyllous, entire
Leaf shape	Ovate
Leaf margin	Serrate
Leaf base	Cordate
Leaf apex	Acute
Leaf surface	Rough
Leaf colour	Dark green
Flowering season	January – March
Sexuality	Dioecious with sterile males flowers
Rooting at 90 th day (%)	Above 90%
Leaf yield (mt/ha/year)	40 to 45 mt
Soluble protein (mg/g fr. wt.)	31.28
Soluble sugar (mg/g fr. wt.)	33.76
Moisture (%)	79.58
Resistance to diseases	Moderately resistant

Advantages over the alternative technologies: Leaf yield is around 50% more over the high yielding S-1 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: Leaves mature a little early. But it fares well through out the country.

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

Technology - 5

Technology: C-1730 - A high yielding mulberry variety for red & lateritic rainfed areas

Year of release: 1995

Salient features of the variety:

Name of the variety	C-1730
Parentage	T-25 (an induced tetraploid) x S-162
Breeding methods used	Crossing
Ploidy level	Triploid ($2n = 3x = 42$)
Shoots per plant	7-10
Phyllotaxy	1/3, 2/5
Leaf lobation	Homophyllous, entire
Leaf shape	Ovate
Leaf margin	Serrate
Leaf base	Cordate
Leaf apex	Acute
Leaf surface	Slightly rough
Leaf colour	Green
Flowering season	January - March
Sexuality	Dioecious
Rooting at 90 th day (%)	90%
Leaf yield (mt/ha/year)	13 to 15 mt
Soluble protein (mg/g fr. wt.)	34.40
Soluble sugar (mg/g fr. wt.)	35.62
Total chlorophyll (mg/g fr. wt.)	1.71
Moisture (%)	80.97
Resistance to diseases	Moderately resistant

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.

Technology - 6

Technology: S-146 – A high yielding mulberry variety for sub-tropical areas of Northern region

Year of release: 1995

Salient features of the variety:

Name of the variety	S-146
Parentage	Open pollinated hybrid
Breeding methods used	Selection
Ploidy level	Diploid (2n = 28)
Shoots per plant	6-7
Phyllotaxy	2/5
Leaf lobation	Homophyllous, entire
Leaf shape	Elliptical
Leaf margin	Serrate
Leaf base	Truncate
Leaf apex	Acute
Leaf surface	smooth
Leaf colour	Green
Flowering season	January – March
Sexuality	Dioecious
Rooting at 90 th day (%)	60-63%
Leaf yield (mt/ha/year)	25 to 26 mt
Soluble protein (mg/g fr. wt.)	23.03
Soluble sugar (mg/g fr. wt.)	28.99
Moisture (%)	77.64
Resistance to diseases	Moderately resistant

Advantages over the alternative technologies: Leaf yield is around 90% more over the local variety.

Best suited practices with the variety: Standard package of practices for cultivation of mulberry should be followed.

Limitations and environmental impact: The variety fairs well in the sub-tropical areas of Northern India.

States/ areas: Uttar Pradesh, Uttaranchal and Northern states in the country.

Technology - 7

Technology: C-776 – A high yielding mulberry variety for saline soil

Year of release: 1998

Salient features of the variety:

Name of the variety	C-776
Parentage	<i>Morus multicaulis</i> x Black cherry
Breeding methods used	Crossing
Ploidy level	Diploid (2n = 28)
Shoots per plant	6-8
Phyllotaxy	1/3, 2/5
Leaf lobation	Homophyllous, entire
Leaf shape	Elliptical
Leaf margin	Serrate
Leaf base	Truncate
Leaf apex	Acute
Leaf surface	smooth
Leaf colour	Dark green
Flowering season	January – March
Rooting at 90 th day (%)	77-78%
Leaf yield (mt/ha/year)	25 to 26 mt
Soluble protein (mg/g fr. wt.)	21.65
Soluble sugar (mg/g fr. wt.)	23.56
Moisture (%)	74.82
Resistance to diseases	Moderately resistant

Advantages over the alternative technologies: Leaf yield is around 2-3 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 fairs well in the saline areas.

States/ areas: West Bengal, Orissa

Technology - 8

Technology: C-2028 - A high yielding mulberry variety for flood prone areas of Gangetic plains

Year of release: Pipe line variety

Salient features of the variety:

Name of the variety	C-2028
Parentage	China white x S-1532
Breeding methods used	Crossing
Ploidy level	Diploid (2n = 28)
Shoots per plant	7-8
Phyllotaxy	2/5
Leaf lobation	Homophyllous, entire
Leaf shape	Elliptical
Leaf margin	Serrate
Leaf base	Truncate
Leaf apex	Acute
Leaf surface	Smooth, glossy
Leaf colour	Dark green
Flowering season	January - March
Rooting at 90 th day (%)	80-82%
Leaf yield (mt/ha/year)	34 to 36 mt
Soluble protein (mg/g fr. wt.)	22.25
Soluble sugar (mg/g fr. wt.)	24.83
Moisture (%)	77.23
Resistance to diseases	Moderately resistant

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 fairs well in the flood prone areas of Eastern and North-Eastern India.

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

Technology - 9

Technology: C-2038 (RG-120) – A high yielding mulberry variety for irrigated areas

Year of release: Pipe line variety

Salient features of the variety:

Name of the variety	C-2038 (RG-120)
Parentage	F-1 (10) of China variety x C-763
Breeding methods used	Crossing
Ploidy level	Diploid (2n = 28)
Shoots per plant	10-12
Phyllotaxy	2/5
Leaf lobation	Homophyllous, entire
Leaf shape	Ovate
Leaf margin	Serrate
Leaf base	Cordate
Leaf apex	Acute
Leaf surface	Smooth
Leaf colour	Green
Flowering season	January – March
Sexuality	Dioecious with female flowers
Colour and taste of sorosis	Black and sour to taste
Rooting at 90 th day (%)	80%
Leaf yield (mt/ha/year)	54-56 mt
Soluble protein (mg/g fr. wt.)	31.44
Soluble sugar (mg/g fr. wt.)	37.41
Total chlorophyll (mg/g fr. wt.)	2.54
Moisture (%)	79.93
Moisture retention (%)	85.61
Resistance to diseases	Moderately resistant

Advantages over the alternative technologies: Leaf yield gain is around 1.5 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.

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

Technology -10

Technology: Recommendation for Chemical fertilizers (NPK) and Farmyard manure (FYM) for mulberry cultivation

Year of release: 1973

Salient features of the technology:

For irrigated condition	For rainfed condition
N: P ₂ O ₅ : K ₂ O @ 336:180:112 kg/ha/year FYM @ 20 mt/ha/year	N: P ₂ O ₅ : K ₂ O @ 150:50:50 kg/ha/year FYM @ 10 mt/ha/year

Methodology: The fertilizers should be applied along the rows of the plants by localized placement and the FYM should be broadcasted.

Advantages over the alternative technologies:

- ❖ **Irrigated areas:** Leaf yield increase of around 61% over the farmers' practice (leaf yield 18 mt/ha/yr).
- ❖ **Rainfed areas:** Leaf yield increase of around 39% over the farmers' practice (leaf yield 7 mt/ha/yr).

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

States/ areas: Eastern and North-Eastern States.

Technology - 11

Technology: Technology for Soil-test based targeted yield approach for fertilizers application for mulberry

Year of release: 1999, 2005

Salient features of the technology:

a. Nitrogen fertilizer:

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 (West Bengal) and rainfed (West Bengal, Jharkhand, Orissa and Assam) have been developed.

b. Phosphatic fertilizer:

Ready reckoners of phosphatic fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values of available phosphate contents under irrigated (West Bengal) and rainfed (West Bengal, Jharkhand, Orissa and Assam) conditions have been developed.

c. Potassic fertilizer:

Ready reckoners of potassic fertilizer application for obtaining targeted yield of mulberry for the common range of soil test values of available potash contents under irrigated (West Bengal) and rainfed (West Bengal, Jharkhand, Orissa and Assam) conditions have been developed.

Soil test based fertilizer recommendations for specific yield target (28 mt/ha/year) for S-1 mulberry (*Morus alba* L.) variety under irrigated Gangetic alluvial soil of West Bengal

N		P ₂ O ₅		K ₂ O	
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

Soil test based fertilizer recommendations for specific yield target (12 mt/ha/year) for S-1 mulberry (*Morus alba* L.) variety under rainfed soils

N		P ₂ O ₅		K ₂ O	
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	113	10	75	100	89
150	90	20	57	200	65
200	66	30	40	300	40
250	43	40	23	400	15
300	20	50	5	500	0
350	0	60	0	600	0

Methodology: Based on the relationship between biomass yield, added fertilizers and the amount of nutrient already present in the soil, information are generated on the efficiency factors for soil nutrient and fertilizers applied with reference to nitrogen, phosphorus and potassium. Subsequently, the obtained data are subjected to Mitscherlich-Bray equation and developed nitrogenous, phosphatic and potassic fertilizers reckoners for different levels of respective soil test values for recommendation.

Advantages over the alternative technologies: Mulberry cultivation can be done at reduced cost by utilizing optimum doses of nitrogenous, phosphatic and potassic fertilizers from the evolved ready reckoners and the soil 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).

Technology - 12

Technology: Nitrofert (*Azotobacter chroococcum*) for mulberry cultivation

Year of release: 2002

Salient features of the technology: Nitrofert is an eco-friendly biofertilizer containing free-living nitrogen fixing bacteria (*Azotobacter chroococcum*). 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 affect 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.

Advantages over the alternative technologies: It reduces about 50% chemical nitrogenous fertilizer by applying @ 20 kg/ha/year for irrigated and 10 kg/ha/year for rainfed areas.

Limitations and environmental impact:

- ❖ By reducing 50% of chemical nitrogenous fertilizer dose, it reduces soil and underground water pollution and improves organic sources of nitrogen nutrition.
- ❖ Water logged conditions, use of pesticides and contact with chemical fertilizers hamper bacterial growth of Nitrofert and its functioning.

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

Application method for optimum gain:

- ❖ 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.

Technology - 13

Technology: Phosphofert (Arbuscular Mycorrhizal fungi) for mulberry cultivation

Year of release: 2002

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 10^8 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 up to six months but fresh material is advised for field application.

Advantages over the alternative technologies: It reduces about 70% chemical phosphatic fertilizer by applying 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 up to 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.

Technology - 14

Technology: Vermicomposting of serifarm residues

Year of release: 2004

Brief description: Vermicomposting - an organic compost produced by recycling the serifarm residues by the help of earthworm, *Eisenia foetida*. Earthworms ingest farm waste and seriwaste collected after each rearing and excrete small pellets in the form of finely ground soil, which are rich in Nitrogen, Phosphorus and Potassium along with growth promoter and other secondary and micronutrients. It also improves physical, chemical and biological properties of soil on repeated application.

Methodology:

- ❖ Normally three different methods viz. pit/tank method, channel/furrow method and cement tub/vat or wooden box method is followed depending on the availability of raw material. Out of these, pit method is more popular in West Bengal and followed at CSR&TI, Berhampore.
- ❖ To accommodate 6 mt biomass, a pit of around 8'x3'x3' size is required. Pits can be constructed either above ground or below ground are covered by a thatched roof. The pits are made with brick lined with cement. The cover not only protects from sun but also helps to maintain 40-50% moisture and also 20-30°C temperature in the pit. A ditch of standing water around the pit and a wire mesh cover keeps away the predators.

- ❖ Farmyard waste and seri-waste are mixed with cowdung in the ratio 8:1 and put in the pit. This feed mixture is allowed to decompose for at least 2-3 weeks. To facilitate quick decomposition *Trichoderma viridae* is mixed with the waste. The partially decomposed biomass in the pit (8'x3'x3') is inoculated with 1000 earthworms, preferably with *Eisenia foetida*, a promising strain well acclimatized to this environment. The worms feed on the biomass assimilating 5-10% for their growth and excreting the rest in the form of nutrient rich cast. After turning the materials softly by forked spade at least once in a week for 3-4 times, the entire material is converted into vermicompost.
- ❖ Once the feed mixture is seen to largely contain casts, it is dumped in a conical heap and left for few hours. The worms are collected and reused. From one acre of mulberry garden generating around 6 MT of seri-waste biomass, more than 4 MT vermicompost is obtained. Water logging in the tank is avoided but regular watering in the pit is arranged to keep the materials in moist condition.

Advantages over the alternative technologies: Eco-friendly and an alternative source of FYM, increases yield and quality of mulberry leaves.

States/areas: All over India

Limitations and environmental impact:

- ❖ Maintenance of temperature (20-30°C), humidity (40-50 %) and pH (6.8 - 7.5) should be taken care of.
- ❖ Direct sunlight & water logging in the vermicompost pit should be avoided.

Technology - 15

Technology: Improvement of mulberry leaf production through foliar spray of Morizyme -B, specially for winter season

Year of release: 2002

Brief Description: Morizyme-B is a combination of growth hormone and micronutrients, which promotes growth and mulberry leaf productivity.

Methodology (Twice spraying for 1.0 acre of land):

- ❖ **1st Spray:** 135 ml. of 'Morizyme-B to be mixed with 135 liter of water (0.1%) and be sprayed on the newly flushed leaves i.e. 15-20 days after pruning.
- ❖ **2nd spray:** 267 ml. of Morizyme -B to be mixed with 267 liters of water (0.1%) and be sprayed 20 days after first spray.

Advantages over the alternative technologies: Morizyme-B containing micronutrients (zinc sulphate, ammonium hepta molybdate) and hormone (Naphthyl acetic acid) improves the root system, accelerates the sprouting of lateral buds and increases mulberry leaf yield by 20%. It also significantly increases cocoon production by 21%.

Limitations and environmental impact: Technology is suitable for enhancing leaf production for autumn and spring crop seasons (September - March) when leaf production is affected due to low temperature and humidity.

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

Technology - 16

Technology: Control of Powdery mildew (*Phyllactinia corylea*)

Year of release: 2002

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% Carbendazin (Bavistin) - a broad-spectrum systemic fungicide.

Methodology: Whenever powdery mildew 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.

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.

Technology - 17

Technology: Control of Leaf rust (*Peridiopsisora mori*)

Year of release: 2007

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 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 14 days of spray.

Advantages over the alternative technologies: The disease is effectively controlled by foliar spray of 0.2% Copper oxychloride (Blitox). 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.

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

States/ areas: All over India.

Technology - 18

Technology: Control of Bacterial Leaf spot (*Xanthomonus campestris* pv. *mori*)

Year of release: 2007

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 later 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 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.

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: Eastern & North-Eastern region.

Technology - 19

Technology: Control of Fungal Leaf spot (*Myrothecium roridum*)

Year of release: 2007

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 *Myrothecium* 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 spray.

Advantages over the alternative technologies: The disease is effectively controlled by foliar spray of 0.1% Carbendazim (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.

States/ areas: Eastern & North-Eastern region.

Technology -20

Technology: Control of *Pseudocercospora* Leaf spot

Year of release: 2007

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. The disease is effectively controlled by foliar spray of Carbendazim (Bavistin) - a broad spectrum systemic fungicide. 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.

Technology -21

Technology: Control of Whitefly (*Dialeuropora decempuncta*, Quaintance & Baker, and *Alleuroclava pentatuberculata*)

Year of release: 2003

I. Mechanical control with Yellow coloured Sticky traps

Brief description: Installation of yellow coloured sticky traps (size: 2 ft x 1 ft) @ 150 Nos. per hectare after 15 days of pruning reduce the whitefly population to the tune of 25-30% upto 14 days.

Methodology: Based on the abundance of whitefly yellow colored traps are placed randomly in the field at the height of plant canopy. Yellow sticky traps (size: 2 ft x 1 ft polythene sheet tying with two sticks) are to be erected in the mulberry fields. The trapped insects are to be removed and cleaned once in a week and then the traps are to be smeared with fresh coat of colourless grease as an adhesive on both sides for further trapping.

Advantages over the alternative technologies: Cheap and eco-friendly management of whitefly can easily be made by the farmers.

Limitations and environmental impact: An eco-friendly approach in whitefly management.

States/areas: Gangetic West Bengal and all States.

II. Chemical control with dichlorvos and Neem oil

Year of release: 2003

Brief description: For spraying of one hectare of mulberry field, 650 ml dichlorvos is required to be mixed with water to make a solution of 500 litres and in case of Neem oil 5 litres is to be mixed with water to make a solution of 500 litres. Synthetic insecticide dichlorvos is cheap and easily available. Botanical insecticide Neem oil is eco-friendly and not harmful to the natural enemies.

Methodology: If the whitefly population is more than 20 Nos. per leaf (i.e. Economic Threshold Level), spray of 0.1% dichlorvos (76% EC) or 1% Neem oil (Azadirachtin 1500 ppm) has to be done on the lower surface of mulberry leaves. Spray should preferably be done during cooler hours of a day. It can be repeated after 14 days, if needed.

Advantages over the alternative technologies: Application of dichlorvos (0.1%) reduces whitefly populations of about 85% and the Neem oil (1%) upto 80%. Safe period for silkworm rearing is 14 days.

Limitations and environmental impact: There is least impact on the environment due to less toxicity of the chemicals.

States/areas: Gangetic West Bengal and Eastern states.

III. Biological control through release of native predator (*Micraspis discolor* (F) (or) *Brumus suturalis* (F) (Coleoptera : Coccinellidae)

Year of release: 2003

Brief description:

Methodology: The native predator @ 500 pairs per acre is released which feeds on both eggs and nymphs of whitefly.

Advantages over the alternative technologies: Release of the native predator @ 500 pairs per acre suppresses whitefly population by about 25%.

Limitations and environmental impact: Eco-friendly management approach.

States/areas: Gangetic West Bengal and Eastern states.

Technology -22

Technology: Control of Thrips (*Pseudodendrothrips mori*, Niwa)

Year of release: 1997

Brief description: For spraying in one hectare of mulberry field, 0.1% dimethoate solution is to be prepared by mixing 1.67 litres of dimethoate (EC 30) with water to make a solution of 500 litres.

Methodology: If thrips population is more than 20 Nos. per leaf (ETL), 0.1% dimethoate (EC 30) should be sprayed on the lower surface of mulberry leaves preferably during cooler hours of the day. Where thrips population is more than 40 Nos. per leaf, 0.2% dimethoate is recommended. Safe period for silkworm rearing is 14 days. It can be repeated after 14 days, if needed.

Advantages over the alternative technologies: Spray of 0.1% dimethoate reduces 88-92% thrips population upto 14 days of spray. Safe period for silkworm rearing is 14 days.

Limitations and environmental impact: The insecticide is mild, its higher concentration has least effect on non-target organisms like natural enemies.

States/areas: Gangetic West Bengal and Eastern states.

Technology -23

Technology: Control of Mealy bug (*Maconellicoccus hirsutus*, Green)

Year of release: 1997

Brief description: The causative organism of Tukra is mealy bug, *Maconellicoccus hirsutus* (Green). This is commonly known as **pink mealy bug** or Hibiscus mealy bug.

Physical Control: Clipping of Tukra infested shoots and burning them during the initial stages of the infestation.

- ❖ **Chemical control:** Spray of 0.1% dimethoate (EC 30) solution on mulberry plants when mealy bug population/tukra infested shoot is more than 10.
- ❖ **Biological control:** After 20 days of pruning of the mulberry, a native predator, *Scymnus bourdilloni* Kapur (Coleoptera: Coccinellidae) is to be released @ 1500 pairs per hectare.

Methodology: If mealy bug population is more than 10 individuals per plant and 10% of the shoot is affected, 0.1% dimethoate 30 EC (3.3 ml dimethoate in one litre of water) solution is to be prepared to make a solution of 500 litres for spraying in one hectare of mulberry field. In case of severe infestation 0.2% is recommended.

Advantages over the alternative technologies: Through application of chemical insecticides mealy bug populations can be reduced upto 75%. The insecticide with recommended concentration has least effect on non-targeted natural enemies. Biological control is eco-friendly and the native predator conserves natural enemies of mealy bug. By adopting physical control measures tukra infestation can be reduced upto 10-12%.

Limitations and environmental impact: Spray of insecticide should be made at least after three weeks of release of the bio-control agent. Waiting period for silkworm rearing with the treated leaves is 14 days after spray of insecticide.

States/areas: Gangetic West Bengal and Eastern states.

Technology - 24

Technology: N x M12 (W) – A productive Multivoltine hybrid

Year of release: 2000

Brief description: This multivoltine hybrid can be reared during unfavourable seasons namely April-May, June-July and Aug-Sept. when temperature and humidity remain high.

Field results on adoption of the technology on commercial scale: The cocoon yield of this hybrid ranges between 25 and 36 kg per 100 dfls in comparison to 18-21 kg per 100 dfls of the ruling breed Nistari.

Advantages over the alternative technologies: This hybrid gives around 35% more yield per 100 dfls than the ruling breed, Nistari.

States/areas: Gangetic West Bengal and Eastern India

Technology - 25

Technology: N x YB - A productive Multi x Bi hybrid

Year of release: 2000

Brief description: N x YB can be reared during favourable seasons viz., November - December, February-March and March-April when temperature and humidity are congenial.

Field results on adoption of the technology on commercial scale: The cocoon yield of this hybrid ranges between 38 and 43 kg per 100 dfls in comparison to 31 and 39 kg per 100 dfls of the ruling hybrid, N x NB4D2.

Advantages over the alternative technologies: NxYB yields 10 - 22% more cocoons over the ruling Multivoltine x Bivoltine hybrid, N x NB4D2. The Bivoltine male parent, YB is successfully raised during preceding seed crop seasons in comparison to the NB4D2, the bivoltine parent of the ruling hybrid, N x NB4D2.

States/areas: Gangetic West Bengal and Eastern India.

Technology - 26

Technology: Incubation pot for better hatching in dry summer

Year of release: 1999

Brief description: The incubation unit consists of two bucket shaped earthen pots, the bigger one is outer chamber and the smaller one is the inner chamber. The inner chamber hangs inside the outer chamber from its rim. In between two chambers, there is a space of about 2.5 cm (1"). In both the chambers, there are two holes of 1 cm. in diameter just below the upper rim in opposite direction for inserting bamboo or wooden stick for hanging the egg sheets during incubation. The farmers of Eastern and North Eastern region do not have any provision for incubation of eggs under fluctuating conditions of environment. It

has been observed that during summer (March-May) when the room temperature and relative humidity are 35-37°C and 45-60% respectively, the incubation pot can maintain more or less uniform temperature of around 29°C and relative humidity of 95%.

Methodology: Prior to incubation, about 7-8 litres of water is poured inside the outer chamber. Then the inner chamber is placed within the outer one. After keeping the egg sheets vertically (in hanging position) for incubation, the opening of the inner chamber is covered with a lid. The whole incubation unit is placed on an earthen plate partly filled with water for protecting ant. About 1½ litres of water should be poured daily inside the outer chamber to compensate the evaporation loss of water. 400 to 500 dfls can be incubated at a time.

Other information: Care should be taken during handling of the incubation pot.

States/ areas: Eastern and North Eastern India.

Technology - 27

Technology: Silkworm egg carrying box

Year of release: 2001

Brief description: The silkworm egg box primarily consists of a frame made of paper (pitch) board and is 180 mm long, 90 mm wide and 4 mm thick. The width of the rim is 10 mm. A thin muslin cloth is stretched and pasted on both sides of the frame. Legs made of similar pitch board of 2 mm thickness and cut in the form of an equilateral right-angled triangle with the equal sides measuring 20 mm support the corners of the frame on its lower surface. A triangular piece of paper is pasted to the muslin cloth on the upper side on one corner to give a rigid support at the time of filling the box with silkworm seed and easy sealing. A semi-circular slit is made on this portion of the muslin cloth through which the eggs are filled and sealed. No adverse effect on hatching and rearing was noted by using the silkworm egg-carrying box.

Methodology: Method of use is same as the traditional egg box.

Advantages over the alternative technologies: No adverse effect on hatching and rearing was noted by using the silkworm egg-carrying box.

States/ areas: All over India.

Technology - 28

Technology: Bleaching powder solution as effective room disinfectant

Year of release: 1988

Brief description: 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. 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.

Methodology: Aqueous solution of 5% bleaching powder is prepared by dissolving 50 g of bleaching powder per litre of water. First make a paste of the bleaching powder using water in a plastic container and then add remaining water to get required 5% concentration. Cover the container with a lid and after sedimentation of un-dissolved materials; filter the solution using a muslin cloth. Spray the solution using a plastic sprayer. 50 litres of solution is required for disinfection of rearing room and appliances for 100 dfls.

States/ areas: Eastern & North Eastern states.

Technology - 29

Technology: LABEX - A Silkworm Bed-Disinfectant

Year of release: 1987

Brief description: Labex is an effective bed disinfectant, which is a mixture of two cheap and 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.

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.

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. Corrosive effect on metals. Person dusting the Labex should take adequate care to prevent its inhalation.

States/ areas : Eastern and North- Eastern states.

Technology - 30

Technology: Integrated Management of Uzi fly

Year of release: 1999

Brief description: 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 can not 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.

Control Measures:

- ❖ **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%.

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.

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.

Technology - 31

Technology: Designing of reeling machine

Year of release: 1993

Brief description: Designing of reeling machine suitable for West Bengal condition to reel Nistari and multi x bi cocoons. Mid course correction on designing suggested towards separate cooking.

Technology - 32

Technology: Cocoon drying chamber

Year of release: 1992

Brief description: Development of cocoon drying chamber suitable for West Bengal condition.