

Mulberry Cultivation and Utilization in India

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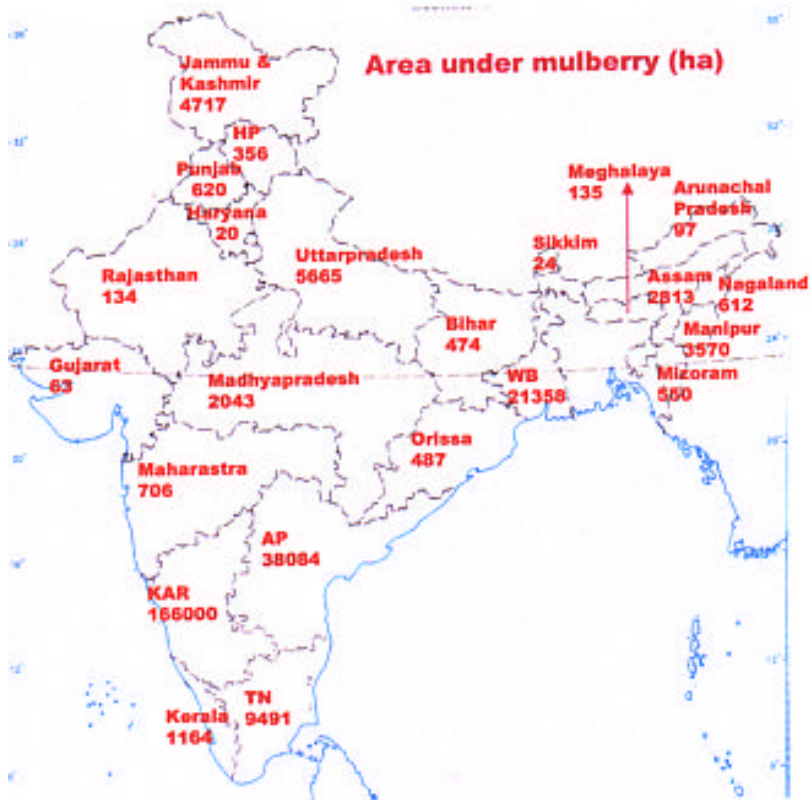
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1. Area cultivated with mulberry in India:

Mulberry foliage is the only food for the silkworm (*Bombyx mori*) and is grown under varied climatic conditions ranging from temperate to tropics. Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area has a direct bearing on cocoon harvest. In India, most states have taken up sericulture as an important agro-industry with excellent results. The total acreage of mulberry in India is around 282,244 ha. The details of area under mulberry cultivation in different states in India is shown in the table given below also in the Map:

Table-1: Area under mulberry cultivation in different states

State	Area (ha)
ANDHRA PRADESH	38,084
ASSAM	2,813
JAMMU & KASHMIR	4,717
KARNATAKA	166,000
KERALA	1,164
MADHYA PRADESH	2,043
MANIPUR	*25,975
TAMIL NADU	9,491
UTTAR PRADESH	5,665
WEST BENGAL	21,358
OTHER	4,934
TOTAL	282,244



2. Species and varieties under cultivation in india

There are about 68 species of the genus *Morus*, the majority of them occur in Asia, especially in China (24 species) and Japan (19). Continental America is also rich in its *Morus* species. The genus is poorly represented in Africa, Europe and Middle East, and it is not present in Australia.

In India, there are many species of *Morus*, of which *Morus alba*, *M. indica*, *M. serrata* and *M. laevigata* grow wild in the Himalayas. Several varieties have been introduced belonging to *M. multicaulis*, *M. nigra*, *M. sinensis* and *M. phillippinensis*. Most of the Indian varieties of mulberry belong to *M. indica*.

Table-2 : Mulberry varieties under cultivation in different states

Variety	Region	Developed at	Origin
Kanva-2	South India Irrigated	CSRTI, Mysore	Selection from natural variability.
S-36	“	“	Developed through EMS treatment of Berhampore Local.
S-54	“	“	“
Victory-1	“	“	Hybrid from S30 x Ber C776.
DD	“	KSSRDI, Thalaghattapura	Clonal selection.
S-13	South India Rainfed	CSRTI, Mysore	Selection from polycross (mixed pollen) progeny.
S-34	“	“	“
MR-2	“	“	Selection from open pollinated Hybrids.
S-1	Eastern and N.E. India Irrigated	CSRTI, Berhampore	Introduction from (Mandalaya) Burma.
S799	“	“	Selection from open pollinated Hybrids.
S1635	“	“	Triploid selection.
S146	N.India and Hills of J & K Irrigated	“	Selection from open pollinated hybrids.
Tr-10	Hills of Eastern India	“	Triploid of Ber.S1.
BC 259	“	“	Back crossing of hybrid of Matigare local x Kosen with Kosen twice.
Goshoerami	Temperate	CSRTI, Pampore	Introduction from Japan.
Chak Majra	Sub-temperate	RSRS, Jammu	Selection from natural variability.
China White	Temperate	CSRTI, Pampore	Clonal selection.

In China there are 15 species. Out of which, 4 species, *Morus alba*, *M. multicaulis*, *M. atropurpurea* and *M. mizuho* are cultivated for sericulture. In the ex-USSR *Morus multicaulis*, *M. alba*, *M. tartarica* and *M. nigra* are present.

Though mulberry cultivation is practiced in various climates, the major area is in tropical zone covering Karnataka, Andhra Pradesh and Tamil Nadu states, with about 90%. In the sub-tropical zone, West Bengal, Himachal Pradesh and north-eastern states have major areas under mulberry cultivation. The details of mulberry varieties under cultivation in different states of India is given in Table-2.

3. General Description

Mulberry is a fast growing deciduous woody perennial plant. It has a deep-root system. The leaves are simple, alternate, stipulate, petiolate, entire or lobed. Number of lobes varies from 1 to 5. Plants are generally dioecious. Inflorescence is catkin with pendent or drooping peduncle bearing unisexual flowers. Inflorescence is always auxiliary. Male catkins are usually longer than the female catkins. Male flowers are loosely arranged and after shedding the pollen, the inflorescence dries and falls off. Number of perianth lobes are 4. Number of stamens are 4 and implexed in bud. Female inflorescence is usually short and the flowers are very compactly arranged. Number of perianth lobes are 4 and persistent. Ovary is one-celled and stigma is bifid. The chief pollinating agent in mulberry is wind. Fruit is a sorosis and the colour of the fruit is mainly violet black.

Most of the species of the genus *Morus* and cultivated varieties are diploid having 28 chromosomes. However, triploids ($2n=(3x)=42$) are also extensively cultivated for their adaptability, vigorous growth and quality of leaves.

4. Climatic Requirement of Mulberry

Mulberry thrives under various climatic conditions ranging from temperate to tropic located north of equator between 28° N to 55°N latitude. The ideal range of temperature is from 24-28°C. It grows well in places with annual rainfall ranging from 600mm to 2500mm. In area with low rainfall, the growth is limited due to moisture stress resulting in low yields. On an average mulberry requires 85,000 gallons of water per hectare once every 10 days in case of loamy soils and 15 days in clayey soils. The atmospheric humidity in the range of 65-80% is ideally suited for mulberry growth. Sunshine is one of the important factors controlling growth and leaf quality. In tropics, mulberry grows with a sunshine range of 9.0 to 13.00 hours a day. Mulberry can be cultivated from sea level up to an elevation of 1000 m above mean sea level.

5. Soil Condition:

Mulberry flourishes well in soils which are flat, deep, fertile, well drained, loamy to clayey, porous with good moisture holding capacity. The ideal range of soil pH is 6.2 to 6.8. The optimum pH required for mulberry is 6.5 to 6.8. Soil amendments may be used to correct the soil to get required pH. The quantity of gypsum or lime to be applied in different cases are as mentioned below:

Soil amendments: (To be taken up after soil test)

<u>PH range (To bring pH to 6.8)</u>	<u>Quantity of gypsum/ha</u>
7.4 to 7.8	2.0 MT
7.9 to 8.4	5.0 MT
8.5 to 9.0	9.0 MT
9.1 to above	14.0 MT

pH range quantity of lime/ha (to bring pH to 6.8)

pH range	Quantity of lime/ha (To bring pH to 6.8)		
	Plain	Hilly areas	Soil type
5.5 to 6.5	1.25 MT	2.5 MT	Sandy
	2.50 MT	5.0 MT	Sandy loamy
	5.0 MT	7.5 MT	Loamy
	7.5 MT	8.75 MT	Clay loamy

Method of application: The powdered gypsum/lime is mixed well with soil with soil of the garden and irrigated to stagnation for 48-72h. Later the water is leached out by drainage and dried (suitable for ploughing and intercultural operations).

A) Mulberry Cultivation in South India under Rainfed Conditions (Karnataka, Andhra Pradesh and Tamil Nadu)

I. Suitable Mulberry Varieties

Kanva-2, S-13 and S-34 varieties are recommended for rainfed (rainfall : 500-800 mm) regions of South India.

Kanva-2 : Belongs to *Morus indica* - Diploid. Widely cultivated in Southern India. Selection from natural population of Mysore Local variety.

Flower and sorosis: Female, profuse flowering, many sorosis.

Economic characters: Medium leaf maturity, yields about 30 to 35 MT/ha/year under irrigated condition. Leaf moisture content 70%, protein content 21% and sugar content 11.5%. High rooting ability (80%) and wide adaptability.

Resistant to leaf spot. Moderately resistant to leaf rust and powdery mildew.

S-13 : Belongs to *M. indica*. Selection from open pollinated hybrids of Kanva-2. Recommended for rainfed areas of South India during 1990.

Flower: Male, profuse flowering.

Economic characters: Yields 8-12 MT/ha/yr under rainfed conditions depending on rainfall. Moisture content 70.6% protein content 24.3% and sugar content 13.8%.

Resistant to leaf spot and powdery mildew, moderately resistant to leaf rust and tukra infestation.

S-34 : Belongs to *M. indica* - Diploid. Selection from progeny of S30 x Berc 776. Recommended during 1990 for rainfed areas with black cotton soils of South India.

Flower and sorosis: Male, profuse flowering, occasionally few sorosis.

Economic characters: Under rainfed conditions, yields about 15 MT/ha/yr. Moisture content 70%, crude protein content 23.7%. Soluble sugar content 13.2%.

Resistant to powdery mildew and leaf rust. Moderately resistant to leaf spot and susceptible to tukra infestation.

II. Establishment of Mulberry

i) Preparation of land: The land meant for mulberry cultivation is ploughed deep with heavy mould board plough up to a depth of 30-35 cm. Thereafter the land is repeatedly ploughed 2-3 times with a country plough to bring the soil to a fine tilth. The land should be properly levelled if it is sloppy. A basal dose of well decomposed Farm Yard Manure or compost is applied at the rate of 10 MT/ha and thoroughly incorporated into the soil.

ii) Spacing: The spacing commonly followed for a rainfed garden is 90 x 90cm Pits of 35 x 35cm. are prepared. About 1 kg farm yard manure/pit should be added.

iii) Preparation of cutting and planting: Branches of 8-10 months old and about 50 mm. in diameter should be used for preparation of cuttings of 22-25 cm. length with 5-6 healthy buds. Three cuttings are planted/pit in a triangular form with a spacing of 15 cm. leaving only one bud exposed above soil surface. If planting is done with saplings, then one sapling is sufficient/pit. Planting should be done during June /July after onset of monsoon.

iv) Inter cultivation: During first year of plantation, inter-cultivation should be done manually. Once the mulberry plants are established, bullock ploughing is carried out.

Application of fertilizer: 50N:25P:25K Kg/ha/yr in two doses.

First dose

Suphala (15:15:15) 167kg, after 2 months of planting

Second dose

Urea 55 kg orCAN (100kg) or Ammonium sulfate (125kg), end of September or early October before cessation of monsoon rains

v) Pruning and leaf harvest: First crop should be taken 6 months after plantation when mulberry gets well established. Then onwards, two more crops are taken during first year by leaf picking method. Mulberry should be pruned after the completion of one year at the onset of next monsoon. The pruning is carried out with a sharp sickle or a pruning saw at the height of 25-30 cm. from the ground.

vi) Green manuring and cover mulching: Green manure crops can be grown as inter-crop with mulberry. It should be done during monsoon only. The green manure crops (cow pea, horse

gram, dhaincha) should be incorporated into soil by ploughing before the flowering starts and well before rains cease. After that the plots may be given cover mulching with any dry material or weeds in which seed is not a source of multiplication.

III. Maintenance of Mulberry Under Rainfed Condition (Second year onwards)

Inputs required for rainfed garden (per ha. per year)

Recommended inputs for gardens maintained under rainfed condition.

Spacing : 90 cm. x 90 cm.

1. FYM/compost, 10 MT, single dose at the onset of monsoon
2. Azotobacter biofertilizer, 4 kg/crop, two times/yr (during rainy season)
3. VAM inoculum, 1000 kg, once in life span of mulberry (inoculation through maize rootlets)
4. Suphala, 167 kg, I crop
5. Single Super Phosphate, 156 kg, I crop
6. Muriate of potash, 42 kg, I crop
7. Urea (55 kg) or Cam (100kg), III crop
8. Green manuring, 15 kg

Crops like horse gram, cow pea, sun hemp, dhaincha, etc., should be incorporated into soil by ploughing before flowering and cessation of monsoon.

LEAF HARVEST: Individual leaf harvesting should be made. The yield for different varieties is as mentioned below:

K-2 – 10-12 MT/ha/yr

S-13 – 14-15 MT/ha/yr

S-34 – 14-15 MT/ha/yr

B) Mulberry Cultivation in South India under Irrigated Condition

I. Suitable Mulberry Varieties

Kanva-2, S-36, S-54, DD, MR2 (especially in Tamil Nadu) and V-1 varieties are recommended for irrigated conditions.

Kanva-2 : Belongs to *Morus indica* - Diploid. Widely cultivated in Southern India after the same was recommended for cultivation in 1969 by CSR & TI, Mysore. Selection from natural population of Mysore Local variety.

Flower and sorosis: Female, profuse flowering, many sorosis.

Economic characters: Medium leaf maturity, yields about 30 to 35 MT/ha/year under irrigated condition. Leaf moisture content 70%, protein content 21% and sugar content 11.5%.

Resistant to leaf spot. Moderately resistant to leaf rust and powdery mildew. High rooting ability (80%) and wide adaptability.

S-36 : Belongs to *M. indica*. Developed at CSRTI, Mysore and recommended during 1984. Evolved from Berhampore local by chemical mutagenesis. Cultivated in Southern India. Moderate rooting ability.

Economic characters: Yields about 38 - 45 MT/ha/yr under assured irrigated conditions of South India. Moisture content 76 % protein content 22 % and carbohydrate content 28 %.

Tolerant to leaf spot and powdery mildew. Moderately susceptible to leaf rust and to tukra infestation.

Most suitable to young age silkworm rearing. Sapling plantation recommended due to moderate rooting ability.

S-54 : Belongs to *M. indica*. Developed at CSRTI, Mysore and recommended during 1984. Selected from Berhampore local by chemical mutagenesis (EMS). Recommended for assured irrigated conditions of South India.

Economic characters: Yields about 45 MT/ha/yr under assured irrigated conditions. Highly responsive to agronomical input. Moisture content of leaf 70.5% protein content 23.9% and sugar content 13.8%. Moderately resistant to powdery mildew and leaf rust and resistant to leaf spot. Loses moisture very quickly. Good rooting ability.

DD : Selected from natural population of Dehra Dun variety and recommended by Karnataka State Sericultural Research and Development Institute, Thalaghattapura. Recommended for Southern India.

Morphology: Erect, thin branches, coarse leaves, greenish grey colour bark. Lower branches spreading, leaves unlobed, big size, ovate shape. Yields 35-40 MT/ha/yr under assured irrigation condition.

MR – 2 : Belongs to *M. sinensis* – Diploid. Selection from open pollinated hybrid population. Developed at CSR & TI, Mysore and recommended for propagation in Tamil Nadu. Mainly cultivated in Tamil Nadu under both irrigated condition in plains and rainfed conditions in hilly regions.

Economic characters: Yields about 30-35 MT/ha/yr under irrigated conditions of Tamil Nadu. Moisture content 68%, protein content 23.2%, sugar content 13.2% (Fig. 7).

Resistant to powdery mildew disease, suitable for hilly areas.

V-1 : Belongs to *M. indica*_L. Recently developed from a cross of S-30 and Berc.776 at CSR&TI, Mysore. Recommended during 1996 for assured irrigated conditions.

Flower: Male, profuse flowering, occasionally few sorosis.

Economic characters: Yields about 70 MT/ha/yr under assured irrigated conditions.

Very high sprouting. Moisture content 78.9% and 72.5% in young and matured leaves respectively, protein content 24.6% and total sugar content 16.98%.

Moderately resistant to leaf rust and tukra infestation and resistant to leaf spot. Quick sprouting ability and very high rooting ability (> 94%) high photosynthetic rate and higher water use efficiency are additional advantages. Moreover, leaves are suitable for both young and grown bivoltine silkworm rearing.

II. Establishment of Mulberry

i) Selection of site: Mulberry flourishes well in soils which are flat, deep, fertile, well drained, loamy to clayey, porous with good moisture holding capacity. The ideal range of soil pH is 6.2 to 6.8. Mulberry can be grown in saline, alkaline and acidic soils after suitably amending the soils.

ii) Preparation of land: The land meant for mulberry cultivation is ploughed deep with heavy mould board plough up to a depth of 30 – 35 cm. Thereafter the land is repeatedly

ploughed 2-3 times with a country plough to bring the soil to a fine tilth. The land should be properly leveled if it is sloppy. A basal dose of well decomposed farm yard manure or compost is applied at the rate of 20 MT/ha and thoroughly incorporated into the soil.

iii) Plantation can be raised by using both cuttings or saplings. The varieties ideally suited for irrigated conditions are Kanva-2, S-36 and V-1. Branches of 6-9 months old and about 15 ml. in diameter should be used for preparation of cuttings of 15-18 cm. length having 3-4 healthy buds for raising nursery or for planting directly in the field.

iv) Spacing: Plant spacing of 90 x 90 cm. is ideal for mulberry. While taking Plantation directly, two cuttings/pit required to be used. In case of using saplings, only one sapling/pit is sufficient. Presently a paired row plantation with the spacing of (90+150)cm x 60cm, is recommended.

v) Inter-cultivation: Two months after planting, weeding is done. A second weeding is done after another 2-3 months. Thereafter, inter-cultivation should be done after every shoot or leaf harvest.

vi) Irrigation: The plantation should be taken up during the onset of monsoon to take advantage of the rains. If the rain is not sufficient, the land should be irrigated at regular intervals of 8-14 days depending on type of soil. About one and a half to two acre inches of water is required/irrigation.

vii) Application of fertilizer: The total dose of fertilizer to be applied in first year is 100 N: 50 P: 50 K/kg/ha/yr. This is applied in two doses. The first dose is applied when the plantation is about 2 months old at the rate of 50 N: 50 P: 50 K/kg/ha. The second dose is applied after taking the leaf harvest at the rate of 50 kg N alone/ha.

viii) Pruning: After 6 months of plantation, mulberry attains a height of about 1.50 to 1.75 m. and is ready for harvest. The first harvest is taken by bottom pruning. The second leaf harvest is taken after 12 weeks of first leaf harvest and the third harvest is taken 12 weeks after the second harvest by shoot harvest. From second year onwards, harvest is made at an interval of 70 days by shoot harvest method.

III. Maintenance of Mulberry under Irrigated Conditions (Second year onwards)

Spacing 90 cm. x 90 cm. or (90 + 150) cm x 60 cm

Recommended inputs:

i) FYM/compost	20 MT	In two equal split doses (10 MT FYM+ MT vermi compost)
ii) Azotobacter	20 kg	In five equal split doses
iii) N-triacontanol***	250 ml	In two equal split doses/crop
iv) VAM inoculum** (for existing garden)	1000 kg	One dose in the life span of mulberry (inoculation through maize as host plant)
v) Ammonium* sulphate or Urea or CAN	750 kg 325 kg 600 kg	In five equal split doses
vi) Single super Phosphate	375 kgs	In two equal split doses(I and III crop)
vii) Muriate of potash	200 kg	In two equal split doses. (I and III crop)

* 50% of chemical fertilizer can be cut down due to application of azotobacter and VAM.

** VAM inoculation is not required for the garden, planted with Mycorrhiza inoculated saplings.

*** 1st spray: In between 10-15 days after pruning/leaf plucking 2nd spray : 10 days after 1st spray.

LEAF HARVEST: Leaf harvesting is done either through individual leaf harvest or shoot harvesting. Later one is more economical and useful for shoot method of silkworm rearing. The yield of varieties is mentioned below:

Kanva-2	-	32-35 MT/ha
S-36	-	38-45 MT/ha
V-1	-	60-70 MT/ha

C. Mulberry Cultivation in Hilly Areas

I. Suitable Mulberry Varieties

S-1, S-7999, S-1635, S-146, Tr-10 and BC-259 varieties are recommended for hilly regions of north and north-eastern India.

II. Establishment of Mulberry

i. Preparation of land: If the land is having gentle slope, it can be leveled with minor land shaping and providing suitable type of bunds across the slope. If the slope is more, contour bunding terrace planting or contour line planting can be adopted. In more sloppy areas, platform for individual plants on contour lines is more suitable as the same involves less soil cutting.

ii. Spacing: Spacing for tree planting depends on soil topography, extent of land available for cultivation and training method. In case of gentle slope, 3`X 3`, 5`x 5` may be adopted. In case of more sloppy land 10` x 10` can be adopted.

Pits are to be prepared for plantation. In case of deep textured loose soils, 45 x 45cm. and in had shallow soils 60cm x 60cm x 60cm) pits are to be prepared. For each pit, 5kg (one iron pan) of FYM or compost must be applied.

iii. Planting: Saplings of 5 months age with 5-6 feet is found suitable to plant during the regular onset of monsoon. One sapling/ pit should be planted. The saplings should be supported with stick to ensure straight growth.

iv. After care of plantation: After one month, all the buds except top 5-6 should be removed carefully without damaging the bark. Weeds around the plant should be removed and regular pot watering should be given. After 3 months of planting, second weeding should be given and 25g of suphala/plant should be applied in trench and should be covered with soil. 2nd dose of fertilizer (25g urea/plant) should be given before cessation of monsoon. Plants must be protected from grazing.

III. Recommendation with Institute Technologies for Hilly Areas (Tropical high land)

Spacing 90 cm. x 90 cm.

FYM/compost	20 MT	In single dose in the month of Jan/Feb.
Azotobacter	7.5 kg	In 3 equal split doses.
VAM inoculum	1000 kgs	In single dose in the life span of mulberry
CAN	200 kg	In 3 equal split doses.
SSP	156 kg	In 2 equal split doses.
MOP	84 kg	In 2 equal split doses.

CAN: Calcium Ammonium Nitrate

SSP: Single Super Phosphate

MOP: Muriate of Potash

Since the recommendation is general, the inputs like fertilizers and amendments may be applied on the basis of soil test reports.

D. Inputs for Mulberry Cultivation in Temperate and Sub-Temperate Regions

The following varieties are found suitable for temperate and sub-temperate regions.

Temperate	-	Goshoerami, China white
Sub-temperate	-	Chak majra, S-146

- i. Temperate (Kashmir) - FYM 20 tons/ha/yr (irrigated)
After annual pruning July-August

All types of plantation (bush, dwarf tree) maintained under irrigated condition.

- ii. Temperate (Kashmir) - 1st dose in April-May
NPK @ 300:150:150 ha/yr - 2nd dose in June-July
in two equal splits

The leaf yield of different varieties are as mentioned below:

Goshoerami	15-20 MT/ha/yr
China white	15-20 MT/ha/yr
Chak majra	20-22 MT/ha/yr

6. Mixed Farming:

Mulberry can be successfully grown as an inter-crop (medium mixed tree) between the rows of tea/coffee as shade plants. By this besides providing shade to the tea/coffee plants, good quantity of quality leaves can be obtained for silkworm rearing and as feed for cattle and goats. Further, the pruned shoots are a good source of firewood.

Mulberry can also be grown as an inter-crop for cultivation in the wider space existing between sources of coconut plantation. A survey has shown that mulberry is inter-cropped with coconut in Channapatna, Ramanagaram, Kanakapura and Bangalore areas of Karnataka state.

7. Insecticide/ Pesticide/ Fungicide and Other Inputs (ha/y) (if required)

- | | | |
|-------|--|---|
| i) | DDVP (Nuvan) (P) | 1.25 ltr. Should be sprayed if required to control tukra/leaf roller.(in 480 l water) |
| | Soap (Washing Soap)
Non-detergent | 5 kg To mix with DDVP solution
(Not required for controlling leaf roller). |
| ii) | Ladybird beetle
(CSRT) | 625 adults, as a biological control for mealy bug. |
| iii) | Bionematicide (N)
(180 days shelf life) | 80 kg, in 3 split doses at an interval of 4 months during intercultural operations to control root-knot disease. |
| iv) | Neem oil cake (N) | 2 ton, in 4 split doses at an interval of 3 months during inter-cultural operations to control root-knot disease. |
| v) | Raksha
(120 days shelf life) | 1 kg, for 100 plants with 50 kg FYM for root-rot |
| vi) | Bavistine (F)
(0.2%) (Carben-
dazim: a.i.-50 WP) | 1 kg, dissolved in 500 l water and sprayed to prevent leaf spot and powdery mildew diseases (safe period – 2 days). |
| vii) | Kavach (F) (Chloro-
tholonil: a.i.-WP) | 1 kg, dissolved in 500 l water and sprayed to prevent leaf rust (safe period – 2 days). |
| viii) | Dithane M-45(Man-
cozeb: a.i. – 75 WP) | 1 kg, dissolved in 500 l water and sprayed to prevent leaf blight due to fungi and bacteria (safe period – 2 days). |
| ix) | Zinc sulphate
(Agro grade) | 4.4 kg, in 440 l of water to increase leaf quality and quantity per crop. |
| x) | Glyphosate 41%
(Agro grade) | 8.5 l, in two split doses (i.e. 2 nd & 4 th crop) to control weeds in mulberry garden). |

8. Animal Feeding Practices and Other Traditional Uses

Mulberry is appropriately known as “Kalpa Vruksha” as all the parts of the plant has many uses. It is essential to sericulture as the foliage constitute the sole feed of mulberry silkworm *Bombyx mori*. Mulberry (*Morus* spp) is a fast growing tree which for convenience of sericulture practices is maintained as a bush. It produces very large amounts of renewable bio-mass in the form of branches, shoots, leaves and fruits. If mulberry is used for silkworm rearing it is possible to get 30-35 MT/ha of leaf every year. By growing mulberry, a farmer gets fodder, fuel and fertilizer. With regard to fodder for animals, farmers in India feed their cows and goats with left over branches and leaves during silkworm rearing period. Many farmers feed their animals with full twig of mulberry when leaves are in excess. But, they always mix mulberry twigs with straw. Farmers also use the mulberry twigs as their fuel source after pruning of the garden. Left over twigs are allowed to dry in the garden itself. Refuses of rearing are also converted to valuable Farm Yard Manure for mulberry garden by the farmers by putting it in a pit and keeping it for 4-5 months prior to its use. As mulberry is mainly propagated by cuttings in tropics and sub-tropics, certain quantity of pruned branches can be used for preparation of cuttings and the remaining as fuel wood. One hectare of mulberry garden yields about 12.1 MT of mulberry sticks. The energy generated/ha (50% moisture loss) is 27830 Kcal (@ 4600 calories/kg of mulberry wood). Accordingly, mulberry can be exploited by raising it as “energy plantation” in cultivable/wasteland/low lying areas/canal bund/road side/fringe areas of the forest etc., under various afforestation, watershed development and soil conservation programmes.

Traditional uses of mulberry: The various species of the genus *Morus* viz., *M. laevigata*, *M. serrata*, *M. alba* and *M.indica* has varied uses which are enumerated below:

M. laevigata: The trees of this species produce sweet fruits which are used in juice and jam making in central India. In North-east India the wood is utilized as firewood, house building, furniture making, for making stocks, spokes, poles, shafts of carriages and casts. The wood is suitable for plywood making and paneling, carving and making of toys and tea chests. It is used for making tennis rackets. The straight log of the tree is used as support in house building work.

M. serrata: The wood is used for furniture making and carving, toys making, sports goods, agricultural implements and cheap types of rifles and guns.

M. alba: It is cultivated in the hilly and plain areas of India (Himalayan region) for silkworm rearing. It is also used as an avenue tree and in social forestry. Fruits are made into juice, liquor and stews. The wood finds use in sports goods industry. It is also used for house building, agricultural implements, furniture, for making spokes, poles, shafts and bent parts of carriages and carts. The stem bark is used for paper making.

M. indica: The cultivated forms belong to *M. indica* which are utilized in silkworm rearing. There are few profuse fruiting varieties occurring in Maharashtra and Meghalaya which can be utilized as female parent in breeding programmes. The fruits are used for jam, jelly and juice making in Maharashtra. The pruned branches are used as fuel.

Medicinal uses: The various parts of mulberry plant finds use in ayurvedic preparations. The leaves have diaphoretic and emollient effects. The leaves are used for making a decoction which can be used as a gargle to get relief from throat inflammation. The fruits are used to treat sore throat, depression, high fever and is both a coolant and laxative. The roots extract have hypoglycemic properties. The root bark is used as an

anthelmintic, purgative and vermifuge. Mulberry root juice is administered to patients with high blood pressure. The chinese use the leaf tips from young leaves to boil with tea and use it to control blood pressure. The milky latex is used as a plaster for sores and for preparation of dermal creams.

9. Fruiting Habit

In South India, fruits are observed in two seasons in a year once during October – November and the other during March – May. However, whenever mulberry is pruned or defoliate flowering takes place along with sprouting of auxiliary buds followed by fruit formation. This feature of mulberry is utilized in mulberry breeding programmes. The immature fruits are green in colour but changes to purplish to violet black. In certain species like *Morus alba* the fruits are white to pinkish and very sweet. In *Morus lavigata* the fruits are very long sometime measuring up to 18cm.

10. Leaf Chemical Composition

Chemical composition of leaf varies with variety and maturity. However on the basis of the analysis carried out at CSR& TI Mysore , the chemical composition of the leaf is as follows:

Leaf component	Range
Moisture	65 - 78 %
Protein	19 – 25 %
Minerals	10 – 15 %
Reducing sugars	1.2 – 1.9
Sugars	10 – 15 %

11. Main Pests and Diseases of Mulberry

Key pests of mulberry:

Maconellicoccus hirsutus (mealy bug) – causing tukra in mulberry.

Diaphania pulverulentalis – Leaf roller.

Spilarctia obliqua – Bihar hairy caterpillar (Sporadic pest).

Minor pests of mulberry:

Thrips, Jassids, Scale insects, short horned grasshopper.

Tolerance of varieties to pests:

The tukra incidence in rainfed areas was found to be maximum in S-34 variety followed by MR-2, BERC 776, MS7 and S-13 (Srinivas et. al., 1996). The spread of tukra in V-1 variety is less compared to other varieties viz., Local, K-2, S-13, S-34, S-36 suggesting V-1 variety to be relatively tolerant to tukra (Anonymous, 1998, Sujatha, 1997). Screening of germplasm maintained at CSRTI, Mysore, indicated the variety TOGHWASE – Acc.No. 257 was found to be tolerant to pest attack (unpublished data).

Main diseases of mulberry:

FOLIAR	Leaf spot
	Leaf rust
	Powdery mildew
	Leaf blight
	Bacterial blight
SOIL BORN	Root rot
	Root knot
	Nursery diseases (Stem-canker, cutting rot, collar rot and die-back)

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