2004

Crop Production Techniques of HORTICULTURAL CROPS

Directorate of Horticulture and Plantation Crops
Chepauk, Chennai-600005
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Coimbatore-641003

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Foreword

Horticultural crops play a vital role to ensure nutritional security and is evidently a growth engine for economic prosperity of the country. The X plan document envisages eight percent growth in horticulture to achieve four percent growth in Agricultural sector.

Tamil Nadu has the potential to become a horticultural state in days to come through commercial exploitation of horticultural wealth and implementation of AEZ for commercial horticultural crops.

Horticulture in itself is an mdustry which involves cultivation, processing for value addition and marketing. Introduction and development of new varieties and innovative production technologies are of prime importance to maximize the productivity. Best of the efforts have been made in this regard, by the scientists of Tamil Nadu Agricultural University to maximize productivity and enhance the quality in terms of nutritive value, acceptable flavour and aroma. Now, it is time to focus much on safe food with zero microbial load and zero residual toxicity besides maximizing horticultural productivity. The Good Agricultural Practices (GAP) has become almost a mandate for export of horticultural produce and products.

I am happy that the manual on crop production techniques of horticultural crops is revised and the state of art and cutting edge technologies has been well incorporated.

I appreciate the efforts put in by the team of horticultural scientists of Tamil Nadu Agricultural University and the horticulture developmental specialists of the Department of Horticulture and Plantation Crops for brining out this updated crop production manual. I am sure this manual will help the officers of horticultural development and farmers of Tamil Nadu to gain mastery over production of horticultural crops.

April 28, 2004
Coimbatore - 641 003

(C.RAMASAMY)

Dr. R. Kannan, Ph.D., I.A.S.,
Agricultural Production Commissioner
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Fort St. George
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Foreword

Horticulture is emerging as a viable option of diversification in the Agriculture sector. The potentials available in our State is also enormous for horticulture development. Horticulture is the answer for the farmers who stepped into diversification from the the existing traditional cropping pattern. Cultivation of horticulture crops is now modemised with improved high tech methods.

The Hi-tech methods and improved technologies should be disseminated to the fanners then and there. The Technical Officers of Horticulture Departmenr are also to be fully equippcd with this new dimension.

The joint action taken by Department of Horticulture and Plantation Crops and Tamil Nadu Agricultural University to publish the "Crop Production Techniques of Horticultural Crops" is highly appreciable. The information given in this manual would be helpful to the technical officers as well as Horticulture entrepreneurs.

I wish all success.

April 8, 2004
Chennai - 600 009

8/4/2004
(R. KANNAN)

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Foreword

Tamil Nadu has got immense potential to grow various kinds of horticultural crops due to its rich Bio-diversity and conducive agro climate. There exists tremendous scope for horticultural development and the area under horticulture has considerably increased from 4.62 lakh ha. In 1980-81 to 8.52 lakh ha. in 2001-02. Horticulture Production has increased from 44.78 lakh MT. in 1980-81 to 117.15 lakh MT in 2001-02.

The Government of Tamil Nadu have recognized the emergence of horticulture as the grown engine of the Agriculture sector in recent years and set up a mission known as "Tamil Nadu Horticulture Development Mission" for the overall development of horticulture in the State. For development of Hi-tech Horticulture and Precision farming, it is imperative that the latest technologies be disseminated to the growers for which the extension staff have to get updated with the latest technical knowledge.

The crop production Manual is an authenticated book of (eference prepared jointly by the Department of Horticulture and Plantation Crops and Tamil Nadu Agriculture University. I am confident that this manual will be very useful to the technocrats, progressive farmers, prograrnme implementers, students and all personnel engaged in various facets of horticultural development.

April 8, 2004
Chennai - 600 009

(K. DHANAVEL)

Contents

Part III - Spices and Condiments

Part IV - Plantation crops

Part V - Medicinal and Aromatic Plants

Part I
Fruits

Chapter A
Tropical and Sub Tropical Fruits

Mango: *Mangifera indica* L.; Anacardiaceae

Varieties: Neelum, Bangalora, Alphonso, Rumani, Banganapalli, Kalepad, Peter, PKM 1, PKM 2, Sendura, Jahangir, Mulgoa, Himayuddin, Paiyur 1, Mallika, Amrapali and Salem Bangalora, Arka Anmol, Arka Aruna, Arka Neelkiran, Arka Puneeth.

Processing varieties : Alphonso, Banganapalli, Totapuri
Export Variety : Alphonso , Banganapalli, Sendura

Soil and climate: Red loamy soil with good drainage is preferable. pH range 6.5 to 8.

Season of planting: July to December.

Planting material: Use approach or soft wood grafts.

Field preparation: Dig pits of 1 m x 1 m x 1 m. Fill in with topsoil mixed with 10 kg of FYM and 100 g of Lindane 1.3% dust per pit.

Planting: Plant grafts in the centre of pit with ball of earth intact, water and stake. The graft union must be 15 cm above the ground level.

Spacing: Spacing 7 to 10 m either way, adopt high density planting (10 x 5 m) for Alphonso, Banganapalli, Mallika, etc. for higher productivity.

Irrigation: Regular watering till establishment.

Intercropping: Short duration crops like legumes, vegetables, groundnut etc. can be raised during pre- bearing age.

Manures and fertilizers (Kg per tree)

Manures and Fertilizers	1 Year old	Annual increase	6th year onwards
FYM	10.00	10.00	50
N	0.20	0.20	1.0
P	0.20	0.20	1.0
K	0.30	0.30	1.5

Manures and fertilizers may be applied during September – October, 45 – 90 cm away from the trunk upto the peripheral leaf drip and incorporated.

Training and pruning: Rootstock sprouts and low lying branches have to be removed. Remove overlapping, intercrossing, diseased, dried and weak branches in old trees to get good sunlight and aeration. For the internal branches, pruning may be done during August – September, once in three years. Flowering should not be allowed upto three years. Among crowded terminal shoots, weak shoots are trimmed to retain two healthy shoots during August-September annually.

Growth regulators: Spray NAA @ 20 ppm at flowering to increase the fruit retention. During February 0.5% Urea (5 g/lit.) or 1% Potassium Nitrate (10g/lit.) may be sprayed to induce flowering, if trees do not flower by that time. Spray 2% KNO_3 at mustard size to increase fruit set and retention of fruits.

Apply Paclobutrazol @ 10 g a.i. / full bearing tree during first fortnight of September to get maximum number of fruits and yield during off years.

Plant Protection - Pests

Hopper: Spray two rounds of acephate 75 SP@ 1g/lit or phosalone 35 EC@ 1.5 ml/lit or carbaryl 50 WP 2 g/lit or phosphamidon 40SL 2 ml/lit of water. First at the time of panicle emergence and the second two weeks after first spray. Wettable sulphur @ 2 g/lit may be sprayed after spraying carbaryl to avoid mite resurgence. Neem oil 5 ml/lit of water can be mixed with any insecticides for the control of hopper and shoot webber.

Leaf galls and Aphids: Dimethoate or methyl demeton 2 ml/lit.

Flower Webber: Phosalone 35 EC 2 ml/lit

Nut Weevil: Fenthion 100 EC 1ml/lit spray during marble stage and second spray 15 days after the first spray.

Mealy bug: Chlorpyriphos 20 EC 2.5ml/lit or monocrotophos 36 WSC 1.5ml/lit.
Band the trees with 20 cm wide 400 gauge polythene sheets
Release of Australian ladybird beetle, *Cryptolaemus montrouzieri* @ 10/tree

Stem borer: Padding with monocrotophos 36 WSC 10 ml in 25 cm^2 per tree soaked in absorbent cotton when the trees are not in bearing stage.

Application of carbofuran 3 G 5g per bore hole and plugging with mud after mechanically removing or killing the grub by introducing a needle or wire.

Fruit fly: Fenthion 1 ml/lit or malathion 2 ml/lit. Plough the inter spaces to expose pupae. Prepare bait with methyl eugenol 1% solution mixed with malathion 0.1%. Take 10 ml of this mixture per trap and keep them in 25 different places in one hectare between 6 a.m. and 8 a.m. Collect and destroy the fallen fruits.

Diseases

Powdery mildew: Apply Sulphur dust (350 mesh) in the early morning to protect new flush or spray Wettable sulphur 0.2% or Tridemorph 0.05%.

Anthracnose and stalk end-rot: Spray Mancozeb 2g/lit or Carbendazim 1g/lit or Thiophanate methyl 1g/lit or Chlorothalonil 2g/lit as pre-harvest spray, 3 times at 15 days interval.

Sooty mould: Spray phosphamidon 40 SL @ 2 ml/ litre + Maida 5% (1 kg Maida or starch) boiled with 1 lit of water and diluted to 20 litres. Avoid spraying during cloudy weather.

Harvest Season: March to June.

Harvest: Yield varies with varieties and spacing adopted.

8 – 10 t/ha upto 15 years.

15 – 20 t/ha from 15 – 20 years.

Post Harvest treatment: Dip the fruits in $52^0 \pm 1^0$ C hot water immediately after harvest for 5 minutes followed by 8% plant wax (Fruitox or Waxol) to reduce anthracnose disease in mango during storage. Two pre-harvest sprays of 0.20% Mancozeb (2.0 g/lit) will also reduce the incidence.

Waiting Period:

Methyl demeton 0.05%	14 days
Fenthion 0.05%	14 days
Quinalphos 0.05%	12 days
Lindane 300 g a.i./ha	2 days

Banana: *Musa* sp; *Musaceae*

Varieties - Dessert: Robusta, Dwarf Cavendish, Grand Naine**,** Rasthali, Vayal vazhai, Poovan, Nendran, Red Banana, Karpooravalli, CO 1, Matti, Sannachenkadali and Neypoovan. Cavendish groups are generally preffered for export.

Culinary: Monthan, Nendran, Vayal vazhai, Ash Monthan and Chakkia.

Hill areas: Virupakshi, Sirumalai and Namaran, Red Banana, Manoranjitham (Santhana vazhai) and Ladan.

Soil and Climate: Well drained loamy soils are suitable. Alkaline and saline soils should be avoided.

Season of planting

Wet lands: Feb – April : Poovan, Rasthali, Monthan, Karpooravalli and Neypoovan.
April – May : Nendran and Robusta

Garden lands: January – February and November – December.

Padugai lands: January – February and August – September.

Hill Banana: April – May (lower Palani hills), June – August (Sirumalai)

Selection and pre-treatment of suckers: Select sword suckers of 1.5 to 2.0 kg weight, free from diseases and nematodes. Trim the roots and decayed portion of the corm, cut the pseudostem leaving 20 cm from the corm and grade the suckers to size. To avoid wilt disease, infected portions of the corm may be pared, dipped for 5 minutes in Carbendazim 0.1% (1 g in 1 lit of water) for Rasthali, Monthan, Neyvannan, Virupakshi and other wilt susceptible varieties. Pralinage with 40 g of Carbofuran 3 G granules per sucker. (Dip the corm in slurry solution of 4 parts clay plus 5 parts water and sprinkle Carbofuran to control nematodes). Alternatively, dip the corm with 0.75% Monocrotophos, shade dry for atleast 24 hours and plant. Sow Sunhemp on 45th day; incorporate it after about a month. This operation reduces nematode build up.

Use tissue cultured banana plants with 5-6 leaves. At time of planting, apply 25 g *Pseudomonas fluorescence* / plant.

Field preparation

Wet lands: No preparatory cultivation is necessary.

Garden land: 2 – 4 ploughings.

Padugai: One deep mammutti digging.

Hill Banana: Remove scrub jungle and construct contour stone walls.

Wet lands: Place the suckers at ground level and earth up at stages.

Digging Pits

Garden land, Padugai and Hill Banana: Dig pits of 45 cm x 45 cm x 45 cm size. The pits are refilled with topsoil, mixed with 10 kg of FYM, 250 g of Neem cake and 50 g of Lindane 1.3 %.

Spacing

	Variety	Spacing	No. of plants/ha
Garden land	Robusta, Nendran Dwarf Cavendish	1.8 x 1.8 m 1.5 x 1.5 m	3086 4444
Wetland	Poovan, Monthan Rasthali, Neyvannan, Neypoovan	2.1 x 2.1 m	2267
Hills	Virupakshi(Sirumalai) Namarai and Ladan	3.6 x 3.6 m	750 (When mixed with coffee)

Adopt high density planting for higher productivity - Plant 3 suckers / pit at a spacing of 1.8 x 3.6 m (4600 plants/ha) for Cavendish varieties and 2 m x 3 m for Nendran (5000 plants/ha).

Irrigation: Irrigate immediately after planting; give life irrigation after 4 days; subsequent irrigations are to be given once in a week for irrigated plantations of garden lands and once in 10 – 15 days for wetlands. Irrigate the fields copiously after every manuring. Use drip irrigation @ 15 litres/ plant/day from planting to 4th month, 20 litres/plant/day from 5th to shooting and 25 litres /plant/ day from shooting till 15 days prior to harvest.

Application of fertilizers

Details	N	P	K
	(g / plant / year)		
Garden land			
Varieties other than Nendran	110*	35*	330*
Nendran	150	90	300
Wetland			
Nendran	210	35	450
Rasthali	210	50	390
Poovan, Robusta	160	50	390

Hill bananas

After forming semicircular basins on uphill side, apply 375 g of 40:30:40 NPK mixture, plus 130 g muriate of potash per clump per application during October, January and April. Apply *Azospirillum* and *Phosphobacteria* 20 gm each at planting and 5th month after planting preceding chemical fertilizer application.

Apply N as Neem coated urea. Apply N and K in 3 splits on 3rd, 5th and 7th month, Phosphorous at 3rd month of planting. Apply 20 g in each of *Azospirillum* and *Phosphobacteria* at planting and five months after planting. (This should be applied prior to chemical fertilizer application).

* For Tissue culture banana apply 50% extra fertilizers at 2nd, 4th, 6th and 8th month after planting.

For maximizing productivity follow fertigation technique **-** Apply 25 litres of water/day + 200:30:300 g N: P_2O_5 : K_2O / plant using water soluble fertilizers. For economizing the cost of fertilizers, fertigate using normal fertilizers (Urea and Muriate of potash) with 50% of the recommended dose alongwith recommended dose of phosphorus as basal at 2nd month after planting. Fertigate at weekly intervals as per the following schedule.

Fertigation schedule

Weeks after planting	N (%)	P2O5 (%)	K2O (%)
9-18 (10 weeks)	30	100	20
19-30 (12 weeks)	50	--	40
31-42 (12 weeks)	20	--	32
43-45 (3 weeks)	--	--	8
Total	100	100	100

Aftercultivation - **Garden Land:** Give mammutti digging at bi-monthly intervals and earth up. Prune the suckers at monthly intervals. The dry and diseased leaves are removed and burnt to control the spread of leaf spot diseases. Male flowers may be removed a week after opening of last hand. In Robusta banana to avoid 'fingertip disease' floral remnants may be removed a week after opening of the last hand. The plants at flowering may be propped. Cover the peduncle with flag leaf to prevent main stalk end rot. Cover the bunches with banana leaves to avoid sunscald.

Wetland: Form trenches in between alternate rows and cross trenches at every 5th row. The trenches are periodically deepened and the soil is spread over the bed. Surface diggings may be given at bi-monthly intervals and desuckering at monthly intervals. Remove the male flower a week after opening of last hand. Prop plants at or prior to flowering. Cover the peduncle with flag leaf and the bunch with leaves to avoid sunscald. For ratoon crops in respect of Poovan, Monthan and Rasthali allow the follower at flowering of the mother plant and remove the other suckers at harvest.

Perennial banana: Give surface digging with mammutti once in two months. Give one deep digging with mammutti during January – February. Other operations as in gardenland.

Hill banana: Give four forkings in January, April, July and October. Remove outer sheaths to keep the corm inside the soil and ward off borer. Maintain two bearing plants and two followers per clump along the contour.

Growth regulators: To improve the grade of bunches 2,4-D at 25 ppm (25 mg/lit.) may be sprayed in Poovan and CO 1 banana after the last hand has opened. This will also help to remove seediness in Poovan variety. Spray CCC 1000 ppm at 4th and 6th month after planting. Spray plantozyme @ 2ml/lt at 6th and 8th month after planting to get higher yield.

Micronutrients: Spray micronutrients *viz*., $ZnSO_4$ (0.5%), $FeSO_4$ (0.2%), $CuSO_4$ (0.2%) and H_3BO_3 (0.1%) at 3, 5 and 7 MAP to increase yield and quality of banana.

Bunch cover: Use transparent polyethylene sleeves with 2% (during cool season) - 4% (during summer season) ventilation to cover the bunches immediately after opening of the last hand.

Intercropping: Leguminous vegetables, Beetroot, Elephant foot yam and Sunhemp. Avoid growing Cucurbitaceous vegetables.

Plant protection

Pests

Corm weevil: Apply lindane 1.3% @ 20 g/plant or carbaryl @ 10 – 20 g/plant in the soil around the stem.

Stem weevil (*Odoiporus longicollis*): Remove dried leaves periodically and keep the plantation clean. Prune the suckers every month. Spray monocrotophos 36 WSC @ 1 ml/lit of water. Alternatively, dilute 54 ml of monocrotophos 36 WSC with 350 ml of water and inject 4 ml (2 ml at 45 cm from the ground level another 2 ml 150 cm from the ground level) in the pseudostem at monthly interval from 5th to 8th month. Do not dump infected materials in the manure pit. Infected trees should be uprooted, chopped into pieces and burnt.

Banana aphid: Aphid is the vector for Bunchy – top virus disease. Spray any one of the following systemic insecticides to control it. Phosphamidon 2 ml/lit or methyl demeton 2 ml/lit or monocrotophos 1 ml/lit or dimethoate 30 EC 2 ml/lit. The spray may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice. Injection of monocrotophos 36 WSC 1 ml/plant (1 ml diluted in 4 ml of water) at 45 days interval from the 3rd month till flowering is very effective. Use 'Banana injector' devised by the Tamil Nadu Agricultural University. Avoid injection of monocrotophos after flowering.

Thrips and Lace wing bugs: Spray methyl demeton 20 EC 2 ml/lit or monocrotophos 36 WSC 1 ml/lit or phosphamidon 40 SL 2ml/lit.

Nematode: Pre-treat the suckers with 40 g of Carbofuran 3G. If pre-treatment is not done, apply 40 g of Carbofuran around each plant one month after planting (refer selection and pre-treatment for alternate technology) or pare and dip the corm into 0.75% Monocrotophos solution; shade dry and plant. Then grow Sunhemp after 45th day and incorporate one month later. Press mud application @ 15 t per ha one month after planting and neem cake 1.5 t per ha one month after planting.

Diseases - Sigatoka leaf spot: Remove affected leaves and burn. Spray any one of the following fungicides commencing from November at monthly interval. Carbendazim 1 g/lit., Benomyl 1 g/lit., Mancozeb 2 g/lit., Copper oxychloride 2.5 g/lit., Ziram 2 ml/lit, Chlorothalonil 2 g/lit. Alternation of fungicides prevents fungicidal resistance. Always add 5 ml of wetting agent like Sandovit, Triton AE, Teepol etc. per 10 lit of spray fluid.

Bunchy-top: The Banana Aphid *Pentalonia nigronervosa* is the vector of Bunchy-top virus disease. Spray any one of the following systemic insecticides to control it.

Phosphamidon 1 ml/lit or methyl Demeton 2 ml/lit or monocrotophos 1 ml/lit.

The spray may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice. Injection of monocrotophos 36 WSC 1 ml/plant (1 ml diluted in 4 ml of water) at 45 days interval from the 3rd month till flowering is very effective. Use 'Banana Injector' devised by the Tamil Nadu Agricultural University. Avoid injection of Monocrotophos after flowering.

To prevent the disease,

i) Use virus-free suckers

ii) Paring and pralinage

Pare the corm and sprinkle 40 g of Carbofuran 3 G over the Corm (Before sprinkling, corm should be dipped in mud slurry).

iii) Destroy virus affected plants.

Insert a gelatin capsule containing 200 mg 2,4 - D into the corm 7 cm deep using capsule applicator or inject 5 ml 2,4 - D solution (125 gm/lit of water) into the pseudostem by using the injection gun. The plant collapses and topples in 3 – 5 days.

Panama Disease: Uproot and destroy severely affected plants. Apply lime at 1 – 2 kg in the pits after removal of the affected plants. In the field, Panama wilt disease can be prevented by corm injection methods. A small portion of soil is removed to expose the upper portion of the corm. An oblique hole at 45° angle is made to a depth of 10 cm. Immediately, a gelatin capsule containing 60 mg of Carbendazim or 3 ml of 2 % Carbendazim solution or of 50 mg of *Pseudomonas fluorescens* is inserted / injected into the hole with the help of 'corm injector' on 2nd, 4th and 6th month after planting. Application of press mud at 5 kg per tree reduces the wilt incidence.

Kottaivazhai in Poovan: Spray 2,4 – D at the rate of 25 ppm within 20 days after opening of last hand (1 g/40 lit/200 bunches) or 1.2 g of Sodium salt of 2,4 – D dissolved in 40 lit of water for 200 bunches.

Crop duration: The bunches will be ready for harvest after 12 to 15 months of planting.

Harvest: Bunches attain maturity from 100 to 150 days after flowering depending on variety, soil, weather condition and elevation.

Yield (t/ha/year)

Poovan	:	40 – 50
Monthan	:	30 – 40
Rasthali	:	40 – 50
Robusta	:	50 – 60
Dwarf Cavendish	:	50 – 60

Acid Lime: *Citrus aurantifolia* (Christm) Swingle; *Rutaceae*

Varieties: PKM1.

Soil and climate: Tropical and subtropical. Can be grown up to 1000 m above MSL. Deep well drained loamy soils are the best.

Season: December – February and June – September.

Planting: Healthy seedlings may be planted during June to December at 5 to 6 m spacing in 75 cm x 75 cm x 75 cm pits.

Irrigation: Irrigate copiously after planting. After establishment, irrigation may be given at 7 – 10 days interval. Avoid water stagnation.

Manures and fertilizers per plant: N to be applied in two doses during March and October. FYM, P_2O_5 and K_2O are to be applied in October.

Manures and Fertilizers	I year (kg)	Annual increase (kg)	From 6th year (kg)
FYM	10.000	5.000	30.000
N	0.200	0.100	0.600
P	0.100	0.025	0.200
K	0.100	0.040	0.300

Spray Zinc sulphate at the rate of 0.5% (500 g/100 lit of water) thrice in a year (March, July and October) after the emergence of new flushes.

After cultivation: Remove branches of main stem up to 45 cm from ground level. Application of green leaves 30 kg per tree once in 3 months.

Intercropping: Legumes and vegetable crops can be raised during pre-bearing age.

Growth regulator: To increase fruit set spray 2,4 – D @ 20 ppm during flowering. For fruit retention spray 2,4 – D @ 20 ppm or NAA 30 ppm after fruit set (marble size).

Plant protection

Pests

Leaf miner: Spray dichlorvos 76 WSC @ 1 ml/lit or dimethoate 30 EC 2 ml/lit or fenthion 100 EC @ 1 ml/lit or monocrotophos 36 WSC @ 1.5 ml/lit or neem seed kernel extract (NSKE) 50g/ lit or neem cake extract or neem oil 3 %.

Leaf caterpillar: Spray endosulfan 35 EC @ 2ml/lit when the infestation is moderate to severe. Hand pick the larvae and destroy.

Sucking pests

White fly : Spray quinalphos 25 EC at the rate of 2 ml/lit

Black fly	:	Spray monocrotophos 36 WSC at the rate of 1.5 ml/lit
Aphids	:	Spray methyl Demeton 25 EC or monocrotophos at the rate of 1 ml/lit or neem oil 3 ml/lit or Fish oil rosin soap 10/25 g/lit. endosulfan 35 EC 2ml/lit.
Rust mite	:	Spray dicofol 18.5 EC at the rate of 2.5 ml/lit or wettable sulphur 50 WP at the rate of 2 g/lit.

Fruit sucking moth: Destroy *Tinospora* weed host. Bait with fermented molasses plus malathion 50 EC at the rate of 1 ml/lit. Bag the fruits with polythene bags punctured at the bottom. Apply smoke and set up light traps or food lures (pieces of citrus fruits).

Shoot borer: Prune the withered shoots 4 cm below the dried portions and spray monocrotophos 36 WSC at the rate of 1 ml/lit or endosulfan 35 EC at the rate of 1.5 ml/lit or carbaryl 50 WP at the rate of 2 g/lit.

Stem borer: Prune the branches containing grubs. Plug the fresh holes with cotton soaked in monocrotophos solution mixed @ 5 ml/20 ml of water.

Fruit fly

1. Spray malathion 50 EC @ 1 ml/lit or fenthion 100 EC @ 1 ml/lit with 1% crude sugar (10 g/lit). Set up bait with methyl eugenol 0.1% solution mixed with malathion 50 EC 0.05% between 6 a.m. and 8 a.m.
2. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml dichlorvas in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Mealy bugs

- Debark the branches and apply methyl parathion paste.
- Use sticky trap on the shoot bearing the fruits at a length of 5 cm.
- Use dichlorvos (0.2%) in combination with fish oil rosin soap (25g/lit) as spray or for dipping the fruits for two minutes.
- Single soil application of phorate 10G @ 50g per tree around the base at the time of pruning.
- Release the predator, *Cryptolaemus montrouzieri.*
- Mark the mealy bug infested plants early in the season.
- Put a band of lindane swab around the tree trunk leaving 30 cm from the main stem. Follow ant control methods such as destruction of ant holes, red ant nests and skirting of citrus trees after fruit harvest which prevents the ant migration through side branches.
- Release beetles @ 10/tree once the patrolling of the ants on the trunk is stopped.
- Make periodic check during the first fortnight and put dried leaf mulch around the tree trunk 20 days after the release of the beetles to facilitate pupation of the full grown grubs.
- Make one to three releases per annum depending on the mealy bug populations.

Nematodes: Application of Carbofuran 3 G @ 75 g/tree to control citrus nematodes in severe infestations. Application of 20 g *Pseudomonas fluorescens* formulation per tree at a depth of 15

cm and 50 cm away from the trunk once in four months. Soil application of phorate @ 2 g followed by drenching with metalaxyl plus mancozeb 72 WP @ 1 % 50 ml/ cutting/ poly bag/ kg of nursery soil for citrus decline.

Diseases

Twig blight: Prune dried twigs and spray 0.3% Copper oxychloride or 0.1% Carbendazim at monthly intervals to reduce the spread of disease.

Scab: Spray 1% Bordeaux mixture.

Canker: Immediately after pruning one spray of Copper oxychloride (COC) 0.3% followed by 4 sprayings with Streptocyclin100 ppm + COC 0.3 % at monthly intervals.

Tristeza virus: Remove the infected trees and destroy. Spray methyl demeton 25 EC or monocrotophos @ 1ml/lit to control the aphids which spread the disease. Use pre-immunized acid lime seedlings for planting.

Harvest: Starts bearing from 3rd year after planting.

Post harvest treatment: Treating the fruits with 4% wax emulsion followed by pre-packing in 200 gauge polythene bags with 1 % ventilation improves the shelf life for more than 10 days.

Yield: 25 t/ha/year.

Sweet Orange: *Citrus sinensis; Rutaceae*

Varieties: Sathukudi.

Soil and climate: Deep well drained loamy soils are the best for the cultivation of Citrus. pH of soil should be 6.5 to 7.5 and EC of water less than 1.0. A dry climate with about 50 – 75 cm of rainfall from June – September and with well defined summer and winter season is ideal. Comes up well in tropical zone below 500 m. Extremes of temperature are necessary.

Season: July to September.

Planting material: Budded plants. (Root Stock-Rangpur lime is best, now rough lemon is also preferred).

Preparation of field: Dig pits at 75 cm x 75 cm x 75 cm size at 7 x 7 m spacing. Fill up the pits with top soil and 10 kg of FYM. Plant the budded plants in the centre of the pits and stake it.

Irrigation: Immediately after planting irrigate copiously. Irrigations may be given once in 10 days. Avoid water stagnation near the plant.

Manures and fertilizers per plant: N to be applied in two doses during March and October. FYM, P_2O_5 and K_2O are to be applied in October.

Manures and Fertilizers	I year (kg)	Annual increase (kg)	From 6th year (kg)
FYM	10.000	5.000	30.000
N	0.200	0.100	0.600
P	0.100	0.025	0.200
K	0.100	0.040	0.300

Manures are applied in the basin 70 cm away from the trunk and incorporated in the soil. Spray solution containing Sulphate of Zinc (0.5%), Manganese (0.05%), Iron (0.25%), Magnesium (0.5%), Boron (0.1%) and Molybdenum (0.003%) once in 3 months at the time of new flush production. In addition to that apply 50 g in each of Sulphate of Zinc, Manganese and Iron per tree per year.

Plant protection

Leaf miner: Spray dichlorvos 76 WSC at the rate of 1 ml/lit or dimethoate 30 EC 2 ml/lit or fenthion 100 EC at the rate of 1 ml/lit or monocrotophos 36 WSC at the rate of 1.5 ml/lit or 5% of neem seed kernel extract (NSKE) or neem cake extract or neem oil 3%.

Citrus root nematode: Apply *Pseudomonas fluorescens* at 20g per tree at a depth of 15 cm and 50 cm away from the trunk for the management of slow decline due to the citrus root nematode (*Tylenchulus semipenetrans*). Soil application of phorate @ 2 g followed by drenching with metalaxyl plus mancozeb 72 WP @ 0.1% 50 ml/ cutting/ poly bag/ kg of nursery soil for citrus decline.

Little leaf malady: To control little leaf, spray zinc sulphate at 1.0 per cent plus Teepol 1 ml/lit of solution at various stages.

1) New flush
2) One month after first spray
3) At flowering
4) Fruit set

After cultivation: Remove water shoots, rootstock sprouts, dead and diseased shoots. Remove laterals upto 45 cm from ground level.

Intercropping: Legumes and vegetable crops can be raised during pre-bearing age.

Harvest: Starts bearing from 5th year after planting.

Yield: 30 t/ha.

Mandarin Orange: *Citrus reticulata* Blanco; *Rutaceae*

Varieties: Coorg Orange and Kodai Orange.

Soil and climate: Subtropical 500– 1500 m above MSL elevation. A rainfall of about 150 cm to 250 cm is required. The winter should be mild and there should be no strong, hot winds during summer. Deep well drained loamy soils are the best. Soil pH should be between 5.5 and 6.5.

Season: November – December.

Planting: Seedlings and budded plants.

Spacing: 6 x 6 m, pit size 75 x 75 x 75 cm. Planting during May – June and September – October.

Manures and Fertilizers (Apply twice in a year during June and October)

a) For Palani Hills

Manures & Fertilizers	I year	II year	III year	IV year	V year	VI year onwards
	Kg/plant/year					
FYM	10.000	15.000	20.000	25.000	25.000	30.000
N	0.100	0.200	0.300	0.400	0.500	0.600
P	0.040	0.080	0.120	0.160	0.160	0.200
K	0.050	0.100	0.200	0.300	0.300	0.400

a) For Shervaroyan hills (for trees above 6 years old):

Apply 700:375:600 g/tree NPK along with VAM (*Glomus fasiculatus)* @ 1 kg/tree.

Manures are to be applied in the basin 70 cm away from the trunk and incorporated. Apply micronutrients as suggested for sweet orange. Apply agricultural lime or Dolomite at 4 kg/tree during January – February once in 2 – 3 years. This should not be combined with other chemical fertilizers.

Aftercultivation: Remove water shoots, rootstock sprouts, dead and diseased shoots. Remove laterals of the main stem up to 45 cm from ground level. Basins should be provided for each tree with gradient slope.

Plant protection; Pests;

Leaf miner: Spray dichlorvos 76 WSC at the rate of 1 ml/lit or dimethoate 30 EC 1 ml/lit or fenthion 100 EC at the rate of 1 ml/lit or monocrotophos 36 WSC at the rate of 1.5 ml/lit or 5% of neem seed kernel extract (NSKE) or neem cake extract or neem oil 3%.

Sucking pests

White fly	:	Spray quinalphos 25 EC at the rate of 2 ml/lit
Black fly	:	Spray monocrotophos 36 WSC at the rate of 1.5 ml/lit
Aphids	:	Spray methyl demeton 25 EC or monocrotophos at the rate of 1 ml/lit or neem oil 3 ml/lit or Fish oil rosin soap 3/25 g/lit or endosulfan 35 EC 2 ml/lit.
Rust mite	:	Spray dicofol 18.5 EC at the rate of 2.5 ml/lit or wettable sulphur 50 WP at the rate of 2 g/lit.

Fruit sucking moth: Destroy *Tinospora* weed host. Bait with fermented molasses plus malathion 50 EC at the rate of 1 ml/lit. Bag the fruits with polythene bags punctured at the bottom. Apply smoke and set up light traps or food lures (pieces of citrus fruits).

Shoot borer: Prune the withered shoots 4 cm below the dried portions and spray monocrotophos 36 WSC at the rate of 1 ml/lit or endosulfan 35 EC at the rate of 1.5 ml/lit or carbaryl 50 WP at the rate of 4 g/lit.

Stem borer: Prune the branches containing grubs. Plug the fresh holes with cotton soaked in monocrotophos solution mixed @ 5 ml/20 ml of water.

Fruit fly: Collection and destruction of fallen fruits. Spray malathion 50 EC @ 1 ml/lit or fenthion 100 EC @ 1 ml/lit with 1% crude sugar (10 g/lit). Set up methyl eugenol 0.1% solution mixed with malathion 50 EC 0.05% between 6 a.m. and 8 a.m. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Green scale: Spray monocrotophos 36 WSC 1 ml/lit or fenthion 100 EC 1 ml/lit.

Brown scale: Spray monocrotophos 36 WSC 1 ml/lit.

Safe waiting period: Methyl demeton and monocrotophos – 12 days.

Diseases

Powdery mildew

Apply sulphur dust 25 – 30 kg (350 mesh) in the early morning to protect new flush or spray Wettable Sulphur 0.3% (or) Triademefon 0.1% - 3 sprays at 15 days interval.

Sooty mould

Spray phosphamidon 40 SL @ 2ml/ litre. Boil 1 kg Maida or starch with 5 lit of water, cool, dilute to 20 lit and spray. Avoid spraying during cloudy weather.

Growth regulators: To increase the fruit retention spray the trees at flowering and again at marble stage with 2,4 - D at 20 ppm or NAA 30 ppm

Harvest: Starts bearing from 3 – 5 years after planting – budded plants, in case of seedlings 5-7 years.

Yield: 15 – 20 t/ha/year

Grapes: *Vitis vinifera; Vitaceae*

Varieties: Muscat (Panneer), Pachadraksha, Anab-e-Shahi, Thompson Seedless, Arka Shyam, Arka Kanchan, Arka Hans, Manik Chaman, Sonaka, Sharadh Seedless and Flame Seedless.

Muscat is grown throughout Tamil Nadu except on the hills.

Soil and climate: Well-drained rich loamy soil with a pH of 6.5 - 7.0 with low water table with EC less than 1.0. Soil depth should be atleast 1 m.

Field preparation and planting: Trenches of 0.6 m width and 0.6 m depth are to be dug at a distance of 3 m apart for Muscat and pits of 1m x 1m x 1m should be dug for other varieties. Well-decomposed FYM or compost or green leaf manure has to be applied in the trenches or pits as the case may be and then covered with soil. Plant the rooted cuttings in June-July.

Spacing: 3 x 2 m for Muscat, 4 x 3 m for other varieties.

Irrigation: Irrigate immediately after planting and on the 3rd day and then once in a week. Withhold irrigation 15 days before pruning and also 15 days before harvest.

Training: The vines are trained with single stem upto pandal with a stalk on tipping at 2 m height. The main arms are developed and trained on opposite directions. On further tipping, secondary and tertiary arms are developed for spreading all over pandal.

Pruning: In general four bud level of pruning for Muscat, Pachadraksha, Bangalore Blue, Anab-e-Shahi and Arka hybrids and two bud level for Thompson Seedless may be adopted. It is better to decide the level of pruning as per bud forecasting technique. Weak and immature canes should be pruned to one or two buds to induce vegetative growth.

Pruning Season

Summer crop: Pruning in December – January and harvesting in April – May.

Monsoon crop: Pruning in May-June and harvesting in August-September.

Manures and fertilizers (Kg per vine)

VARIETY	FYM			GREEN LEAVES			N			P			K		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Muscat	50	50	100	50	50	100	0.10	0.20	0.20	0.08	0.16	0.16	0.30	0.40	0.60
Pachadraksha Thompson seedless	50	50	100	50	50	100	0.20	0.30	0.40	0.08	0.16	0.24	0.40	0.80	1.20
Sonaka, Manikchaman Sharad seedless, Anab-e-Shahi	50	50	100	50	50	100	0.20	0.40	0.60	0.08	0.16	0.24	0.40	0.80	1.20

The manures should be applied twice after pruning. Apply half the dose of potash immediately after pruning and the other half after 60 days of pruning.

Foliar spray of 0.1% Boric acid + 0.2% $ZnSO_4$ + 1.0% Urea twice before flowering and 10 days after first spray to overcome nutrient deficiency.

Special practices: Tipping of shoots and tying of clusters in the pandal after the fruit set. Remove tendrils. Nipping the growing shoots of axillary buds and terminal buds at 12 to 15 buds. Thinning the compact bunches by removing 20 % of the berries at pea stage.

Dip the clusters in solution containing Brassinosteroid 0.5 ppm and GA_3 25 ppm at 10-12 days after fruit set to maintain vigour, yield and quality parameters.

Plant protection; Pests

Nematodes: Apply 60 g of Carbofuran 3 G or 20 g Phorate 10 G per vine a week before pruning and the plots are irrigated profusely. The soil should not be disturbed for atleast 15 days. Thereafter normal manuring may be done. Application of neemcake 200 g/vine also controls nematodes. Alternatively application of *Pseudomonas fluorescens* formulation in talc containing 15 x 10^8 colony forming units/g, 30 cm away from base of the vine atleast 15 cm depth at the time of pruning.

Flea beetles: Spraying phosalone 35 EC (2ml/lit of water) after pruning and followed with two or three sprayings. The loose bark may be removed at the time of pruning to prevent egg laying.

Thrips: Methyl demeton 25 EC or dimethoate 30 EC 2 ml/lit of water.

Mealy bug: Apply quinalphos or methyl parathion dust in the soil @ 20 kg/ha to kill the phoretic ants. Spray methyl demeton 25 EC or monocrotophos 36 WSC at the rate of 2 ml/lit of water or spray dichlorvos 76 WSC at the rate of 1 ml/lit with fish oil rosin soap at 25 g/lit. Release Coccinellid beetle, *Cryptolaemus montrouzieri* at the rate of 10 per vine.

Stem girdler: Swab the trunk with carbaryl 50 WP 2 gm/lit.

Safe waiting period: Five days for dimethoate and carbaryl

Diseases

Powdery mildew: Spray 0.3% Wettable sulphur or dust sulphur @ 6-12Kg/ha in the morning.

Anthracnose and downy mildew: Spray 1 % Bordeaux mixture or any other copper fungicide at 0.25 %. Depending upon the weather conditions the sprays have to be increased.

Ripening: To get uniform ripening in Muscat, spray the bunches at 20th day after berry set and another spray on 40th day with 0.2% Potassium chloride (2 g/lit).

Dip the clusters of Thompson seedless and other seedless varieties at calyptra fall with 25 ppm GA (25 mg/lit) and repeat again at pepper stage to increase the size of berries.

Yield

Seedless	:	15 t/ha/year
Muscat	:	30 t/ha/year
Pachadraksha	:	40 t/ha/year
Anab-e-Shahi and Arka hybrids	:	20 t/ha/year

Preparation of 1% Bordeaux mixture: A quantity of 500 g of Copper sulphate should be dissolved in 25 lit of water and 500 g of lime in another 25 lit of water separately. The copper sulphate solution should be added to the lime solution constantly stirring the mixture. Earthern or wooden vessels and plastic containers alone should be used and metallic containers should not be used. To find out whether the mixture is in correct proportion, a polished knife should be dipped in the mixture for one minute and taken out. If there is reddish brown deposit of copper, additional quantity of lime should be added till there is no deposit in the knife.

Guava: *Psidium guajava* L. ; *Myrtaceae*

Varieties: Allahabad, Lucknow 49, Arka Amulya, Arka Mridula**,** and Banaras.

Soil and climate: Guava grows well both in wet and dry regions but it does better under irrigation in the dry tracts. It can be grown upto 1000 m altitude. Well drained soils are the best. Tolerates salinity and alkalinity. In saline soils add 3 Kg Gypsum/plant during planting and once in three years after planting.

Planting material: Layers.

Season of planting: June - December.

Spacing: 5 - 6m either way.

Planting: Plant the layers with the ball of earth in the centre of pit of 45 cm x 45 cm x 45 cm size filled with FYM 10 Kg, neem cake 1 Kg and top soil + 50 g Lindane 1.3%.

Irrigation: Irrigate copiously immediately after planting, again on third day and afterwards once in 10 days or as and when necessary.

Manures and fertilizers: FYM 50 Kg and one Kg in each of N, P and K per tree in two split doses during March and October. To increase the yield spray Urea 1 % + Zinc sulphate 0.5% twice a year during March and October. To correct the boron deficiency (reduction in size of leaves and fruit cracking and hardening) spray 0.3% borax during flowering and fruit set stage.

Micronutrients spray for controlling bronzing of leaves: Spraying of a combination spray containing ZnSO4, MgSO4 and MnSo4 @ 0.5% and CuSO4 and FeSO4 @ 0.25 % plus Teepol @ 1ml per 5 lit of solution on various stages

1. New flush
2. One month after first spray
3. Flowering
4. Fruit set

Intercropping: Legumes and short duration vegetable crops may be raised during pre-bearing stage.

Aftercultivation: Pruning of past season's terminal growth to a length of 10-15 cm is to be done during September-October and February – March to encourage more laterals. The erect growing branches are to be bent by tying on to pegs driven on the ground. Old unproductive but healthy trees may be either pollarded or cut the trunks at 75 cm from ground level or dehorned by cutting the secondary branches at a distance of 75 cm from their origin.

Plant protection; Pests

Tea mosquito bug: Spray endosulfan 35 EC at the rate of 2 ml/lit or fenthion 100 EC @ 1 ml/lt or malathion 50 EC at the rate of 1 ml/lit or monocrotophos 36 WSC @ 2ml/lit or neem oil 3 %. Spraying should be done in early mornings or late evenings, at least four times at 21 days interval during fruiting season.

Aphids: Spray monocrotophos 36 WSC @ 1ml/lit or dimethoate 30 EC @ 2 ml/lit.

Mealy bug: Triazophos @ 2ml/lit + neem oil 5 ml or phosalone 0.05% + neem oil 5 ml. Release of *Cryptolaemus montrouzieri* beetles (Coccinellid beetles) @ 10 beetles /tree.

Fruit fly: Remove the fallen fruits and bury them deeply with lindane 1.3% dusted over them. Spray endosulfan 35 EC or malathion 50 EC @ 1 ml/lit four times at 15 days interval. Stir the soil around the tree during pest incidence and dust Lindane 1.3%. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Safe waiting period: Monocrotophos 36 WSC-10 days and malathion 50 EC – 9 days.

Diseases

Red rust: Spray Copper oxy chloride 2.5 g /lit or Bordeaux mixture 0.5 % or Wettable sulphur 2 g per litre.

Harvest: Layers come to bearing in 2 - 3 years.

First crop : February – July.
Second crop : September – January.

Yield: 25 t/ha.

Pineapple: *Ananas sativus; Bromeliaceae*

Varieties: Kew, Mauritius and Queen.

Soil and climate: Mild tropical climate as found in the humid hill slopes is best suited. Can be grown in plains under shade. Elevation from 500m to 700 m is ideal. A light well drained soil with pH 5.5 to 7.0 is preferable. Heavy soils can also be used if drainage facilities are available.

Spacing: Plant in double rows either in beds or in trenches with the plants into the second rows set in the middle of the plants in the first row.

The spacing between two trenches will be 90 cm. Row to row spacing in the same bed per trench will be 60 cm and plant spacing within the row is 30 cm.

Planting: Use suckers and slips of 300-350 g weight for planting. Give a slanting cut to the suckers before planting and dip in Mancozeb 0.3 % or Carbendazim 0.1%.

Season: July – September

Manures and fertilizers: FYM 40-50 t/ha. N 16 g, P 4 g and K 12 g/plant in two equal splits at 6th and 12th month after planting. Apply as foliar spray 0.5% - 1.0 % sulphate of Zinc and Ferrous solutions at 15 days interval to overcome the deficiencies in the early crop phase.

Aftercultivation: To have uniform flowering apply the following when the crop attains 35 – 40 leaf stage. NAA 10 ppm + 2 % urea (20 g in 1 lit of water) @ 50 ml/plant poured into crown or 2 % urea + 0.04 % Sodium carbonate + 20 ppm Ethephon (ethrel) @ 50 ml/plant poured into the crown. To increase the size of the fruit, 200 – 300 ppm NAA should be sprayed after fruit formation. To avoid calcium induced Iron chlorosis adequate shade should be given.

Plant protection

Mealy bug: Spray methyl demeton 2 ml/lit or monocrotophos 36 WSC 2 ml/lit

Crop duration: 18-24 months.

Harvest: Fruits can be harvested from 18 to 24 months. Slight colour change at the base of the fruit indicates maturity.

Yield: 50 t/ha.

A plant crop and two ratoon crops are normally taken and in Mauritius variety upto five crops can be taken.

Sapota: *Manilkhara achras; Sapotaceae*

Varieties: Oval, Cricket Ball, Kirtibarti, Guthi, CO 1, CO 2, CO 3**,** PKM 1, PKM 2, PKM 3, PKM 4, and Kalipatti.

Soil and climate: It is a tropical crop and can be grown up to an altitude of 1000 metres. It can be grown in all types of soils.

Planting materials: Grafted on *Manilkhara hexandra* (Pala) rootstock.

Season of planting: June to December

Spacing: 8 x 8 m spacing. Adopt 8 x 4 m for high density planting

Planting: Dig pits of 1 m x 1 m x 1 m size. Fill up with top soil mixed with 10 Kg of FYM, 1 Kg of neem cake and 100 g of Lindane 1.3%. Plant the grafts in the centre of the pit with ball of earth intact. The graft joint must be atleast 15 cm above the ground level. Stake the plants properly to avoid bending or damage to graft joint.

Irrigation: Irrigate copiously immediately after planting and on the third day and once in 10 days afterwards till the graft establishes.

Manures and fertilizers (Kg/tree)

Manures and Fertilizers	I year old	Annual increase	6th year onwards
FYM	10.000	10.000	50.000
N	0.200	0.200	1.000
P	0.200	0.200	1.000
K	0.300	0.300	1.500

Manures and fertilizers may be applied in September-October, 45 cm away from the trunk upto the leaf drip and incorporated.

Aftercultivation: Remove the rootstock sprouts, water shoots, criss-cross and lower branches.

Intercropping: Legumes and short duration vegetable crops may be raised as intercrop during pre-bearing stage.

Plant protection; Pests

Leaf webber: Spray phosalone 35 EC 2 ml/lit.

Hairy caterpillars: Spray chloropyriphos 20 EC or endosulfan 35 EC or phosalone 35 EC 2 ml/ lit of water.

Bud worm: Spray phosalone 35 EC 2 ml/lit or phosphamidon 40 SL 2 ml/lit or endosulfan 35 EC 2 ml/lit or carbaryl 50 WP @ 2 g/lit or neem seed kernel extract 5 %.

Diseases

Sooty mould: Boil 1 Kg maida or starch with 5 lit of water, cool and dilute to 20 lit (5 %) and spray. Avoid spraying during cloudy weather.

Harvest: A mature fruit is dull brown in colour and the colour immediately below the skin when scratched is of lighter shade, while in the immature fruits it is green. The mature fruits are harvested by hand picking.

Season: February-June and September-October. Ripen the fruits by keeping a beaker containing 5000 ppm Ethrel + 10 g NaOH pellets in an air tight chamber. (5 ml Ethrel in one lit of water is 5000 ppm)

Yield: 20-25 t/ha/year.

Papaya; *Carica papaya* L.; *Caricaceae*

Varieties: CO 1, CO 2, CO 3, CO 4, CO 5, CO 6 and CO 7.

CO 3 and CO 7 are gynodioecious (bisexual + female) types highly suitable for table purpose and CO 2, CO 5 and Co 6 are dual-purpose varieties for table and papain production.

Soil and climate: It is a tropical fruit and grows well in regions where summer temperature ranges from 35^0 C - 38^0 C. Tolerates frost and comes up to an elevation of 1200 m. Well drained soils of uniform texture are preferable. If drainage is not adequate, collar - rot disease may occur.

Sowing: 500 g of seeds is required for planting one ha. June-September is the best season for planting. Avoid planting in rainy season.

Nursery: Treat the seeds with Captan @ 2 g/kg of seeds. Dibble four seeds in polythene bags in depth not exceeding one cm. Provide partial shade. Water the bags in rose can. Seedlings will be ready in about 60 days.

Planting: Plant the seedlings at 1.8 m either ways in pits of 45 cm x 45 cm x 45 cm size.

Irrigation: Irrigate copiously after planting. Irrigate the field once in a week.

Application of fertilizers: Apply FYM 10 Kg/plant as basal. Apply 50 g in each of N, P and K per plant at bi-monthly intervals from the third month of planting after removing unwanted sex forms. Apply 20 g in each of *Azospirillum* and Phosphobacterium at planting, again six months after planting.

Aftercultivation: Male trees should be removed after the emergence of inflorescence maintaining one male tree for every 20 female trees for proper fruit-set. In each pit only one vigorously growing female/hermaphrodite tree should be retained and other plants should be removed. In gynodioecious type like (CO 3, & CO 7) keep one hermophrodite type/pit and remove female trees.

Micronutrients: Spray $ZnSO_4$ 0.5% + H_2BO_3 0.1% during 4th and 8th month to increase growth and yield characters.

Plant protection

Nematodes: To control in the nursery, apply carbofuran 3 G @ 1 g/polythene bag after germination.

Diseases

Root rot and wilt: In water stagnated areas root-rot may appear. It is advisable to drench the soil with 1 % Bordeaux mixture or Metalaxyl 0.2%, 2 or 4 times at fortnightly intervals. Good drainage is vital.

Crop duration: 24 – 30 months.

Harvest: Fruits should be picked at colour break stage.

Yield: The average yield is as follows

CO 2 : 200-250 t/ha
CO 3 : 100-120 t/ha
CO 5 : 200-250 t/ha
CO 6 : 120-160 t/ha
CO 7 : 200-225 t/ha.

Papain extraction: Papain has several industrial uses, the important one being in brewing industries. It is used as “meat tenderiser” and in textile and leather “sanforization” processes and drugs.

The method of extraction of papain from papaya fruits is simple. The latex should be tapped from immature papaya fruits. Select 75 to 90 days old fruits. On the selected fruit, give incisions (cut) with a razor blade or stainless steel knife. The cuts should be given from stalk to tip of the fruit. The depth of the cut should not be more than 0.3 cm. Four such cuts are given spaced equally on the fruit surface. Tap the latex early in the morning and complete the tapping before 10.00 a.m. Repeat the tapping four times on the same fruit at an interval of three days. The cut should be given on the fruit surface in places not covered by previous cuts. The latex collected from all the trees in a day should be pooled, shade dried in an aluminium pan or tray and passed through a 50 mesh sieve to remove all foreign matter. In large plantations, vacuum driers can be adopted with advantage. Papain produced by artificial heating will have better colour and high quality. Add potassium meta-bi-sulphite (KMS) at 0.5 % for better colour and keeping quality.

The latex should be dried very rapidly at temperatures of 50^0 to 55^0 C. Stop drying when the dried product comes off as flakes having a porous texture. Powder the dried papain by means of wooden mallets or in electrically operated granulators and sieve the powder through 10 mesh sieve. Pack the powder in polythene bags in convenient quantities and seal them. Put the sealed bags in a tin container and seal it after evacuating air. Exposure to air deteriorates the quality of papain and vacuum sealing is therefore necessary. For large scale manufacture of papain, vacuum sealing machine and a granulator will be useful.

The green papaya fruits after extraction of papain can be used for pectin manufacture and “tooty – fruity” or they can be allowed to ripen and made into other products. The CO 2 and CO 5 varieties of papaya released by Tamil Nadu Agricultural University, Coimbatore are ideal for papain production. Tamil Nadu Agricultural University, Coimbatore, supplies pure seeds of these varieties.

Yield: The yield of crude papain is as follows:

CO 2 : 600 kg/ha
CO 5 : 800 Kg/ha.

Seed Production Technology

Germination improvement: Soak seeds in 100 ppm GA_3 for 16 hours or in 2% fresh leaf extract of arappu or 1% pungam leaf extract or pellet the seeds with arappu leaf powder.

Optimum depth of sowing: Sow seeds at 1 cm depth for better germination and seedling growth.

Seed extraction: Fruit size or weight has no association with seed quality except that the seed content is more in large fruits and less in small fruits. The seeds from different fruit weight or size classes did not differ in their quality. Hence, all ripened fruits can be used for seed extraction.

Grading: BSS 6 wire mesh sieve.

Storage: Dry seeds to 8-10% moisture and treat with halogen mixture containing $CaOCl_2$, $CaCo_3$ and arappu leaf powder (at 5:4:1 ratio) @ 3g/kg and pack in cloth bag to maintain viability upto 5 months.

Invigoration of old seeds

Stored seeds can be invigorated by soaking them in dilute solution of disodium phosphate (10^{-4} M) adopting 1:8 seed to solution ratio for 4 hours followed by drying back to original moisture content.

Pomegranate: *Punica granatum* L.; *Punicaceae*

Varieties: Jyothi, Ganesh, CO 1, YCD 1, Araktha, Rudhra and Mirudhula.

Soil and climate: It is grown in a wide range of soils; drought resistant and tolerant to salinity and alkalinity. Cool winter and dry summer are necessary for the production of high quality fruits. It performs well upto 1800 m elevation.

Planting: Rooted cuttings or layers of 12 to 18 months age can be planted during June to December in pits of 60 cm x 60 cm x 60 cm at 2.5 to 3 m spacing either way.

Irrigation: Copious irrigation is essential during fruiting season.

Application of fertilizers: (per plant)

Manures and Fertilizers	1st year	2nd to 5th year	6th year onwards
FYM	10 kg	20 kg	30 kg
N	200 g	400 g	600 g
P	100 g	250 g	500 g
K	400 g	800 g	1200 g

Training and pruning: Fruits are borne terminally on shoot growth emerging from mature wood. To promote new shoots on all sides annual pruning is done after harvest is completed during December by shortening of past season shoot by removing one third of the shoot. Besides, dried, diseased and cross-cross branches and root suckers are removed. The tree is trained to get a single stem upto 60 cm with 3 or 4 scaffold branches. Thinning of flower clusters ensures better size of the fruit. Spraying liquid paraffin at 1 % concentration at 15 days interval twice during June reduces fruit cracking.

Plant protection; Pests

Aphids: Release of first instar larvae of green lace wing bug *Chrysopherla carnea* @ 50 grubs/ flowering branch four times at 10 days interval starting from flower initiation during April.

Fruit Borer:

1) Bag the fruits with polythene covers during flowering period to prevent egg-laying when the fruits are upto 5 cm diameter. Spray neem oil 3 % or NSKE 5% at the time of butterfly activity. Repeat it if necessary twice at an interval of 15 days.

2) Adopt ETL (5 eggs/plant with bearing capacity of 60 fruits)

3) Release *T. chilonis* @ 1 lakh/acre.

Apply endosulfan 35 EC 2 ml/lit or malathion 50 EC 2 ml/lit

Yield: 20-25 t/ha/year.

Jack: *Artocarpus heterophyllus; Moraceae*

Varieties: Velipala, Singapore, Hybrid jack, Panruti selection, Thanjavur jack**,** Burliar 1, PLR 1 and PPI 1.

Soil and climate: Deep well drained soil is necessary. Soil pH around 5.5 at the time of planting is desirable. Otherwise treat the soil with 1% Aluminium sulphate in the pit to reduce the pH. Comes up well in the plains and upto an elevation of 1200 m.

Preparation of field and planting: Dig pits of 1 m x 1 m x 1 m. Fill up the pits with top soil mixed with 10 Kg of FYM and 1 Kg of neem cake per pit. Apply Lindane 1.3% @ 100 g/pit and mix it thoroughly. Plant preferably grafts during June – December at 8 x 8 m spacing.

Irrigation: Once in a week till the plant is established. Thereafter irrigate as and when necessary.

Manures and fertilizers: To be applied in two splits during May - June and September - October.

kg/plant

Sl. No	Manures & Fertilizers	1 year old	Annual Increase	6th year and above
1	FYM	10.000	10.000	50.000
2	N	0.150	0.150	0.750
3	P	0.080	0.080	0.4000
4	K	0.100	0.100	0.500

Plant protection; Pest

Spittle bug: Spray methyl parathion 50 EC 2ml/lit. or methyl demeton 25 EC @ 2ml/lit. Phosphamidon 40 SL 2 ml/lit or Dust methyl parathion 2 D or quinalphos dust 1.5 D.

Diseases

Rhizopus rot: Spray 1 % Bordeaux mixture or Copper oxychloride 2.5 g/lit. three sprays at 15 days interval.

Harvest: Yield commences from 5th year in grafts and 8th year in seedling trees. Harvest during March-July.

Yield: 30-40 t/ha.

Ber: *Zizyphus mauritiana* Lam; *Rhamnaceae*

Varieties: Kaithali, Umran, Gola and Banarasi.

Soil and climate: The ber plant comes under arid and semi-arid situation. Tolerates salinity and alkalinity.

Planting material: Budded plants.

Planting: Plant during July-August with a spacing of 7 x 7 m in pits of 60 cm x 60 cm x 60 cm. 8 x 3 m for Kaithali and 8 x 4 m for Banarasi.

Irrigation: Irrigate the plants initially for establishment. Provide 5 % slope towards the base of the tree for *in situ* water harvesting.

Manures and fertilizers (per plant/year)

Manures and Fertilizers	1st year	2nd year onwards
FYM	20 kg	50 kg
N	200 g	500 g
P	100 g	200 g
K	200 g	500 g

Manuring to be given immediately after pruning.

Spray 2% KNO_3 thrice at monthly intervals in Jan., Feb. and March.

Training and pruning: Remove the root stock sprouts and have a straight stem upto 75 cm from the ground level. It is very important in the early years to build up a strong framework and in later years to maintain vigour to improve fruit size and quality.

During February - March prune and thin the crowded branches to provide maximum fruit bearing area in the tree.

Plant protection; Pests

Fruit fly: Destroy infested fruits. Dig the soil under tree canopy to destroy pupae and incorporate Lindane 1.3% dust @ 30 g /tree. Spray malathion 50 EC or endosulfan 35 EC or quinalphos 25 EC at 2 ml/lit. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Scale insects: During pruning all the affected materials should be collected and burnt. The trees should be sprayed with phosphamidon 40 SL or methyl demeton 25 EC at the rate of 2 ml/lit.

Diseases

Black leaf spot: Spray Carbendazim 1 g/lit. or Chlorothalonil 2 g/lit. at 15 days interval from the initial appearance of the symptom.

Powdery mildew: Spray Dinocap 1 ml/ litre

Yield: 70-80 Kg of fruits/tree/year

Seed Production Technology: Seeds of Ber attain physiological maturity 13 weeks after anthesis. It is indicated by yellowish red colour of fruit pericarp. Stones can be size graded using 22/64" round perforated metal sieve. Ber stones can be stored upto 30 months without any treatment under ambient conditions.

Amla: *Phyllanthus emblica;* Euphorbiaceae

Varieties: Banarasi, NA 7, Krishna, Kanchan, Chakaiya, BSR 1.

Soil and climate: Amla is a subtropical plant and prefers dry climate. Hardy plant it can be grown in variable soil conditions. Tolerates salinity and alkalinity.

Planting material: Seedlings, Grafts, Buddings

Planting: Plant during July-August with a spacing of 6 x 6 m in pits of 1x1m or 1.25 x 1.25m.

Irrigation: Irrigate the plants initially for establishment. No irrigation is required during rainy and winter season. Drip irrigation is appropriate with a water saving of 40-45%.

Manures and fertilizers (per plant/year)

Manures and Fertilizers	Bearing tree
FYM	10 kg
N	200 g
P	500 g
K	200 g

Manuring to be given immediately after pruning.

Training and pruning: The main branches should be allowed to appear at a height of 0.75-1 m above the ground level. Plants should be trained to modified central leader system. Two to four branches with wide crotch angle, appearing in the opposite directions should be encouraged in early years.

During March – April prune and thin the crowded branches to provide maximum fruit bearing area in the tree.

Plant protection; Pest

Gall caterpillar: Young caterpillars bore into the apical portion of the shoot during rainy season and make tunnel. Due to this, apical regrowth is checked, side shoots develop below the gall and subsequent growth in following season is greatly hampered. Cut the infected apices and spray systemic insecticide like dimethoate 0.03 % prophylatically.

Bark eating caterpillar: Damages the stem and branches of grown up trees by eating bark. Affected portion should be cleared and a few drops of kerosene should be applied in holes to keep this in control.

Disease

Rust: Rust appear as circular reddish solitary or gregarious pustules on leaves and also on fruits. Spray 0.2 per cent mancozeb at an interval of 7 to 28 days during July to September

Yield: 100 kg/tree annually

Chapter B

Temperate Fruits

Apple: *Malus sylvestris; Rosaceae*

Varieties: Warm winter resistant varieties with low chilling requirements alone are suitable to the hills of Tamil Nadu.

Early varieties: Yield : April – May.

Irish Peach and Zouches Pipin.

Mid season varieties: Yield : June – July.

Carrington and Winterstein.

Late varieties: Yield : August – September.

Rome Beauty, Parlin's Beauty and KKL 1.

Soil and climate: Red lateritic soils with good drainage and high organic matter are more suitable. The soil pH should be around 5.8 to 6.2. Can be grown from 1200 to 2000 m.

Planting material: One year old grafts on M.778 and M.779 rootstocks during June – July.

Season: June to December.

Spacing: 4 x 4 m in pits of 60 cm x 60 cm x 60 cm.

Irrigation: Water the plants till establishment.

Application of fertilizer: Apply FYM 25 kg. N 500 g and 1 kg in each of P and K per bearing tree.

Training and pruning: The tree is trained to open centre system. Prune the tree every December – January.

Plant Protection; Pests

Wooly aphis: Use resistant rootstalks M 778, 799, MM 104, MM 110, MM 112, MM 113, MM 114 and MM115.

The parasite *Aphelinus mali* should be conserved in the field. Spray methyl demeton 25 EC at the rate of 4 ml/lit.

Disease

Apple scab: To control apple scabs follow the spray schedule:

1. Silver tip to green tip : Captafol or Mancozeb or 2 g/lit.
2. Pink bud or after 15 days : Mancozeb 2 g/lit.
3. Petal fall : Carbendazim 0.5 g/lit.
4. 10 days after petal fall : Mancozeb 2 g/lit.
5. 14 days after fruit set : Captafol 2 g/lit.

Add stickers like Triton AE or Teepol at 10 ml/10 lit of spray fluid. Use low volume sprayers.

Lichens: Spray quick lime 1 kg/20 lit of water after pruning to control lichens growth.

Yield: 10 – 20 kg/tree/year. The tree starts bearing from 4th year of planting.

Pear: *Pyrus communis L. ; Rosaceae*

Varieties: Common pear, Kieffer, New Pear, William and Jargonelle.

Soil and climate: Red laterite soil with good drainage and high organic matter content. Can be grown at an elevation of above 1200 m. pH 5.8 to 6.2.

Planting material: Plant one year old grafts/rooted cuttings.

Planting season: June to December.

Spacing: 5 x 5 m or 6 x 6 m in pits of 60 cm x 60 cm x 60 cm size.

Application of fertilizers: Apply FYM 25 kg, N 500 g and 1 kg in each of P and K per bearing tree/year.

Training and pruning: Remove stock sprouts regularly. Train the plants to open centre system and prune every year in November - December. Top working on country pear with choice varieties can be done during December - January with cleft grafting.

Plant protection: No serious pest and disease are noticed. Prophylactic spraying with a copper fungicides and methyl demeton after pruning can be given.

Harvest: Early varieties will come to harvest in May – June and late varieties in July – October.

Yield: 100 to 120 kg per tree per year in common pear.

70 to 80 kg per tree per year in Kieffer and New Pear.

30 to 40 kg per tree per year in William and Jargonelle.

Plum: *Prunus salicina L. ; Rosaceae*

Varieties

Early: Rubio.

Mid-season: (June – July)

Hale, Gaviota and Abundance.

Late: (July – August)

Shiro, Kelsey and Satsuma.

Hale has to be planted along with other varieties to enhance pollination and fruit set.

Soil and climate: Red lateritic soil with good drainage. The soil pH should be around 5.8 to 6.2 and rich in organic matter. Can be grown above 1200 m elevation.

Planting material: One year old budded plants may be planted during June - July or October - December with a spacing of 4 x 4 m in pits of 60 cm x 60 cm x 60 cm size.

Planting season: June to November.

Application of fertilizer: Apply FYM 30 kg and 500 g of N and 1 kg in each of P and K for bearing tree during October – November.

Training and pruning: The growing points tipped at a height of 50 – 60 cm to allow the side shoots to develop. Train to open centre system. Prune the trees during December – January. Dried, dead, diseased water shoots and criss-cross branches are removed.

Plant protection; Pests

Fruit Fly: Spray malathion 50 EC at the rate of 2 ml/lit of fenthion 100 EC at the rate of 1 ml/lit. Set up methyl eugenol 1 % trap with malathion 50 EC 1 ml/lit between 6 a.m. and 8 a.m. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Yield: 25 – 30 kg/tree/year.

Peach: *Prunus persica; Rosaceae*

Varieties

Early: (April – May)

Killikrankie and Floridasun.

Mid season: (June – July)

Shaw Pasand.

Late: (July – August)

Red Shanghai.

Soil and Climate: Red lateritic soil with good drainage and high organic matter is suitable. Grown at an elevation of 2000 m. Soil pH should be around 5.8 to 6.2.

Planting material: One year old budded plants.

Planting season: June – December.

Spacing: 4 x 4 m in pits of 60 cm x 60 cm x 60 cm.

Manures and fertilizers: Apply FYM 25 kg. N 500 g and 1 kg in each of P and K per bearing tree.

Training and pruning: Train to open centre system. The trees are pruned annually during December – January. Dried, diseased, water shoots and criss-cross branches may be removed.

Plant protection

Lichens: Against lichens growth, spray 1 kg of quick lime/20 lit of water immediately after pruning.

Pests

Fruit Fly: Spray malathion 50 EC at the rate of 2 ml/lit of water. Set up methyl eugenol 1 % trap with malathion 50 EC 2 ml/lit between 6 a.m. and 8 a.m. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Diseases

Leaf curl: To control leaf curl aphids spray methyl dimeton 25 EC 2 ml/lit.

Spray Carbendazim 0.5 g/lit.

Powdery mildew: Spray Carbendazim 0.5 g/lit. or use Sulphur dust @ 25 kg/ha.

Yield: 10 – 15 kg/tree/year.

Chapter C

Minor Fruits

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
1	2	3	4	5	6	7	8	9	10
Mangosteen *(Garcinia mangostana)*	-	Seedlings	7 x 7 m	FYM, 75 kg N : 1 kg P : 0.8 kg & K : 3.0 Kg/treeJune - July.	Potting of plants at two leaf stage	-	April - JuneAugust - October	500 - 600fruits/tree	-
Straw berry *(Fragaria vesca)*	Phenomen-al, Majestic, Chandler, Labella, Sujatha	Runners/ Slips	40 x 25 cm(double row planting)	FYM : 3kg/m² N:8gP:8g and K:8 g/plant, apply during October and February	Removal of flower buds till Jan. Mulching with dry grass	Spray Methyl demeton against mealy bugs and aphids. Spray Copper fungicides against leaf diseases	Harvest at three months after planting	1 kg/m² or 10 t/ha	-
Passion fruit (*Passiflora edulis* Sims.)	Purple for hills, yellow for plains	Rooted cuttings or seedlings	2 x 2 m	FYM 10 kg, N 20 g, P 20 g and K 15 g/plant	Tying vine on trellies	Spray Methyl demeton against mealy bug and aphids	May - September	60 - 80 fruits/vine	Train on trellies or pandal.

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Litchi (*Litchi chinensis* Sonner.)	Muzafarpur, Dehradun, Calcutta, seedless late and Rose scented Cauvery	Seedlings / Budded plants/layers	10 x 10 m	FYM : 60 kg, N:100 g, P:40 g and K:400 g for 10 year old tree. Apply N in two split doses in Feb. & April. FYM, P and K to be applied in Dec.	For Zinc deficiency spray Zinc sulphate (0.5%)	Spray dicofol 18.5 EC 2.5 ml/lit against mites. Use fumigants against bark borers	Harvest from 6th year onwards	80 - 100 kg/tree	
Bilimbi (*Averrhoa bilimbi*)	-	Seedlings	-	N : 80 gP : 50 gK : 100 g/ bearing tree/year	-	-	-	50 kg/tree	-
Carambola (*Averrhoa carambola*)	Highly acidic, mild acidic	Seedlings	-	N : 100 g,P : 50 g andK : 100 g/Plant	-	-	-	-	-
Karonda (*Carissa caranda*)	Green, pink, white	Seedlings & layers	2 x 2 m	FYM : 10 kg/ plant	Irrigation weekly	-	Aug-Sep	2 to 4 kg/tree	-
Loquat (*Eriobotrya japonica*)	Mammoth, Safed batia, Golden red, Tanaka, California, Advance, Pale yellow, Golden yellow	Seedlings / Rooted cuttings / Grafts / Buddings	-	N : 50 g,P : 30 g,K : 150 g and Ca : 40 g per tree	-	-	Yield after third year	40 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Jamun (*Eugenia jambolana)*	Local, Seedless, large	Seedlings/ grafts	10 x 10 m	FYM : 20 kg, N : 100 g, P : 100 g and K : 100 g/tree	-	100 g Lindane 1.3 D pit against white ants	Yield 8 - 10 years after planting, harvest in June - July	50 - 80 kg/tree	-
Phalsa (*Grewia asiatica*)	-	Seedlings / Rooted Cuttings / layers	2 x 2 m	N : 50 g, P : 20 g andK : 50 g/plant	Pruning at one m height; dormant during Dec - Jan. Irriga-tion once in 7 to 10 days in summer	-	Yield in third year pick ripe fruits on alternate days	2 - 3 kg/bush, fruits mature by May, June	-
Mulberry (*Morus nigra*)	Black mulberry	Seedlings / Rooted cuttings / Budlings	Pits by0.5 x 0.5 mat 7 m apart	FYM : or Tank silt10 kg, N:50g, P:50 g and K:50 g per plant	Pruning in December - January	-	-	4 - 8 kg/tree	-
West IndianCherry (*Malphigia punicifolia*)	-	Seedlings/ grafts / layers / rooted cuttings	2 x 2 m	FYM 10 kg, N:200 g,P:50 g and K:100 g/tree	Training and pruning	Spray Methyl demeton 2 ml/lit against mealy bugs and aphids	Harvest in Dec-Jan	10 - 15 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Annona (*Annona squamosa*;) (*A.cherim noya; A.reticulata*)	Balanagar, Mammoth, Atemoya, APK-1	Seedlings/grafts	5 x 5 m	FYM : 10 kg, neem cake one kg, BHC 10 % 100 g, N:250 g, P:125 g and K:250 g/treeApply 30 gm each of Azotobacter, VAM, Azospirillum, Phosphobacteria and 50% of 125:65:125 g N, P2O5, K2O per tree.	-	-	Yield after 4 - 5 years	80 - 100 Nos./tree	-
Lemon (*Citrus limon*)	Malta, Nepali oblong, Nepali round, Rajamundry, Lisbon, Willafranka, Italin, Eureka, Seedless, Seville Mayor	Layers	5 x 5 m	FYM:30 kg N 400 g, P : 200 g and K : 300 g/tree twice in a year	-	Spraying Zinc, Manganese, Iron, Magnesium at 0.125 %	Harvest 1 1/2 to 2 years after planting	50 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Rambutan (*Nephelium lappaceum*)	-	Layering and inarching on own root stock	7 x 10 m	-	-	-	Crops are obtained in September and December	10-20 kgs of fruits per tree.	-
Durian (*Durio zebethinus*)	Specific varieties are not available	Seeds, Inarching on its own root stock as well as on seedling of Cullenia excelsa	10 x 10m, 12x 12 m	N - 38.3P - 8.2K - 20.9 kg/ha(bearing tree)	-	Dieldrin at 0.3-0.5% to control hawk moth.	August - September	40-50 fruits per tree	-
Avocado (*Persea americana*)	TKD-1 Pollock,Fue-rte and Peradenia Purple Hybrid	Inarching, soft wood grafting or budding on own root stock	5 x 5 m	40-45 kg FYM1 kg urea1kg Super phosphate	-	-	August-September	200-300 fruits/tree	-
Fig (*Ficus carica*)	Capri fig, Smyrna fig, White San Pedro	Cuttings	4 x 4 m	36 kg FYM2.25 kg Neem cake680 g sulphate of Ammonia	-	Phospotoxin 1 tablet /hole to control stem borerTo control fig rust spray bordeaux mixture		10-12 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Persimmon (*Diospyros kaki*)	Dai Dai Maru, Tanenashi, Martoria	Inarching on its own rootstock	5 x 5 m	-	Tipping past season shoots annually in December	-	-	20-25 kg /tree	-
Kiwi (*Actinidia delicious*)	Abbott, Allison, Bruno, Hayward, Monty, Tomuri	Stem cuttings	6 x 6m	20 kg FYM basal dose,0.5 kg NPK mixture containing 15 % N is applied each year. After 5 years,N- 850-900gP - 500-600gK- 800-900g/vine	T baror Pergola system of training .Pruning in winter for 4-5 fruiting shoots at 4-5 bud interval between 2 such shoots	-	Harvest from 5th year onwards	50-100kg /vine	-
Apricot (*Prunus americana*)	Alfred, Baiti, Beladi	Grafting or budding	6 x 6 m	40 kg FYMN-500gP2O5-250gK- 200g	Trained to open vase and modified leader system25-30 % thinning of old shoots or 1/3rd hedding back	-	Harvest from 7th year onwards	50-80 kg / tree	-
Bread fruit (*Artocarpus incise*)	-	Rootcuttings-.Air layeing	10 x 10 m	25 kg FYM7 : 10 : 5 NPK mixure @ 1-2 kg/plant	-	Spray Bordeaux mixture 1 % to control fruit rot	Harvest from 3rd year onwardsFeb--Mar-June-August	500-2000 fruits/ tree	-
Egg fruit (*Pouteria campechian-a*)	-	Seeds, grafting, budding	6 x 6m	-	-	-	Harvest from 3-4 year onwards	300-400 fruits/tree	-

Part II
Vegetables

Chapter A
Fruit vegetables

Tomato: *Lycopersicon esculentum* Mill; Solanaceae

Varieties: PKM 1, CO 3 (Marutham) and Paiyur 1.

Soil: Well drained loamy soil rich in organic matter with a pH range of 6.5-7.5.

Season of sowing: May - June and November - December

Seed rate: Apply FYM 10 kg, Neemcake 1 kg, VAM 50 g, Super phosphate 100 g and 10 g furadon per square metre before sowing.

Seed treatment: Treat the seeds with *Trichoderma viride* 4 g or *Pseudomonas fluroscens* 10 g or Carbendazim 2 g per kg of seeds 24 hours before sowing. Just before sowing, treat the seeds with *Azospirillum* @ 40 g/400 g of seeds. Sow in lines at 10 cm apart in raised nursery beds and cover with sand.

Preparation of field: Plough the land to a fine tilth. Form ridges and furrows and transplant 25 days old seedlings on one side of the ridges. Apply 2 kg of Azospirillum, Phosphobacteria per ha mixed with 100 kg FYM before planting.

Spacing: PKM 1, Paiyur 1 : 60 x 45 cm

CO 3 : 45 x 30 cm

Irrigation: After establishment of seedlings irrigate at weekly intervals.

Application of fertilizer: Apply FYM 25 t/ha, N 75 kg, P 100 kg, K 50 kg, Borax 10 kg and Zinc sulphate 50 kg/ha as basal dose and 75 kg N/ha on 30th day of planting during earthing up. Spray 1 ppm (1 mg in one lit) Triacontanol, 15 days after transplanting and at full bloom stage to increase the yield.

Weed control: Apply Pendimethalin 1.0 kg a.i./ha or fluchloralin 1 kg a.i/ha as pre-emergent herbicide followed by one hand weeding 30 days after planting.

Mulching: Black LDPE sheets of 25 micron thickness and bury both the ends into the soil to a depth of 10 cm.

Plant Protection; Pests

Fruit borer: *Helicoverpa armigera* and *Spodoptera litura* (common for both)

Grow simultaneously 40 days old American tall marigold and 25 days old tomato seedlings @ 1:16 rows.

i. Set up pheromone traps @ 12/ha.

ii. Collection and destruction of damaged fruits and grown up caterpillars.

iii. Spray endosulfan 35 EC 2 ml/lit or carbaryl 50 WP 2 g/lit or *Bacillus thuringiensis* 2g/lit or quinalphos 2.5 ml/lit.

iv. Release *Trichogramma chilonis* @ 50000/ha release coinciding with flowering time and based on ETL.

For *Helicoverpa armigera:* H.a.NPV 1.5 x 10^{12} POBs/ha

For *Spodoptera litura*: S.l. NPV 1.5 x 10^{12} POBs/ha

Provide poison bait with carbaryl 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 lit.

Serpentine leaf miner: Spray Neem Seed Kernel Extract 50 g/lit.

Whitefly:

1. Install yellow sticky traps to attract the adult.
2. Spray dichlorvos 76 WSC @ 1 ml/lit or triazophos 40 EC 2 ml/lit or fish oil rosin soap 25 g/lit. or dimethoate 2 ml/lit or methyl demeton 25 EC 2 ml/lit. Add wetting agent.
3. Remove alternate weed host *Abutilon indicum*

Nematode: Application of Carbofuran 3 G at 10 g/sq.m at sowing and 1 kg a.i./ha in the main field one week after transplanting. Treat the seeds with antagonistic fungi *Trichoderma viride* at 4 g/kg seed along with pressmud at 5 kg/m^2 for nematode disease complex.

Diseases - Damping off (nursery)

Treat the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g /kg of seed 24 hours before sowing. Apply *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM. Stagnation of water should be avoided. Drench with Copper oxychloride at 2.5 g/lit at 4 lit/sq.m.

Leaf spot: Spray Zineb or Mancozeb 2 g/lit.

Leaf curl: Spray systemic insecticides like Methyl demeton or Monocrotophos or Dimethoate at 2 ml/lit. to kill the insect vector, whitefly.

Tomato spotted wilt virus: Carbofuran 3 G 1 kg a.i./ha in nursery at sowing and second application at 1.25 kg a.i./ha 10 days after transplanting in mainfield and 3 sprays of Endosulfan 35 EC 1.5 ml/lit @ 25, 40, 55 days after transplanting.

Yield:

PKM 1 : 30-35 t/ha

CO 3 : 40 t/ha

Paiyur 1 : 30 t/ha

COTH 1 HYBRID TOMATO

Season: May – June, November - December

Seed Rate: 150 g/ha

Seed Treatment: Treat the seeds with *Trichoderma viride* @ 4g/kg of seeds 24 hours before sowing and with *Azospirillum* @ 20 g/150 g just before sowing.

Nursery: Hybrid seedlings can be raised in protrays filled with composted coir pith (98 cells) with 1.25 kg composted coir pith.

Fill the protrays with composted coir pith and sow 1 seed per cell and water with rose can.

Field preparation and planting: Thoroughly prepare the field with the addition of FYM @ 25 t/ha and form ridges and furrows at a spacing of 60 cm. Apply 2 kg (10 packets) of *Azospirillum* and Phosphobacteria 2 kg/ha by mixing with 20 kg of FYM. Irrigate the furrows and transplant 25 days old seedlings, with the ball of earth, on the ridges adopting a spacing of 45 cm between the plants.

Manuring: Basal Dose : NPK 50:300:50 kg/ha

Top dressing : N and K each 150 kg/ha in 3 equal splits at 30, 45 and 60 days after planting.

Irrigation: Irrigate the field on the third day of planting and subsequently at weekly intervals.

Weed control: Apply Pendimethalin 1.0 kg a.i./ha or fluchloralin 1 kg a.i/ha as pre-emergence herbicide followed by one hand weeding on 30 days after planting.

Mulching: Black LDPE sheets of 25 micron thickness and bury both the ends into the soil to a depth of 10 cm.

After cultivation

a) Weeding and hoeing on 30th day and earth up.
b) Stake the plants 30 days after planting with 1 - 1.5 m tall stakes.
c) Remove the side branches up to 20 cm from ground level.
d) Foliar spray of $ZnSO_4$ 0.5 per cent thrice at 10 days interval from 40 days after planting.

Plant protection

Apply carbofuran 3 G granules 7 days after transplanting to control sucking pests/vectors.

Spray methyl demeton or monocrotophos or dimethoate 1 ml/l against thrips and whitefly.

Spray endosulfan 2.5 ml/l or carbaryl 2.5 g/l to control fruit borer.

Spray Zineb or Mancozeb 2 g/l to control leaf spot diseases.

Harvest: Harvest the fruits when they turn red.

Duration: 110 - 115 days from transplanting (135 - 140 days from sowing).

Yield: 80-90 t/ha

Brinjal: *Solanum melongena L. ; Solanaceae*

Varieties: CO 2, MDU - 1 , PKM 1, PLR 1, KKM – 1, PPI 1, Annamalai and COBH 1 (Hybrid)

Soil: Well drained soil rich in organic matter with pH of 6.5-7.5

Season of Sowing: December – January and May – June.

Seed rate:

Varieties : 400 g/ha

Hybrids : 100 g/ha

Nursery area : 100 sq.m./ha.

Apply FYM 10 kg, neem cake 1kg, super phosphate 100 g, furadan 10 g per square metre.

Treat the seeds with *Trichoderma viride* @ 4 g/kg of seed. Treat the seeds with *Azospirillum* at 40 g/400 g of seeds using rice gruel as adhesive. Irrigate with rose can. In raised nursery beds sow the seeds in lines at 10 cm apart and cover with sand. Transplant the seedlings 30 – 35 days after sowing at 60 cm apart in the ridges.

Spacing : 60 x 60 cm

Preparation of Field: Plough the field to a fine tilth. Apply FYM or compost at the last ploughing and form ridges and furrows at 60 cm apart. Pre-emergence application of pendimethalin @ 1.0 kg a.i (or) fluchloralin 1 g a.i/ha is recommended.

Irrigation: After establishment, irrigate at weekly intervals.

Application of fertilizers: Apply FYM 25 t/ha. N 50 kg, P 50 kg and K 30 kg/ha as basal dose, N 50 kg/ha 30 days after transplanting during earthing up. Apply 2 kg each of *Azospirillum* and *Phosphobacteria* in the mainfield at planting. Spray 2 ppm (1 ml in 500 lit) Triacontanol plus Sodium Borate or Borax 35 mg/lit of water 15 days after transplanting and at the time of full bloom to increase the yield.

After cultivation: One hand weeding, Top dressing and earthing up on 30 days after planting.

Plant protection - Pests

Nematode and Damping off disease: Seed treatment with antagonistic fungi *viz. Trichoderma harzianum* 4 g/kg seed or *T. viride* 4 g/kg seed along with application of press mud at 5 kg/m^2 or Carbonfuran 3 G 10 g/m^2. Application of Carbofuran 3 G at 10 g/sq.m at the time of sowing. Apply *Pseudomonas fluorescens* at 10 g/m^2 for nematodes and damping off disease.

Epilachna beetle: Collect the beetles, grubs, pupae and destroy. Spray carbaryl 50 WP 2 g/lit or endosulfan 35 EC 2 ml/lit.

Whitefly: Monitor the whitefly with yellow sticky trap at 12/ha. Spray Neem oil 3% plus Teepol (1 ml/lit) or spray Neem Seed Kernel Extract 5 %.

Shoot & fruit borer: Remove the affected terminal shoot showing boreholes. Remove the affected fruits and destroy. Spray any one of the following chemicals starting from one month after planting at 15 days interval.

1. Carbaryl 50 WP 2 g/lit + Wettable Sulphur 50% WP 2 g/lit.
2. Endosulfan 35 EC 2 ml/lit + Neem oil 3 %.
3. Quinalphos 25 EC 2 ml/lit + Neem oil 3 %.
4. Neem Seed Kernel Extract 5 %.
5. Avoid using synthetic pyrethroids.

Ash Weevil: Apply carbofuran 3 G at 15 kg/ha 15 days after planting.

Aphid: Methyl demeton 25 EC 2 ml/lit or dimethoate 30 EC 2 ml/lit. Release 1st instar larvae of Green lace wing bug (*Chrysoperla carnea*) @ 10,000 per ha.

Red Spider mite: Spray dicofol 18.5 EC 2.5 ml/lit or wettable sulphur 50 WP 2 g/lit.

Diseases

Damping off: Treat the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g /kg of seed 24 hours before sowing. Apply *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM. Stagnation of water should be avoided. Drench with Copper oxychloride at 2.5 g/lit at 4lit/sq.m

Leaf Spot: Spray Mancozeb 2 g/lit.

Little Leaf: Remove the affected plants in the early stages and spray methyl demeton 25 EC 2 ml/lit or dimethoate 30 EC 2 ml/lit. to control the vector.

Yield:

Varieties : 25 - 30 t/ha

Hybrids : 45 - 50 t/ha

Bhendi: *Abelmoschus esculentus (L)* Moench; Malvaceae

Varieties: MDU 1, Arka Anamika, Arka Abhay, Parbhani Kranti and CO 3 (hybrid).

Soil: It is adaptable to a wide range of soils from sandy loam to clayey loam.

Season and sowing: June - August and February.

Seed rate: 8.0 kg/ha

Apply FYM 10 kg, neem cake 1kg, super phosphate 100 g, furadon 10 g per square metre.

Seed treatment with *Tricoderma viride* 4 g/kg of seeds are again treated with 400 g of *Azospirillum* using starch as adhesive and dried in shade for 20 minutes. Sow three seeds per hill at 30 cm apart and then thin to 2 plants per hill after 10 days.

Preparation of field: Plough the land 4 - 5 times and form ridges and furrows at 45 cm apart.

Spacing: 45 x 30 cm

Irrigation: After germination, irrigate at weekly intervals.

Application of Fertilizers: Apply FYM 25 t/ha, N 20 kg, P 50 kg and K 30 kg/ha as basal and 20 kg N/ha 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* each at 2 kg/ha mixed in 100 kg of FYM before sowing.

Foliar nutrition: 1 % urea (10 g/l) + 1% Muriate of Potash (10 g/l) on 30 and 45 days after planting.

For hybrids, foliar application of water soluble fertilizer 19-19-19 grade three times @ 0.5% at 10 days interval from 30 days after planting.

Weed control: Spray Oxyflourfen at 0.15 kg ai/ha or Fluchloralin at 1.0 kg ai/ha or Metolachlor at 0.75 kg a.i/ha as pre emergence application on third day after sowing. Herbicide application should be integrated with one hand weeding on 30 days after sowing.

Plant protection - Pests

Fruit borers: Integrated Pest management

Spray carbaryl 50 WP 2 g/lit. or endosulfan 35 EC 2 ml/lit. or monocrotophos 36 WSC 2 ml/lit. combined with or neem seed Kernel extract 5 %.

1. Set up pheromone trap at 12/ha.
2. Collection and destruction of affected fruits.
3. Release of egg parasite *Trichogramma* at 1.0 lakh/ha.
4. Release of 1st instar larvae of green lace wing bug *Chrysoperla carnea* @ 10,000/ha.
5. Spray *Bacillus thuringiensis* 2 g/lit.

Leaf hopper: Monocrotophos 36 WSC 2 ml./lit. or dimethoate 30 EC 2 ml/lit combined with neem seed kernel extract 5 %.

Nematode: Application of Carbofuran 3 G 1 kg a.i /ha or Phorate 10 G 1 kg a.i./ha and Neem cake 400 kg/ha at sowing in furrows along with fertilizers.

Diseases

Yellow vein mosaic virus: Spray monocrotophos 2 ml/lit to kill the vectors i.e., white flies.

Powdery mildew: Dust Sulphur 25 kg/ha or spray Dinocap 2 ml/lit or Tridemorph 0.5 ml/lit or Carbendazim 1 g/lit or Wettable sulphur 2 g/lit immediately after noticing the disease and repeat after 15 days or four sprays of Triademephon (0.5%) at 10 days interval from 30 days after sowing

Yield: 12 - 15 t/ha

Chillies: *Capsicum annuum* L.; *Solanaceae*

Varieties: K 1, K 2, CO 1, CO 2, CO 3, CO 4 (Vegetable type), PKM 1, PMK 1 (for semi-dry conditions in Southern Districts) and PLR1 (for coastal regions of North - East Tamil Nadu).

Soil: Well drained loamy soil rich in organic matter with pH range 6.5-7.5.

Season of sowing

1) January - February
2) June - July
3) September - October

Seed rate: 1.0 kg/ha.

Nursery area: 100 sq.m/ha.

Treat the seeds with *Trichoderma viride* @ 4 g/kg and sow in lines spaced at 10 cm in raised nursery beds and cover with sand. Watering with rose can has to be done daily. Drench the nursery with Copper oxychloride at 15 days interval against damping off disease. Apply Carbofuran 3 G at 10 g/sq.m. at sowing.

Preparation of field: Plough the land to a fine tilth. Form ridges and furrows 45 cm apart. Transplant 40-45 days old seedlings at 30 cm spacing. Adopt 30 x 15 cm for CO 3 Chillies in flat beds.

Irrigation: Irrigate at weekly intervals.

Application of fertilizers: Apply FYM 25 t/ha. N 30 kg; P 60 kg and K 30 kg/ha as basal and 30 kg N/ha each on 30, 60 and 90 days of planting.

Potassium as K_2SO_4 for quality improvement. Application of potassium in the form of potassium sulphate will increase quality of chilli.

Weed control: Spray Fluchloralin 1 lit a.i/ha or pendimethalin 1 kg/a.i. or oxyflourfen 0.15 kg/a.i. as pre-emergence herbicide and may be combined with one hand weeding and earthing up 45 days after planting. Raise intercrop of onion in paired row system to get additional income.

Growth regulator: Spray NAA 10 ppm (10 mg/lit of water) on 60 and 90 days after planting to increase fruit set. Spray Triacontanol at 1.25 ppm (1.25 ml/lit) on 20, 40, 60 and 80th day of planting.

Plant protection; Pests

Fruit borer: Integrated pest management of fruit borer:

1. Set up pheromone traps for *Helicoverpa armigera/Spodoptera litura* at 12 No./ha.
2. Collection and destruction of damaged fruits and grown up caterpillars.
3. Spray *Bacillus thuringiensis* at 2 g/lit.
4. Provide poison bait with carbaryl 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 lit/ha.
5. Spray carbaryl 50 WP 3 g/lit or chlorpyriphos 20 EC 3 ml/lit or quinalphos 25 EC 2 ml/lit.

Thrips: Spray dimethoate 30 EC 2 ml/lit or methyl demeton 25 EC 2 ml/lit or formothion 2 ml/lit or dust quinalphos 1.5 D at 20 kg/ha thrice at fortnightly intervals.

Aphids: Acephate 75 SP 1 g/lit or methyl demeton 25 EC 2 ml/lit or phosalone 35 EC 2 ml/lit.

Yellow Muranai mite: Spray dicofol 18.5 EC 2.5 ml/lit or ethion 50 EC 4 ml/lit or wettable sulphur 50 WP 6 g/lit.

Rootknot nematode: Apply TNAU formulation of VAM (containing 1 spore/g to control rootknot nematode in nursery).

Diseases

Damping off: Treat the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g /kg of seed 24 hours before sowing. Apply *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM. Stagnation of water should be avoided. Drench with Copper oxychloride at 2.5 g/lit at 4 lit/sq.m

Leaf spot: Spray Mancozeb 2 g/lit or Copper oxychloride 2.5 g/lit.

Powdery mildew: Spray Wettable sulphur 3 g/lit or Carbendazim 1 g/lit, 3 sprays at 15 days interval from the first appearance of symptom.

Die-back and fruit rot: Spray Mancozeb 2 g/lit or Copper oxychloride 2.5 g/lit thrice at 15 days interval starting from noticing the die-back symptoms.

Chilli mosaic: Raise 2 rows of maize or sorghum for every 5 rows of chilli crop against wind direction. Spray recommendations given for aphids may be adopted for controlling the vector.

Yield: 2 - 3 t/ha of dry pods or 10 - 15 t/ha of green chillies.

Capsicum (Sweet pepper / Bell pepper): Solanaceae

Varieties: Arka Basant, Arka Gaurav, Arka Mohini, Green Gold, Bharath.

Soil: Well drained loamy soil rich in organic matter.

Seasons of sowing: September - February

Seed rate: 1.250 kg/ha

Nursery area: 3 cents/ha

Treat the seeds with 2.5 g of Bavistin and sow in lines across the bed at a spacing of 2.5 cm and then covered with top soil and then paddy straw. Watering with rose can has to be done daily. On 20th day of sowing 300g of furadan 3G granules have to be applied in between the seedling lines across the bed stir the soil and then the beds are irrigated.

Preparation of field: Plough the field to a fine tilth. Form ridges and furrows 45 or 60 cm apart. Transplant 40-45 days old seedlings at 30 cm spacing.

Irrigation: Irrigation at weekly or 10 days interval.

Application of fertilizers: Apply FYM 25 t/ha 40:60:30 kg NPK/ha as basal and 40 kg N/ha each on 30, 60 and 90 days of planting.

Weed control: On 30th day, one hoeing and weeding and the plants are earthed up.

Growth regulator: Spray 1.25 ppm triacontanol (10 lit. of water) on 20th, 40th, 60th and 80th day after transplanting. Spray NAA 50 ppm (1 ml planofix /4.5 lit. of water) on 60 and 90 days after planting.

Plant protection - Pests

Nematodes and Sucking pests: Apply carbofuran 10-12 kg/ha at 15 days after transplanting followed by dimethoate @ 1ml/lit. at 25 days interval.

Aphids and Thrips: monocrotophos @ 1.5 ml /lit for control aphids. Neem oil 1% or neem cake extract 5% to control aphids and thrips. For white aphids acephate 1 kg/ha.

Diseases: Powdery mildew: Wettable sulphur @ 2g/lit

Dieback and fruit rot: Mancozeb @ 2g/lit.

Harvest and yield

Fully matured green fruits should be harvested before ripening.

Yield 15 tonnes/ha in 150-160 days.

Paprika: *Capsicum annum* var. *longum*; *Solanaceae*

Varieties: KTPL-19

Soil: Well-drained sandy loam or clay saline free soil is preferable. It can be grown on any fertile well-drained soil suitable for chillies cultivation with pH 6.5 - 7.0.

Season: June - July.

Seed rate: 500 g/ha.

Spacing: 60 x 45 cm

Nursery: Prepare 10 - 12 beds of 7 m long 1.2 m wide and 15 cm height and sow the seeds in rows 10 cm apart on 0.5 cm deep. Apply 15 - 20 kg well decomposed compost and 500 g of 15:15:15 NPK complex fertiliser to each bed 15 to 20 days before sowing.

Transplanting: Healthy seedlings may be transplanted at a spacing of 45 cm apart.

Application of fertilisers: Apply FYM 20 - 25 tonnes/ha, 60, 100 and 60 kg NPK/ha as basal, 20 kg N and 20 kg K three weeks after transplanting. 40 kg N and 40 kg K/ha six weeks after transplanting.

Plant protection - Pest

Fruit borer: Spray endosulfan 2 ml/lit.

Diseases

Anthracnose: Spray Mancozeb 2 g/lit.

Fruit rot: Spray Copper oxychloride @ 2.5 g/lit.

Powdery mildew: Spray Wettable sulphur @ 0.3%

Yield: 25 - 35 t/ha.

Pumpkin: *Cucurbita moschata* Poir.; *Cucurbitaceae*

Varieties: CO 1, CO 2, Arka suryamuki and Arka Chandan.

Soil: Sandy loam rich in organic matter and with good drainage. The pH range from 6.5-7.5 is found ideal.

Season and sowing: June- July and December- January.

Soak the seeds in double the quantity of water for 30 minutes and incubate for 6 days. Sow the seeds (5 seeds/pit) treated with *Azospirillum* just before sowing and thin the seedlings to two per pit after 15 days.

Seed rate: 1.0 kg /ha.

Spacing: 2 m x 2 m. Pit size 30 cm x 30 cm x 30 cm.

Application of fertilizers: Apply 10 kg of FYM (20 t/ha) and 100 g of NPK 6:12:12 g as basal and 10 g of N per pit after 30 days of planting.

After cultivation: Hoe and weed thrice. Spray Ethrel 250 ppm (2.5 ml per 10 lit of water) four times at weekly intervals commencing from 10 to 15 days after sowing.

Pests and diseases

Beetles and caterpillars: Spray malathion 50 EC 1 ml/lit. or dimethoate 30 EC 1 ml/lit. or methyl demeton 25 EC 1 ml/lit. or fenthion 1000 EC 1 ml/lit.

Fruit fly

1) Collect the damaged fruits and destroy.
2) The fly population low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
    1) Plough the field to expose the pupae.
    2) Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required per ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust. These are phytotoxic

Diseases

Powdery mildew: Spray Dinocap 1 ml/lit or Carbendazim 0.5 g/lit.

Downy mildew: Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Yield: 18-20 t/ha in 140 days.

Snake gourd: *Trichosanthes cucumerina.* L; *Cucurbitaceae*

Varieties: CO 1, CO 2, PKM 1 and MDU 1.

Soil: Sandy loam rich in organic matter with good drainage and the pH range from 6-5-7.5. The crop requires a moderate warm temperature.

Season and sowing: July and January.

Sow the seeds (5 seeds/pit) treated with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g/kg or carbendazim 2 g/kg and thin the seedlings to two per pit after 15 days.

Seed rate: 1.5 kg/ha.

Preparation of field: Plough the field to fine tilth. Dig pits of size 30 cm x 30 cm x 30 cm at 2.5 x 2 m spacing and form basins.

Irrigation: Irrigate the basins before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply 10 kg of FYM, 100 g of NPK 6:12:12 as basal per pit and N @ 10 g pit 30 days after sowing.

After cultivation: Hoe and weed thrice. Provide stakes to reach the pandal height (2 m). Pandal is not essential for CO 2 variety. Spray Ethrel 100 ppm (1 ml in 10 lit of water) four times from 10 to 15 days after sowing at weekly intervals.

Plant protection - Pests

Leaf beetles, and leaf caterpillars: Spray malathion 50 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or methyl demeton 25 EC 1 ml/lit or fenthion 100 EC 1 ml/lit.

Fruit fly

1. Collect the damaged fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence, the sowing time may be adjusted accordingly.
3. Expose the pupae by ploughing.
4. Use 20 x 15 cm poly bags fish meal traps with 5 g of fish meal + 1 ml of dichlorvos in cotton @ 50 traps/ha. Fish meal and cotton are to be removed once in 20 and 7 days respectively.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust. These are phytotoxic.

Diseases

Powdery mildew: Spray Dinocap 1 ml/lit or Carbendazim 0.5 g/lit.

Downy mildew: Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Yield: 18 t/ha in 135 – 145 days.

Ribbed gourd: *Luffa acutangula* Roxb; *Cucrbitaceae*

Varieties: CO 1, CO 2 and PKM 1.

Soil: Sandy loam rich in organic matter with good drainage and pH range from 6.5-7.5. The crop requires a moderate warm temperature.

Season and sowing: July and January.

Seed rate: 1.5 kg/ha. Sow the seeds (5 seeds/pit) treated with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 2g/kg of seeds) and thin the seedlings to two per pit after 15 days.

Preparation of field: Plough the field to fine tilth. Dig pits of 30 cm x 30 cm x 30 cm size at 2.5 x 2 m spacing and form basins.

Irrigation: Irrigate the basins before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply 10 kg of FYM, 100 g of NPK 6:12:12 g mixture as basal per pit and N @ 10 g per pit 30 days after sowing.

After cultivation: Hoe and weed thrice and provide support for the plants to reach the pandal erected at a height of 2 m. Spray Ethrel 250 ppm (2.5 ml/10 lit of water) four times commencing from 15th day after sowing at weekly intervals to increase yield.

Plant protection - Pests

Beetles, fruit flies and caterpillars: Spray malathion 50 EC 1 ml/lit. or dimethoate 30 EC 1 ml/lit. or methyl demeton 25 EC 1 ml/lit. or fenthion 100 EC 1ml/lit.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust as these are phytotoxic.

Diseases - Powdery mildew

Spray Dinocap 1 ml/lit. or Carbendazim 0.5 g/lit.

Downy mildew: Spray Mancozeb or Chlorothalonil 2 g/lit. twice at 10 days interval.

Yield: 14 – 15 t/ha in 125 days.

Bottle gourd: *Lagenaria siceraria (*Mol) Standl; *Cucurbitaceae*

Varieties: CO 1, Pusa Summer Prolific long, Summer Prolific Round, Pusa Manjari, Pusa Megdoot and Arka Bahar.

Soil: Sandy loams rich in organic matter with good drainage and the pH ranges from 6.5 to 7.5. The crop requires a moderate warm temperature.

Season and sowing: July and January. Sow the seeds (3 seeds/pit) treated with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 10 g or carbendazim 2 g/kg of seeds and thin the seedlings to two per pit after 15 days.

Seed rate: 3 kg/ha.

Preparation of field: Plough the field to fine tilth. Dig pits of the 30 cm x 30 cm x 30 cm size at 2.5 x 2 m spacing.

Irrigation: Irrigate the field before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply 10 kg of FYM (20 t/ha) 100 g of NPK 6:12:12 mixture as basal and 10 g of N per pit 30 days after sowing.

After cultivation: Hoe and weed thrice.

Plant protection - Pests

Beetles, fruit flies and caterpillars: Spray malathion 50 EC 1 ml/lit. or dimethoate 30 EC 1 ml/lit. or methyl demeton 25 EC 1 ml/lit. or fenthion 100 EC 1 ml/lit.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust as these are phytotoxic.

Powdery mildew: Spray Dinocap 1 ml/lit. or Carbendazim 0.5 g/lit.

Downy mildew: Spray Mancozeb or Chlorothalonil 2 g/lit. twice at 10 days interval.

Yield: 15 – 20 t/ha in 135 days.

Bitter gourd; *Momordica charantia* L.; *Cucurbitaceae*

Varieties: CO 1, MDU 1, COBgoH 1 (Hybrid), Arka Harit, Priya and Preethi.

Soil: Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5. The crop requires a moderate warm temperature.

Season and sowing: July and January.

Sow the seeds (5 seeds/pit) treated with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 10 g or carbendazim 10 g/kg of seeds and thin the seedlings to two per pit after 15 days.

Seed rate: 4.5 kg/ha.

Preparation of field: Plough the field to fine tilth. Dig pits of 30 cm x 30 cm x 30 cm size at 2 x 1.5 m spacing and form basins.

Irrigation: Irrigate the basins before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply 10 kg of FYM per pit (20 t/ha) 100 g of NPK 6:12:12 per pit as basal and 10 g of N per pit 30 days after sowing.

After cultivation: Hoe and weed thrice. Provide stakes to reach the pandal (2 m). Spray Ethrel 100 ppm (1 ml dissolved in 10 lit of water) four times from 15th day after sowing at weekly intervals.

Plant protection; Pests and diseases; Beetles, fruit flies and caterpillars: Spray malathion 50 EC 1ml/lit or dimethoate 30 EC 1ml/lit or methyl demeton 25 EC 1ml/lit or fenthion 1000 EC 1ml/lit.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust, as these are phytotoxic

Powdery mildew: Spray Dinocap 1ml/lit or Carbendazim 0.5 g/lit.

Downy mildew: Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Yield

Varieties : 14 t/ha in 140 - 150 days.

Hybrids : 40 t/ha in 180 days

Ash gourd: *Benincasa hispida* Cogn; *Cucurbitaceae*

Varieties: CO 1 and CO 2.

Soil: A deep loamy soil with pH ranges from 6.5-7.5 is suitable. A warm tropical climate is ideal.

Season and sowing: July and January.

Five to six seeds are sown in each pit the seeds are treated with *Trichoderma viride* 4 g or *Pseudomonas fluroscens* 10 g carbendazim 2 g/kg of seeds and after germination, the seedlings are thinned to two per pit.

Seed rate: 2.5 kg/ha. Soak the seeds in double the quantity of water for 30 minutes and incubate for 6 days.

Preparation of field: Plough the field 3 – 4 times. Dig pits of 30 cm x 30 cm x 30 cm at a spacing 2 x 1.5 m and form basins.

Irrigation: Irrigate the basins before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply 10 kg FYM per pit and 100 g of NPK 6:12:12 mixture/pit and 10 g N/pit 30 days after sowing.

After cultivation: Hoe and weed thrice. Spray Ethrel 250 ppm (2.5 ml/10 lit of water) four times at weekly intervals commencing from 15th day after sowing.

Plant protection - Pests

Leaf beetles, and leaf caterpillars: Spray malathion 50 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or methyl demeton 25 EC 1 ml/lit or fenthion 100 EC 1 ml/lit.

Fruit fly

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust, as these are phytotoxic.

Diseases - Powdery mildew

Spray Dinocap 1 ml/lit or Carbendazim 0.5 gm/lit.

Downy mildew: Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Yield: 20 t/ha in 140 days.

Cucumber: *Cucumis sativus* L.; *Cucurbitaceae*

Varieties: CO 1, Japanese Long Green, Straight Eight and Poinsettee.

Soil: Sandy loam rich in organic matter with good drainage and pH range from 6.5-7.5 . The crop requires a moderate warm temperature.

Preparation of field: Plough the field four times. Form long channels at 1.5 m apart.

Season and sowing: Sow the seeds during June or January to April at 2.5 kg/ha after treating with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 10 g/kg or carbendazim 2 g on one side of channel giving a spacing of 0.6 m between hills. Thin the seedlings to two per hill.

Irrigation: Irrigate the field before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply FYM 40 t/ha as basal and 35 kg of N/ha at 30 days after sowing.

After cultivation: Hoe and weed twice or thrice.

Plant protection - Pests

Fruit fly

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust, as these are phytotoxic.

Yield: 8 – 10 t/ha in 80 to 90 days for salad.

Gherkin: *Cucumis sativus* var. *angaria Cucurbitaceae*

Varieties: Hybrids.

Soil: Comes up well in wide range of soils. Well-drained sandy loam with a pH range of 6.0 to 6.8 is optimum.

Season: Warm season crop requiring a moderately high temperature.

Seed rate: 800 g per hectare.

Sowing: Sow the seeds at 30 cm spacing on sides of the ridges with 2 seeds per hill after treating with Trichoderma viride 4 g or Pseudomonas 10 g or carbendizim 2 g/kg of seeds.

Preparatory cultivation: Apply 25 t/ha of FYM. Prepare ridges and furrows one metre apart.

Manuring: Apply N - 150 kg, P - 75 kg and K - 100 kg/ha in 3 equal splits *i.e.,* basal, three and five weeks after sowing.

After cultivation: Earth up the plants 25 days after sowing. Provide support to plants as and when vines start trailing.

Plant protection

Minor pest: For leaf miner, white fly, aphids and thrips spray dimethoate 1.5 ml/lit or monocrotophos 1.5 ml/lit or malathion 1.5 ml/lit.

Diseases

Spray Carbendazim 0.05 % (0.5 g/lit) to control diseases.

Yield: 10 - 12 tonnes/ha in 90 days.

Watermelon: *Citrullus lanatus* (Thumb) Matsum and Nakai; *Cucurbitaceae*

Varieties: PKM 1, Sugar Baby, Arka Manik, Arka Jyoti (F1 hybrid) and Pusa Bedana (F1 hybrid).

Soil: Sandy loam rich in organic matter with good drainage and pH range for 6.5-7.5. The crop requires a moderate warm temperature.

Season of sowing: Sow the seeds during november-December at 3.5 kg/ha after treating with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 10 g or carbendazim 2g/kg of seed on one side of the channel with a spacing of 0.9 m between hills. Thin the seedlings 2 per hill 15 days after sowing.

Preparation of field: Plough the field to a fine tilth and form long channel 2.5 m apart.

Irrigation: Irrigate the field before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply FYM 20 t/ha, P 55 kg and K 55 kg as basal and N 55 kg/ha 30 days after sowing.

After cultivation: Spray ethrel 250 ppm (2.5 ml/10 lit of water) 4 times at weekly intervals commencing from 15 days after sowing. Hoe and weed thrice.

Plant protection; Pests

Beetles: Spray malathion 50 EC 1 ml/lit at weekly intervals.

Fruit fly

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use polythene bags, fish meal trap with 5 g of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust, as these are phytotoxic

Yield: 25 – 30 t/ha in 120 days.

Muskmelon: *Cucumis melo* L; *Cucurbitaceae*

Varieties: Annamalai, Pusa Sharbati, Hara Madhu, Durgapura Madhu, Arka Rajhans and Arka Jeet.

Soil: Sandy loam rich in organic matter with good drainage and pH range from 6.5-7.5. The crop requires a moderate warm temperature.

Season and sowing: November to February. Sow the seeds @ 3.0 kg/ha after treating with *Trichoderma viride* 4g or *Pseudomonas fluroscens* 10 g or carbendazim 2g/kg of seed on one side of the channel giving a spacing of 0.6 m between hills. Thin the seedlings after 15 days, to maintain two per hill.

Preparation of field: Plough the field to a fine tilth and form long channels at 1.5 m apart.

Irrigation: Irrigate the field before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply FYM 20 t/ha, NPK 40:60:30 kg/ha as basal and N @ 40 kg/ha 30 days after sowing.

After cultivation: Hoe and weed thrice.

Plant protection - Pests

Beetles: Spray malathion 50 EC 1 ml/lit at weekly intervals.

Fruit fly

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust, as these are phytotoxic.

White fly: Spray neem seed kernel extract 5 %.

Yield: 20 t/ha in 120 days.

Tinda: *Citrullus vulgaris* Schrad *var. fistulousus; Cucurbitaceae*

Varieties: Annamalai and Arka Tinda.

Soil: Sandy loam rich in organic matter with good drainage and pH ranges from 6.5-7.5. The crop requires a moderate warm temperature.

Season and sowing: Sow the seeds on one side of the channel during January-February.

Seed rate: 3.5 Kg/ha.

Treat the seeds with *Trichoderma viride* 4g or *Pseudomonas fluroscens* 10 g or carbendazim 2g/kg of seed. Thin the seedlings after 15 days to maintain two per pit at 0.9 m spacing.

Preparation of field: Plough the field to fine tilth and form long channels at 1.5m apart.

Irrigation: Irrigate the field before dibbling the seeds and thereafter once in a week.

Application of fertilizers: Apply FYM 10 t/ha, N 20 kg/ha as basal and N 20 kg/ha 30 days after sowing.

After cultivation: Hoe and weed thrice.

Plant protection

Beetles: Spray malathion 50 EC 1 ml/lit at weekly intervals.

Fruit fly

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.

Do not use DDT, lindane 1.3% dust, copper and sulphur dust, as these are phytotoxic.

White fly: Spray Neem Seed Kernal Extract 5 %.

Yield: 10 t/ha in 90 days.

Chow Chow: *Sechium edule*

Varieties: Two types: Green fruited and White fruited.

Soil: Requires well drained acidic soil with a pH of 5.5 - 6.5 and thrives best in a temperature range of 18 - 22^0 C and at an altitude of 1200 - 1500 m. In plains it comes up well during winter season.

Preparation of field: Dug pits of 45 cm x 45 cm x 45 cm at a spacing of 2.4 x 1.8 m.

Fill up the pits with 10 kg of FYM, 250 g of urea, 500 g of Super phosphate and 500 g of Muriate of Potash.

Season and sowing

Hills: April - May.

Fully matured and sprouted fruits collected from high yielding vines are planted in pits @ 2 – 3 per pit.

After cultivation: Hoeing and weeding are done as and when necessary.

At initiation of vine growth, stake the plants. Provide pandal at a height of 2 m height. Prune the plants to ground level during winter from second year after planting.

In hills, pruning period is January. Apply 250 g of urea for each vine after pruning and at the time of flowering.

Plant protection - Pests

For scales, mealy bugs and aphids spray dimethoate 30 EC @ 1 ml/lit.

Fruit fly

1) Collect the damaged fruits and destroy.
2) The fly population low in hot day condition and it is peak in rainy season. Hence adjust the sowing time accordingly.
3) Plough the field to expose the pupae.
4) Use polythene bags fish meal trap with 5 g of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Diseases - Mosaic

Spray dimethoate 30 EC 2 ml/lit or methyl demeton 25 EC 2 ml/lit. thrice at fortnightly intervals.

Yield: 25 - 35 tonnes/ha.

Cluster beans: *Cyamopsis tetragonoloba* L; *Fabaceae*

Varieties: Pusa Mausami, Pusa Naubahar and Pusa Sadabahar.

Soil: Well drained sandy loam with pH range of 7.5-8.0 and warm climate. Tolerates salinity.

Season and sowing: June- July, October -November. Dibble the seeds on the sides of the ridges 15 cm apart.

Seed rate: 10 kg per ha.

Seed treatment: Treat the seeds with Rhizobial culture @ 600 g/ha using rice gruel as binder. Dry the treated seeds in shade for 15 – 30 minutes before sowing.

Preparation of field: Plough the field to fine tilth and form ridges and furrows 45 cm apart.

Irrigation: Irrigate the field immediately after sowing then at weekly intervals.

Application of fertilizers: Apply FYM 25 t, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg /ha, N 25, P 50 and K 25 kg/ha as basal and 25 kg N/ha 30 days after sowing.

Plant protection - Pests

Leaf hopper: Methyl demeton 25 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit.

Pod borer: Carbaryl 50 WP 2 g/lit; or endosulfan 35 EC 2 ml/lit

Diseases

Leaf spot: Spray Mancozeb 2 g/lit.

Powdery mildew: Spray Wettable sulphur 2 g/lit or dust with Sulphur 25 kg/ha. Repeat it at 15 days interval.

Yield: 5 – 7 t/ha in 90 days.

Vegetable Cowpea: *Vigna unguiculata* (L) Walp.; *Fabaceae*

Varieties: CO 2, VBN 2 and Pusa Komal.

Soil: Well drained soil with organic matter. Warm humid climate.

Season: June – July (Rainfed), February – March (irrigated).

Seed rate: 20 kg/ha.

Treat the seeds with 600 g of *Rhizobium* bacterial culture before sowing as in cluster beans. Dibble the seeds on both sides of the ridges or in lines in the beds.

Preparation of field: Plough the field to fine tilth. Form ridges and furrows at 45 cm apart or beds of convenient size.

Spacing: 45 x 15 cm.

Irrigation: Give irrigation immediately after sowing and on 3rd day, thereafter once a week.

Application of fertilizers: Apply FYM 25 t, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg /ha, and N 25 kg and P 50 kg/ha for irrigated crop. Apply FYM at 12.5 t/ha and N 12.5 kg and P 25 kg/ha for rainfed crop.

After cultivation: Give one hoeing and weeding on 25th day after sowing.

Plant protection - Pests

Aphids: Spray dimethoate 30 EC 1 ml/lit or methyl demeton 25 EC 1 ml/lit.

Pod Borer: Spray endosulfan 35 EC 2ml/lit.

Diseases

Powdery mildew: Dust Sulphur 25 kg/ha or spray Wettable sulphur 2 g/lit.

Yield: 2500 kg (rainfed) and 5000 kg (irrigated) in a crop duration of 75 to 90 days.

Lab lab or Dolichos bean: *Lab lab purpureus var. typicus; Fabaceae*

Varieties - Bush types

CO 6, CO 7, CO 8, CO 9, CO 10, CO 11, CO 12, CO 13, Arka Jay and Arka Vijay.

Pandal types: CO 1, CO 2, CO 3, CO 4, CO 5 and Pusa Early Prolific.

Soil: Well drained loamy soil with pH range of 6.5-8.5.

Rhizobial treatment: Treat the seeds with three packet (600 g) of Rhizobial culture per ha. using rice gruel as binder. Dry the treated seeds in shade for 15 – 30 minutes before sowing.

Season: Bush type throughout year; Pandal type July – August.

Seed rate and spacing: 25 kg/ha for Bush type and 5 kg/ha for Pandal type.

Dibble single seed 30 cm apart on one side of the ridge formed at a spacing of 60 cm for bush type. For pandal type 2 - 3 seeds/pit at 2 x 3 m spacing. Spacing for CO 1 Dolichos beans is 1 x 1 m.

Preparation of field: Plough the land to a fine tilth. Form ridges and furrows 60 cm apart for bush types. Dig pits of 30 cm x 30 cm x 30 cm at required spacing and fill it up with FYM and soil for pandal type.

Irrigation: Immediately after sowing and on 3rd day, thereafter once in a week.

After cultivation: Hoe and weed thrice. Provide stakes to reach pandal of 2 m height and train the vines on pandal.

Application of fertilizers

(a) Basal dressing for bush type

Manures and fertilizers	Irrigated	Dry
FYM	12.5 t/ha	12.5 t/ha
N	25 kg/ha	12.5 kg/ha
P	50 kg/ha	25 kg/ha
K	-	-

(b) For pandal type

Apply 10 kg FYM per pit (20 t/ha) 100 g of NPK 6:12:12 mixture as basal and 10 g N per pit after 30 days. Apply 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of sowing.

Plant protection - Pests

Pod borer: Spray carbaryl 50 WP thrice at fortnightly intervals at the rate of 2 g/lit. Dust with carbaryl 10 D at the rate of 25 kg/ha or endosulfan 35 EC @ 2 ml/lit.

Sucking pests: Spray malathion 50 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or methyl demeton 25 EC 1 ml/lit or fenthion 1000EC 1 ml/lit at 15 days interval to control aphids and other sucking insects.

Diseases

Powdery mildew

Spray Wettable sulphur 2 g/lit or Carbendazim 0.5 g/ litre.

Yield

Pandal type : 12 – 13 t/ha in 240 days.

Bush type : 8 – 10 t/ha in 120 days.

French bean: *Phaseolus vulgaris* L; *Fabaceae*

Bush type - Varieties

Hills: YCD 1, Ooty 1 and Arka Komal (Sel.9), Premier

Plains: Arka Komal, (Sel.9) Premier

Soil: Well drained loamy soils with pH range of 5.5-6.0. Cool climate.

Season

Hills: February –March

Plains: October- November

Sowing: Treat the seeds with *Trichoderma* 4 g/kg or Thiram or Carbandazim @ 2 g/kg of seed 24 hours before sowing to control fungal diseases. If the crop is raised for the first time it should be treated with *Rhizobium* as in cluster beans. In hills, sow the seeds in lines or in beds. In plains, sow the seeds in the sides of the ridges.

Seed rate and spacing

Hills: 80 kg/ha (2 seeds/hill) 30 x 15 cm.

Plains: 50 kg/ha (2 seeds/hill) 45 x 30 cm.

Preparation of field

Hills: Dig the soil thoroughly and incorporate FYM. Form beds of convenient size.

Plains: After two ploughings form ridges and furrows.

Irrigation: Immediately after sowing, third day and thereafter once a week.

Application of fertilizers: Apply FYM 25 t/ha at the last ploughing. N at 90 and P at 125 kg/ha should be applied on one side of the ridges.

For rainfed conditions of Shevaroy hills, apply as a basal dose of 62.5 kg/ha of Phosphorous as super phosphate and with another half of 62.5 kg/ha Phosphorous as FYM enriched super phosphate.

After cultivation: Weeding should be given 20 – 25 days and 40 – 45 days after sowing. The crop should be earthed up after each weeding.

Plant protection - Pests

Aphids and thrips: Treat the seeds with carbofuran 3 G at 10 g/kg of seed or monocrotophos 36 WSC 10 ml/kg of seed using adhesive. Spray monocrotophos 36 WSC or methyl demeton 25 EC or dimethoate 30 EC each at 1 ml/lit. In hills, glass house white fly occurs during May - August. Spray monocrotophos 36 WSC 1 ml/lit. Place 20 yellow sticky traps coated with castor oil in polythene sheet to attract the white flies.

Pod borer: Spray carbaryl 50 WP thrice at fortnightly intervals at the rate of 2 g/lit. Dust with carbaryl 10 D at the rate of 25 kg/ha or endosulfan 35 EC @ 2 ml/lit.

Ash weevil: Spray endosulfan 35 EC @ 2 ml/lit.

Whitefly: Spray methyl demeton 25 EC or dimethoate 30 EC or monocrotophos 36 WSC or phosphamidon 40 SL @ 1 ml/lit of water.

Diseases

Powdery mildew: Spray Wettable sulphur at 2 g/lit or dust Sulphur at 25 kg/ha.

Rust: Dust Sulphur at 25 kg/ha.

Anthracnose: Spray Mancozeb at 2 g/lit or Carbendazim 1 g/lit or Chlorothalonil 2 g/lit.

Leaf spot: Spray Mancozeb 2 g/lit.

Root rot: Drench with Carbendazim 1 g/lit.

Yield: 8 - 10 t/ha green pods in 90 - 100 days.

Pole types

Varieties: TKD 1, KKL-I, Ooty 1, Murungai bean

Soil: Well drained loamy soils with pH range of 5.5-6.0. Requires cool climate.

Season and sowing

Hills: February – March, July - August.

Preparation of field: Prepare the land to fine tilth. Sow the seeds at a spacing of 20 cm between plants in double rows of 30 cm apart with the distance of 1.5 metre between each pair of rows.

Seed rate: 50 - 55 kg/ha. Treat the seeds with *Rhizobium* (4 packets/ha).

Irrigation: Immediately after sowing, on 3rd day and after once in a week.

Application of fertilizers: FYM 25 t/ha, 90 kg each of NPK as basal and 45 kg each 20 days after sowing.

After cultivation: First weeding and staking 20 days after sowing.

Plant protection - Pests

Leaf hopper: Methyl demeton 25 EC or dimethoate 30 EC at 2 ml/lit.

Pod borer: Carbaryl 50 WP 2 g/lit.

Diseases

Mosaic: Remove the affected plants and spray with systemic insecticides to control insect vectors.

Powdery mildew: Spray with Wettable sulphur at 2 g/lit or dust with Sulphur 25 kg/ha.

Rust: Dust with Sulphur @ 25 kg/ha.

Anthracnose: Spray with Mancozeb 2 g/lit. Remove the affected plants and pods.

Yield: Green pods 8 - 10 t/ha in 90 to 110 days.

Broad beans: *Vicia faba* L; *Fabaceae*

Varieties: Local, SRS 1, BR 1 and BR 2.

Soil: Thrives in almost all soils with suitable pH range is 6.5-7.5 in hills only. Requires cool climate.

Season and sowing: Sow the seeds during July - August. November - December at 25 kg/ha at 45 x 15 cm spacing.

Preparation of field: Plough the land to a fine tilth and level it and form beds.

Irrigation: Once in 5 days.

Application of fertilizers: Apply 25 t of FYM and 50 kg P and 25 kg K/ha as basal dose. 25 kg N and 25 kg of K/ha are applied between 20 - 25 days after sowing and application of remaining 25 kg of N is done between 40 - 45 days.

After cultivation: Earthing up is done on 45th day after sowing. As soon as the plants start flowering the top is pinched off which causes the pods to develop early.

Yield: 400 - 500 kg of Beans/ha in 10 - 12 months.

Peas: *Pisum sativum* L.; *Fabaceae*

Varieties: Ooty 1, Bonneville, Arkel, Azad.

Soil: Well drained loamy soil with optimum pH range of 6-7.5. Thrives best in cool weather. Withstands low temperature at the seedling stage.

Season and sowing: Sow the seeds from February - March and October - November in line. Treat the seeds with *Tricoderma* 4 g/kg or Thiram or Captan at 2 g/kg of seed to avoid seed borne diseases. Treat the seeds with *Rhizobium* culture at the rate of 2 kg and apply 2 kg *Phosphobacteria* as soil application just before sowing.

Preparation of field: Dig the land thoroughly to fine tilth.

Spacing: 45 x 10 cm.

Seed rate: 100 kg/ha.

Irrigation: Once in a week.

Application of fertilizers: Apply FYM at 20 t/ha and 60 kg N, 80 kg P and 70 kg K/ha as basal and 60 kg N/ha 30 days after sowing.

After cultivation: Weeding should be done 15 days after sowing. Subsequent weedings as and when necessary. Stake the plants.

Plant protection - Pests

Pod borer: Spray carbaryl 50 WP thrice at fortnightly intervals at the rate of 2 g/lit. Dust with carbaryl 10 D at the rate of 25 kg/ha or endosulfan 35 EC @ 2 ml/lit.

Aphids: Spray methyl demeton 25 EC or dimethoate 30 EC or monocrotophos 36 WSC or phosphamidon 40 SL @ 1 ml/lit of water.

Diseases

Powdery mildew: Spray Wettable sulphur 2 g/lit or dust Sulphur at 25 kg/ha or Dinocap 1 ml/lit or Tridemorph 0.5 ml/lit, three rounds at 15 days interval.

Yield: 8 -12 t/ha in 80 - 110 days.

Annual moringa: *Moringa oleifera* L.; *Moringaceae*

Varieties: PKM 1, PKM 2 and KM 1.

Soil: Comes up well in a wide range of soil. A deep sandy loam soil with a pH of 6.5 – 8 is optimum.

Season: July – October.

Seed Rate: 500 g/ha

Sow two seeds per pit at a depth of 2.5-3.0 cm. The seeds can also be sown in the poly bags containing pot mixture and transplanted after 35 -40 days of sowing.

Preparatory cultivation: Dig pits of size 45 cm x 45 cm x 45 cm with a spacing of 2.0-2.5 m either way. Apply 15 kg of compost or FYM/pit after mixing with top soil.

After cultivation: Gap filling may be done within a month. Pinch off the seedlings when they are about 75 cm in height to facilitate more branching. Short duration vegetables like Cowpea, Bhendi and Tomato can be grown as intercrop.

Manuring: A fertilizer dose of 45:15:30 g of NPK/pit may be applied 3 months after sowing. Apply 45 g of N/pit after 6 months when the crop is in bearing.

Irrigation: Irrigate before sowing and on the 3rd day after sowing and subsequently at 10 – 15 days interval according to soil type.

Plant protection - Pests

Fruit fly: Spray dichlorvos (1 ml/lit) or fenthion 1.5 ml/lit to control fruit flies when pods are about 20 – 30 days old. Rake the soil after applying lindane 1.3 D at 25 kg/ha.

Bud worm, leaf caterpillar and leaf webber: Dust carbaryl 10 D at 25 kg/ha or spray carbaryl 50 WP @ 2 g/lit.

Hairy caterpillar

1. Use flame torch when the caterpillars settle on the tree trunk.
2. Spray chlorpyriphos 20 EC or quinalphos 25 EC @ 2 ml/lit.

Ratoon crop: Cut back the trees at 90 cm from ground level after the harvest is over. In another 4 – 5 months, plants will again come for harvest. Ratoon crops can be taken for 3 years. Apply the fertilizer dose of 45:15:30 g NPK/Plant, within a week after cutting back along with 25 kg of FYM or compost every year.

Yield: 50 - 55 tonnes of pods/ha (220 pods/tree/year).

Baby corn: *Zea mays*

Variety: CO 1.

Soil: Suitable for all maize growing soils with pH range of 6-7 and climate.

Season

Irrigated : Through out the year.

Rainfed : June - July and September - October.

Seed rate: 25 kg/ha.

Preparation of field: Plough the field to fine tilth. Form ridges and furrows at a spacing of 45 cm x 25 cm.

Irrigation: First irrigation after sowing, thereafter once in ten days.

Application of fertilisers: Apply FYM 12.5 t/ha, NPK 75, 60, 20 kg/ha as basal, 75 kg N and 20 kg K top dressed on 25th day after sowing.

After cultivation

First weeding	:	15 days after sowing.
Earthing up and top dressing	:	25 days after sowing.
De-Tasseling (removal of male flowers before pollen shedding)	:	40 - 45 days

Plant protection

Basal application

Carbofuran 3 G 10 kg/ha is to be applied and incorporated.

Yield

Tender cob (baby corn)	:	6660 kg/ha
Green fodder	:	32.2 t/ha

CHAPTER B

Cole vegetables

Cabbage: *Brassica oleracea var. capitata; Brassicaceae*

Varieties

Hills: Quisto.

Plains: Golden Acre, Maha Rani.

Soil: It is commonly cultivated in cool moist climate. It is grown as a winter crop in plains. It is grown in varied types of soils ranging from sandy loam to clay. It requires a pH ranging from 5.5 to 6.5 for higher production.

Season of sowing

Hills: January – February, July – August, September – October.

Plains: August – November.

Seed rate: 650 g/ha.

Nursery: 100 sq.m nursery area/ha. Apply FYM at 300 kg, and 10 kg of No.5 mixture (9:9:9) along with 50 g of Sodium molybdate and 100 g of Borax. Sow the seeds at 10 cm between rows in raised seed beds after drenching it with Copper oxychloride (2.5 g/lit). Transplant 40 -45 days old seedlings at a spacing of 45 cm. Avoid land infected with 'club root disease'.

Preparation of field: Bring the soil to a fine tilth. Pits should be taken up at a spacing of 40 cm either way in Hills. Ridges and furrows are formed at 45 cm apart in plains.

Spacing

Hills : 40 x 40 cm

Plains : 45 x 30 cm

Irrigation: Provide continuous supply of moisture.

Application of fertilizers

Hills: Apply 30 t/ha FYM, 90 kg N, 90 kg P and 90 kg K as basal and 45:45:45 kg NPK/ha 30 to 45 days after planting. Departmental Micronutrient mixture (Borax & Molybdenum) at the rate of 2 kg per ha as basal dressing.

Plains: Apply 20 t/ha of FYM. 50 kg N, 125 kg P and 25 kg K/ha along with 2 kg *Azospirillum* as basal and 50 kg N after one month of planting and earth up.

After cultivation: Deep hoeing should be avoided, as the Cabbage roots are surface feeders.

Plant protection - Pests

Cut worms: Apply chlorpyriphos 2 ml/lit in the collar region during evening hours for the control of common cutworm - *Agrotis segetum*.

Aphids: The incidence is severe during autumn season. Install yellow sticky trap at 12 no/ha to monitor “macropterous” adults (winged adult).

Spray neem oil 3 % or dimethoate 2 ml/lit with 0.5 ml Teepol/lit.

Diamond backmoth

1. Grow mustard as intercrop as 20:1 ratio to attract diamond back moths for oviposition. Periodically spray the mustard crop with insecticide to avoid the dispersal of the larvae.
2. Install pheromone traps at 12/ha.
3. Spray cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* 2 g/lit at primordial stage (ETL 2 larvae/plant)
4. Spray NSKE 5 % after primordial stage.
5. Release parasite *Diadegma semiclausum* at 50,000/ha, 60 days after planting.

Diseases

Club root: Seed treatment at 10 g/ kg of seeds or soil application @ 2.5 kg/ha or seedling dip in solution of 5g/ litre with *Pseudomonas fluorescens*. Dip the seedlings in Carbendazim solution (1 – 2 g/lit) for 2 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit of water. Follow crop rotation. Crucifers should be avoided for three years.

Leaf spots: Spray Mancozeb at 2 g/lit or Carbendazim 1 g/lit.

Leaf Blight: Spray Mancozeb @ 2.5 g/ litre.

Ring spot: Spray Mancozeb 2 g/lit or Carbendzim 1 g/lit or Copper oxychloride 2.5 g/lit.

Downy mildew: Spray combination of Metalaxyl + Mancozeb 2 g/lit 3 sprays at 10 days interval.

Black rot: Dip the seeds in 100 ppm Streptocycline for 30 minutes. Two sprays with 2 g/lit Copper oxychloride + Streptomycin 100 ppm after planting and head formation.

Yield

Hills : 70 – 80 t/ha in 150 days.

Plains : 25 – 35 t/ha in 120 days.

Cauliflower: *Brassica oleracea var. botrytis; Brassicaceae*

Varieties

Hills: Ooty 1, Pusa Dapoli.

Plains: Early Synthetic and Tropi cross.

Soil: It requires cool moist climate. The early varieties may tolerate higher temperature and long days. This can be grown in plains during September to February. Deep loamy soils are good with higher organic matter and good drainage. It can be grown in a pH range of 5.5 to 6.6.

Season and sowing

Nursery: 100 sq.m nursery area/ha. Apply FYM at 300 kg and 10 kg of No.5 mixture (9:9:9) along with 50 g of Sodium molybdate and 100 g of Borax. Sow the seeds at 10 cm between rows in raised seed beds after drenching it with Copper oxychloride (2.5 g/lit). Transplant 30 to 40 days old seedlings at a spacing of 45 cm. Avoid land infected with 'club root disease'.

Seed rate: 375 g/ha.

Sow the seeds in raised beds and transplant 25 days (early varieties), 45 days old seedlings (late varieties) at 45 cm apart.

Preparation of field: Bring the soil to fine tilth. Pits should be taken at a spacing of 45 cm either way in hills. Form ridges and furrows at 60 cm in plains.

Irrigation

Hills: Once in a week during January and February.

Plains: Once in a week.

Application of fertilizers

Hills: Apply 30 t/ha of FYM and 90 kg N, 90 kg P and 90 kg K as basal dose and 45:45:45 kg NPK/ha after 45 days.

Plains: Apply 15 t of FYM/ha and 50 kg N, 100 kg P and 50 kg K as basal and 50 kg N after 45 days. Apply 2 kg of Departmental Vegetable micronutrient mixture without mixing with the chemical fertilizers.

After cultivation: Gap filling after 20 days of planting to maintain the population and uniform growth. Hoeing and weeding on 30th and 45th day. Avoid deep intercultivation as it is a shallow rooted crop.

Plant protection - Pests

Cut Worms: Set up light trap in summer months. Spray chlorpyriphos 2 ml/lit in the collar region during evening hours.

Aphids: The incidence is severe during autumn season. Install yellow sticky trap at 12 no/ha to monitor Macropterous adults (winged adult).

Spray neem oil 3 % or dimethoate 2 ml/lit with 0.5 ml Teepol/lit.

Diamond backmoth

1. Grow mustard as intercrop at 20:1 ratio.
2. Install pheromone traps at 12 No/ha.
3. Spray cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* 1g/lit at primordial stage (ETL 2 larvae/plant)
4. Spray NSKE 5 % after primordial stage.
5. Release larval parasite *Diadegma semiclausum* (Ichneumonidae: Hymenoptera) at 50,000/ ha, 60 days after planting.

Diseases

Club root: Seed treatment at 10 g/ kg of seeds or soil application @ 2.5 kg/ha or seedling dip in solution of 5g/ litre with *Pseudomonas fluorescens*. Dip the seedlings in Carbendazim solution (1 – 2 g/lit) for two minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit. Follow crop rotation. Crucifers should be avoided for three years.

Leaf Spot: Spray Mancozeb at 2 g/lit or Carbendazim 1 g/lit.

Leaf Blight: Spray Mancozeb @ 2.5 g/ litre.

Blanching: Blanching refers to covering of curds. A perfect curd of flower is pure white. It is necessary to exclude sunlight to obtain this. The common practice is to bring the outer leaves up over the curd and tie them with a twine or rubber band. By using a different coloured twine each day. It is easy at the time of harvest to select those tied earlier.

Physiological disorders

Browning or brown rot: This is caused by Boron deficiency. It appears as water soaked areas and later changes into rusty brown. Spray one kg of Borax in 500 lit of water 30 days after planting.

Whip tail: This results from the deficiency of Molybdenum. It is more pronounced in acidic soil. The leaf blades do not develop properly. In severe cases only the midrib develops and it can be corrected by spraying 100 g of Sodium molybdate in 500 lit of water 30 days after planting.

Buttoning: The term buttoning is applied to the development of small curds or buttons. The plants do not develop normally and leaves remain small and do not cover the developing curds. Deficiency of Nitrogen and planting the early varieties late may cause these symptoms. Avoid transplanting aged seedlings.

Blindness: Blind-cauliflower plants are those without terminal buds. The leaves are large, thick, leathery and dark green. It is due to the prevalence of low temperature when the plants are young or due to damage to the terminal bud during handling the plants or due to injury by pests.

Yield

Hills : 20 – 30 t/ha

Plains : 15 – 20 t/ha

CHAPTER C

Root and Tuber vegetables

Carrot: *Daucus carota* L; *Umbelliferae*

Varieties

Hills: Ooty-1, Early Nantes and New Korda

Plains: India Gold, Pusa Kesar and Half Long Danvers.

Soil: The Carrot is a cool season crop and when grown at 15°C to 20°C will develop a good colour. The carrot crop needs deep loose loamy soil. It requires a pH ranging from 6.0 to 7.0 for higher production.

Season

Hills: At elevation above 1500 metres, Carrot can be grown throughout the year under assured irrigation. At elevations between 1000 – 1500 metres. Carrot can be grown in July – February.

Plains: August.

Seed rate: 4 kg/ha.

Mark the rows with a spacing of 25 – 30 cm apart. Sow the seeds mixed with sand (one part of seed with 4 parts of sand).

Thinning

Hills: 10 cm between plants.

Plains: 5 cm between plants.

Preparation of field

Hills: Prepare the land to a fine tilth and form raised beds of one metre breadth and convenient length.

Plains: Two ploughings are given and ridges and furrows are formed at 30 cm spacing.

Irrigation: Once in five days.

Application of fertilizers: 30 t FYM and 90:90:90 kg of NPK per ha as basal dose and 45:45:45 kg NPK after 45 days. Apply 25 kg of $ZnSO_4$/ha as basal.

After cultivation: Spray Fluchloralin 1 lit a.i./ha immediately after sowing the seeds to control weeds or first weeding to be done on 15th day. Thinning and earthing up should be given on 30th day.

Plant protection: Carrot is not much affected by pests.

Nematode: Application of neem cake @ 1 ton/ha at planting to control root knot nematode, *Meloidogyne* spp.

Diseases

Leaf spot: Spray Mancozeb at 2 g/lit.

Yield: 25 – 30 t/ha in 100 – 120 days.

Radish: *Raphanus sativus* L; *Brassicaceae*

Varieties

Hills: Nilgiris Red, Japanese Long.

Plains: CO 1, Pusa Rashmi, Pusa Chetki, Pusa Desi, Japanese White and Arka Nishant.

Soil: Sandy loam soils with high organic matter. The optimum soil pH is 5.5 to 6.8. Roots of best size, flavour and texture are developed at about 15°C.

Season of sowing: June –July in hills and from September in plains.

Seed rate: 10 kg/ha.

Preparation of field: The land should be prepared to fine tilth and levelled.

Spacing: 15 x 10 cm.

Irrigation

Plains: Once in a week.

Application of fertilizers

Plains: Apply FYM at 25 t/ha and 25 kg N, 100 kg P and 50 kg K/ha as basal dressing and 25 kg N/ha after 30 days.

After cultivation: Weeding and hoeing. At the second weeding, thinning of thickly sown plants should be done.

Plant protection - Pests

Aphids, flea beetles and mustard saw fly: Spray malathion 50 EC 1 ml/lit twice or thrice at 10 days intervals.

Diseases

White rust: Spray Mancozeb 2 g/lit or Copper oxychloride 2 g/lit.

Yield: 20 – 30 t/ha in 45 – 60 days.

Beet root: *Beta vulgaris* L.; *Chenopodiaceae*

Varieties: Ooty 1, Crimson Globe, Detroit Dark Red and Red Ball.

Soil: It comes up well in all types of friable soils. The suitable soil pH is 6.0-7.0. It is considered to be a cool weather crop.

Season and sowing: July – August.

Seed rate: Sow 6 kg/ha directly in ridges at a spacing of 10 cm.

Preparation of field: Plough to a fine tilth and ridges and furrows are formed at 30 cm apart.

Irrigation: Irrigate the field copiously immediately after sowing and afterwards as and when necessary.

Application of fertilizers: Apply FYM at 20 t/ha and 60:160:100 kg NPK/ha as basal and 60 kg N/ha after 30 days.

After cultivation: 20 days after sowing thin to a single seedling per hill.

Plant protection - Pests

Leaf miner and flea beetle: Spray malathion 50 EC 2 ml/lit.

Diseases

***Cercospora* leaf spot:** Spray Mancozeb at 2 g/lit.

***Rhizoctonia* root rot:** Spot drenching with Carbendazim at 1 g/lit.

Yield: 20 - 25 t/ha in 120 days.

Potato: *Solanum tuberosum* L.; *Solanaceae*

Varieties: Kufri Jyoti, Kufri Muthu, Kufri Swarna, Kufri Thangam and Kufri Malar.

Soil: The soil should be friable, porous and well drained. The optimum pH range is 4.8 to 5.4. It is a cool weather crop. Potato is mostly grown as a rainfed crop. Cultivated in regions receiving a rainfall of 1200 - 2000 mm per annum.

Season and planting

Hills

Summer : March – April

Autumn : August – September

Irrigated : January – February

Plains: October – November.

Use disease free, well spouted seeds weighing 40 – 50 grams. Use Carbon disulphide 30 g/100 kg of seeds for breaking the dormancy and inducing sprouting of seeds. Plant the tubers at 20 cm apart.

Seed rate: 3000 – 3500 kg/ha.

Preparation of field: Prepare the land to fine tilth. In hills provide an inward slope of 1.40 in the terraces. Provide drainage channel along the inner edge of the terrace. Form ridges and furrows with a spacing of 45 cm between ridges either by hand hoe or ridger.

Irrigation: Irrigate the crop 10 days after planting. Subsequently irrigation should be given once in a week.

Application of fertilizers: Apply 15 t of FYM/ha, and 2 kg each of *Azospirillum* and *Phosphobacteria* as basal and 120 kg N, 240 kg P and 120 kg K/ha in two splits; half as basal and the balance for top dressing 30 days after sowing. Apply Magnesium sulphate at 60 kg/ha as basal dose.

After cultivation

Weed control: Spray of Gramaxone @ 2.5 lit/ha in 500 lit of water as post - emergence. The critical period of weed-competition is upto 60 days and it is essential to keep the field weed-free during that period. Take up the first hoeing on 45th day without disturbing stolons. Second hoeing and earthing up at 60th day.

Plant protection - Pests

Nematodes: Avoid growing potato year after year in the same field. Follow rotation of crop with vegetables and green manure. Application of carbofuran 3 G (1.0 kg a.i.) 33 kg/ha in furrows while seeding. For cyst nematode resistant variety Kufri Swarna, half dose of the above nematicide is enough.

Biological control of nematodes: Applicaton of *Pseudomonas fluorescens* at 10 kg/ha.

Aphids: Spray methyl demeton 25 EC or dimethoate 30 EC 2 ml/lit.

Cut worms

1. Install light trap during summer to attract adult moths.
2. Install Sprinkler irrigation system and irrigate the field in day time to expose the larvae for predation by birds.
3. Drench the collar region of the plants in evening hours with chlorpyriphos or endosulfan 2 ml/lit a day after planting.

White grub

1. Summer ploughing to expose the pupae and adults.
2. Dust endosulfan 5 D or quinalphos 5 D at 25 kg/ha 10 days after first summer rains.
3. Install light traps between 7 p.m. and 9 p.m. in April - May months.
4. Hand pick the adult beetles in the morning.
5. Hand pick the 3rd instar grub during July - August.
6. In endemic areas apply phorate 10 G at 25 kg/ha during autumn season (August - October).

Potato tuber moth

1. Avoid shallow planting of tubers. Plant the tubers to a depth at 10 - 15 cm deep.
2. Install pheromone traps at 20 No/ha.
3. Earth up at 60 days after planting to avoid potato tuber moth egg laying in the exposed tubers.
4. To control foliar damage spray NSKE 5 % or quinalphos 20 EC 2 ml/lit (ETL 5 % leaf damage).
5. Keep pheromone traps in godowns.
6. In godowns cover the upper surface of potato leaves with *Lantana* or *Eupatorium* branches to repel ovipositing moths.
7. Treat the seed tubers with quinalphos/endosulfan dust @ 1 kg/100 kg of tubers.

Diseases

Late blight: Carefully select seed tubers. Remove ground creepers which serve as a source of infection. Spray Mancozeb 2 g/lit or Chlorothalonil 2 g/lit on 45, 60 and 75 days after planting. Grow late blight resistant varieties like Kufri Jyothi, Kufri Malar and Kufri Thangam.

Brown rot: Select disease free seeds. Give proper drainage facilities. Remove and destroy the affected plants.

Early blight: Spray Mancozeb 2 g/lit or Chlorothalonil 2 g/lit at 45, 60 and 75 days after planting.

Virus diseases: Use virus free potato seeds. Rogue the virus affected plants regularly. Control the aphid vectors by spraying Dimethoate or Methyl demeton 2 ml/ha.

Yield: 15 – 20 t/ha in a duration of 120 days.

Sweet potato: *Ipomoea batatas* (L) Lam; *Convolvulaceae*

Varieties: CO 3, CO - CIP 1, Sree Nandini, Sree Vardhini, Kiran, Sree Bhadra, Sree Rethna, Gouri and Sankar.

Soil: Can be grown in loamy soil with a pH range of 5.6-6.6. It requires a warm and moist climate.

Season and planting: June – July and September. Plant the terminal vine cuttings (80,000/ha) at 20 cm spacing. The cuttings should be 10-15 cm in length with 2-3 nodes and to be collected from matured vines aged 3 months and above. Dip the vine cuttings in a solution by mixing 400 g of *Azospirillum* in sufficient quantity of water.

Preparation of field: Plough the field to fine tilth. The soil depth should be atleast 30 cm. Form ridges and furrows at 60 cm apart. Can be grown in beds also.

Irrigation: Irrigate before planting, on 3rd day and then after once in a week. Stop irrigation one week before harvest.

Application of fertilizers: Apply 25 t FYM/ha and 20:40:60 kg NPK/ha as basal and 20:40:60 kg NPK/ha after 30 days. If 20 kg/ha *Azospirillum* is applied, apply only 2/3rd dose of N. It is preferable to apply N and P in the form of DAP (Diammonium phosphate).

After cultivation: The field should be kept clean by hand weeding till vines are fully developed. Earth up the field on 25th, 50th and 75th day after planting. The vines are lifted and turned on 50th and 75th day after planting but before earthingup to prevent root formation at nodes and to make the originally formed roots larger. Spray Ethrel five times at 250 ppm at fortnightly intervals commencing from 15 days after planting.

Plant protection - Pests

Sweet potato weevil

1. Remove previous sweet potato crop residues and alternate host *i.e., Ipomoea* sp. and destroy them.
2. Use pest free planting materials.
3. Dip the planting material in fenthion 100 EC or fenitrothion 50 EC or monocrotophos 36 WSC @ 2 ml/lit.
4. Rake up the soil and earth up at 50 days after planting.
5. Drench the soil with endosulfan 35 EC or fenthion 100 EC at 2 ml/lit. Spray any one of the insecticides, if needed.
6. Harvest the crop immediately after maturity and destroy the crop residues.

Diseases

Soft rot: Spot drench with Carbendazim 1 g/lit.

Yield: 20-25 t/ha of tubers in 110 – 120 days.

Tapioca: *Manihot esculenta* Crantz.; *Euphorbiaceae*

Varieties: CO 2, CO 3, CO (TP) 4, MVD 1, H 165, H 226, Sree Vishakam (H.1687), Sree Sahaya (H.2304), Sree Prakash (S. 856), Sree Vijaya, Sree Jaya, Sree Rekha and Sree Prabha.

Soil: Any well drained soil preferably red lateritic loam with a pH range of 5.5-7.0. Thrives best in tropical, warm humid climate with well distributed rainfall of over 100 cm per annum. Cultivated upto an elevation of 1000 m.

Season and planting: Plant throughout the year under irrigation. Plant during April for rainfed crop. Select healthy mosaic free vigorous plants for taking planting materials. Prepare setts of 15 cm long with 8 – 10 nodes from the middle portion of the stem. Avoid mechanical damage while preparation and handling of setts. The cut end should be uniform. Dip the setts in Carbendazim 1 g in one lit of water for 15 minutes before planting. Plant the setts vertically with buds pointing upward on the sides of ridges and furrows. 17,000 setts are needed for one ha.

For rainfed conditions, treat the setts with a mixture of Potassium chloride @ 5 g/lit and micronutrients viz., $ZnSO_4$ and $FeSO_4$ each @ 0.5%for 20 minutes.

Dip the setts for 20 minutes in *Azospirillum* and phosphobacteria each at 30 g/lit.

Preparation of field: Plough the field 4 – 5 times to get a fine tilth. The soil depth should be atleast 30 cm. Form ridges and furrows at the following spacings:

Irrigated: 75 x 75 cm (17,777 setts) and 90 x 90 cm (12,345 setts)

Rainfed: 60 x 60 cm (27,777 setts)

Under Kanyakumari conditions: 90 x 90 cm (12,345 setts)

Irrigation: First irrigation is given at the time of planting. Life irrigation is given on the 3rd day followed by once in 7 – 10 days upto 3rd month and once in 20 – 30 days upto 8th month.

Sequential cropping: Raise CO 2 vegetable cowpea during March and harvest green pods before planting cassava during June –July. After green pod harvest, incorporate the cowpea haulms into the field by disc ploughing. Through sequential cropping 50% reduction in application of FYM (12.5 t/ha) and P (30 kg/ha) is ensured.

Manuring

Irrigated crops: Apply 25 t FYM/ha and incorporate at the time of planting. Apply 45:90:120 kg NPK/ha as basal and 45:120 kg NK/ha 90 days after planting during earthing up.

Rainfed crop: FYM at 12.5 t/ha along with 50 kg N, 65 kg P and 125 kg K/ha as basal. 2 kg of *Azatobactor* as soil application at 30 – 60 days after planting on receipt of showers (2.0 kg *Azatobacter* + 20 kg FYM + 20 kg soil per hectare).

Chlorosis: Foliar spray of 1% $FeSO_4$ + 0.5% $ZnSO_4$ at 60 and 90 DAP.

After cultivation: Fill up the gaps within 20 days of planting. Carry out 1st weeding 20 days after planting. Subsequent weedings should be done once in a month upto 5 months depending upon the weed intensity.

Thin to two shoots per plant during 60th day. Grow aggregatum onion, coriander, short duration pulses and short duration vegetables as intercrops.

Plant protection - Pests

Mites: Soaking spray with dicofol 18.5 EC 2.5 ml/lit during 3rd and 5th month.

White fly (*Bemisia tabaci*)

Integrated pest management practices:

1. Remove alternate weed hosts viz., *Abutilon indicum*.
2. Install yellow sticky trap at 12 Nos/ha.
3. Use nitrogen judiciously.
4. Avoid excessive irrigation.
5. Spray neem oil 3 % or fish oil rosin soap 25 g/lit or methyl demeton 25 EC 2 ml/lit. While using neem oil teepol or sandovit should be added at 1 ml/lit for better contact with foliage. Apply methyl demeton in the early stage and phosalone in the late stages of crop growth.
6. Avoid use of synthetic pyrethroids.
7. Avoid extending the crop growth beyond its duration.

Spiralling whitefly

1. Grow resistant genotypes.
2. Install sticky cum light trap and operate between 4 to 6 AM to attract the adult.
3. Spray dichlorvos 76 WSC @ 1 ml/lit or triazophos 40 EC 2 ml/lit. Add wetting agent.
4. Conserve parasitoids *Encarsia haitiensis, E. guadeloupae.*

Diseases

Mosaic: Select the planting materials from healthy plants. For the control of white fly vectors, adopt IPM practices mentioned above.

***Cercospora* Leaf spot:** Spray Mancozeb at 2 g/lit twice at 15 days interval.

Tuber rot: Avoid water stagnation. Give good drainage facilities. Spot drenching with Copper oxychloride 2.5 g/lit.

Iron deficiency: Spray 3 to 4 times Ferrous sulphate 2.5 g/lit on the appearance of deficiency symptom at weekly intervals. Equal quantity of lime should be added for neutralising the solution.

Crop duration: 9 to 11 months.

Yield

Irrigated : 40 - 50 t/ha

Rainfed : 20 - 25 t/ha

Elephant yam: *Amorphophallus companulatus* Blume; *Araceae*

Varieties: Gajendra, Sree Padma

Soil: Rich red-loamy soil with a pH range of 5.5-7.0 is preferred. It is a tropical and subtropical crop. It requires well distributed rainfall with humid and warm weather during vegetative phase with cool and dry weather during the corm development period.

Season and planting: April – May.

The tuber is cut into small bits in such a way that each bit has atleast a small portion of the ring around each bud. There are also projections with tender buds called “Arumbu”. These are removed before planting as they do not give vigorous growth. An ordinary sized yam gives about 6 to 8 bits for planting. The cut pieces are dipped in cow dung solution to prevent evaporation of moisture from cut surface. In some places, the small round daughter corms are also planted. The cut pieces are planted in beds at 45 cm x 90 cm spacing. The pieces are planted in such a way that the sprouting region (the ring) is kept above the soil. About 3500 kg of corms will be required to plant one hectare. Sprouting takes place in about a month.

Preparation of field: The land is brought to fine tilth and form beds of convenient size.

Intercropping: Vegetable cowpea var. CO 2 is recommended as suitable intercrop in Amorphophallus.

Irrigation: Weekly once.

Application of fertilizers: Apply 25 tonnes of FYM/ha and incorporate during last ploughing and 80:60:100 kg NPK/ha two months later.

After cultivation: Weeding and earthing up as and when necessary.

Yield: 30 – 35 t/ha in 240 days.

For seed purpose, the yams can be left in the field itself till planting the next crop or the lifted yams can be stored in sand or paddy straw.

Colocasia: *Colocasia esculenta* L. Scott; *Araceae*

Varieties: Co 1, Panchamukhi and Satamukhi (Kovvur), Sree Pallavi, Sree Rashmi

Soil: It comes up well in loamy soils with a pH range of 5.5-7.0 and a combination of warm and moist climate. It can be grown up to 1500 m elevation.

Seed rate: 800 kg/ha.

Season and planting: June – July and February – March. Plant at a spacing of 45 cm in furrows.

Preparation of field: Plough the field to a fine tilth and form ridges and furrows at a spacing of 45 cm.

Irrigation: Once in a week.

Application of fertilizers: Apply 25 tonnes of FYM, 20 kg N, 30 kg P and 60 kg K/ha as basal and 20 kg N, 30 kg P and 60 kg K/ha 45 days after planting.

After cultivation: Weeding and earthing up should done 45 to 60 days after planting. Deep cultivation should be avoided. It requires profuse irrigation and shade.

Yield: 8 – 10 t/ha in 180 days.

Dioscorea: *Dioscorea esculenta* L. *Dioscorea alata* L.; *Dioscoreaceae*

Varieties

Peruvalli (*D.alata*) : CO 1, Sree Roopa, Sree Keerthi, Sree Shilpa

Siruvalli (*D.esculenta*) : Sree Latha, Sree Kala

Soil: Sandy loam soil with a pH of 6.0 to 6.5 is preferred with good drainage and cool weather.

Season and planting: May – June.

Use mature tubers or pieces of tubers taken from the previous crop as seed material at the rate of 1875 – 2500 kg/ha. Mini setts of 25 g is recommended for planting directly in the field or raising a nursery and planting plants after 60 days. Planting is done in beds or in ridges or in mounds or in rows 75 cm apart either way.

Preparation of field: Plough the field to a fine tilth and form ridges and furrows at 75 cm spacing.

Irrigation: Copious watering once in a week is necessary.

Application of fertilizers: Apply FYM @ 25 t/ha at the time of last ploughing. Follow fertilizer schedule of 40:60:120 kg NPK/ha as basal. 4 kg/ha of *Azospirillum* (mixed with 40 kg of soil) 30 days after planting. Apply 50 kg N and 120 kg K/ha 90 days after planting.

After cultivation: The vines should be trained on bamboo poles. Weeding as and when necessary.

Yield: 20 – 25 t/ha in 240 days.

Coleus / Chinese potato: *Coleus parviflorus* L.; Syn : *Solenostemon rotundifolius*; *Labiatae*

Varieties: CO 1, Sree Dhara

Soil: Red, loamy and well drained soils. Comes up well in shade with warm humid climate.

Season and planting: Harvest the tubers in January and store under room temperature for two months. Plant the sprouted tubers in the nursery beds in March – April. Use herbaceous cuttings of 10 cm length taken from the nursery beds and plant in the main field during July – August at a spacing of 30 cm.

Preparation of main field: The field is ploughed 4 to 5 times to a fine tilth and form ridges and furrows 60 cm apart.

Irrigation: At weekly intervals.

Application of fertilizers: FYM at 25 t/ha as basal and NPK at 30:60:150 kg/ha. Apply 30 kg N 30 days after planting at the time of earthing up along with 2 kg of *Azospirillum*.

After cultivation: 2 or 3 weedings and earthing up 2 months after planting.

Yield: 15 to 20 t/ha in 120 days.

CHAPTER D

Bulb vegetables

Onion - Small Onion (Aggregatum); *Allium cepa var. aggregatum; Alliaceae*

Varieties: CO 1, CO 2, CO 3, CO 4 and MDU 1, CO(On) 5 free flowering and seed setting type.

Soil: Red loam to black soils with good drainage facilities. It grows well between pH range of 6-7 and a mild season in without extremes of heat and cold.

Season and sowing: Sow the medium sized bulbs during April – May and October – November.

Seed rate: 1000 kg/ha.

Preparation of field: Plough the land to a fine tilth. Form ridges and furrows at 45 cm spacing. Sow the bulbs on both the sides of the ridges at 10 cm apart.

Irrigation: After sprouting, irrigate at weekly intervals. Withhold irrigation 10 days before harvest.

Application of fertilizers: Apply FYM 25 t/ha, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg/ha, N 30 kg, P 60 kg and K 30 kg/ha as basal and 30 kg N/ha on 30th day of sowing.

Plant protection - Pests

Thrips and onion fly: Methyl demeton 25 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or monocrotophos 36 WSC 1 ml/lit with Teepol 0.5 ml/lit.

Cutworm: Drench the soil with chlorpyriphos @ 2 ml/lit.

Diseases

Leaf spot: Spray Mancozeb 2 gm/lit or Copper oxychloride 2.5 gm/lit. Add Teepol 0.5 ml/lit of spray fluid.

Harvest and Yield

12 – 16 t/ha in 70 to 90 days. 18 t/ha in 90 days for CO(On) 5 onion

Clean and dry the bulbs for 4 days in shade soon after harvest.

Spray Maleic hydrazide at 2500 ppm 15 days before harvest to extend the shelf life of onion.

Bellary onion: *Allium cepa var. cepa; Alliaceae*

Varieties: Bellary Red, Pusa Red, NP 53, Arka Niketan, Arka Kalyan, Agri Found Light Red and Agri Found Dark Red, Rose onion (small)

Soil: Red loam to black soils with good drainage facilities. The optimum pH would be 5.8-6.5. Mild season is preferred.

Season: May – June.

Seed rate and Sowing: 10 kg/ha. Treat the seeds with *Azospirillum* @ 400 g/kg of seed using rice gruel as adhesive, dry under shade for 30 minutes and sow them. Apply VAM 1 kg/sq. m in the beds along with FYM 10 kg/sq.m before sowing.

Preparation of main field: Plough the land to get a fine tilth and incorporate 25 t/ha of FYM at the time of last ploughing. Form ridges and furrows at 45 cm spacing. Plant 45 days old seedlings at 10 cm apart on both the sides of the ridges.

Irrigation: After establishment irrigate at weekly intervals.

Application of fertilizers: Apply FYM 25 t/ha, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg/ha, N 50 kg, P 150 kg and K 75 kg/ha as basal dose and N 50 kg/ha as Top-dress 30 days after planting. Apply Zinc sulphate as basal dose @ 50 kg/ha at the time of last ploughing.

Plant protection - Pests

Thrips and onion fly: Methyl demeton 25 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or monocrotophos 30 WSC 1 ml/lit with Teepol 0.5 ml/lit.

Cutworm: Drench the soil with chlorpyriphos @ 2 ml/lit.

Nematode: Application of Carbofuran 3 G 1 kg a.i./ha or phorate 10 G 1 kg a.i./ha at 10 days after transplanting.

Disease

Leaf spot: Spray Mancozeb 2 g/lit or Copper oxychloride 2 g/lit. Add 1 ml of Teepol to 1 lit spray fluid.

Yield: 15 – 18 t/ha in 140 – 150 days.

CHAPTER E

Leafy vegetables

Amaranthus: *Amaranthus* sp *L.; Amaranthaceae*

Varieties

CO 1 (Mulaikeerai and Thandukeerai)

CO 2 (Mulaikeerai and Thandukeerai)

CO 3 (Clipping)

CO 4 (Grain)

CO 5 (Mulaikeerai and Thandukeerai)

Soil: Well drained loamy soils with slightly acidic nature and warm climate are suitable.

Season and sowing: Can be sown throughout the year.

Seed rate: 2.5 kg/ha.

Broadcast the seeds evenly on the bed after mixing with 10 parts of sand.

Preparation of field: The field is prepared to a fine tilth and beds of 2 x 1.5 m are formed. After germination thin the seedlings to have a spacing of 12 – 15 cm.

Irrigation: Irrigate before and after sowing and at weekly intervals after germination.

Application of fertilizers: Apply FYM 25 t/ha, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg/ha, N 75 kg and K 25 kg per ha as basal dose.

Plant protection - Pests

Ants: Apply lindane 1.3% dust @ 10 kg/ha around the beds to control ants, termites and other burrowing insects.

Leaf eating caterpillar: Carbaryl 50 WP @ 2 g/lit.

Harvest and yield

Leafy types

25 days after sowing for Mulaikeerai (10 t/ha);

40 days after sowing for Thandukeerai (16 t/ha).

Clipping types: 10 clippings at weekly intervals (30 t/ha).

Grain types: CO 4 – 2.4 t grains/ha + 8 tonnes of tender greens.

CURRY LEAF; *Murraya koenigii* Linn. Sprengal; Rutaceae

Varieties: Sen Kaampa, Dharwad-1, Dharwad-2

Soil and climate: Red sandy loam with good drainage will be ideal for its normal and fleshing growth which will result in better leaf yield. The optimum temperature requirement is 26 to 37.

Season of sowing and planting: The main season of availability of curry leaf fruits is July – August with in 3-4 days of collection of fruits, the seeds should be pulped and sown in nursery beds or poly bags.

One year old seedlings are suitable for planting. One seedling is planted at the centre of the pit.

Preparation of field: The field is ploughed 3-4 times to get a fine tilth. Before last ploughing well decomposed FYM is applied @ 20 tonnes/ha. Pit size of 30 x30x30 cm are dug one to two months before planting at a spacing of 1.2 to 1.5 m.

Irrigation: Immediately after planting the pits are irrigated. On the third day the second irrigation is given, then the irrigation is given once in a week.

Application of fertilizers: After each harvest 20 kg of FYM/plant is applied and mixed with soil.

Inter cultivation: Periodical hoeing and first year one intercrop like pulses can be taken. After attaining 1 m height, the terminal bud is cut off to encourage basal branching. In total 5-6 branches are maintained per bush. Ten to twelve months after planting the first harvest starts.

Plant protection - Pests

Citrus butterfly : Hand picking and destruction of the larvae. Malathion @ 1 ml/ lit.

Psyllid bug and scale: Dimethoate @ 1 ml/lit.

Diseases

Leaf spot: carbendazim @ 1 g/lit of water. Spraying sulphur compounds should be avoided.

Harvest and yield: At the end of first year 250-400 kg of leaves/ha can be harvested.

In II year	**:**	Once in 4 months every time 1800 kg/ha which would work out to 5400 kg/ha/year.
III year	**:**	Yield 5400 kg/ha
IV year	**:**	2500 kg/ha once in 3 months which would work out to 10,000 kg/ha/ year
V year onwards	**:**	5000 kg/ha once in 3 months which work out to 20,000 kg/ha/year.

CHAPTER F - MINOR VEGETABLE CROPS

Name of crop	Varieties	Method of propogation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	yield
Coccinia(*Coccinia indica*)	Padappai	Stem cuttings from pistillate plants	2 x 2 m	10 t FYM, 75 kg N, 40 kg P and 75 kg K/ha	Erection of pandal or trellis and training the vines	Yields 6 months after planting and continues throughout the year	10 - 15 t/ha
Chekurmanis (*Sauropus androgynus*)	-	Stem cuttings	45 x 60 cm	5 - 10 kg FYM per plant	Weeding, pruning once in a year	Yields four months after planting throughout the year	5 kg leaves per plant
Bread fruit (*Artocarpus altilis*)	Seedless and seeded types	Root cuttings/air layering of root suckers/seedling	12 x 12 m	-	-	First harvest 5 to 6 years after planting. February - March, June - August	300 - 500 fruits/tree
Ceylon spinach (*Talinum triangulare*)	-	Tender herbaceous stem cuttings	15 x 15 cm	-	Grows well under shade	Harvest within a month after planting and continues throughout the year	4000 - 6000 kg/ha

Name of crop	Varieties	Method of propogation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	yield
Mint *(Mentha virides)*	-	Cuttings	15 x 15 cm	-	-	Harvest one month after planting and continues through out the year	2000 kg/ha
Palak (*Beta vulgaris var. Bengalensis)*	Ooty 1	Seeds 20 - 25 kg/ha	20 x 10 cm	FYM 25 t/ha, N 60 kg, P 60 kg and K 60 kg/ha	-	First harvest of leaves one month after sowing. Total duration 3 months	20000 kg/ha
Basella(Green : *Basella alba*) (Pink: *Basella rubra*)	-	Stem cuttings and seeds	2 x 2 m in pits	10 kg FYM per pit	Train the vines on trellis or pandals	Harvest 2 months after planting throughout the year	4000 - 6000 kg/ha
Brussels sprout (*Brassica oleracea* var. *Gemmifera)*	Jade cross	Seeds 500 g/ha	60 x 50 cm	-	-	Starts yielding in 6 months; continues for 3 years	4 - 5 t/ha
Asparagus (*Asparagus officinalis* var.*altilis*)	Marth Washington, Mary Washington.	Seeds and Crowns	30 x 30 cm	Basal: N 50 kg, P 10 kg and K 75 kg/ha	-	Harvest from third year of planting	1250 - 3750 kg/ha

Name of crop	Varieties	Method of propogation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	yield
Celery (*Apium graveolens)*	Standard Bearer, Wright Grove Grant Giant Pascal	Seeds (125 g/ha)	60 x 15 cm	Top dress: N 140 kg, P 55 kg and K 220 kg/ha	-	Crop duration 4-5 months	10 t/ha
Rhubarb(*Rheum rhaponticum)*	Victoria, Cherry, Mc Donald, Ruby, Valentino & Sunrise	Root cuttings	Between plants 60 - 120 cm; between rows 1-2 m	Fertiliser mixture of 1:1:1	-	Stalks are harvested 2 years after planting, 5-6 stalks per plant for further growth. Crop duration 5 years	-
Chakravathi keerai (*Chenopodium album)*	Ooty 1	Seeds (50 kg/ha)	30 x 15 cm Broadcasti-ng thinning	Basal FYM -25 t/ha NPK -25-25-25 kg/ha Azospirillum & Phosphobacteria 2 kg/ha each	-	50-60 days harvest once	30 t/ha herbage
Lettuce *(Lactuca sativa)*	Head type, Leaf cos type	Seed (500 g/ha)	30 x 15 cm	Basal and Top: FYM 30 t/ha, N 50/50 kg/ha, P 30/30 kg/ha and K 30/30 kg/ha	Top dressing 60 days after planting	Crop duration 2 months	10-15 t/ha

Name of crop	Varieties	Method of propogation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	yield
Knol-khol (*Brassica caulorapa*)	White Vienna, Purple Vienna	Seed (1.5 kg/ha)	30 x 25 cm	Basal 30 t/ha and Top: 180:120:100 kg NPK/ha	-	Crop duration 75 days in main field	20 - 25 t/ha
Turnip(*Brassica rapa*)	Temperate types:Purple top White Globe Snow BallTropical Types:Pusa ChandrimaPusa SwetiPusa Kanchan	Seed (4 kg/ha)	30 x 15 cm	Basal: FYM 30 t/ha, N 90 kg, P 125 kg and K 100 kg/ha.Top: N 90 kg/ha	Thinning of seedlings	Crop duration 75-90 days	-
Winged Bean (*Psophocarpus tetragonalobus)*	-	Seeds	1 x 0.5 m	Basal: FYM 10 t/ha, N 40 kg, P 100 kg and K 25 kg/ha	Staking	Duration 10-12 months	10-12 t/ha
Chinese cabbage (*Brassica pekinensis*)	Chinese cabbageBrassic-a Campestris Sp. Pekinensis Michihili as Veg-I	Seeds (375 g/ha)	45 x 45 cm	Basal: FYM 10 t/ha, N 90 kg, P 125 kg and K 100 kg/ha. Top: 90 kg/ha	Earthing up 60 days after planting	Crop duration 4 months	25 - 35 t/ha
Butter bean *(Phaseolus lunatus)*	KKL-1	25 to 35 kg/ha	35 x 25 cm	FYM 20-30 t/ha 40:50:50 NPK kg/ha	-	80-85 days	500 - 1000 kg/ha of grains 5 - 10 t/ha tender pods.

Part III
Spices and Condiments

Chapter A
Spices

Pepper: *Piper nigrum* L.; *Piperaceae*

Varieties: Panniyur 1, 2, 3, 4, 5, 6 and 7, Karimunda, Kottanadan, Sreekara, Subhakara, Panchami, Pournami, Ottaplackal 1, Kalluvally, Balamkotta, Uhiramkotta, PLD – 2, Aimpirian, Arkulam munda, Kuching, Kurimalai, Chumala.

In lower elevation and less shady areas Panniyur 1 performs well for higher elevations with more shady area Karimunda is preferable. Panniyur 5 is suited for growing in Arecanut plantation.

Soil and climate: Pepper is grown mainly as a rainfed crop. Pepper requires heavy rainfall (150 - 250 cm) high humidity and warm climate.

Thrives best on virgin soils rich in humus content at elevations up to 1500 m.

Season: June - December.

Planting: Slopes facing West and South should be avoided. Pits of 50 cm x 50 cm x 50 cm size are dug at a spacing of 2 to 3 m in either direction. 5 to 10 kg of FYM/Compost is mixed with top soil and the pits are filled. Rooted cuttings are planted in June - July @ two per standard like Silver oak, Dadap and Jack. In multitier cropping system, standards should be planted at a spacing of 7 – 8 m.

Manuring: Apply cattle manure or Compost @ 10 kg/vine just before the onset of South West monsoon. In addition 100 g of N, 40 g of P and 140 g of K per vine are applied in two split doses in the months of May - June and in September - October. Slaked lime at 500 g per vine is applied in alternate years during May - June. The manures and fertilizers are applied around the vine at a distance of 30 cm from the base and incorporated into the soil. *Azospirillum* @ 100 g/vine can be applied one month after the application of chemical fertilizers.

Irrigation: Protective irrigation in basins during December - May at 10 days interval is more beneficial wherever facilities are available.

Aftercultivation: Two weedings are given during the months of June - July and at October - November. The vines are to be trained to the standards. Prune excessive foliage of the standards and limit the height of the standards to about 6 m. Spray NAA @ 40 ppm to increase the berry size.

Plant protection - Pests

Pollu Beetle: Spray endosulfan 35 EC 2 ml/lit once in July and again in October.

Leaf gall thrips: Spray monocrotophos 36 WSC 1.5 ml/lit or dimethoate 30 EC 2 ml/lit or chlorpyriphos 2 ml/lit or dichlorvos 76 WSC 1 ml/lit or phosphomidan 40 SL @ 2 ml/lit three rounds at monthly intervals starting from new flush formation.

Diseases

Foot rot

Nursery

Application of *Trichoderma viride* @ 1 g/kg of pot mixture.

Main field

Application of neem cake 1/2 kg per vine.

Swabbing Bordeaux paste upto 1 m from the ground level.

Application of *Trichoderma viride* @ 20 g/vine along with FYM or Bordeaux mixture 1% or Metalaxyl-Mancozeb @ 2 g/lit.

Combined application of Neem cake 2 kg per vine + 3 monsoon foliar spray and soil application of 0.1% Metalaxyl.

Any of the above formulation may be used for drenching the soil twice in a year once during May- June and the other during October - November.

Spray Bordeaux mixture 1% or Fosetyl-Al 3 g/lit or Metalaxyl-Mancozeb 2 g/lit twice in a year once during May - June and the other during October - November.

Harvest: It starts bearing after 3 years of planting. The harvesting season is from November to March. Harvest is done by hand picking the whole spikes when few berries in the spike start turning red. The berries are separated and dipped in hot water (80°C) for one minute and sun dried for 7 to 10 days.

Yield: 2 to 3 kg/vine/year.

Cardamom: *Elettaria cardamomum* (Maton.); *Zingiberaceae*

Varieties: Malabar, Mysore, Vazhukka, Mudigree-1, CCS 1, ICRI 1, ICRI 2, PV 1, SRP 14 and Green Gold.

Soil and climate: Thick shady areas with loamy soil are ideal. Grown at an elevation from 600 to 1500 m. Areas exposed to heavy winds are unsuitable. Adequate drainage must be provided.

Season: June - December.

Seeds and sowing: Seedlings/suckers.

Propagation from Seeds: Collect seeds from healthy and good yielding plants. To plant one hectare 600 grams of seeds will be sufficient. Sow fresh seeds. Treatment with commercial grade Sulphuric acid or Hydrochloric acid for 20 minutes. Sowing in the beds, after washing with water will increase the percentage of germination. Prepare the beds to a fine tilth. A mixture of equal quantity of well rotten cattle manure, wood ash and jungle soil is incorporated in the nursery beds.

Provide mulching and shading to seed beds. Sow the seeds on the surface of the bed and just cover the seeds with a thin layer of fine sand. The beds should be kept moist but not too wet. Germination starts usually a month after sowing and goes on for three months. When the seedlings are about one year old, they are transplanted to secondary nursery.

Preparation of the field: Dig pits of 60 cm x 60 cm x 60 cm size and fill with compost and top soil. Contour planting may be done in slopy areas.

Spacing

Larger types	:	2.5 x 2.0 m.
Smaller types	:	2.0 x 1.5 m.

Irrigation: Generally Cardamom is grown as a rainfed crop, but provide sprinkler irrigation during summer for increased yields.

Manuring: Apply compost 25 t/ha; 75 kg N; 75 kg P and 150 kg K/ha in two split doses during June - July and October - November.

Aftercultivation: Shade regulation is important. Weed the field as and when necessary. Towards the end of monsoon rains a light raking or digging and mulching is given around the plant to a radius of about 75 cm to conserve moisture during the dry period.

Plant protection - Pests

Thrips: Spray monocrotophos 36 WSC 2 ml/lit.

Hairy caterpillar: Spray phosalone 35 EC 1 ml/lit.

Shoot and fruit borer: Spray monocrotophos 36 WSC 2 ml/lit.

Setup pheromone trap @ 12/ha to attract and destroy the female moths.

Mites: Spray dicofol 18.5 EC 2 ml/lit.

Rhizome weevil: Soil drenching of lindane 20 EC @ 2 ml/litre.

Diseases

Mosaic or Katte disease: This is a serious disease affecting the productivity of Cardamom.

This is transmitted by banana aphid which can be controlled by regular spraying with Methyl demeton 25 EC, Dimethoate 30 EC or Phosphomidon 40 SL at 750 ml/ha.

Damping off or clump rot or rhizome rot: Drench nursery with 1 lit of Formaldehyde in 50 lit water for 3 sq.m. before sowing. Prophylactic drench with 0.25% Mancozeb or 1% Bordeaux mixture immediately after germination to control *Pythium* and 0.05% Carbendazim after 15 days to control *Rhizoctonia*.

Capsule rot or panicle rot or Azhukal: Three sprays with 1% Bordeaux mixture or 0.25% Copper oxychloride or 0.2% Mancozeb just before onset of South West monsoon in early August and in September. Drench soil with 1% Bordeaux mixture.

Harvest: Harvesting commences from the third year onwards. But good yields are expected from 5th year. Harvesting is generally done once in a month. Pick only those fruits which are just ripe but not fully ripe. Fully ripe fruits tend to split on drying and do not develop the desirable dark green colour.

Yield: 200 - 250 kg/ha.

Clove: *Syzigium aromaticum; Myrtaceae*

Varieties: Local.

Soil and climate: Humid tropical climate with an annual rainfall of 150 - 250 cm and a mean temperature range of 20^0 C to 30^0 C and elevation up to 1000 m are suitable. Deep rich loams with high humus content and lateritic soils are the best suited.

Season: June - December.

Slopes facing South and West should be avoided. North and North-Eastern slope is preferred.

Planting: Seeds are extracted from ripe fruits and sown immediately. The seeds germinate in five to six weeks. Two year old seedlings are planted in pits of 30 cm x 30 cm x 30 cm size filled with soil and FYM 10 kg/pit at a spacing of 6 m either way. Apply, 50 g *Azospirillum* before planting.

Aftercultivation: Provide shade for seedlings. Mulch the basins with dried leaves. Weed the basins as and when necessary.

Banana can be grown to provide shade during the initial establishment. Small temporary pandal may provide partial shade during initial establishment.

Irrigation: Frequent watering is essential in the initial stages in the absence of rains. Irrigation should be given during summer months. Applying 8 litres of water either through drip or through basin during the months of January - May is beneficial.

Manuring: One year old plants can be applied with FYM 15 kg, N 20 g, P 20 g, K 60 g in two splits during June - July and September - October. Every year the dosage is correspondingly increased and a bearing tree of 7 years old may be applied with FYM 50 kg, N 300 g, P 300 g and K 960 g. 50 g in each of *Azospirillum* and *Phosphobacteria* to be applied one month after manuring.

Plant protection - Pests

Stem Borer: Smear the surface of the stem and branches with carbaryl 50 WP at 2 g/lit of water.

Pour quinalphos 25 EC 1 ml/lit in to the bore hole and plug it.

Leaf eating caterpillar: Spray endosulfan 35 EC 2 ml/lit.

Harvest: Bearing starts from sixth year onwards. The flower buds should be harvested when they are fully mature but before opening. The buds are harvested as clusters and separated and dried in the sun for five to seven days.

Yield: 2 - 3 kg dried buds/tree.

Nutmeg: *Myristica fragrans* Houlf.; *Myristicaceae*

Varieties: Local.

Soil and climate: Friable, well drained clay to red soils is suitable. Can be grown up to an elevation of 1000 metres with 150-250 cm of rainfall, humid tropical climate.

Season and planting: Seeds or grafts are used as planting material. Seeds germinate in 4 to 6 weeks. Plant 12 - 18 months old seedlings in pits of 60 cm x 60 cm x 60 cm size and filled up with equal parts of forest soil and cattle manure. Spacing of 8 m x 8 m either way. Season of planting is June – December. Nutmeg grafts are better than seedlings. Plant the grafts in the same way as seedlings.

Manuring: Apply FYM 15 kg, N 20 g, P 20 g, K 60 g per tree during first year and FYM 50 kg, N 300 g, P 300 g, K 960 g for adult trees in two splits June - July, September - October. Apply 50 g in each of *Azospirillum* and *Phosphobacterium* one month after manuring.

Irrigation: Irrigation is given once in 5 - 7 days during summer months.

Aftercultivation: Keep the area around the plant weed free. Regulation of shade is important. It requires medium shade especially during the initial stages of growth. Fast growing shade trees or banana are planted in between them a few months prior to planting and can be thinned out later. It can be grown as mixed crop with arecanut and coconut. In Arecanut plantations, nutmeg can be planted after every third row of Arecanut.

Plant protection

Loranthus sp: It is a serious plant parasite affecting the growth of the nutmeg plant. This can be controlled by mechanical removal of the plant parasite. Remove severely affected branches. Twigs of nutmeg trees may also be removed along with the plant parasite and paint with Bordeaux paste.

Harvest: The bearing starts from six to seven years after planting. The mature fruits when they start splitting are harvested. The aril commonly known ‘mace’ and ‘seed’ are separated and dried.

Yield

Fruits	:	1000 - 2000/tree
Dried nuts	:	5 - 7 kg/tree
Dried mace	:	0.5 - 0.7 kg/tree.

Cinnamon: *Cinnamomum zeylanicum* Blume.; *Lauraceae*

Varieties: YCD 1, SL 63.

Soil and climate: Sandy or lateritic soils with high humus are suitable. Requires a sheltered situation, can be grown up to an altitude of 800 - 1000 m from MSL receiving an annual rainfall of 150 to 250 cm.

Season: June - December.

Planting: Cinnamon seedlings or rooted cuttings are planted under partial shade. Pits are dug at a distance of 2 m either way filled with top soil and FYM 10 kg at 1:1 ratio. One year old seedlings or rooted cuttings are transplanted.

Irrigation: Protective watering during summer in beneficial.

Manuring

Manures and fertilizers	1st year	Annual increase	10th year onwards
FYM	-	2 kg	20 kg
N	20 g	20 g	200 g
P	18 g	18 g	180 g
K	25 g	25 g	250 g

Aftercultivation: Immediately after transplanting, the plants are provided with temporary shade by erecting a small pandal. Weeds are removed as and when necessary. Young trees are cut close to the ground to produce side shoots. This process is called “Coppicing”. By stooling around the stumps, more side shoots are encouraged from the base of the trees.

Plant protection - Pests

Shoot borer: Smear stem and branches with carbaryl 50 WP 2 g/lit of water once in a month.

Coffee red borer: Trunk injection of monocrotophos 36 WSC 1 ml/bore hole with a waiting period of 20 days to be allowed between application and harvest of the bark.

Leaf eating caterpillar, red ants and termites

Dust lindane 1.3%.

Diseases

Leaf spot: Spray 1 % Bordeaux mixture.

Harvest: The harvesting starts from 4th or 5th year after planting. The shoots are cut for the extraction of bark once in May and again in November. As soon as rain ceases, cutting of shoots for peeling of bark is commenced. After cutting, young shoots spring up from the stump which will be ready for removal in subsequent season within 18 months. The bark is peeled from the selected shoots of 18 to 24 months old, which are usually one metre long and 1 to 2 cm thick. Shoots ready for peeling are removed from the stumps and terminal ends of shoots are also removed. Peeling is done by knives after scraping off the outer bark. From leaves, Cinnamon oil can be extracted by steam distillation. Harvested produce is called as ‘Quills’.

Yield:

100 g of dried bark/bush.

35 kg of leaf oil/ha/year.

Chapter B

Condiments

Coriander: *Coriandrum sativum* L.; *Apiaceae*

Varieties: CO 1, CO 2, CO 3 and CO(CR) 4

Season: June - July and October - November.

Seed Treatment: *Azospirillum* @ 1.5 kg /ha

Field preparation and sowing: Prepare the main field to a fine tilth and form beds and channels (for irrigated crop). Sow the split seeds at a spacing of 20 x 15 cm. The seeds will germinate in about 8-15 days.

Presowing seed hardening treatment with Potassium Dihydrogen Phosphate @ 10g/lit of water for 16 hours is to be done for rainfed crop.

Seeds are to be treated with *Azospirillum* @ 3 packets/ha.

Seed treatment with *Trichoderma viride* @ 4 g/kg of seed has to be done to control wilt disease.

Seed rate: 10 - 12 kg/ha.

Broadcast the seeds for rainfed crop. (20 – 25 kg/ha)

Manuring:

Clipping coriander	:	60 kg N : 40 kg P : 60 kg K kg / ha.
Split	:	35th day 30 kg N
		55th day 30 kg N after clipping.

Basal: FYM 10 t/ha; 10 kg N, 40 kg P and 20 kg K for rainfed and irrigated crops.

Top dressing: Top dressing may be done at 10 kg N/ha 30 days after sowing for the irrigated crop only.

Irrigation (for irrigated crop only): First irrigation immediately after sowing and the second on the third day. Subsequent irrigations at 7-10 days interval.

Aftercultivation: Pre-emergence spray of herbicide Fluchloralin 700 ml in 500 lit/ha. Thinning is done 30 days after sowing. Subsequent weeding is done as and when necessary. Leave 2 plants per hill. Spray CCC @ 250 ppm one month after sowing for inducing drought tolerance in rainfed crops.

Plant protection

Aphid: Spray methyl demeton 25 EC @ 2 ml/lit or dimethoate 30 EC @ 2 ml/lit.

Diseases

Powdery mildew: Spray Wettable sulphur 1 kg/ha or Dinocap 250 ml/ha at the time of initial appearance of the disease. Neem seed kernel extract 5% spray thrice. (1st spray immediately

after the appearance of disease. 2nd and 3rd at 10 days interval. 3 sprays of NSKE (5%), 1st spray immediately after appearance of the disease, 2nd & 3rd at 15 days interval.

Grain mould: Spray Carbendazim 0.1 % (500 g/ha) 20 days after grain set.

Harvest: The plants are pulled just when the fruits are fully ripe but green and start drying. The plants are dried and thrashed with sticks, winnowed and cleaned. For leaf, pull out the plants when they are 30-40 days old.

Yield

Rainfed Grain yield	:	300-400 kg/ha.
Irrigated	:	500-600 kg/ha
Leaf yield	:	6-7 t/ha.

Garlic: *Allium sativum* L.; *Alliaceae*

Varieties: Local, Ooty 1, Farwi, Rajalle Gaddi and Singapore.

Season: June-July; Oct-Nov.

Soil and climate: Well drained, silt or clay loam soils are suitable. Require relatively cool weather.

Seeds and sowing: The field is prepared to a fine tilth. Shallow furrows are formed at a spacing of 15 cm. The seed bulbs called as 'cloves' at a seed rate of 500-600 kg/ha are planted at a spacing of 10 cm.

Manuring

Basal: FYM 50 t/ha; 40 kg N, 75 kg P and 75 kg K/ha + Neem cake 1 t/ha + 50 kg of $MgSO_4$/ha.

Top dressing: 35 kg N/ha at 45 days after planting.

Controlling rubberisation: Avoid excessive application of N to minimise rubberisation. N should not be applied in the form of Urea. Use Ammonium sulphate. Spray 1500 ppm of CCC or MH on 30th day of planting. Reduce the frequency of irrigation to minimise rubberisation. Apply 0.2 % Boron 0.1 % Sodium molybdate on 30th, 60th and 90th days after planting.

Aftercultivation: 3-4 hand weeding and earthing up.

Plant protection - Pests

Thrips: Spray methyl demeton 25 EC or dimethoate 30 EC @ 2 ml/litre or acephate 75 SP @ 1 g/lit or phosphomidan 85 EC 2 ml/litre.

Focus the spray fluid in the leaf whorls.

Diseases

Bulb rot: Clove treatment with Carbendazim at 2 g/kg and spot drench with Carbendazim 1 g/lit of water.

Leaf blight: Spray Carbendazim 500 g/ha.

Nematode: Soaking seed cloves in water over night and followed by soaking in phosphomidan 40 SL at 2 ml/litre for 15 minutes.

Yield: 6 – 8 t/ha.

Tamarind: *Tamarindus indicus* L.; *Caesalpiniaceae*

Varieties: PKM 1, Urigam, Hasanur and Tumkur.

Season: June - December.

Spacing: 8-10m x 8-10m.

Planting: The grafts should be planted in the pits of 1 m x 1 m x 1 m filled with FYM and top soil. Add 50 g of Lindane 1.3% dust in the pit. Immediately after planting, support the graft with stakes.

Irrigation: Regular watering should be given till the plants establish well in the field.

Fertilizers: It is a dryland crop and generally not manured. Responds to organic manure.

Aftercultivation

Remove the rootstock sprouts.

Remove the dried and diseased parts

Intercrops may be raised in the alley spaces upto four years.

Plant protection - Pests

Leaf caterpillar (*Achaea janata*): Spray endosulfan 35 EC 2 ml/lit or monocrotophos 36 WSC 2 ml/lit.

Storage beetle *(Pachymeres gonagra):* Spray endosulfan 35 EC 1 ml/lit at the time of fruiting season.

Diseases

Powdery mildew: Spray Dinocap 1 g/lit.

Yield: Pods are harvested in March-April every year. 150 - 200 kg/tree/year.

Turmeric; *Curcuma domestica* Val.; *Zingiberaceae*

Varieties: CO 1, BSR 1, Roma, Swarna, Sudarshana, Suguna, Sugandham, BSR 2, Ranga, Rashmi, Rajendra Sonia, Krishna, Suroma and Allepy Finger Turmeric (AFT).

Soil and climate: A friable well drained red loamy soil in wet or garden lands under tropical conditions is ideal.

Season: May-June

Seed Treatment: 30 tonnes of FYM + 500 kg of AM as soil application + 10 kg each of *Azospirillum* and phosphobacteria as rhizome treatment / ha.

In addition to the above dose application of $FeSO_4$ 100 kg / ha + $ZnSO_4$ 50 kg / ha + 1 t of composted coir waste can be done. Enriched manure can be applied in 3 equal splits at 3, 4 and 5 months after planting to alleviate chlorosis in turmeric.

Seeds and sowing: Mother rhizomes are better yielder than finger rhizomes.

Seed rate: 1500-2000 kg rhizome/ha.

Spacing: The rhizomes are to be dibbled in the sides of ridges, 45 cm apart at 15 cm spacing at a depth of 4 cm.

Manures and manuring

Basal: FYM 10 t,/ha neem or groundnut cake - 200 kg/ha, N, P and K at 25, 60 and 18 kg; 30 kg of Fe SO_4 and 15 kg $ZnSO_4$. 10 kg in each of *Azospirillum* and *Phosphobacterium* per ha to be applied planting one month.

Top dressing: N, K at 25 and 18 kg/ha applied on 30, 60, 90, 120 and 150 days after planting.

Micronutrient application: For correcting deficiency of micronutrients especially Boron, Iron and Zinc at rhizome development stage, apply 375 g Ferrous sulphate, 375 g Zinc sulphate, 375 g Borax, 375 g of Urea in 250 lit of water/ha. Spraying twice at 25 days interval is recommended. The above micronutrients are dissolved in Super phosphate slurry (15 kg Super Phosphate is dissolved in 25 lit of water stored overnight and the supernatant solution is made upto 250 lit). In this solution, the micronutrients are added.

Intercultivation: Onion, Coriander and Fenugreek can be planted as intercrop on the sides of the ridges 10 cm apart (250 kg seed Onion per ha) Redgram and Castor can also be planted at wider spacing. First weeding after three weeks and whenever weeding is necessary. The plants are earthed up at the time of 2nd and 4th top dressings.

Plant protection

Pre planting treatment: The seed rhizomes are dipped in carbendazim 1 g/lit and phosalone 35 EC 2 ml/lit or monocrotophos 36 WSC 1.5 ml/lit for controlling rhizome rot and scales.

Pests

Thrips: Spray dimethoate 30 EC or methyl demeton 25 EC 2 ml/litre.

Rhizome scale: Apply well rotten sheep manure @ 10 t/ha in two splits (one basally and other at earthing up) or Poultry manure in 2 splits followed by drenching dimethoate 30 EC 2 ml/lit or phosalone 35 EC 2 ml/lit or Application of Carbofuran 3 G @ 1.5 kg a.i./ha.

Seed rhizomes dipped in phosalone 35 EC 2ml/lit or monocrotophos 36 WSC 1.5 ml/lit and then stored.

Nematode: Avoid planting turmeric after Banana or other solanaceous vegetables. Plant only after taking suitable control measures. Apply Carbofuran 4 kg a.i./ha twice on the third and fifth month after planting the rhizomes.

Diseases

Rhizome rot: Drench with Bordeaux mixture 1 % or Copper oxychloride 0.25 %. Treat the seed rhizomes with 0.3% Copper oxychloride for 30 min before storage.

Leaf spot: Spray Carbendazim 500 g/ha or Mancozeb 1 kg/ha or Copper oxychloride 1.25 kg/ha.

Harvest: The plants will start lodging in about nine months. Yellowing and drying of leaves are the signs of crop maturity. The rhizomes are picked after digging deeply with spade or digging forks.

Yield

Fresh rhizomes	:	25-30 t/ha
Cured rhizomes	:	5-6 t/ha

Storage of seed rhizomes: Seed rhizomes can be stored in open sand media with a partially closed pandal.

Ginger: *Zingiber officinale* Rosc.; *Zingiberaceae*

Varieties: Rio de Janeiro, Maran, Nadan, Suruchi, Surabi, Suprabha and Surati.

Season: April - May.

Soil and climate: A friable well drained loamy soil rich in humus with warm and humid conditions with 150 cm of annual rainfall are preferable. Grown as an irrigated crop in humid zones from sea level to an altitude of 1500 metres.

Seed rate: 1500 - 1800 kg of rhizome/ha.

Spacing: For irrigated crop, ridges are formed 40 cm apart and rhizomes planted at 20 cm spacing.

Manures and Manuring

Basal: FYM 40 t, 50 kg P and 25 kg K/ha.

Top dressing: 37.5 kg N and 12.5 kg K/ha each applied on 45th and 90th day.

Aftercultivation: Mulching is done at the time of planting with green leaves. After each top dressing, earth up the plants.

Plant protection - Pests

Shoot borer: Spray dimethoate 30 EC 2 ml/lit or phosphamidon 40 SL 2 ml/lit.

Leaf roller: Spray carbaryl 50 WP 2 g/ha or quinalphos 25 EC 2 ml/lit.

Diseases

Soft rot (*Pythium* sp.): Lack of drainage and continued dampness expose the plants to infection. The disease spreads through the seed rhizomes and soil. Provide adequate drainage facilities and select healthy and disease-free seed rhizomes and pre-treat the seed rhizomes. In the field drench the bed with 2.5 g/lit of Copper oxychloride or 1% Bordeaux mixture or Metalaxyl-mancozeb 4 g/lit. Treat the seed rhizomes with Mancozeb or Copper oxychloride 3 g/lit or 200 ppm Streptocycline for 30 minutes before storage.

Leaf spot: Spray with 1 % Bordeaux mixture or Copper oxychloride 0.25%.

Harvest: The crop can be harvested after 8 - 9 months when leaves start yellowing and drying.

Yield: 12 - 15 t/ha.

Fennel: *Foeniculum vulgare* Mill.; *Apiaceae*

Varieties: CO 1

Soil and climate: Well drained loamy soil or black or sandy soil rich in organic matter is suitable. It comes up well in fairly mild climate.

Seed rate

For direct sowing : 9 - 12 kg/ha.

For transplanting : 3 - 4 kg/ha – Nursery area 100 sq.m.

Spacing: 5 - 6 weeks old seedlings are transplanted at 60 x 30 cm spacing.

Seasons for sowing

Hills: May - June.

Plains: October - November.

Irrigation: First irrigation immediately after sowing, second on the third day and subsequent irrigations at 7 - 10 days intervals.

Manuring

Basal: FYM 10 t/ha, N at 25 kg and 10 kg P/ha.

Top dressing: 25 kg N at the time of flowering.

Aftercultivation: Two or three weedings are necessary. The plants are earthed up after 3 months. Pre-emergent application of Pendimethalin @ 1 kg a.i./ha and one hand weeding.

Plant protection - Pests

Aphids: Spray dimethoate 30 EC 2 ml/lit or methyl demeton 25 EC 2 ml/lit.

Powdery mildew: Dust Sulphur at 25 kg/ha at the time of appearance of disease.

Harvest: The crop matures in 7 - 8 months. Harvest the umbels 4 - 5 times at 10 - 15 days intervals, dry in sun for 4 - 5 days and seeds are thrashed.

Yield: 500 - 750 kg/ha/year.

Fenugreek: *Trigonella foenum graecum* L.; *Leguminosae*

Varieties: Co 1, Pusa Early Bunching and CO 2.

Soil: A rich well drained loamy soil is best suited.

Season: June - July and October - November.

Seeds and Sowing: The field is prepared to a fine tilth, beds of 3.5 x 1.5 m are formed, and seeds are sown.

Seed treatment: *Azospirillum* 1.5 kg / ha for 12 kg of seeds.

Seed rate: 12 kg/ha.

Manuring

Basal: FYM 20 - 25 t/ha and N, P, K at 30:25:40 kg/ha.

Top dressing: 20 kg of N at 30 days after sowing.

Irrigation: Five first irrigation immediately after sowing, second on the third day and subsequently at 7 - 10 days intervals.

Aftercultivation: Plants are thinned at 20 - 25 days after sowing and the thinned seedlings are used as greens. One pinching at a height of about 4" will encourage branching. Pre-emergence spray of Fluchloralin 700 ml in 500 lit water/ha and subsequent weeding are done whenever necessary.

Plant protection

Diseases

Root rot: Soil application of Neem cake @ 150 kg/ha and Seed treatment with *Trichoderma viride* @ 4g/kg or drenching with Carbendazim 0.5 g/l or Copper oxychloride 2 g/litre.

Crop duration and harvest

20 - 25 days for greens.

90 - 100 days for grains.

Yield

The yield of green is	:	4000 - 5000 kg/ha.
Grains	:	500 - 700 kg/ha.

VANILLA: *Vanilla planifolia*; *Orchidaceae*

Varieties: No named varieties

Soil and Climate: Vanilla can be grown in adopted wide range of soil types. Soils rich in humus and having good drainage found to be ideal. Well in humid tropic climate with an annual rainfall of 150 – 300 cms.

Elevation : 700 – 1500 metres MSL.

Latitude : 10 and 20 north and south respectively.

Temperature : 21^0 C – 32^0 C.

The rainfall should be well distributed for a period of 9 months and dry period of 3 months for flowering are essential.

Season :

Standards : *Glyricidia sp*
Erythrina indica
Jatropha curcus
Plumeria alba
Casuarina equisitifolia

Planting during on-set of rain after summer during May and June.

Planting of vanilla cuttings 6 months after planting standards (i.e.) September – October – November.

Method of propagation: Stem cuttings (90 - 100 cm long)

Spacing

Spacing within rows 1.2 – 1.5 m.

Between rows 2.0 to 2.5 mts.

Population 1600 – 2000 plants / ha.

1.5 x 1.5 m in hills of the standards

Planting

Pit size 30 x 30 x 30 cms for standards and for planting of vanilla cuttings.

Cuttings of 60 – 120 cms long unrooted were selected.

Cuttings should be planted with 2 nodes below soil surface.

Cuttings less than 60 cm after collection should be washed and dipped in 1 % BM or 0.2% COC. Then cuttings are stored in 2 – 3 days under shade for partial moisture loss and raised in nursery, of shown sprouting within 4 to 8 weeks.

Training: Upward growing vines on the tree rarely blooms. For easy operations including pollination the vines are allowed to grow to a height of 1.2 to 1.5 m and then trained horizontally or allowed to grow downward towards the ground. Horizontally trained vines are coiled round the pole connecting the two supporting trees and vines trained to grow downward is allowed to

touch the soil and allowed to root and again brought back upward on the same supporting tree and the same procedure is repeated.

Manuring: Decomposed mulch is the main source of nutrients to Vanilla. Pruned vegetation must be dropped and applied as mulch. It is applied 2 to 3 times in a year.

Recommended dose of fertilizers: 40 – 60 gms of N + 20 – 30 gms of P + 60 – 100 gms of K per vine per year. It is given in 2 to 3 splits. Vanilla responds well for foliar feeding.

1% solution of 17 : 17 : 17 NPK mixture can be sprayed once in a month for boosting growth and flower production.

Flowering and pollinations: Vanilla usually starts flowering in the third year of planting. Vanilla flowers during December – January. Pinching of top 7.5 – 10 cm of vine 6 – 8 months before flowering seasons encourages flower bud initiations. Similarly pruning of older fruiting branches also encourages flower productions.

Each inflorescence consists of 15 – 20 flowers. The artificial pollination is useful in vanilla and pollination must be done on the same day as flowers opening from 4.00 am to 1.00 pm. About to 10 to 20 inflorescence may be pollinated in a vine. Normally 5 to 6 flowers in the lower side of inflorescence pollinated. Hand pollination using a needle or a piece of pointed wood or a tooth pick to lift the hood covering the anther cap. The standards are brought it in to contact with stigma. A skilled worker can pollinate 1000 – 1500 flowers in a day.

Plant protections

Pest

i. Leaf eating beetles and caterpillars can be controlled by spraying quinolphos 0.05 %.

ii. Feeding bugs are controlled by quinolphos 0.05% or endosulfan 0.05%.

Diseases

Fusarium wilt: Infection starts in the axil of the leaf and spread to nodal region resulting in rot. To control this spraying and drenching of 0.1% Carbendazim. Addition of organics also reduces the intensity of the disease.

Phytophthora rot: It causes rotting of beans, leaves and stems. Spraying Bordeaux mixture 1% and drenching COC 0.2% is effective.

Sclerotium rot: It occurs in root tips and latter extends to whole root system followed by yellowing and wilting of vines. To control this drenching of Carbendazim 0.1% is effective.

Shoot tip rot and Sclerotium rot: As in root rot drenching of Carbendazim 0.1% is effective.

Harvesting: The pods are ready for harvest 6 to 9 months after flowering. The matured beans change colour from green to pale yellow. The right picking stage is when the distal end of the pod turns yellow. Daily picking of matured pod is essential. The pods harvested by cutting with a knife.

Yield: Average cured beans yield / ha / year is 300 to 600 kgs. 6 kg of green pods produces 1 kg of cured beans. The economic life of vine is 12 – 14 years.

Chapter C

Minor - Spice crops

Name (Botanical name)	Method of propagation	Spacing	Manurial recommendation	After cultivation and special practices if any	Cropping and harvest	Yield
All spice (Pimenta officinalis Lindl.)	Six months old seedlings. Hard wood cuttings	6 x 6 m	-	Weeding and hoeing whenever needed	Harvest season July - August. Harvest when the berries are fully mature but unripe. Cured by sun drying till the berries become crisp and produce a metallic sound.	50 - 60 kg of dry berries/tree. Remarks: Economic part: Dried fruits, Dried leaves are used for flavouring.
Mustard (Brassica juncea (L) Czenjajer.)	Seed 6 - 7 kg/ha	45 x 30 cm in beds	Basal: FYM 25 t, N 25 kg, P 60 kg. Top dressing: N 25 kg	2 - 3 weedings	Duration: 3 - 4 months. Plants pulled after pods turn brown, dried in the sun and thrashed.	1000 - 1200 kg/ha

Part IV
Plantation crops

Tea: *Camellia sinensis* L. O. Kuntze.; *Camelliaceae*

Varieties: Pandian, Sundaram, Golconda, Jayaram, Evergreen, Athrey, Brookeland, BSS 1, BSS 2, BSS 3, BSS 4, BSS 5, Biclonal seed stocks and Grafts.

Soil and climate: Tea requires well drained soil with high amount of organic matter and pH 4.5 to 5.5. The performance of tea is excellent at elevations ranging from 1000 - 2500 m.

Nursery: The nursery soil should be well drained and deep loam in nature with pH of 4.5 to 4.8. The soil and sand, which are to be used in the preparation of rooting medium, should be tested for pH and nematode infestation.

Pre-treatment of rooting medium: Treating with Aluminium sulphate can reduce soil pH. For this purpose the nursery soil is formed into beds of one metre width and about 8 cm height and of a convenient length. Then the beds are drenched with 2% solution of Aluminium sulphate applied at 10 litres per 2.5 sq.m of area. Over this another layer of soil of 8 cm height is spread and again drenched with equal quantity of water twice. Then the soil is allowed to dry and the pH is checked before use in the nursery.

Preparation of sleeves: Polythene sleeves of 150 or 200 gauge and 10 cm width and 30 - 45 cm length may be used. Drainage holes may be provided. The lower 3/4 of the sleeves should be filled with 1:3 sand and soil mixture and the top 1/4 with 1:1 sand and soil mixture and staked in rows. Overhead shade is provided.

Selection of mother bush and its treatment: Healthy and vigorously growing high yielding bushes should be selected. Apply to each selected bush, 40 g of young tea mixture 60:90 NK mixture upto 5 years. In addition, 3 weeks before 0.5 % Al SO_4+ 1 % Mg SO_4; 2 weeks before 2 % Zn SO_4; 1 week before 1 % Urea.

Preparation of cuttings: Cuttings are taken on April - May and August - September. Semi hard-wood cuttings are prepared with one full leaf and an internode with a slanting cut at the bottom.

Planting of cuttings: The sleeves are watered thoroughly and holes are made in the soil. The cuttings are inserted in the hole and the soil around is pressed firmly to avoid airspace followed by watering. Small polythene tents may be provided which maintain high humidity and regulate the temperature inside. Cuttings may take 10 - 12 weeks for rooting. After 90 days i.e. when all the cuttings have rooted, the polythene tent may be removed gradually over a period of 10 - 15 days.

Manuring of nursery: After the tent is removed the cuttings are sorted and staked. 30 g of Nursery soluble mixture of the following composition dissolved in 10 litres of water may be applied over an area of 4 sq.m. This should be done fortnightly.

Composition of the fertilizer:

Ammonium phosphate (20:20)	35 parts by Wt
Potassium sulphate	15 parts by Wt
(or) MOP	12 parts by Wt
Magnesium sulphate	15 parts by Wt
Zinc sulphate	3 parts by Wt
Total	80 parts by Wt

Hardening of the cuttings: Hardening of 4 - 6 months old young cuttings should be done by removing shade gradually in stages over a period of 4 - 6 weeks starting from a few hours exposure to sun every day initially and extending the time of exposure gradually.

Methods of planting

Single Hedge System: In this method the spacing is 1.20 x 0.75 m accommodating 10,800 plants/ha.

Double Hedge System: In this method, the spacing is 1.35 x 0.75 x 0.75 m accommodating 13,200 plants/ha.

Season and planting: May - June or September - October.

Sleeves should be opened lengthwise without injuring the roots and planted in the pit and the soil is gently pressed.

Irrigation: Subsoil irrigation may be given for young teas during summer months.

Manuring: Manuring should be done 2 months after planting. Phosphorous should be applied at 80 - 100 kg/ha as Rock phosphate once in a year by placement at 15 - 25 cm depth upto the first pruning and thereafter once in two years. N : K ratio 2 : 3 should be adapted for the first 3 years and a ratio 1 : 1 thereafter.

Year of application	Total weight kg/ha/annum		No. of applications	Qty/plant (g)	
	N	K		Ammonium Sulphate	Urea
I year	180	270	5	13	27
II year	240	360	6	23	15
III year	300	450	6	29	18
IV year onwards	300	300	6	33	19

Application of fertilizers should be done before the onset of monsoon. Fertilizers should be broadcast around the drip circle avoiding contact with the collar.

Aftercultivation: Control perennial grasses (Forbicot weeds) by spraying Glyphosate 1.75 lit + Kaoline 2 lit + 2 kg of wetting agent in 450 lit. of water followed by Gramoxone 500 ml in 200 lit of water to control dicot weeds.

Training young tea

Centering: To induce more laterals centering should be done 3 - 5 months after planting. The main leader stem should be cut, leaving 8 - 10 matured leaves.

Tipping: Tipping at a height of 35 cm from the second tipping at 60 cm from ground level.

Pruning: To maintain convenient height and vegetative growth and to remove dead and diseased branches:

$$\text{Area to be pruned every year} = \frac{\text{Total extent of the garden}}{\text{Pruning cycle}}$$

$$\text{Pruning interval} = (\text{Elevation in feet} / 1000) + 1$$

Pruning should be done in April - May or August - September.

Types of pruning

Rejuvenation pruning: The whole bush should be cut near the ground level less than 30 cm with a view to rejuvenate the bushes.

Hard pruning: Formation pruning of young tea at 30 to 45 cm (12" to 18") for proper spread of bushes.

Medium pruning: To check the bush growing to an inconvenient height this type of pruning is done in order to stimulate new wood and to maintain the foliage at lower levels less than 60 cm.

Light pruning: Pruning depends on the previous history of the bush raising the height of medium pruning by an inch or less to manageable heights for plucking (less than 65 cm).

Skiffing: This is the lightest of all pruning methods. A removal of only the top 5 - 8 cm new growth is done so as to obtain a uniform level of pruning surface (more than 65 cm).

Shade regulation: Pollarding of shade trees should be done prior to heavy rains at a height of 8 - 10 m from the ground level.

Annual lopping: Cutting the erect type branches on the laterals in shade trees.

Plant protection

Scales: Spray carbaryl 50 WP @ 2 g/lit. or endosulfan 35 EC 2 ml/lit or quinalphos 25 EC 2 ml/lit or chlorpyriphos 20 EC 2 ml/lit.

Sahydrassis/Phassus borer: Locate the particle mat covering at the base tea bush and remove.

Insert a thick wire in the bore hole to kill the larvae.

Pour quinalphos 25 EC by an ink filler inside the borehole and close it with moist clay.

Thrips and Aphids: Spray phosalone 35 EC or endosulfan 35 EC 2 ml/lit.

Mites: Spray dicofol 18.5 EC 2 ml/lit or sulphur 40 WP 2 g/l or sulphur 80 WP 1 g/l.

Diseases

Blister blight:

Hexagonazole 200 ml + Copper oxychloride 210 g 5 days interval/ha. Spray 210 g Copper oxychloride and Nickel chloride per ha at 5 days interval from June - September; 11 days intervals in October and November.

or Copper oxychloride 210 g + 200 ml Propiconazole/ha 10 days interval.

Crop duration and harvest: Plucking commences when the tea bush is 3 years old. The plucking of extreme tip of the growing branch consists of an unopened bud together with two leaves is popularly known as “Two leaves and a bud” while fine plucking is anything less than this. Plucking continues throughout the year in South at weekly intervals during March - May and at intervals of 10 -14 days during the other months.

2 – 3 leaves with a bud – 7 to 10 days interval – rush period.

10 – 15 days interval – lean period.

Yield: The yield of green leaves is 10 t/ha.

Coffee: *Coffea canephora* Pierre ex Frechna. *Coffea arabica* L.; *Rubiaceae*

Varieties

Arabica varieties: Sln 795, Sln 7, Sln 9, Sln 10, Cauvery and its selections and HRC. (Hawaian Red Cuturra)

Robusta varieties: Sln 274.

Soil and climate: Soil should be deep, friable, open textured rich in plant nutrients with plenty of humus and of neutral reaction. It grows up well from 500 m to 1650 m MSL with a well distributed rainfall of 150 to 200 cm annually. Definite wet and dry season are essential to have a well marked cycle of flowering. A blossom shower during March - April and a back up shower during May - June is essential for successful crop.

Seeds and sowing: Coffee is propagated by seeds.

Season: June - December.

Preparation of seeds: Healthy and well developed fully ripe berries are harvested from specially identified plants for use as seed bearers. After discarding the floats, the sound fruits are depulped, sieved and mixed with sieved wood ash and dried in shade. The seed is then graded to remove all cut, triangular and elephant beans. Prior to planting, the seeds are treated with Agrosan or any Organomercurial compound to prevent fungal infection.

Nursery practices: Select light loamy soil of good drainage and high organic matter content with water and shade facilities. Form raised beds of 15 cm height, 1m width and at convenient length. Incorporate 30 - 40 kg of well rotten compost, 2 kg of finely sieved agricultural lime and 400 g of rock phosphate to a bed of 1 x 6 m size. In heavy soils, it is necessary to add coarse sand for drainage and aeration.

Sowing: Pre-sowing seed treatment with *Azospirillum* and *Phosphobacterium* can be done.

Seeds are sown in December - January in the bed 1.5 - 2.5 cm apart with the flat side down wards in regular rows. Then they are covered with a thin layer of fine soil and a layer of paddy straw. Water the beds daily and protect from direct sunlight by an over head pandal. Seeds germinate in about 45 days after which they are transplanted to a secondary nursery beds for raising ball or Bag nursery.

Bag nursery: Polythene bags with adequate number of holes in the bottom half are taken and are filled with a prepared mixture containing jungle soil, FYM and in the proportion of 6:2:1. An area of 12 x 8 m can accommodate 5000 seedlings. Seedlings are planted in polythene bags. Seeds can be treated with *Phosphobacterium*.

Preparation of field: Selective felling may be done while retaining a number of desirable shade trees. Terracing should be done in deep slopy areas. After the summer showers, pits of 45 cm x 45 cm x 45 cm are dug at 1.25 - 2.5 m apart. The pits are left open for weathering and then filled and heaped for planting. At the time of filling, apply 500 g of rock phosphate per pit along with top soil. Planting is done along the contour in slopy areas.

Planting shade trees: Dadap is commonly used as a lower canopy shade. Two metre long stakes are planted for every two plants of coffee. Silver Oak and Dadaps are planted during June when rains of South-West monsoon commences. During summer the stem of young Dadaps are painted with diluted lime or wrapped in agave leaves or polythene sheets in order to prevent them from sun scorch. Regulate shade by cutting criss-cross branches during monsoon season. Silver oak trees are planted for permanent shade.

Spacing

Arabica Coffee: 1.5 to 2.0 m either way.

Dwarf varieties: Sanraman : 1 x 1 m.

Robusta coffee: 2.5 m either way.

Irrigation: It is generally grown as a rainfed crop. But irrigation with sprinkler during March - April increases blossoming and results in higher yields.

Aftercultivation: Weeding and mulching should be done as and when necessary. Digging is done to a depth of 30 cm towards the end of monsoon (October - November). The weeds and vegetative debris are completely turned under and buried in the soil while the stumps are removed. This is known as the cover digging. In slopy areas dig trenches on the contour 45 cm wide and 30 cm deep of any convenient length. Prune water shoots and disease affected shoots.

Plant protection - Pests

White stem borer: Attacks arabica coffee grown under inadequate shade. Swab with 2 kg lindane 20 EC in 180 lit of water. Padding with monocrotophos 36 WSC 5 ml by making a window in the stem at 5 cm x 5 cm and filling it with absorbant cotton dipped in insecticide solution and close it.

Berry borer:

Carry out timely and thorough harvest.

Avoid gleanings as far as possible.

Pick up and destroy the gleanings.

Meticulously remove the leftover berries.

Remove offseason berries to save main crop.

Avoid excessive shade.

Prune plants properly to facilitate better ventilation and illumination.

Spray endosulfan 35 EC @ 340 ml/200 lit or lamda cyhalothrin 5 EC 120 – 160 ml / 200 lit.

Note: The approximate time is 120 – 150 days after flowering. However decision on pesticide application to be done by closely watching the pest incidence.

Set up traps with ethyl : methyl alcohol (1 : 1) to attract adults.

While processing at the estate level dry coffee berries to the prescribed moisture level : Arabica / robusta parchment 10 %, Arabica cherry 10.5 % and robusta cherry 11.0 %.

Shot hole borer beetle: Attacks branches and suckers of robusta coffee. This pest thrives under heavy shade and can be controlled by pruning the branches and spraying with endosulfan 35 EC 2 ml/lit.

Cockchafer beetles/White grub: Systemic insecticide like phorate 10 G can be applied.

Green scales and mealy bugs: Spray quinalphos 25 EC 2 ml/lit or fenthion 100 EC 1 ml/lit or fenitrothion 50 EC1 ml/lit. Release coccinellid predator *Cryptolaemus montrouzieri* @ 300 beetles/ acre. Spray *Verticillium lecanii* @ 6 x 106 spores/ml.

Diseases

Rust: Spray 0.5% Bordeaux mixture in February - March (Pre-bloom) followed by 0.03% Oxycarboxin in May - June (Pre-monsoon). Repeat in July - August (mid-monsoon) September - October (Post-monsoon) with any one of the above fungicides or Spray 0.5% Bordeaux mixture during the month of June followed by 0.02% Triadionefon during September and 0.5 % Bordeaux mixture during the month of December.

Black rot or Koleroga: Centering and handling of the bushes should be done prior to the onset of South-West monsoon. Remove affected twigs. Spray 1% of Bordeaux mixture during break in monsoon.

Collar rot: Treat seeds with Carbendazim 1 g/kg or Carboxin 0.7 g/kg. Maintain filtered shade in nursery. Drench nursery beds with Mancozeb or Captan 0.5 g/lit before sowing.

Brown eye spot: Spray Captan or Mancozeb or Ferbam 2 g/lit or Carbendazim 0.5 g/lit in September.

Black root rot: Dig out and burn infected bushes. Dig a trench 30 cm deep around affected spot along with a ring of healthy bushes. Prune the healthy bushes within and outside the trench to allow sunlight. Keep the trench free from fallen leaves. Do not replant for 18 months.

Harvest: Harvest starts during November and harvesting extends upto February. Coffee fruits should be harvested as and when they become ripe. Coffee is just ripe when on gently squeezing the fruits the beans inside come out easily. Unripe fruits should be scrupulously sorted out before using the fruits for pulping. They may be dried separately as cherry.

Yield: Dry parchment 750 - 1000 kg/ha.

Rubber: *Hevea brasiliensis* Muell-Arg.; *Euphorbiaceae*

Varieties: Tjir 1, PB 86, BD 5, BD 10, PR 17, GT 1, RRII 105, RRIM 600, PB 28/59, PB 217, PB 235, RRIM 703, RRII 5, PCK-1, 2 and PB 260.

Soil and climate: It requires deep and fertile soil with pH of 4.5 to 6.0.

Season: June - July.

Method of propagation: Propagated by green budding, brown budding and crown budding.

Planting: In the cleared forest area, pits at 1 m x 1 m x 1 m are dug and filled up with soil and compost. The spacing of 3 x 2 m or 5 x 5 m are adapted.

Seed at stake planting: Germinated seeds are sown *in situ* in the pits. Healthy ones are retained and the others removed.

Manuring

For immature rubber trees at pre-tapping stage

Apply 12 kg of compost or FYM and 120 g of rock phosphate in each pit before planting.

Apply 10:10:4:1.5 NPK and Mg as per schedule given below:

Months after planting	Period of application	Quantity per plant	
		10:10:4	12:12:6
3	September/October	225 g	190 kg
9	April/May	445 g	380 kg
15	September/October	450 g	380 kg
21	April/May	450 g	480 kg
27	September/October	550 g	480 kg
33	April/May	550 g	380 kg
39	September/October	450 g	380 kg

Apply 400 kg of mixture per ha in 2 doses, once in April/May and another in September/October from the 5th year till the tree is ready for tapping.

Matured rubber trees under tapping

Apply NPK 12:6:6 mixture at the rate of 400 kg/ha every year in two split doses.

Add 10 kg commercial Magnesium sulphate for every 100 kg of the above mixture if there is magnesium deficiency.

Aftercultivation: Growing of cover crops, incorporation of cover crops and weeding are important operations. *Pueraria phaseoloides, Calopagonium muconoides, Centrosema pubescens* and *Desmodium evalifolium* are common cover crops.

Tapping: Trees attain tappable stage in about 7 years. First tapping in seedling trees will commence when the trunk attains a girth of 55 cm at 50 cm height from the ground. In budded trees the girth should be 50 cm at 125 cm height from the bud union.

Ethrel treatment: Ethrel is recommended to increase latex yield of trees tapped on panel D. It is applied at 5% a.i. concentration with a brush below the tapping cut to a width of 5 cm after light scraping of the outer bark. The first application may be done after a drought period preferably after a few pre-monsoon showers and subsequent applications may be done in September and November. However, continuous application of Ethrel is not recommended for periods of more than 3 years at a stretch.

Plant protection - Pests

Scale insect: When severe infestation is noticed, spray organophosphorus insecticides like malathion 50 EC 2 ml/lit.

Mealy bug: Spray fish oil rosin - soap 25 g/lit. Release Australian lady bird beetle, *Cryptolaemus montrouzieri* @ 10/tree.

Termite (White ant): Drench the soil at the base of affected plants with chlorpyriphos 20 EC 2 ml/litre.

Cockchafer grub: Drench soil at the base of plants in the affected area with the solution of chlorpyriphos 20 EC 2 ml/litre.

Mites: Spray sulphur 50 WP at 2 g/lit or spray dicofol 18.5 EC 2.5 ml/lit.

Diseases

Abnormal leaf fall: Prophylactic spraying of the foliage prior to the onset of South-West monsoon with,

Bordeaux mixture 1% at 4000 - 5000 lit/ha using high volume sprayers.

Oil based Copper oxychloride dispersed in diluent spray oil employing either low volume air blast sprayers (Micron 420 or Minimicron 77 or Shaw Duster Sprayer) from the ground or through aerial application.

For micron spraying on the tree spread, foliage intensity, planting material used and age of plants, two rounds of spray using about 17 to 22 lit of fungicide oil mixture per ha per round (1:6 proportion) with gap of 10 to 15 days or a single round of spray with about 30 - 37 lit of fungicide oil mixture per ha (1:5 proportion) may be necessary.

Secondary leaf fall: The control measures suggested for abnormal leaf fall will check this disease also.

Powdery mildew: Dusting during the defoliation period commencing from the bud break in about 10% of the trees, giving 3 to 5 rounds at weekly to fortnightly intervals before 10.00 a.m. using 11 to 14 kg 325 mesh fine Sulphur dust per round per ha. Sulphur dust can be mixed with talc in the proportion of 7:3. Wettable sulphur (1 kg in 4000 lit of water) is also effective in nurseries and for young plants as a spray.

Bird's eye spot: Repeated sprayings with Bordeaux mixture 1% or Mancozeb or Copper oxychloride 0.2%. Provide shade in nursery. Give balanced manuring to increase tree vigour.

Leaf spot: Spray 1% Bordeaux mixture or 0.2% Mancozeb, or 0.1% Carbendazim at fortnightly intervals.

Pink disease: Frequent tree to tree inspection during July – September period for detecting the infected trees and application of Bordeaux paste in the early stages upto 30 cm above and below the affected region. In advanced cases apply Bordeaux paste and when it dries up scrape off the superficial mycelium and damaged bark and apply Bordeaux paste once again. Prune off and burn the dried up branches after disinfecting by Bordeaux spraying.

Patch canker or Bark cankers: The affected region may be scraped to remove all the rooting bark and the coagulated rubber and the wound washed well with solution. When the fungicide dries up apply wound dressing compound.

Dry Rot, Stump Rot, Collar Rot Or Charcoal Rot

Clean up affected areas, by washing with Carbendazim (0.1%) solution. Scrape out the fructifications. Affected bark and wood show black lines. Wash the wound again with fungicide solution. When it dries up apply a wound dressing compound. Avoid accumulation of rubber at the base of the trees. For root infection see the treatment for brown root disease.

Brown root disease: Open up the root system. Completely killed and dried roots may be traced and pruned. Partially affected and healthy roots washed with Carbendazim (0.1%) solution. When the fungicide dries up, a thin coating with a wound dressing compound may be given. Refill the soil and drench the base with fungicide solution.

Yield: Rubber yield steeply increases year by year, reaching a peak after 14 years of planting. In South India, the annual yield of rubber is 375 kg/ha from seedlings trees, whereas budded plants yield 800 - 1000 kg/ha.

Cashewnut: *Anacardium occidentale* L.; *Anacardiaceae*

Varieties: VRI 1, VRI 2, VRI 3 and VRI 4.

Soil and climate: It grows up well in all soils. Red sandy loam is best suited. Plains as well as hill slopes upto 600 - 700 feet elevation are suitable.

Season: June - December.

Propagation: Soft wood grafting, air layer and epicotyl grafting.

Requirement of plants: 200 plants/ha.

Preparation of field: Pits of 45 cm x 45 cm x 45 cm size are dug and filled up with a mixture of soil + 10 kg FYM + one kg neem cake and 100 g Lindane 1.3 %.

Spacing: 7 m either way.

Manuring (per tree)

Manures and fertilizers	I year old	II year old	III year old	IV year old	V year onwards
FYM or Compost (kg)	10	20	20	30	50
N(g)	70	140	210	280	500
P(g)	40	80	120	160	200
K(g)	60	120	180	240	300

Fertilizer application may be done during November - December in the East Coast areas. Wherever possible the fertilizer can be applied in 2 equal split doses during June-July and October-November periods.

Intercropping: Plough the interspaces after the receipt of rain and raise either groundnut or pulses or minor millets till the trees reach bearing age.

Training and pruning: Develop the trunk to a height of 1 m by removing low lying branches. The dried twigs and branches should be removed every year.

Plant protection - Pests

Stem borer - Collection and destruction of affected shoots.

Swabbing the bark of exposed roots and shoots with carbaryl 50 WP 2 g/lit. Twice a year before the onset of South West Monsoon (March – April) and after cessation of monsoon (November) painting of coal tar + kerosene mixture (1:2) or swabbing with a suspension of carbaryl 50 WP (4 g/lit) upto one metre length in the exposed trunk region after shaving the bark.

Root feeding with monocrotophos 36 WSC 10 ml + 10 ml of water kept in a polythene bag on one side of the tree and keep the same amount on the other side of the tree (Total 20 ml/tree) divided into two equal halves will give protection when there is moderate incidence.

Swab the trunk with lindane 20 EC 1 ml/lit or carbaryl 50 WP 500 g in 20 lit of water.

Tea mosquito bug: Spray endosulfan 35 EC 2 ml/lit thrice. The first at the time of emergence of new flushes, the second at floral formation and the third at fruit-set.

Shoot caterpillars: Spray endosulfan 35 EC 2 ml/lit.

Root borer: Pour monocrotophos 10 ml/tree in the bore holes split into two halves (insecticide 5 ml + 5 ml water).

Diseases

Die back or Pink disease: Prune the affected shoots just below the affected portion and apply Bordeaux paste. Spray 1 % Bordeaux mixture or copper Oxychloride 0.25 % twice i.e. in May - June and again in October as a prophylactic measure.

Harvest: The peak picking months are March and May. Good nuts are grey green, smooth and well filled. After picking, the nuts are separated from the apple and dried in the sun for two to three days to bring down the moisture content to 10 to 12 %. Properly dried nuts are packed in alkathene bags. This will keep for 6 months.

Yield: 3 - 4 kg/tree/year.

Arecanut: *Areca catechu* L.; *Palmae*

Varieties: Mangala, Sumangala, Subamangala, Mohitnagar, Srimangala and Samruthi (Andaman)

Soil and climate: Arecanut is capable of growing in a variety of soils. It thrives best in well drained soils. Adequate protection from exposure to South-Western sun is essential to avoid sun-scorch. Quick growing shade trees have to be planted on the southern and western sides well in advance of planting seedlings. It is sensitive to moisture deficit and should be grown where adequate water facilities are available.

Season: June - December.

Seeds and sowing: For raising seedlings seed nuts from pre-marked and pre-potent mother palms of outstanding performance are selected and sown at a spacing of 5 - 6 cm apart in sand beds under partial shade with their stalk end pointing upwards. After the sprouts have produced two to three leaves, they are transplanted to a polythene bag 30 x 10 cm filled with forest soil and are allowed to grow for 12 to 18 months under partial shade. The seedlings can also be transplanted in secondary nursery beds with a spacing of 30 cm on either side. Periodical watering should be given.

Planting: Dwarf and compact seedlings with more number of leaves should be selected. Seedlings of 1 - 2 years age are planted in pits of about 90 cm x 90 cm x 90 cm at a spacing of 2.75 m either way and covered with soil to the collar level and pressed around. Provide shade during summer months. Growing Banana or other crops in advance may also provide shade.

Irrigation: Irrigation should be given as and when necessary.

Manuring: Apply to each bearing palm (5 years and above) 10 - 15 kg of FYM or green leaf. 100 g N, 40 g P and 150 g K. To palms less than five years old, half of the above dose is recommended. Manures are applied during January - February after the North - East monsoon in a basin of 0.75-1.00 m radius around the tree to a depth of 20 - 30 cm.

Aftercultivation: Weeding is done twice or thrice a year by giving mammutti digging. Wherever the land is slopy terracing has to be done to prevent soil erosion.

Plant protection - Pests

Mites: Dicofol 18.5 EC at 2.5 ml/lit.

Spindle bug: The bugs of the spindles may be given a drenching spray with lindane 1.3 D @ 2.5 g/lit of water.

Inflorescence caterpillars: Spray with lindane 20 EC 2 ml/lit or WP @ 2.5 g in one litre of water.

Diseases

Bud rot or Mahali disease: Infected tissues of the bud should be scooped off and treated with 10 % Bordeaux paste. Destruction and removal of seed palms and also bunches affected by Mahali and drenching crowns of surrounding healthy palms with 1 % Bordeaux mixture would help in minimising the incidence of the disease.

Foot rot or anabe: Affected palms have to be isolated by digging trenches all round. The severely affected palms should be cut and destroyed. The stumps should be pulled out by digging and the drainage improved.

Root feeding with 125 ml of 1.5 % (15 ml/litre of water) Tridemorph at 3 months interval.

Stem breaking: Wrapping up of the green portion of the stem which are exposed to the South-West sun to protect against sun-scorch.

Harvest: The bearing starts after 5 years of planting. Nuts are harvested when they are three quarters ripe. The number of harvests will vary from three to five in one year depending upon the season and place of cultivation.

Yield: 1250 kg/ha.

Cocoa: *Theobroma cacao* L.; *Sterculiaceae*

Varieties: Criollo, Forestero and Trinitario.

Soil and climate: Potash rich alluvial soils friable in nature with high humus and moisture retentivity with a pH of 6.6 - 7.0 are suitable. Cocoa is normally cultivated at altitudes upto 1200 m with an annual rainfall of 150 cm and a relative humidity of 80 % and annual mean temperature of 24^0 C to 25^0 C. Cocoa can be grown as intercrop in coconut and arecanut gardens.

Season: June - July and September - October.

Seeds and sowing: Cocoa is normally propagated by seed. Before sowing the seeds the pulp adhering to the seeds has to be removed. Cocoa seeds are individually sown in polybags soon after extraction. The bags are filled with surface soil and sub-soil mixed with compost, leaf mould and fertilizers. Nursery plants are ready for transplanting at 6 months of age when they attain a height of 60 cm.

Planting: Seedlings are transplanted with a ball of earth in 45 cm x 45 cm x 45 cm pits at a spacing of 3 x3 m either way. Periodical mulching with leaves and watering should be done. Temporary shade has to be provided.

Irrigation: Irrigation should be given as and when necessary. During summer months irrigation should be given once in three days.

Manuring: Trees of 3 years of age and above are manured with 100 g N, 40 g P and 140 g K per tree in two split doses during April - May and August - September. Trees younger than three years may be applied with half of this dose.

Aftercultivation: Weeding is done as and when necessary. The unproductive shoots, dead, diseased twigs should be removed periodically. Banana is better as a primary shade plant in the early years of plantation. For permanent shades Jack, Silver Oak, etc. are planted.

Plant protection - Pests

Mealy Bug: Spray phosphamidon 40 SL 2 ml/lit or dimethoate 2 ml/lit at fortnightly intervals. Release coccinellid predator *Cryptolaemus montrouzieri* @ 10 tree.

Aphids: Spray dimethoate 35 EC 1 ml/lit at monthly intervals.

Grey Weevil: Spray phosphamidon 40 SL 2 ml/lit.

Hairy caterpillar: Dust lindane 1.3 D or spray lindane 20 EC 2ml/lit.

Semilooper: Dust lindane 1.3 D.

Diseases

Black pod disease: Spray 1 % Bordeaux mixture or 0.2 % Mancozeb or Copper oxychloride at 20 days interval.

Dieback disease: The disease can be controlled by spraying 1 % Bordeaux mixture.

Charcoal disease: Spray with 1 % Bordeaux mixture.

Pink disease: Prune the affected branches and swab the cut ends regularly with 1 % Bordeaux mixture.

Harvest: Bearing starts from 4th year but economic yield starts from 6th year onwards. The season of harvest is November - December and May - June.

Yield: The yield ranges from 500 - 1000 kg of dry beans/ha.

Betelvine: *Piper betel; Piperaceae*

Varieties: Karpurakodi, Kallarkodi, Revesi, Karpuri and SGM 1.

Soil and climate: Well drained fertile clay loams are suitable. It does not tolerate saline and alkaline conditions. Betelvines require a cool shade, considerable humidity and regular supply of moisture in the soil.

Seeds and sowing: The vines are propagated by terminal stem cutting or setts about 30 - 45 cm long. Setts obtained from the top portions of the vines are easy to root and hence best for planting. Number of setts 1,00,000/ha. Setts with vigorous apical buds and nodal adventitious roots are selected and planted at the base of the live supports, which are to be planted 4 to 5 months earlier.

Season: November - December and January - February.

Preparation of field: The field is prepared to a fine tilth and beds of 2 m wide are formed to a convenient length. Provide drainage trenches of 0.5 m width by 0.5 m depth in between two adjoining beds. Plant the seeds of the live supports i.e. Agathi (*Sesbania grandiflora*) in long rows. About 750 banana suckers are planted at the edges of the beds, which are used, for tying the vines on the live support and for packing the betel leaf. When the Agathi supports grow to a height about 4 m they are topped. The crop is planted in two rows in beds of 180 cm width on Agathi plants with a spacing of 45 cm between plants in the row.

Irrigation: Irrigate the field immediately after planting and afterwards once in a week.

Aftercultivation

Training of the live Standards: Before the establishment of vines the side branches of Agathi trees upto a height of 2 m are removed for early creeping of the vines.

Training of the vines: Training is done by fixing the vine at intervals of 15 to 20 cm along the standards loosely with the help of banana fibre. Training is done every 15 - 20 days depending upon the growth of vines.

Lowering of vines: Under normal cultivation, the vines grow to height of 3 m in one year period. When they reach this height their vigour to produce normal size leaf are reduced and they need rejuvenation by lowering during March - April. After the vine is lowered a number of tillers spring up from the nodes at the bends of the coiled vines at the ground level and produce many primary vines. After each lowering irrigation should be given.

Manuring: Apply 150 kg N/ha/year through Neem cake (75 kg N) and Urea (75 kg N) and 100 kg P_2O_5 through Super phosphate and 30 kg Muriate of potash in three split doses first at 15 days after lifting the vines and second and third dose at 40 - 45 days intervals. Apply on beds shade dried neem leaf or C*alotrophis* leaves at 2 t/ha and cover it with mud (2 t in 2 split doses).

Plant protection - Pests

Scale insects: Select scale-free seed vines. Spray chlorpyriphos 20 EC 2 ml/lit when one or two scales are noticed on the basal portion of the stem/leaves. Direct the spray solution to the basal portion of the vines. Spray NSKE 5 % or malathion 50 EC 1 ml/lit.

Mites (Sevvattai): Spray wettable sulphur 50 WP @ 1 g/lit or dicofol 18.5 EC 0.5 ml/lit.

Sooty mould (Aphids): To control aphids spray chlorpyriphos at 2 ml/lit on Agathi leaves. Clip off excess Agathi leaves.

Mealy bugs: Spray chlorpyriphos 20 EC at 2 ml/lit or dimethoate 30 EC 2ml/lit. Concentrate the spray towards the collar region.

Nematode: Application of Neem cake at 1 t/ha or chopped and shade dried *Calotrophis* leaves at 2.5 t/ha to soil, after lowering the vines.

Diseases

***Phytophthora* Wilt:**

Integrated method for the management of *Phytophthora* wilt.

Select well matured (more than 1 year old) seed vines free from pest and diseases.

Soak the seed vines for about 30 minutes in Streptocyline 500 ppm or Bordeaux mixture 0.5 %.

Apply 150 kg N/ha/year through Neem cake (75 kg N) and Urea (75 kg N) and 100 kg P_2O_5 through Super phosphate and 30 kg Muriate of potash in 3 split doses first at 15 days after lifting the vines and second and third dose at 40 - 45 days intervals. Apply on beds, shade dried neem leaf or *Calotrophis* leaves at 2 t/ha and cover it with mud (2 t in 2 split doses).

Drench Bordeaux mixture 0.25% in basins formed around the vine at monthly intervals starting from October – January, three times soil drench and six times spray from June - July.

During winter season avoid frequent irrigation.

Remove the affected vines away from the garden and burn them.

Application of Alliette 3 g/lit 4 times at monthly intervals.

Application of *Trichoderma viride* @ 5 g/vine.

Bacterial leaf spot, blight and bacterial stem rot: Spray Streptocycline 400 ppm + Bordeaux mixture 0.25% when the first disease symptoms appear. Continue spraying at 20 days intervals. Always spray the chemical after plucking the leaves.

Anthracnose (Theechal): Spray 0.2% Ziram or 0.5% Bordeaux mixture after plucking the leaves after the first appearance of the symptom. The variety Karpoori is susceptible to the disease.

Powdery mildew: Spray 0.2% Wettable sulphur after plucking the leaves.

Harvest: It depends upon the growth of the vines and market condition. Once harvesting starts it continues almost every day.

Yield: 75 to 100 lakh leaves/ha/year.

Varieties released in each spice and plantation crop in India

Pepper	Cardamom	Ginger	Turmeric	Coriander	Fenugreek	Cinnamon	Coffee
Varieties for higher	**Malabar**	**Green Ginger**	CO 1,	CO 1, CO 2,	CO 1, CO 2,	YCD – 1,	***Coffea arbica***
elevation:	ICRI – 1, 3	Himachal	BSR 1, 2	CO 3,	Rajendra Kanti,	SL- 63	
(above 1000 mtr)	TDK – 4, 11	Suruchi	Prabha,	CO(CR)4	RMt – 1,	PPI – 1	Sel. 5 B
Panniyur–1,4,7	Mudigere 1, 2	Suprabha	Prathiba,	Guj. CO 1,	Lamsel – 1	Nithya shree	Sel. 7-3
Kalluvally,	MCC – 40	Suravi	Swarna	Guj.CO 2,	Hisarsonchi	Navashree	Sel. 7 – 4
Aimpirian	IISR-Coorg Suvasini	Rio-de-jeniro	Suguna	Rajendra Surabi,	RMt – 303		Cauvery
Panchami	IISR Avinash	Nadia	Sudharsana,	RCr-41	Gunj Methi 1		Sachin more
Chumala	IISR Vijetha I	**Dry ginger**	Ranga	Sadhana,	Hisar Suvarna		
Lower elevation	PV 1	Maran	Rasmi	Swati,	Hisar Madhavi		***Coffea canephora***
Panniyur – 1, 6	**Mysore**	Himagiri	Sona	Sindhu,	Hisar Mukta		
Sreehara	ICRI – 2,	Varadha	Varuna	CS – 287	RMt – 143		Sel. 274,
Subhara	**Vazhukka**			Hisar Anand	RMt-305		C x R
Panchami	NCC – 200			Azad Dhania-1	Pant Ragini,		
Pournami	(Njallani)			RCr – 20,	Pusa Early		
	MCC–12,16			RCr – 435	bunching		
	PV -2			RCr – 436	Rajendra		
				RCr – 446	Khushba		
				RCr – 684			
				Hisar Suganthi			
				DH – 5			
				Pant Haritma,			
				DWD – 3			

Part V
Medicinal and Aromatic Plants

Chapter A
Medicinal Plants

Senna: *Cassia angustifolia* Vahl.; *Leguminosae*

Varieties : KKM Se 1, ALF-T2.

Soil and climate: In Tamil Nadu, it is grown in sandy or sandy loam or laterite soils. It is a hardy warm weather crop grown under rainfed and irrigated conditions.

Seed rate: 15 - 20 kg/ha.

The seeds are scarified with sand or can be soaked overnight in water and sown in beds at a spacing 45 x 30 cm during February – March or June – July.

Season: February - March and June - July.

Manuring

Basal: Apply FYM 10 - 15 t/ha and N, P and K at 25, 25 and 40 kg/ha.

Top dressing: Apply 25 kg N two splits at 40 and 80 days after sowing.

Aftercultivation: One or two weedings.

Plant protection - Pests

Aphids: Spray dimethoate 30 EC or methyl demeton 25 EC at 1 ml/lit of water.

Harvest: The first harvest of leaves and pods are done 2 months after sowing and subsequent harvests at 30 days interval. Leaves and pods are dried for 7 - 10 days.

Yield - Irrigated

Dried leaves	:	2 t/ha.
Dried pod	:	150 - 200 kg/ha.

Rainfed

Dried leaves	:	1 t/ha.
Dried pods	:	75 - 100 kg/ha.

Seed Production Technology: Seeds attain physiological maturity at 40 days after anthesis associated with colour change of pods from green to brown. Seeds can be processed by using 8/64" round perforated metal sieves. Hard seededness can be effectively overcome by acid scarification with commercial sulphuric acid @ 100 ml/kg seed for 10 minutes.

Periwinkle: *Catharanthus roseus; Apocynaceae*

Varieties: White flowered, Purple flowered and Nirmal(white flowered variety: from CIMAP)

Soil and climate: It is suited to all types of soil and tropical climatic conditions. Well distributed annual rainfall of 100 cm or more is ideal for raising as a rainfed crop.

Seeds and planting: Propagated through seeds either by direct sowing or through transplanting.

Seed rate: 2.5 kg/ha : Direct sowing

0.5 kg/ha : Through seedlings

45 - 60 days old seedlings are transplanted at a spacing of 45 x 20 cm during June - July or September - October.

Manuring

Basal: Apply FYM at 10 t/ha and N P and K at 50 kg/ha.

Top dressing: Apply 50 kg N 60 days after planting.

Aftercultivation: The crop requires 2 weedings, the first 90 days after sowing/transplanting and second 60 days after the first weeding.

Harvest: The crop becomes ready for harvest of roots after one year. Two leaf strippings can be taken, the first one after 6 months and the second after 9 months of sowing. Aerial parts are cut and the soil is ploughed for harvest of roots. Fruits are collected without damage.

Yield

	Irrigated	**Rainfed**
Roots	1500 kg/ha	750 kg/ha
Stems	1500 kg/ha	1000 kg/ha
Leaves	3000 kg/ha	2000 kg/ha

Seed Production Technology: The physiological maturity of periwinkle seeds is attained at 40 days of anthesis with maximum dry weight, germination and vigour with a change of pod colour from green to yellow with translucence.

Seeds can be processed by using 4/64" round perforated metal sieves with maximum seed recovery.

Pyrethrum: *Chrysanthemum cinerariaefolium.* Vis.; *Asteraceae*

Varieties: 'Hansa' is the released variety from CIMAP, Kodaikanal

Soil and climate: Light and medium well drained loamy soils are suitable. It grows best in areas, which have mild cool climate and a short winter and cool summer with an annual rainfall of 100 cm or more. A period of chilling in which the temperature falls below 17^0 C for six weeks is necessary for flower bud initiation.

Season: April - May and October - November.

Seeds and planting: Propagated by seeds with a seed rate of 2 - 3 kg/ha.

Seedlings are raised in nursery beds and transplanted after 6 - 8 weeks a spacing of 45^0 x 30 cm.

Manuring

Basal: Apply N, P and K at 20, 50 and 50 kg/ha.

Top dressing: 20 kg of N in 2 split doses.

Harvest: Flowers are picked at fortnightly intervals from third month and dried immediately.

Yield: 500 kg of flowers/ha.

Digitalis: *Digitalis lanata* Ehrh.; *Scrophulariaceae*

Varieties: Strain E.C. 115996 is reported to five higher foliage yield with high glycoside content

Soil and climate: A well drained sandy soil rich in organic matter and slightly acidic in reaction is suitable. It requires a cool and mild climate and comes up well in hill slopes.

Planting season: May - June.

Seeds and sowing: Propagated by seedlings.

Seed rate: 8 kg/ha.

Spacing: 45 x 30 cm.

Manuring

Basal: Apply FYM 10 t/ha, N and P at 30, 50 kg/ha respectively.

Top dressing: 30 kg N as foliar application on 60th and 180th day after planting.

Aftercultivation: Give 1 - 2 weedings in the initial stages.

Harvest: 8 - 10 cm long leaves (excluding petiole) are collected between July and August from the first year crop and second harvest taken one and half months later. Dry the leaves by passing hot wind at 60^0 C. 2 - 3 harvests can be done.

Yield: 2000 - 3000 kg of dried leaves/ha.

Medicinal Dioscorea: *Dioscorea floribunda* Mart and Gal.; *Dioscoriaceae*

Varieties: Arka Upkar, Pusa 1 and FB(C) - 2.

Soil and climate: Well drained clay loam soil is suitable. Can be grown in tropical and sub-tropical climatic conditions.

Propagation: Propagated through single node leaf cuttings or tuber pieces.

Single node leaf cuttings: This consists of a single leaf with petiole and about 0.8 cm of the stem. The cuttings are quick dipped in 5000 ppm IBA and planted in mist chamber for rooting. After about 8 - 10 weeks, the plants are transferred to polythene bags. After 5 - 6 months, they are planted in the main field at a spacing of 45 x 3 cm during June - July or September - October. Rhizomes each piece weighing 50 - 60 g with one or two buds can also be used for planting. A pre-planting dip in Carbendazim 2 g/lit for 10 minutes is essential.

Manuring

Basal: Apply FYM 20 t/ha. N, P and K 100 kg/ha.

Top dressing: Apply 10 kg N in three equal splits at second, third and fourth months.

Aftercultivation: The vines need support for optimum growth and a pandal may be provided. Bamboo poles or gunny twines may be used to lead the vines to the pandal. 1 - 2 weedings are essential in the first year. Spray the crop with 25 ml Dicofol in 10 lit of water to control aphids and red spider mites.

Harvest: Harvest at 2 years of age manually using pick axes or deep ploughing with mould plough.

Yield

Fresh tubers	:	50 - 60 t/ha.
Diosgenin content	:	3.0 to 3.5 %

Medicinal solanum: *Solanum khasianum* Clarke.; *Solanaceae*

Varieties: RRL-20-2, RRL-SL-6, Glaxo, Arka Sanjivini.

Soil and climate: Well drained loamy soils are suitable. Grows well under moderate climatic conditions.

Seeds and planting: Being a hardy plant, even land with medium fertility can give a good stand. Propagated through seedlings.

Seed rate: 400 g/ha. Requires a resting period of one month and sowing should not be delayed further. Seedlings are raised in nursery and transplanted at six leaf stage at a spacing of 50 x 50 cm during June - July. Drench the seedlings with Copper oxy chloride 2.5 gm/lit of water to prevent damping off disease in Nursery.

Irrigation: Irrigation should be given once in a week in the first month and later reduced to once in a fortnight.

Manuring

Basal: Apply FYM 10 t/ha. N, P and K at 25, 40 and 40 kg/ha respectively.

Top dressing: 25 kg of N at second month after planting.

Aftercultivation: First weeding is done after 3 - 4 weeks and second weeding at 2 – 3 months.

Harvest: After transplanting, the crop takes six months for harvest. The berries after harvest are dried.

Yield

Fresh berries	:	700 - 800 kg/ha
Solasodine content	:	2.0 to 2.5 %

Chapter B

Aromatic Plants

Lemongrass: *Cymbopogon flexuosus; Graminae*

Varieties: OD-19, OD-408, RRL-39, Pragathi, Praman, CKP-25, Krishna and Cauvery.

Soil and climate: Sandy loam with abundant organic matter and pH of 6.0. It comes up well under tropical and sub-tropical conditions with a high rainfall (200 - 250 cm) and humidity.

Seeds and planting: 55,600 slips/ha at a spacing of 60 x 30 cm in ridges. Can also be propagated through seeds at 4 kg/ha. Seedlings are to be raised and transplanted during June - July.

Manuring: Apply FYM or compost at 20 - 25 t/ha as basal. Apply 50 kg N/ha annually, half at planting and half one month after planting. From the second year onwards, first dose of fertilizer should be applied after cutting and again one month after the first dose.

Irrigation: Life irrigation on third day and further irrigation at 7 - 15 days interval.

Aftercultivation: Hand hoeing and weeding as and when required.

Plant protection - Pests and diseases

In general, pests and diseases may not affect the plant. If there is any sucking pest spray methyl demeton 25 EC or dimethoate 30 EC 1 ml/lit. For caterpillars, spray phosalone 35 EC or monocrotophos 36 EC 2 ml/lit.

Harvest: Harvest the leaves first at 90 days after planting and thereafter 75 - 90 days interval. Cut the bush by leaving 10 - 15 cm above the ground level. Oil is extracted either by water or steam distillation method. Oil recovery 0.2 - 0.3 %.

Yield

Herbage	:	20 - 30 t/ha.
Oil		
First year	**:**	25 kg/ha.
Second year onwards	**:**	80 - 100 kg/ha.

Citronella: *Cymbopogon winterianus; Graminae*

Varieties: Java-2, Jerlab-2, Java citronella, Java II and Ceylon citronella, Bio-13, Mandakini and Manjusha are the high yielding varieties.

Soil and climate: Sandy loam with abundant organic matter and pH of 6.0. It comes up well under tropical and sub-tropical conditions with a high rainfall (200 - 250 cm) and humidity.

Season: June - July. 28,000 slips/ha at a spacing of 60 x 45 cm in ridges.

Manuring

Basal: FYM 30 t/ha and NPK at 25:40:40 kg/ha.

Top dressing: 75 kg N/ha in 3 equal splits of 25 kg each at 3, 6 and 9 months after planting.

Irrigation: Life irrigation on third day and again at 10 – 15 days interval.

Aftercultivation: 1 - 2 weedings at the initial stages and earthing up after each harvest.

Plant protection - Diseases

Leaf blight: Spray any one of the Dithiocarbamates namely Mancozeb or Zineb at an interval of 15 - 20 days.

Harvest: The first harvest at 6 months after planting. Second and subsequent harvest at two and a half months intervals.

Yield

Herbage : 20 - 30 t/ha/year.

Oil is extracted by water distillation. Oil content 0.2% to 0.3%.

OIL

First year	:	50 - 100 kg/ha.
Second year	:	100 - 150 kg/ha.
Fifth year	:	250 - 300 kg/ha.

Geranium: *Pelargonium graveolens* (L) Hervitt.; *Geraniaceae*

Varieties: Algerian, Reunion, IIHR-8, Kodaikanal 1 and Egyptian.

Soil and climate: A deep light porous well drained soil rich in organic matter and acidic in reaction with a pH 5.5 to 6.0 is suitable. An elevation ranging from 1000 - 2400 m with an annual rainfall of 100 to 150 cm evenly distributed throughout the year is ideal.

Propagation: Geranium is propagated by stem cuttings. Cuttings of about 10 cm taken from current season growth with a well formed crown of leaves with 3 - 4 nodes and terminal bud and raised on sphagnum moss or in polythene bags of 10 x 10 cm size. Thorough field preparation leading to fine tilth condition is essential. Pits of 30 x 30 cm size are dug and cattle manure at 250 g/pit is applied and rooted cuttings of 2 months age are planted at a spacing of 45 x 45 cm during April - May.

Manuring: 60 kg in each of N, P and K/ha is recommended. P and K are applied every year at the time of first harvest while N is applied in equal splits depending upon the number of harvests per year.

Irrigation: Geranium is usually grown as a rainfed crop. Irrigation during dry periods increases the yield.

Aftercultivation: Weedings, uprooting and burning the diseased plants throughout the life cycle of the plant. From the second year onwards give a deep soil forking around the plants to improve the growth of more suckers.

Pruning: Pruning of the bushes is necessary when the bush shows signs of decline. The branches are cut back leaving 15 - 20 cm once in 4 - 5 years.

Plant protection - Pests

Nematode: To control the nematodes (*Meloidogyne hapla*) in nursery, apply Carbofuran at 2 kg a.i./ha once in 6 months in June and December.

Diseases

Wilt: Drench with Carbendazim 1 g/lit at monthly intervals.

Harvest and distillation: In the year of planting, only one harvest can be done at 7 - 8 months and thereafter 3 or 4 harvests can be done in a year. The tender tip portion with 6 - 12 nodes constitute the materials for harvest. The harvested material is withered in shade for two to three hours and distilled.

Yield

Herbage	:	20 - 25 t/ha.
Oil yield	:	15 - 20 kg/ha.

Palmarosa: *Cymbopogon martinii var. motia* (Roxv) Wats.; *Graminae*

Varieties: Trishna, PRC-1, IW 31245, IW 3629, IW 3244, OPD-1, OPD-2 and RRL(B)-77.

Soil and climate: A well drained loamy soil is suitable. Comes up well under tropical conditions with an annual rainfall of about 150 cm.

Seeds and planting

Through seeds: 2.5 kg of seeds/ha.

Sow in raised nursery beds in lines 15 - 20 cm apart. Transplant at 3 - 4 weeks in ridges at a spacing of 60 x 60 cm during June - July.

Through slips: Establishment will be poor as compared to seedlings.

28,000 slips/ha will be required to plant at 60 x 60 cm spacing.

Manuring

Basal: FYM 10 t/ha and NPK at 20:50:40 kg/ha.

Top dressing: 15 kg/ha in 3 splits at 3, 6 and 9 months of planting.

Aftercultivation: Give 1 - 2 weedings in the early stages and earth up after each harvest and top dressing.

Harvest: The first harvest commences at 3 - 4 months of planting. Subsequent harvests at 3 - 4 months interval.

Yield

Herbage	:	20 - 30 t/ha/year.
Oil		
First year	:	20 kg/ha.
Second year	:	60 kg/ha.
Third and Fourth year	:	70 kg/ha.

Seed Technology: Seeds attain physiological maturity at 40th day after 50% flowering when the fluff (seed) moisture is around 20%. Leaching of fluffs in running water for 8 hours followed by soaking in KNO_3 at 0.5% for 6 hours recorded maximum germination.

Patchouli; *Pogostemon patchouli* Hook.; *Labiatae*

Varieties: Johore, Singapore and Indonesia are commonly cultivated. Out of these the first one yields the best quality oil. Where as the other two give high yield of oil.

Soil and climate: Well drained loamy soil with slightly acidic condition is suitable. Thrives best in hot and humid conditions, under shade of rubber, coconut, coffee, etc.

Propagation and Planting: Rooted stem cutting of 15-20 cm are used. The field is prepared to a fine tilth and the rooted cuttings are planted at a spacing of 60 x 30 cm during April – May.

Manuring

Basal: Apply NPK at 30 kg/ha each.

Top dressing: 30 kg N/ha after 3 months of planting.

Irrigation: Grown as a rainfed crop in hills. In plains irrigation is to be given at 7 - 10 days interval.

Plant and protection - Pests

Nematode: Application of Carbofuran in @ 2 kg ai./ha the nursery.

Harvest: First harvest when fully grown (6 - 8 months). Subsequent harvest at 3 to 5 months intervals. The leaves are dried in shade and distilled.

Yield: 30 - 40 kg oil/ha/year.

Mint: *Mentha sp; Labiatae*

Varieties

Japanese mint – MAS-1, MA-2, Hybrid-77, Shivalik and EC-41911

Spear mint – MSS-1, MSS-5 and Punjab Spearmint-1.

Bergamot mint – Kiran

Pepper mint - Kukrail

Soil and climate: Well drained loamy and acidic soil high in organic matter content is suitable. Sub-tropical areas receiving an annual rainfall of 100 - 150 cm are good.

Propagation and planting: Rooted stem cuttings are planted in beds at 40 x 40 cm spacing during June - July.

Manuring

Basal: Apply NPK at 30, 60 and 10 kg/ha.

Top dressing: Apply 30 kg N in 2 splits at 60th and 120th day of planting.

Harvest: First cutting starts in about 5 months after planting and subsequently at 3 months interval. Under good management conditions, the crop will give economic yield for about four years.

Yield

Herbage	15 - 20 t/ha/year.
Oil	50 - 100 kg/ha/year.

Production techniques for important medicinal plants

No.	Crop	Uses	Alkaloids	Varieties	Seed rate Kg/ha	Spacing (cm)	Population /ha.	Duration Days	Yield (Kg/ha)
1.	*Gloriosa superba* (Kanvazhi kizhangu)	Gout, Rheumatism and in polyploidy	Colchicine, colchicoside	-	1500 kg tubers	60 x 30	55,500	6 months	625 kg seed
2.	*Coleus forskohlii* (Marundhu koorkkan)	Obesity, antihepertens-ion	Forskohlin	Maimul, Garmai	37,000 herbaceous cuttings	60 x 45	37,000	6 months	20 ton fresh roots
3.	*Withania somnifera* (Aswagandha)	Stress reliever, tonic	Withanilides	Jawahar	5 kg seed	60 x 30	55,500	6 months	500 kg dry root
4.	*Phyllanthus amarus* (Keezhanelli)	Hepato-tonic	Hypo phyllanthin	Navyakrit	2 kg seed	30 x 15	2.2 lakh seedlings	3 months	2.5 ton dry herbage
5.	*Mucuna pruriens* (Poonaikali)	Cures Parkinsons disease	L DOPA	White and Black seeded	10 kg seed	90 x 60	19,000 plants	6 months	1200 kg seed
6.	*Aloe vera* (Katralai)	Cosmetics	Gel	-	10,000 suckers	90 x 90	10,000 plants	13 months	40 ton fresh leaves
7.	*Piper longum* (Tippili)	Bronchitis, cough	Longumine	Vishvum	55,500 rooted cuttings	60 x 30	55,500 plants	5 years	750 kg dry spikes/year
8.	*Acorus calamus* (Vasambu)	Cough, digestive	Calamine	-	10,000 rhizhomes	60 x 60	28,000	1 year	10 ton rhizomes
9.	*Hibiscus rosasinensis* (Sembaruthi)	Blood purifier	Laxative	Red single whorl	3085 rooted cuttings	1.8 x 1.8 m	3085 rooted cuttings	Monthly harvest	200 kg dry flowers, 600 kg dry leaves

No.	Crop	Uses	Alkaloids	Varieties	Seed rate Kg/ha	Spacing cm	Population /ha.	Duration Days	Yield Kg/ha
10.	*Bixa orellana* (Annatto)	Organic dye	Bixin	Mexico	1100 seedlings	3 x 3 m	1100 seedlings	Perennial	1 ton dry seed
11.	*Andrographis paniculata* (Nilavenbu)	Anti diabetic	Andrographol-ide	-	55,000 seedlings	60 x 30 cm	55,000 seedlings	4 months	2.0 ton dry herbage
12	*Gymnema sylvetre* (Sarkarai kolli)	Anto diabetic	Gymnemic acid	-	1000 cuttings	2 x 2 m	1000	Perennial	1.0 ton dry leaves
13.	*Centella asiatica* (Vallarai)	Memory enhancer	Asiaticoside	Kayakirti, Majjaposhak	2.2 lakh runners	30 x 15 cm	2.2 lakh runners	Perennial	2.5 ton dry leaves
14.	*Aconitum heterophyllum*	Pain reliever, tonic	Atisine	-	10,000 rooted cuttings	60 x 60	28,000	1 year	8 ton roots
15.	*Saussurea lapa*	Cardiac stimulant	Saussurin, tannin	-	Seed	30 x 15 cm	2.2 lakh plants	3 years	1 tom dry root
16.	*Embelia ribes*	Anathemintic	-	-	Seed/cuttings	60 x 45	37,000	I year	2 ton fresh roots
17.	*Asparagus racemosus* (Shatavri)	Aphrodisiac	Glycosides	-	Root suckers	90 x 60	19,000 plants	12-14 months	1 ton dry root
18.	*Solanum nigrum*	Digestive, laxative	Solosodine	Black fruited variety	Seed	60 x 45	400 g seed	Perennial	1 dry leaves

No.	Crop	Uses	Alkaloids	Varieties	Seed rate Kg/ha	Spacing cm	Population /ha.	Duration Days	Yield Kg/ha
19.	*Swertia chirata*	Anti inflammatory	-	-	Seed	60 x 60	28,000 plants	1 year	1 ton dry roots
20.	*Commiphora wightii*	Anti-obesity	Lipids	Marusudha	Cuttings	90 x 90	10,000 plants	12-14 months	200 kg resin
21.	*Plantago ovata*	Laxative	-	GI5, HI2	Seed	30 x 15	2.2 lakh seedlings	3 months	150 kg seed
22.	*Picrorhiza kurroa*	Carminative, hepatitic	Picrorhizin	-	2 kg seed	30 x 15	2.2 lakh seedlings	3 months	1 ton dry root
23.	*Glycyrrhiza glabra*	Refrigerant	Glycyrrizin	Haryana Mulhati	Root suckers	60 x 45	37,000 plants	12 -14 months	2 ton dry root
24.	*Chlorophytum borivilianum* (Musli)	Energy supplement	Saponin	RC5	500-600 kg seed tubers	60 x 45	37,000	8 months	1 ton dry root
25.	*Rauwolfia serpentine*	Anti hypertension	Ajmalcine, serpentine, rauwolfine	RS-1	4 kg seed	60 x 30	55,500 seedlings	3 years	1500 kg dry roots
26.	*Stevia rebsudiana*	Non-calorific sweetener	Stevioside	-	75,000 cuttings	25 x 60	75,000 plants/hectare	4-5 months (3 years)	6750 kg/ ha/year

No.	Crop	Uses	Alkaloids	Varieties	Seed rate Kg/ha	Spacing (cm)	Population /ha.	Duration Days	Yield Kg/ha
	Herbal Spices								
1.	*Rosemarinus officinalis* (Rosemary)	Anti-oxidant	Rosemarinic acid	-	19,000 rooted cuttings	1.2m x 45	19,000 rooted cuttings	Perennial	12-15 ton green herbage
2.	*Thymus vulgaris*	Digestive	Thymol	-	500 g seed	90 x 30	37000 plants	Perennial	100 kg dry herb
3.	*Ociumum basilicum* (Sweet basil)	Carminative	Eugenol, linaloel	European, ReUnion	5 kg seed	60 x 30	55,000 seedlings	Four months	14 ton green leaves
4.	*Salvia officinalis* (Sage)	Carminative, eye disorders, anti-oxidant	Linalool acetate	-	4 kg seed	60 x 60	28,000 plants	Perennial	1.7 ton dry herbage
5.	*Ocimum sanctum* (Tulsi)	Perfumery, cosmetics	Eugenol	-	300 g seed	45 x 45	50,000 seedlings	170 days	10 ton fresh herbage
6.	*Lavendula officinalis* (Lavender)	Perfumery, cosmetics	-	-	14,000 plants	120 x 60	14,000 plants	3-4 years	200 kg dry biomass
7.	*Ocimum gratissimum* (Clocimum)	Perfumery, cosmetics	Methyl Eugenol	-	2 kg seeds	45 x 30	74,000 seedlings	Perennial	20-25 ton green leaves

Part VI
Commercial flowers

Rose: *Rosa sp; Rosaceae*

Varieties: Edward Rose and Andhra Red Rose.

Soil and climate: Well-drained sandy loam is suitable. Can be grown in the plains of Tamil Nadu.

Propagation and planting: Cuttings with 2-3 buds are dipped in IBA or IAA @ 500 ppm. Pits of 45 cm x 45 cm x 45 cm are dug at 2.0 x 1.0 m spacing and 10 kg FYM is added to each pit before planting. Lindane 1.3% 20 g per pit is added to prevent attack by white ants.

Irrigation: Once in 2 days until plants establish and once a week thereafter.

Manuring: After pruning in October and again in July the plants are manured with FYM 10 kg and 6:12:12 g of NPK per plant.

Aftercultivation

Pruning: The best time of pruning is the period when the activity of rose plant is least and the plant is dormant to near dormant stage. Pruning time will depend on climatic conditions of the particular region. Cutting back the vigorous past season shoots to half the length. All the weak, diseased, criss-crossing and unproductive shoots are removed. The cut ends should be protected with Bordeaux or Copper oxychloride + Carbaryl 50 WP.

Plant protection - Pests

Rose chaffer beetle: Hand pick Cetonid beetles and destroy during day. Spray endosulfan 35 EC 2 ml/lit.

Setup light to attract *Holotrichia* and *Anomala* spp.

Red scale: Rub off the scales with cotton soaked in kerosene or diesel. Cut and burn the affected branches. Spray malathion 50 EC 2 ml/lit at the time of pruning and again during March - April or Apply carbofuran 3G 5 g/plant or spray fish oil rosin soap 25 g/lit or endosulfan 35 EC 2 ml/lit.

Mealy bug: Spray monocrotophos 2 ml/lit or methyl parathion 2 ml/lit.

Flower caterpillar

Helicoverpa armigera: Spray Ha NPV 1.5 x 10^{12} PIB/ha.

Spodoptera litura: Spray Sl NPV 1.5 x 10^{12} PIB/ha.

Bud worm: Spray monocrotophos 36 WSC 2 ml/lit at fortnightly interval during flowering.

Thrips, aphids and leaf hoppers

Spray methyl demeton 25 EC 2 ml/lit of water or carbofuran 3G 5 g/plant. Spray Neem oil 3 % or phosalone 35 EC 2 ml/lit.

Diseases

Black spot disease (*Diplocarpon rosae*)

Spray Carbendazim 1 g/lit twice at fortnightly intervals.

Powdery mildew

Spray Carbendazim 1 g/lit or Wettable sulphur at 2 g/lit.

Crop duration

The plants will start flowering in the first year and will give economic yield from the second year onwards.

Season of flowering and harvesting: Flowering will commence 45 days after pruning. Fully opened flowers are picked early in the morning.

Yield: About 10 lakh flowers/ha/year.

Hybrid Rose: *Rosa hybrida; Rosaceae*

Varieties: Gladiator, Baby Pink, Sofia Lawrance, YCD 1, YCD 2, YCD 3,

Soil and climate: Generally suitable for higher elevation (1500 m and above). Can also be grown in the plains under ideal condition of fertile loamy soils with salt-free irrigation water.

Propagation and planting: Propagated by rooted cuttings or by budding on Briar root stocks in hills and on Edward Rose and *Rosa indica* in plains. One year old budded plants are planted in July - August at 75 cm x 75 cm spacing.

Aftercultivation: The plants should be watered daily until they establish and thereafter once in a week. Pruning is done during March and October. Spray Diuran 2.5 kg a.i/ha to control weeds. Avoid spray fluid coming in contact with Rose plants.

Manuring: At three months interval, apply FYM at 10 kg and 8:8:16 g NPK per plant after each pruning. For cv. Happiness NPK may be applied at 75:150:50 g/plant per year.

Yield: 70 - 80 flowers for Hybrid Tea Roses per plant per year.

80 - 90 flowers for Floribundas per plant per year.

Malligai: *Jasminum sambac* Ait.; *Oleaceae*

Varieties: Single Mogra, Double Mogra, Iruvatchi, Ramanathapuram local etc.

Soil and climate: Well drained fertile soil.

Preparation and planting: Layers or rooted cuttings are planted with a spacing of 1.25 m either way to accommodate 6400 plants per ha during June to November in pits 30 x 30 x 30 cm. 20 kg FYM per pit is applied before planting.

Irrigation: Irrigation should be given immediately after planting followed by weekly irrigation depending upon weather conditions.

Manuring: FYM 10 kg and NPK at 60:120:120 g per plant applied twice once after pruning and again during June - July.

Pruning: The bushes are pruned to 50 cm height from the ground level during last week of November.

Plant protection - Pests

Bud worm: Spray monocrotophos 36 WSC 2 ml/lit or profenofos 50 EC @ 1 ml/lit.

Blossom midge: Spray monocrotophos 36 WSC 2 ml/lit or endosulfan 35 EC 2 ml/lit.

Red spider mite: Spray sulphur 50 WP @ 2 g/lit or dicofol 18.5 @ EC 2.5 ml/lit.

Diseases

Yellowing of leaves: It is caused by 3 factors *viz.,* iron deficiency, nematode infection and root rot disease.

Iron deficiency: Spray Ferrous sulphate 5 g/lit at monthly intervals until the chlorotic symptoms disappear.

Nematode: Test the soil for nematode infection. Apply 10 g of Phorate granules near root zone and irrigate.

Root rot: Drench the soil around the plant with Copper oxychloride at 2.5 g/lit.

Season of flowering and harvest: Flowering commences in March - April. Fully developed unopened flower buds should be picked in the mornings.

Yield: 8750 kg of flower buds/ha.

Mullai: *Jasminum auriculatum* (Vahle.); *Oleaceae*

Varieties: CO 1 and CO 2.

Soil and climate: Well drained red and sandy loam soils under tropical conditions are suitable.

Season of planting: June to November.

Propagation and planting: Layers or rooted cuttings are planted in 30 cm x 30 cm x 30 cm pits dug at 1.5 x 1.5 m spacing to accomodate 4400 plants per ha.

Manuring: 120:240:120 g NPK/plant applied in six split doses at bimonthly intervals, the first dose being given immediately after pruning.

Pruning: The bushes are pruned to 45 cm height from ground level during the last week of January.

Plant protection - Pests

Bud worm: Spray monocrotophos 36 WSC 2 ml/lit.

Red spider mites: Spray wettable sulphur 50 WP 2 g/lit.

Leaf eating caterpillar: Spray endosulfan 35 EC 2 ml/lit.

Season of flowering and harvest: May to November. Fully developed unopened flower buds should be picked in the morning.

Yield: 10,000 kg of flower buds/ha.

Jathi malli (Pitchi): *Jasminum grandiflorum* L.; *Oleaceae*

Varieties: CO 1 and CO 2.

Soil and climate: Well drained red loamy soils and tropical climate are best suited.

Season of planting: June - November.

Propagation and planting: Layers or rooted cuttings are planted at 2.0 x 1.5 m spacing (3350 plants/ha) in 30 cm x 30 cm x 30 cm pits.

Irrigation: Once in 10 days.

Manuring: FYM or compost 10 kg, NPK at 60, 120 and 120 g per plant applied in 2 split doses in December after pruning and again in June - July.

Pruning: Pruning is done during the last week of December to 45 cm height from ground level.

Plant protection - Pests

Bud worm: Spray Monocrotophos 2 ml/lit.

***Holotricha* beetle:** Install light trap to attract the adults immediately after summer rain.
Incorporate lindane 1.3 D into the soil 25 g/bush.

Red spider mite: Spray 50 % wettable sulphur 2 g/lit.

White ants: Dust lindane 1.3 D to the pits before planting at 5 g/pit.

Diseases

Leaf spot: Spraying of Mancozeb at 2 g/lit. from the onset of monsoon at monthly intervals.

Season of flowering and harvest: May to October. Fully developed unopened flower buds are picked in the morning for fresh flower trade. For oil extraction open flowers are to be picked before 10 a.m.

Yield: 11 t/ha of flower buds.
Jasmine concrete - 29 kg/ha.

Crossandra: *Crossandra infundibuliformis* L.; *Acanthaceae*

Varieties: Orange, Red and Delhi Crossandra.

Soil: Well drained sandy loam soil.

Seeds and sowing: Fresh seeds are sown during July - October in raised beds 15 cm apart in lines. Watering should be done daily. The seedlings will be ready for transplanting in 60 days.

Seed rate: 5 kg/ha for plant population.

For Delhi Crossandra, rooted cuttings have to be used for planting.

Preparation of field: Land is ploughed thrice and FYM at 25 t/ha is incorporated. Ridges are formed 60 cm apart. Dip the roots of seedlings in Carbendazim (1 g/lit of water) and plant on one side of the ridge at 30 cm spacing. For seed production the spacing may be 60 x 60 cm. For Delhi Crossandra a spacing of 60 x 40 cm is to be followed.

Aftercultivation: Spray Diuron (pre-emergence) 2.5 kg a.i/ha for weed control.

Manuring: Apply FYM 25 t/ha as basal and NPK at 75, 50 and 125 kg/ha as top dressing three months after planting. Repeat NPK application at the same dose at half yearly intervals for two more years. Instead, apply N at 60 kg/ha + *Azospirillum* 2 kg/ha and three months after planting. Spray ascorbic acid 1000 ppm for high yield (1 g/lit of water).

For Delhi Crossandra

Basal: Apply FYM 25 t/ha, Gypsum 100 kg/ha and P & K at 50 and 100 kg/ha.

Top Dressing: 30 days after planting, apply Neem cake 250 kg and N 40 kg/ha. Apply 90 days after planting N P K 40:20:60 Kg and repeat this dose at quarterly intervals for a time period of two years.

Irrigation: Once in a week.

Plant protection - Pests

Nematode: Avoid planting Crossandra in nematode infested fields. To control nematodes application of phorate or carbofuran 3 G at 1 kg a.i./ha a week after planting and to be repeated six months after application with any one of the above chemicals at 3 and 9 gm respectively per metre length.

Aphids: Spray dimethoate 30 EC 2 ml/lit.

Diseases

Wilt: Drench the soil around the plants with Methoxyethyl mercury chloride (Emisan) at 2 g/lit or Carbendazim 0.5 ml/lit.

Crop duration: 3 years including ratoon crop in the third year.

Harvest: Flowering will start a month after transplanting. Fully opened flowers are picked once in two days.

Yield: 2000 kg of flowers per ha/year.

Delhi Crossandra 2800 kg of flowers per ha per year.

Chrysanthemum: *Dendranthema grandiflora. Tzeuleu; Asteraceae*

Varieties: CO 1, CO 2 and MDU 1.

Soil: Well drained red loamy soils.

Propagation and planting: 1,11,000 suckers obtained from 15 cents of the previous crop are required to plant 1 ha. Dip the roots of the suckers in Carbendazim 1 g in 1lit to protect against wilt. The suckers are planted during June - July at 30 x 30 cm spacing on one side of the ridges. Pinching once in 4 weeks after planting to induce more branching.

Irrigation: Twice a week in the first month and subsequently at weekly intervals.

Manuring: FYM 25 t/ha + 125:120:25 kg NPK/ha, half of the N and the entire dose of P and K are to be applied basal just before planting. The other half of N is to be applied 30 days after planting the suckers. The same dose has to be repeated if a ratoon crop is allowed in December. Spray GA at 50 ppm 30, 45 and 60 days after planting to increase the flower yield.

Plant protection

Pests: Thrips, Aphids and leaf eating caterpillars

Spray monocrotophos 36 WSC 2 ml/lit.

Diseases

Root rot: Drench the soil around the plants with Copper oxychloride 2.5 g/lit.

Leaf spot: Spray Mancozeb 2 g/lit.

Duration: 6 - 8 months for plant crop and 4 months for ratoon crops.

Harvest: Pick the flowers from 3rd month onwards at 4 days intervals.

Yield:

20 t/ha from plant crop.

10 t/ha from ratoon crop.

Marigold (African marigold): *Tagetes erecta* L.; *Asteraceae*

Varieties: Pusa Narangi Gainda, Pusa Basanthi Gainda (IARI varieties) and MDU 1

Soil: Well drained loamy soil.

Seeds and sowing: Sown throughout the year. Nursery is raised with 1.5 kg seed/ha and the seedlings are transplanted after four weeks on one side of the ridge at 45 x 35 cm spacing. Treat the seeds with *Azospirillum* (200 g in 50 ml of rice gruel) before sowing.

Irrigation: Once in a week or as and when necessary. Water stagnation should be avoided.

Manuring: Apply 45:90:75 kg NPK/ha as basal and 45 kg N/ha as top dressing 45 days after planting.

Crop duration: 130 - 150 days.

Harvest: Flowers are picked once in 3 days beginning from 60 days after planting.

Yield: 18 t/ha.

Tuberose: *Polianthes tuberosa* L.; *Amaryllidaceae*

Varieties:

Single – Mexican single, Shringar, Prajwal

Double – Pearl Double, Suvasini, Vaibhav

Soil: Well drained loamy soil, pH – 6.5-7.5 pH

Propagation and planting: Corms (25 to 30 g) are planted (1,12,000 corms/ha) on the sides of ridges at 45 x 20 cm spacing at 2.5 cm depth during June - July. Corms are planted after 30 days of harvest. Dip the corms in 5000 ppm CCC (5 g/lit) before planting to increase the yield.

Manuring and Aftercultivation: FYM 25 t/ha. NPK 200:200:200 kg/ha (IIHR Recommendation)

Plant protection - Pests

Nematode: Apply carbofuran 3 G @ 1 g/plant near the root zone and irrigate immediately.

Crop duration: 2 years. The crop can be maintained for one more year with good management practices.

Harvest: Flowers are picked daily.

Yield

Yield – 14-15 t/ha

8 to 10 kg concrete per ha.

Nerium: *Nerium indicum* Mill.; *Apocynaceae*

Varieties: Single Rose, Single White, Single Red and Double Types.

Soil: Red lateritic or black or loamy soils with adequate drainage.

Propagation and planting: Hard or semi hard woodcuttings of 60 cm length are used; their ends are buried inside the soil forming an arch. Rooted cuttings can also be planted in the normal manner during June to July in 30 cm x 30 cm x 30 cm pits dug at 2 x 2 m spacing and filled with FYM, red earth and top soil.

Aftercultivation: The plants are irrigated as and when required and manured with 10 t FYM/ha during January and again in August. No chemical fertilizers are normally applied.

Plant protection - Pests and diseases

No serious pests or diseases affect this crop.

Leaf Caterpillar: Spray endosulfan 35 EC 1 ml/lit or phosalone 35 EC 1 ml/lit or monocrotophos 2 ml/lit.

Flowering season: Throughout the year.

Peak flowering between April to August.

Harvest: Flowering begins from the 4th month after planting.

Yield: 100 - 125 kg of flowers/ha/day.

Marikolundu (Dhavanam): *Artemisia pallens* Walls.; *Asteraceae*

Varieties - Local.

Soil and climate: A well-drained loamy soil with irrigation facilities preferably under cooler climate is suitable.

Seeds and sowing: During November 1.5 kg of seeds per ha is sown in raised bed and seedlings are transplanted after 30 days at 15 x 7.5 cm spacing in beds.

Aftercultivation and manuring: Crop is irrigated in four or five days. Apply NPK at 125:125:75 kg/ha with 25 t FYM and P and K as basal and 125 kg N/ha as top dressing with 50 kg N as first dose on 25th day of transplanting followed by 25 kg N every time after 75, 110 and 150 days of transplanting (after every cuttings)

Crop duration: 5 - 6 months.

Harvest: The plants become ready for cuttings in two and half months after transplanting. Subsequent cuttings are taken at 30 - 40 days intervals.

Oil recovery will be 0.13 % on 50th day and 0.23 % on the 75th day.

Maruvu: *Origanum majorana* L.; *Labiatae*

Varieties: Local.

Soil and climate: Well drained loamy soils.

Propagation and planting: Cuttings from the previous crop are planted during December - January on both the sides of the ridges at 30 x 15 cm spacing.

Irrigation: Once in 4 to 5 days.

Manuring

Basal: FYM 25 t/ha. NPK 55:110:60 kg/ha.

Top dressing: After first cutting 55 kg N/ha.

Plant protection - Pests

Aphids: Spray dimethoate 30 EC or methyl demeton 25 EC at 2 ml/lit.

Duration: 2 years.

Harvest: The herbage becomes ready for harvest in 100 days and thereafter once in every 30 to 40 days.

Yield: 10,000 kg of herbage/year/ha.

Carnation: *Dianthus* Spp; *Caryophyllaceae*

Varieties: Standard Types - Killer, Malaga, Delphi, Madame Colette, Varna, Solar, Lady Green

Spray Types: Estimade, Indira, Vera, Durago, Amore, Kiss Siga

Soil and Climate: Well drained and Red loamy soil with the pH of 6 is most suitable. Temperature should be within the range of 25^0 C - 27^0 C.

Season: Throughout the year as it is cultivated under controlled conditions.

Propagation and Planting: Plantlets/suckers – 5-10 cm terminal cuttings treated with NAA at 500 ppm for 5 minutes. Cuttings are dipped in Carbendazim 2g/lit. solution. Raised beds at 3 feet width and 45 cm height are formed at 45 cm interval and planting is done on top of the bed at 15 x 15 cm spacing.

Growing condition -

Day temperature	- 20-25^{0}C
Night temperature	- 10-15^{0}C
Critical photoperiod	- 13 hours
RH	- 50-60%

Irrigation: Irrigation @ 4-5 lit/m^2/day is provided with drip system once in 2-3 days according to soil moisture to maintain water holding capacity at 60% to 65%.

Manuring: Basal : Neem cake 2.5 ton/ha. Phosphorus 400 g/100 sq.feet, Magnesium sulphate 0.5 kg/100 sq.feet.

Top dressing: Calcium Ammonium Nitrate + MOP at 5:3 ratio is mixed and applied @ 2.5 g/ plant/month.

Plant Protection

1. Red spider mite	-	Plant varieties having straight and flat leaves Spray dicofol 18.5 EC @ 2 ml/lit or wettable sulphur 50 WP 3 g/lit.
2. Thrips	-	Spray dimethoate 30 EC 1 ml/lit or malathion 50 EC 2 ml/lit or fenitrothion 50 EC 2 ml/lit
3. Nematode	-	Carbofuran 7-8 kg/ha is applied at the time of planting
4. Leaf spot	-	Spray Carbendazim or Mancozeb 2 g/lit.
5. Blight	-	Spray Mancozeb @ 2.5 g/ litre.
6. Wilt		
7. Root rot		

Season of Flowering development and Harvest: Starts after 4 months of planting and continued upto one and half years. Daily harvest is made leaving bottom 5 nodes of stalk to facilitate side shoot development. To keep the stalk erect, 4 – 5 stage stocking is provided.

Post harvest Treatment: Citric acid is added to water to make the pH 4.5 to 5 and 5 mg of Sodium hypochloride is added to 1 litre of water. Cut flower stalk is soaked in this solution for 4 - 5 hours to improve vase life.

Grading: Based on stem thickness, stem length and quality of flower grading is done as A, B, C,D

Yield: 8 Stalks/plant/year.

Gladiolus: *Gladiolus* spp; Iridaceae

Varieties: Pusa Gunjan, Pusa Bindiya, Pusa Subhangini, Nazrana, Punjab Morning, Punjab Dawn, Kumkum, Chaubattia Arunima, Chaubatita Ankur.

Soil and Climate: Well drained soil with the pH of 6 is highly suitable. Temperature should range between 27^0 C and 30^0 C.

Season: This crop requires minimum 10 hours of sunlight to over come blindness. So season should be adjusted or light substitution is given.

Propagation and planting: Corms conforming the grades (height/circumference) 8/10, 12/14, 10/12

Bed system: Ridges and furrows

Irrigation: Open field 7-8 days interval. Poly house - Drip irrigation 2-3 days interval.

Manuring

Basal

N 60 kg/ha.

P 150 kg/ha

K150 kg/ha

Top dressing N alone is given.

30 kg/ha - 4 leaf stage as foliar spray.

30 kg/ha - Bud stage as soil application.

After cultivation: Hand weeding is done whenever necessary.

Plant Protection: Corms are dipped in hot water at 40 - 45^0C + fungicide (captan or thiram 2 g/lit) to control Nematode and fungal disease.

Thrips – Methyl demeton 25 EC 2 ml/lit. or dimethoate 30 EC @ 2 ml/lit.

Semilooper and *Helicoverpa* – methyl demeton or monocrotophos @ 2 ml/lit.

Leaf spot

Spray Carbendazim or Mancozeb 2 g/lit.

Season of flowering and Harvesting

When first bud shows the colour of the variety harvesting is started

Early varieties

Mid season varieties

Late season varieties

Post harvest treatment and Grading: Soaking stem in water to avoid wilting and lodging of stem and flower. Based on stem length and number of florets grouped into A, B, C, D grades.

Yield: Only 85% of stalks produced will give flowers and remaining 15% will become blind, so 2.0 to 2.5 lakhs stalks/ha can be harvested per crop.

Gerbera: *(Gerbera jamesonii) Compositae*

Varieties: Sun Set, Nevada, Sangna, Lynx, Macho, YCD-1. YCD-2, Vino, Venturi. etc.

Soil and Climate: Sandy loam with well drainage with the pH of 5.5 - 6 is well suitable. Temperature should be within the range of 25^0 C - 27^0 C to avoid bud abortion/scorching. So crop is raised under polygreen house.

Season: Throughout the year.

Propagation and Planting: Suckers tissue culture plantlets. Raised beds with 4 ft. width and 40 cm height are formed at an interval of 60 cm and planting is done at a spacing of 30 x 30 cm.

Irrigation: Provided with drippers once in 2 – 3 days of 15 – 20 minutes. Average water requirement is 500 – 700 ml/day/plant.

Manuring

Basal

Neem cake 2.5 ton/ha

P - 400 g/100 sq.ft.

$MgSo_4$ - 0.5 kg/100 sq.ft.

Top dressing: Calcium Ammonium Nitrate and Muriate of Potash at the ratio of 5:3 is mixed and applied at 2.5 g/plant/month.

After cultivation: Hand weeding is done whenever necessary.

Plant Protection

1. To control Nematode - Carbofuran 7-8 kg/ha is applied at the time of planting.
2. Leaf spot - Carbendazim 2 g/lit or Mancozeb 2 g/lit is sprayed alternatively.
3. Leaf miner - Chlorpyriphos 20 EC 2 ml/lit.
4. Glasshouse whitefly - Monocrotophos 36 WSC 2 ml/lit or Neem oil 3 ml/lit.

Season of flowering and Harvesting: When flowers completely open harvesting is done, flower stalk is soaked in Sodium hypochloride solution (5-7 ml/lit of water) for 4-5 hours to improve vase life.

Grading: Based on stem length and diameter, flowers are graded in A, B, C and D.

Yield: 2 stems/plant/month. Harvest starts from 3rd month of planting and continued upto two years.

Golden Rod: *Salidago spp;* Asteraceae

Varieties - Local.

Soil and climate: Sandy loam and Red loam soils with proper drainage grown under varied climatic condition, cooler climate gives high quality cut flower.

Season: Throughout the year.

Propagation and Planting: Suckers. Soil ploughed to fine tilth, flat beds are formed, slips are planted at 45 x 45 cm spacing.

Irrigation: Normally once in three days to keep the soil always wet to induce profuse stalk production.

Manuring: N P K at the rate of 140 : 175 : 150 kg/ha. + 5 t FYM/ha as basal and half the dose is applied after every harvest.

After cultivation: Hand weeding as and when required.

Plant protection: No serious pests and diseases occur during crop growth.

Season of flowering and Harvesting

First harvest is made after 75th day of planting and continued daily for 30 days. This practice is repeated continuously for 2 years.

Yield: 3 lakhs stems/crop/ha.

Aster: *Aster amellus;* Asteraceae

Varieties: Red, White, Orange and Pink. All colours are available in light and dark shades.

Soil and climate: Well drained red loamy and sandy loam soils. This crop comes up well in cooler climates.

Season: Throughout the year.

Propagation: Seeds 10-12 kg/ha.

Land preparation and sowing: Soil made into fine tilth and flat beds are formed. Seeds are sown either by broad casting or line sowing at 20 x 15 cm.

Irrigation: Irrigate once in 4-7 days according to soil moisture conditions.

Manuring: 5 t FYM/ha + NPK 70 : 175 : 75 kg/ha as basal.

Weeding: Two hand weedings.

Plant protection

1) Spray methyl demeton 2 ml/lit to control sucking pests.

2) To control leaf spot, Carbendazim @ 2 g/lit.

Harvest: Starts 110 days and staggered upto 140 days.

Yield: 0.9 lakhs to 1.0 lakhs stem per/ha.

List of cut foliage

Asparagus sp.

Adiantum sp.

Araucaria sp.

Athyrium sp.

Davallia sp.

Dryopteris sp.

Nephrolepis sp.

Pteris sp.

Jasmine concrete extraction:

The fragrance of jasmine flowers has been praised virtually in all ages. Jasmine oil and its synthetic substitutes are extensively used in high grade perfumes in the Western countries. There is therefore good demand for these products in the foreign countries, the main buyers being U.S.A., U.K.,France, Japan, Holland and Russia. Jasmine concrete and absolute are the valuable perfumery products used in expensive floal perfumes. Jasmine concrete is the waxy like substance containing the natural perfume of the fresh flowers together with flower waxes and albuminous and colouring matters. The absolute is the volatile oil derived from the concrete and it contains the perfumery principles. The absolute therefore represents the highly concentrated form of jasmine perfume. There is hardly any perfume of floral origin which does not contain at least a small amount of either jasmine concrete or it absolute.

There are more than 40 species of jasmine growing in our country. Only a few of them are the scented varieties amongst the most important ones are *Jasminum grandiflorum* (syn:*J. Officinale*), *J. auriculatum* and *J. sambac*. These three varieties are cultivated commercially in south India. The flowers of *J. grandiflorum* commonly known as French jasmine (Cheameli in Hindi) have been found suitable for the production of jasmine perfume. The foreign perfumery houses have a preference for the concrete and absolute prepared form the flowers of this variety compared to the products prepared from the flowers of the other varieties. The demand for the absolute form *J. sambac* flowers (Gundu malli; Bela) is now picking up slowly. These two varieties of jasmine are under cultivation in large areas in our country. Grandiflorum variety is being cultivated commercially in France, Syria, Algeria, Morocco and Egypt also. In South India, the plant is under cultivation in about 4000 ha. area. In Northern State, it is cultivated to a small extent. It has been reported that one hectare plantation yields approximately 8.0 to 10.0 tonnes of flowers per annum. The yield of flowers from *J. sambac* variety is understood to be low compared to *J.grandiflorum*. The flowers are mostly used for garlands and bouquets, ceremonial purposes and for the preparation of the perfumery products. If large quantities of the flowers are utilized for concrete production, the returns will be higher. At present the world production of jasmine concrete is around 20 tonnes per annum out of which India is producing and exporting about 2 tonnes.

Methods of Extraction of Jasmine Perfume

There are many extraction procedure for the preparation of jasmine perfume which include the use of volatile organic solvents and enfleurage process utilizing the absorptive properties of fats. Although steam distillation process can be used for extraction of the perfume, most of the volatile components of the flowers evaporate under the high temperatures involved. So this method is not used on the delicate flowers of jasmine.

In the enfleurage process, freshly picked flower petals are placed on layers of fat made up predominantly of purified fat such as lard. A number of these fat filled trays or chassis are stacked one on top of the other. The flowers which are still alive after harvesting from the plant continue to produce and release the volatile chemicals and these chemicals are absorbed by the fat. After 24 hrs. the old flowers are removed and the fresh flowers are placed on the fat. The procedure is continued for several weeks until the fat layers are saturated with the perfume oil. The fatty layers are then melted and resolidified to create a uniform mass which is then extracted with alcohol. The alcohol is removed by vacuum distillation at low temperatures to obtain the perfume oil. Although relatively high yields of the oil are obtained in this process, a great deal of expensive hand labour, time and effort are required by this process. Today the enfleurage method is almost totally replaced by volatile solvent extraction of the flowers.

In the solvent extraction process, the flowers are placed in large extractors containing the volatile organic solvent. The perfume of the flowers is extracted into the solvent. The perfume enriched solvent is then transferred to a vacuum still where the solvent is distilled off and recovered for reuse. The residue obtained after the removal of the solvent is known as the concrete. On an average, about 250-340 g. of concrete is obtained from 100 kg. of flowers. The concrete is a yellowish brown waxy mass having odour characteristics of fresh flowers. The yield and quality of the concrete depend upon a number of factors. Two types of extractors are in vogue for the preparation of concrete. These are the rotatory extractor and the static extractor. In the rotatory extractor, the solvent is circulated by rotating the extractor and it continuously extracts the organic compounds of the flowers taking advantage of the preferential solubility of the perfumery principles in the solvent. In the static extractor, the flowers kept in trays are placed in the extractor containing the solvent. The extract is then removed and the solvent recovered by distillation. Static type extractors yield better quality concrete than the rotatory extractors.

As in this procedure, the desired fragrant principles and the undesired waxes are extracted by the solvent, the concrete is further processed for the separation of the waxes to obtain purified alcohol and cooling the extract to about $-25^{0}C$ when the soluble waxes are precipitated which are later separated from the solution by filtration. The wax-free solution is concentrated by distilling out the solvent at low temperatures. The product obtained after the removal of the solvent is the absolute.

The recently developed techniques of super critical extraction using liquid carbon dioxide and extraction with hydrofluorocarbon-134 a solvent (1,1,1,2-tetrafleuroethane) may yield jasmine oil of high quality. Another method of preparing jasmine oil directly is the dynamic adsorption process in which the perfume of the flowers is volatilized and the vapours are absorbed on to a purified activated charcoal. This method is not employed in India at present.

Jasmine absolute is a yellowish-brown viscous oily substance having the delicate odour of fresh jasmine flowers. The yield of absolute from the concrete varies from 40-60% depending on the quality of the concrete.

Major equipment and Machinery required

The major equipment and machinery required for jasmine concrete production are stainless steel extractors, condensers, solvent rectification assembly, storage tanks, chilling units, vacuum pumps, boiler etc.]

Economics of the Project

The economics of jasmine concrete production has been worked out approximately as follows :

Plant capacity	**:**	**150 tonnes flowers processing in a year1ton flowers per day450 kg of jasmine concrete production per season (150 days).**
Capital Investment(Land, building, plant and machinery)	:	Rs. 40 lakhs
Working capital	:	Rs.14 lakhs
Total Investment	:	Rs. 54 lakhs
Cost of production	:	Rs. 38 lakhs
Sales	:	Rs. 56 lakhs
Profit	:	Rs. 18 lakhs
Net return on investment	:	33.30%

The returns will be much higher if jasmine absolute is produced from the concrete and exported.

NEW CUT FLOWERS-PRODUCTION TECHNOLOGY

Sl.-No.	Crop	Varieties	Propagation	Growing media	Spacing	Water requirement	Manurial Schedule	Special practices	Harvest & Yield	Post Harvest Practice
1.	Cut Rose (*Rosa* sp.)	First Red, Grand gala, Ravel, Konfetty, Bianca, Pretty women, Passion	Budding	Paddy Husk 5kg + FYM 25kg + Cocopeat 2kg per sq.m. Media pH 5.5 - 6.5 Water EC < 0.7	There are five paths of 0.85 m in each 6 m wide house. The roses are planted in double rows with 0.30 m between the rows and 0.25 m between the plants in the rows. This gives a total of 5.6 plants per gross m^2 or about 10 plants per net m^2.	5 - 8 lit. per m^2.	2 kg superphosphate + 1 kg calcium ammonium nitrate + ½ kg muriate of potash/m^2 as basal dose. Fertigation with calcium nitrate 1.5 kg, potassium nitrate 0.8kg, monopotassium phosphate 1 kg, sulphate of potash 0.5kg, Magnesium sulphate 0.4kg, Borox 0.2kg for 500 m^2 at an interval of twice a week.	Bending Disbudding Pruning	Flowers are harvested in the early morning at tight Bud stage.Yield 150 flowers per sq.m.	Pre cooling for 4 hours at 6^0-8^0 C. Storage at 2^0-5^0 C.20 flower per bunch packed in corrugated cardboard sheet.

Sl.-No.	Crop	Varieties	Propagation	Growing media	Spacing	Water requirement	Manurial Schedule	Special practices	Harvest & Yield	Post Harvest Practice
2.	Cut Chrysanthemum (*Dendranthema grandiflora*)	Yellow Reagan, White Reagan, Cassa cream, Money maker, Polaries, Sunshine	Terminal cuttings 5-7 cm.	Soil rich with organic matter mixed with Cocopeat (2kg/m^2).pH 6-6.5.EC 1-1.5.	12.5 x 12.5 cm (84 plants/m^2)	6-9 litres/ m^2/day	17:17:17 NPK 0.5kg + neem cake 1kg/ m^2 as basal dose. Fertigation with calcium nitrate 3g. + Potassium nitrate 1.5g + Monopotassium phosphate 3g + sulphate of potash 1g + $MgSO_4$ 1g + Borox 1g per m^2 at twice/week.	Pinching Disbudding De-suckering. Lighting - 2 hours extra lighting after flower bud initiation during short day period and 14 hours shade during long day period for flower bud formation.	2-3 flowers opening in the bunch.	After harvested the stem have to be cut at equal length (90 cm is the standard), bunched in five putting a rubber band at the base and sliding them into a plastic sleeve and putting the bunches in plastic buckets filled with 20 cm of water. Early morning on the day of shipment (or night before) the bunches can be packed in boxes.

Sl.-No.	Crop	Varieties	Propagation	Growing media	Spacing	Water requirement	Manurial Schedule	Special practices	Harvest & Yield	Post Harvest Practice
3.	Anthurium (*Anthurium andreanum*)	Temptation, Tropical, Midori, Valcano, Leema white, Angel, Honduras, B.13, Meringue, Maxima, Cheers.	Suckers & TC Plants	Leaf Mould + Cocopeat (1:1) pH 5.5-6.5 Shade: 7% Temperature--18^0 - 28^0C RH-70-80%	30 x 30 cm	-	NPK @ 30:10:10 at 0.2% + GA_3 200 ppm spray at weekly interval (or) Soil application of NPK 17:17:17 @ kg/ha	Removal of old leaves leaving 3-5 healthy leaves/plant	Spathes are fully opened and spadix shows about 1/3 female phase maturity (7-10 days after spathe opening) 5-7 flowers / plant / year	Pulsing with BA 50 ppm for 24 hours. Holding solution BA 25 ppm + 2% sucrose. Packing with 50 gauge polyfilm and covering the base of the flower stalk with cotton dipped in BA 25 ppm.

Sl.-No.	Crop	Varieties	Propagation	Growing media	Spacing	Water requirement	Manurial Schedule	Special practices	Harvest & Yield	Post Harvest Practice
4.	*Dendrobium* orchid	Sonia.17, Sonia. 28, Emma white, Madam vipor, Pampodar	Off-shoots (Kei kis)	Mixtures of charcoal, Brick pieces, Coconut husk, perlite, spagnum moss etc. Temperature 18^0 - 32^0C (N/D) Shade-75%-RH-75%	Grown in perforated pots 9 pots/m^2	Watering through misting	NPK @ 20:10:10 at 0.1% + GA_3 125 ppm + BA 125 ppm at weekly interval spray	Periodized removal of off-shoots.	A Spike can be cut when the last one or two buds are yet to open or at the nearest about 20 per cent of flowers are in bud condition.	Pulsing at 8-HQS 500 ppm + 5% sucrose for 12 hours Holding solution $AgNo_3$ 25 ppm + 8-HQS 400 ppm + 5% sucrose Packing with 50 gauge polythene paper covering the base of the spikes cotton dipped in 8-HQS 25 ppm.

Sl.-No.	Crop	Varieties	Propagation	Growing media	Spacing	Water requirement	Manurial Schedule	Special practices	Harvest & Yield	Post Harvest Practice
5.	*Lilium* sp. Asiatic lily Oriental lily Longiflorum	All round, America, Brunello, Casa Bella, London. Star Gazer, Star Fighter, Crystal Star, Alliance. Elegant lady, Corno, Snow queen	Bulb 10-12, 12-14 cm	Leafmould + Cocopeat + FYM (1:1)	10 x 15 cm 15 x 15 cm 20 x 15 cm	5-6 litres/m^2/day	NPK 17:17:17 0.5 kg/m^2 + Triple superphosphate 50g/m^2 as basal. Top dressing with Calcium nitrate 10g per m^2 at 21st and 35th day of planting.	-	Harvesting colour breaking stage of the bud before bud opening comes to harvest from 80-120 days.20-40 flowers per m^2	-
6.	China Aster (*Callistephus chinensis*)	Kamini, Poornima, Shashank, Violet cushion, Phule Ganesh White, Phule Ganesh Pink, Phule Ganesh violet, Phule Ganesh Purple.	Seeds 2.5-3.0 kg/ha	Well drained Loamy soil	30 x 30 cm	Irrigation at 7-10 days interval	NPK 100:200:200 kg/ha as basal 100kg N as top dressing at 40 days after transplanting	Pinching of main shoot at one month after transplanting	Individual flowers are harvested with stalks18-20 t/ha	$Al_2 (So_4)_3$ at 0.2 per cent + sucrose 0.2 per cent increase the vase life upto 8 days.
7.	Statice (*Limonium sinuatum*)		Seeds	Soil rich in organic manure	45 x 30 cm	Watering weekly once	60:150:150 kg NPK/ha topdressed 10kg N/ha twice	Open cultivation	Harvesting before opening of flowers	--

Sl.-No.	Crop	Varieties	Propagati-on	Growing media	Spacing	Water requireme-nt	Manurial Schedule	Special practices	Harvest & Yield	Post Harvest Practice
8.	Limonium (*Limonium latifolium*)		TC Plants	Soil enriched with Leaf mould + Cocopeat cattle manure	45 x45 cm	Watering 4-6 litres/sq.ft.	Basal 5:10:10 kg NPK/1000 sq.ft.Top dressing: Potassium Nitrate 2 g/lit. weekly once.	Protected cultivation	Harvesting at before opening of flowers	---
9.	Alstroemer-ia (*Alstroeme-ria aurantiaca*)	Aladdin,Pluto	Rhizomes	Soil rich in organic manure, pH 5.5-6.5	60x45 cm	Basal 60:150:150 kg/NPK/ha Top dressing Potassium Nitrate 10 gm/plant per year	Removal or Blind shoots	Harvest at Bud opening stage 40-60 flowers per plant	Flowers kept in water at 5-6^0 Cfor 4 hours before packing at 20/buds	---
10.	Lisianthus (*Eustoma* sp)		Seeds/ TC plants	Soil enriched with leaf mould Cocopeat Cattle manure	30 x 30 cm	6-9 litre/Sq.mt/d-ay	Basal 5:10:10 kg NPK/100 sq.mt. Top dressing Potassium Nitratre 5kg/1000 sq.mt	Pinching to get 3-4 flower stems per plant	Harvesting before flower opening stage	Pre cooling at 4-6^{0}C for 4 hours.
11.	Gyphsophil-a Baby's breathe (*Gyphsoph-ila elegans*)	Million Star	TC Plants / Seeds	Soil enriched with organic manure	45 x 45 cm	Weekly twice	Basal 60:150:150 kg/NPK/ha top dressing 10 kg N at monthly interval	Pinching to induce branching	Harvesting before opening of flowers	Pre cooling at at 4-6^{0}C for 4 hours.

Sl.-No.	Crop	Varieties	Propagati-on	Growing media	Spacing	Water requireme-nt	Manurial Schedule	Special practices	Harvest & Yield	Post Harvest Practice
12.	Bird of paradise	---	Suckers/Se-eds	Soil rich in organic manure	1.25 x 1.25 m.	Weekly twice at 2 lit./plant	Basal 6:10:10 kg/NPK/100 sq.mt.Top dressing NPK 5kg/100 sq.mt. at monthly interval	---	Harvesting at 1st flower opening stage	--
13.	Calla lily	---	Rhizomes	Soil enriched with leaf mould, cattle manure, Cocopeat sand	20 x 10 cm	4-6 lit/sq.mt. per day	5:10:10 kg NPK/1000 sq.mt.Top dressing Potassium Nitrate 2 g/sq.mt	---	2-4 flowers per plant per year	Pre cooling at 6^0-8^0C for 4 hours
14.	Snap dragon (*Antirhinum majus*)	Rocket stars	Seeds	Soil enriched with cattle manure Cocopeat Leaf mould sand	15 x 10 cm	4-6 litres per sq.mt. per day	5:10:10 kg NPK per 1000 sq.mt. Topdressing Potassium Nitrate 2g/sq.mt.	Pinching to give 2-3 branches per plant	Flowers harvested at 4-5 Florets opened.	Pre cooling at 4-6^0C for 4 hours
15.	Freezia	---	Seeds/Suc-kers	Soil enriched with Leaf mould, Cattle manure, Cocopeat sand	15 x 10 cm	4-6 litres/sq.mt./-day	Basal 5:10:10 kg by NPK/1000 sq.mt. Top dressing Potassium Nitrate 2 g/sq.ft	---	Harvesting at Bud Colouring Stage	Pre cooling at 4-6^0C for 4 hours

PART VII - PARTICULARS OF IMPROVED VARIETIES OF HORTICULTURAL CROPS

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
A. Fruits				
Mango	PKM.1	Perennial	500 fruits/tree (100 kg/tree)	A high yielder selected from a hybrid (Chinnaswarnareka x Neelum). Regular bearer, fruit is big and sweet in taste.
	PKM.2	Perennial	It yields higher than Neelum and Mulgoa. Each fruit weighs 650-700g	A high yielder selected from a hybrid (Neelum x Mulgoa). Mid season variety, fruit is big and sweet in taste.
	Paiyur.1	Perennial	8.92 t/ha	Dwarf tree, suitable for close planting (400 trees/ha); regular bearer; medium long fruits, oval yellow skin and good taste and keeping quality.
Banana	CO 1	13 - 14 months	22 t/ha	It is a multiple cross involving Ladan (AAB) as female parent and *Musa bulbisiana (*BB) and Kadali (AA) as male parents. It is akin to hill banana Virupakshi; retains the flavour and taste of Virupakshi and suited to plains.
Sapota	CO 1	Perennial	12 - 20 kg/tree	It is a hybrid between Cricket ball and Oval; small size with sweet taste
	CO 2	Perennial	16 - 25 kg/tree	It is a pure line selection from Baramasi; round shape; bigger than Co.1
	CO 3	Perennial	157kg /tree	It is a hybrid between Cricket Ball and Vavilavalasa. Fruit weight is 133 g. The trees are highly suitable for high density planting. Under high-density planting system it yields 40-50t/ha
	PKM.1	Perennial	236 kg/tree (3500 fruits/tree)	Clonal selection from Guthi; dwarf statured and adaptable to southern and central districts.
	PKM.2	Perennial	80 kg/tree	Hybrid between Guthi and Kirtibarthi. Fruits are bigger in size, oval shaped. Higher TSS.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	PKM.3	Perennial	14 t/ha	Hybrid between Guthi and Cricket ball. Suitable for high density planting. Tolerant to leaf spot and leaf webber.
	PKM.4	Perennial	20.08 t/ha	Open pollinated clone of PKM 1. Distinguisely spindle shaped fruits. Suitable for high density planting The flesh has a light pink colour with pleasant flavour.
Papaya	CO 1	2.5 years	200 t/ha/2 years	It is a selection from Ranchi. A choice round fruit, dwarf type suited exclusively for table purpose with yellow flesh and good quality.
	CO 2	2.5 years	200 t/ha/2 years Papain 500kg/ha/2 years	A pure line selection suitable for papain as well as table purpose; medium tall variety large sized fruit with yellow flesh.
	CO 3	2.5 years	120 - 150 t/ha/2 years	It involves the parents Co.2 and Sunrise Solo. It is a hermaphrodite type with red flesh and sweet taste exclusively suitable for table purpose. It is a medium tall variety with small sized fruits.
	CO 4	2.5 years	200 t/ha/2 years	It is a hybrid derivative from a cross between Co.1 x Washington. It has purple pigmentation on the stem, petiole, flower stalk etc. Fruits are round with purple tinged yellow flesh. Tree medium tall, suitable for home and kitchen gardens; a table purpose variety.
	CO 5	2.5 years	Papain 1200 kg/ha/2 year	It is a pure line selection from Washington variety, medium tall with purple pigmentation all over the plant surface; fruits are large, weighs 2 to 2.5 kg/fruit. It gives the highest papain yield of 15 g/fruit. Exclusively suitable for papain extraction only. Not recommended for table use.
	CO 6	2 years	80 - 100 fruits/year	Selection from a giant papaya. Dioecious. Suitable for papain extraction and also for table purposes. Dwarf in stature.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	CO 7	2 years	340 t/ha	Gynodioecious. Parents involved are Pusa Delicious, Co.3, CP 75 and Coorg Honeydew. Red fleshed. Fruits oblong with an attractive and firm red flesh.
Pomegranat-e	CO 1	Perennial	50 fruits/bush	It is a pure line selection. It is quick growing, high yielding and with attractive fruit colour both exterior and interior. It has soft seeds, with sweet taste and bright pink colour.
	YCD.1	Perennial	60 - 70 fruits/bush	Soft - seeded; clonal selection from local varieties. 20% more than the local. The colour of the pulp is purple. Keeps well for about 5 - 7 days at cold temperature.
Jack	Palur.1	Perennial	80 fruits/tree/yearweighing 900 kg	Clonal selection from Panikkan kuppan local. Suitable for high density planting. Yield fruits in off season also (Nov - Dec). Regular bearing season April - June.
	PPI.1	Perennial	107 fruits/tree/year weighing 1018 kg	Clonal selection from Millagumoodu local. Suitable for commercial planting and in Home gardens.
Apple	KKI.1	Perennial	22 t/ha	Selection from Parlin's Beauty. Best adapted to warm winter conditions prevailing in Kodaikanal hills.
Amla	BSR.1	Perennial	155 kg fruits/tree/year	Selection from Thimbam local type. Fruits contain more flesh, less phenol and high ascorbic acid content.
Avocado	TKD.1	Perennial	26.4 t/ha	Suitable for high density planting. Fruits are dark green coloured, round shaped and medium in size.
Fig	Yercaud Timla	Perennial	4000 Nos. per tree per year	It is drought tolerant, high yield, fruits are large and reddish purple in colour.
Custard apple	APK . 1	Perennial	14.9 kg/tree	Clonal selection. Suited to rainfed conditions. Fruit weight 210 g. Sweet in taste.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
B. Vegetables				
Tomato	CO 1	135	36	Round fruits, light green when unripe and red at ripening, bears in clusters.
	CO 2	145	42	Fruits ovate, large and flat.
	CO 3	110	50	Dwarf plants fruits globular and red; bears in clusters of 4 - 5 fruits. Suitable for summer.
	PKM.1	135	32	Determinate plants; fruits flattish with ridges. Suited for long distance transport.
	Paiyur.1	130	32	A hybrid derivative suitable for irrigated and rainfed conditions of Dharmapuri district. Fruits are round, smooth fleshy and suitable for long distance transport.
	COTH.1	110 - 115	95.9 t/ha	F1 hybrid developed by crossing IHR 709 x LE 812. Plants are semi determinate. Fruits are medium sized, bright red, smooth, round to slightly oblong and born in clusters of 4 - 5.
Brinjal	CO 1	100	24	Fruits light green with white - base and oblong. Medium sized fruits (50-60g); good keeping quality.
	MDU.1	135	34	Fruits round, bright purple and weight 280 g.
	PKM.1	150	34	Fruits are medium sized, 45 - 65g; drought tolerant and can withstand long distance transport.
	CO 2	150	35	Fruits are oblong with brown stripes. Suitable for Periyar and Coimbatore districts.
	KKM.1	130 - 135	37	Fruits egg shaped with milkywhite colour born in clusters of 2 - 4.
	COBH 1	120-130	56	Fruits are slightly oblong, glossy violet colour.
	PPI 1	185	45	Fruits are oblong, pale green colour and moderately resistant to shoot and fruit borer and wilt
Bhendi	CO 1	90	14	Plants medium tall; pods pink, long tender and less fibrous; tolerant to yellow vein mosaic.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	CO 2	90	16.51	Fruits fairly long with hairy surface.
	CO 3	90	16 - 18	Fruits medium in size and dark green in colour. Moderately resistant to yellow vein mosaic disease.
Chillies	CO 1	210	2.1	Fruits long and red at ripening; seed content 55%; samba type.
	CO 2	210	2.2	Fruits oblong and bright red on ripening; seed content 60%
	K1	210	1.8	Plants bushy; pods green; long samba type; dark red on ripening.
	K2	210	1.98	Plants tall, compact, pods long and bright red on ripening; samba type; high seeded content.
	PKM.1	200	2.36	Suitable for semi-dry condition. Fruits contain high Capsaicin content - 0.36%
	MDU.1	215	1.8	Determinte growth. Fruits born in clusters of 4 - 9. Fruits are long with dark shiny red colour.
	CO 3	165	3 - 3.5	Fruits long, slender with attractive dark green colour. Suitable for export purposes.
	PLR.1	210	18.4 t of green chillies/ha	Suitable for green chillies.
	CO 4	165	2.3 (green chillies)	Vegetable chilli, fruits are dark green, less pungent and suitable for high density planting
Pumpkin	CO 1	175	30	Fruits are globular, large sized (8 - 10 kg); light pink skin and yellow flesh.
	CO 2	135	23	Fruits small (1.5 kg), flattish round, light brown skin and yellow flesh
Snakegourd	CO 1	135	16	Fruits long (160 - 180 cm) green with white stripes, each weighs 500 - 750 g, smooth flesh of less fibre; moderately resistant to powdery mildew.
	PKM.1	145	26	Fruits dark green with white stripes; each weighs 700 g; suitable for growing all through the year.
	MDU.1	125	32	Vine-less spreading with moderate branching; flowers in 56 days; fruits are short (40 cm) and weighs 550 g.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	CO 2	105	36	Fruits are short ant stout weighing 400 to 600 g, light green to white in colour. Does not require pandal.
Ribbed gourd	CO 1	125	14	Fruits long (60 - 75 cm) light green and weighs 300 g each.
	CO 2	120	25	Fruits are very long (1 m) green and fleshy.
	PKM.1	160	28	Fruits long, dark green with shallow grooves.
Bottle gourd	CO 1	135	36	Fruits round at the base and bottleneck at the top, light green, each weighs 2 kg.
Bittergourd	CO 1	115	14	Fruits green, 30 - 35 cm long, 100 - 200 g each.
	MDU.1	140	32	Fruits green and each weighs 410 g.
	COBgoH 1	120	44	Fruits creamy white and weighs 300 gm each
Ash gourd	CO 1	150	25	Fruits globular, green, large, oblong - oval in shape, ashy coated weighing 6 - 8 kg.
Cucumber	CO 1	100	25 - 28	Ripe fruits are bright yellow in colour with greenish yellow intermitant stripes.
Watermelon	PKM.1	120	37	Suitable for arid, semi-arid, irrigated conditions; pulp pink in colour; high TSS of 9.2° Brix.
Butter Beans	KKL.1	140	3.47	White seed; good cooking quality, suitable for hilly regions (1200 - 2000 m)
French Bean	TKD.1	90	5.6 - green pods2.78 - dry seeds	Pods are less fibrous. Seeds turn white on maturity.
	YCD.1	105	9.7 - green pods 6.3 - dry seeds	Plants are semi dwarf and bushy. Pods are slightly flat, long, broad and robust.
Dolichos Bean	CO 1	210	18 - green pods	Pods are dark green, flattish and slightly curled, tender and fleshy.
Moringa Beans	KKL.1	140 - 160	7 - green pods	Pods are fleshy and thick skinned.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
Annual Moringa	PKM.1	2.5 years	52.8	Pods are 70 cm long weighs about 150 g.
	PKM 2	2.5 years	96.0	Pods are 120 cm, long weighs about 370 g
Radish	CO 1	45	22	Roots milky white, less fibrous; suitable for growing throughout the year; set seed in plains.
Beetroot	Ooty.1	120 - 130(direct sown)135 - 150(transplanted)	31.45	Roots are blood red colour with thin skin and good quality.
Garlic	Ooty.1	120 - 130	17.1	Bigger bulbs weighing 30 - 40 g each.
Palak	Ooty.1	2 years	15(leaves)	Higher carotene in content. Rich in vitamins.
Cauliflower	Ooty.1	110 - 120	46.4	Compact uniform curds with attractive creamy white colour. Curd is free from ricyness and have good keeping quality.
Sweet potato	CO 1	135	28	Tolerant to root weevil; tubers with light pink skin and white flesh; starch content 24%
	CO 2	115	32	Tubers with light pink skin and white flesh; starch content 30%; tolerant to root weevil.
	CO 3	110	42	Tolerant to root weevil; tubers - light pink skin and orange flesh; high carotene content.
	CO Sib-1	95 - 100	32	Short duration, resistant to root weevil, high market value.
Tapioca	CO 1	270	30	Tuber with whitish brown skin and white flesh; starch content 35%; field tolerance to mosaic virus; suitable for consumption and industries.
	CO 2	240-270	36	Branching type, flowers easily. Tubers with whitish grey and skin and creamy white flesh; starch 34.5%; moderately tolerant to mosaic virus; suitable for consumption and industries.
	CO (TP) 4	240	50	Shorter crop duration, erect with branching habit, high starch (40%) and suitable for irrigated and rainfed cultivation
	CO 3	240	43	Shorter crop duration, branching type; high starch - 36% suitable for irrigated and rainfed cultivation.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
Dioscorea	CO 1	240 - 255	44.8	Tubers are bigger with white flesh.
Coleus	CO 1	180 - 190	31.93	Tubers have 21.5% starch.
Onion	CO 2	65	12	Bulbs bigger (10 - 15 g) and crimson in colour; photo-insensitive type.
	CO 3	65	16	Bulbs light pink, bold (10-15 g) bulbs store well for 120 days.
	CO 4	65	19	Bulbs light pink, bold (12-15 g) with better consumers' appeal; bulbs store well for 150 days.
	CO(On) 5(Seed propagated)	90	19seed yield 300 kg/ha	Bulbs redish pink, bold, 80-90 g/cluster
Amaranthus	CO 1	20-25	7	Can be grown throughout the year (25 days - Mulaikeerai) (50 - 60 days for Thandukeerai)
	CO 3	90	31	Plants dwarf; clipping type.
	CO 4	90	2.5 t grains	A grain amaranthus type, seeds are rich in protein (19.55 %) and aminoacid like lysine (7.5 mg per 100 g) can be substituted for minor millet like Ragi and Thenai
	CO 5	120	10 - Mulaikeerai30 - Thandukeerai	Single plant selection from A-166-1. Double coloured type with dual purpose. Suitable for container cultivation.
C. Spices and Condiments				
Coriander	CO 2	90-100	400-500 and 600-800 kg of grains/ha under dry and irrigated conditions respectively.	It is a dual purpose variety suited for greens and seed purpose.
	CO 3	85 - 90	644 kg grains/ha	Seeds are medium sized with attractive brownish yellow in colour.
Tamarind	PKM.1	Perennial	263.3 kg/tree	Bear fruits in clusters of 3 - 7 and the fruits are characteristically semicircular in shape. 39% pulp recovery.
Turmeric	BSR.2	240 - 250	32	Medium statured. Resistant to scale insects.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
Fennel	CO 1	210 - 220	600-800 kg/ha	Suited for growing in plains as well as in lower hill slopes under irrigated and rainfed conditions. It can be grown as border crop with other long duration crops, and as intercrop in young plantation of Coconut and Arecanut gardens.
Fenugreek	CO 1	80 - 90	500-750 kg of grains/ha	It is a dual purpose variety suited for greens as well as grains. It yields 4000 kg of greens/ha when harvested at 25 days after sowing.
	CO 2	85 - 90	418.8 kg	Fairly resistant to root rot disease.
Cinnamon	YCD.1	Perennial	3800 kg dried leaves per ha359.75 quills per ha	Quills of sweet and light pungent.
D. Plantation Crops				
Cashew	VRI.1	Perennial	7 kg nuts/tree/year	A high yielder bearing good quality nuts suitable for export.
	VRI.2	Perennial	8 kg nuts/tree/year	A seedling selection, bearing high percentage of perfect flowers, with medium sized nuts and high shelling percentage (28%). Variability in seedling progenies is minimum.
	VRI.3	Perennial	14.19 kg nuts/tree/year	Larger nuts. Shelling - 29.1 %
Palmyrah	SVPR.1	Perennial	298 lit padaneer per palm/year 140 fruits/palm/year	It is semi dwarf, high jaggery content of 144 g/lit, high recovery of 13.16%, high brix value 13.3°C
Betelvine	SGM.1	2 - 2.5 years	109 lakh leaves/ha	Vines are dwarf vigorous, bushy in growth. Leaves posses attractive yellowish green colour with desirable pungency.
E. Commercial Flowers				
Hybrid Rose	YCD.1	Perennial	100-120 Nos/bush/year	Suitable for hilly regions of above 1500 m. It is a free bloomer, good for bedding and decorative purposes. Flowers medium size (7-8 on diameter) Mostly bears in clusters. The colour of the flowers is pleasing yellow when opened.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	YCD.2	Perennial	150 - 200 Nos/bush/year	Suitable for 1000 - 2000 m. Unopened flower bud is bright yellow with a scarlet red tinge at the tip. The just opened flower is scarlet red with yellow shade at the petal base. The fully opened flower is in pleasing scarlet colour.
Mullai	Parimullai	Perennial	8 t/ha	A selection from a medium point type; resistant to gall mite, medium long corolla tube.
	CO 1 Mullai	Perennial	10 t/ha	It has bold flower buds with long corolla tube enabling easy tying in garland making; suited for fresh flower marketing.
	CO 2 Mullai	Perennial	11.1 t/ha	Flower buds have long corolla tube and longer buds. Exhibits completely field tolerance to phyllody disease.
Jasmine (Pitchi)	CO 1 (Pitchi)	Perennial	11 t/ha	Suitable for fresh flower market and also for extraction of floral concrete. The plants are fairly tolerant to salt water. Concrete recovery is 0.29 %
	CO 2 (Pitchi)	Perennial	11.68 t/ha	Bolder pink buds.
Chrysanthemu-m	CO 1	180-220	16.7 t/ha	Yields 16.7 t/ha in the main crop. Flowers early by 15 days than local varieties; blooming period is also longer by 15 days.
	CO 2	190	20 t/ha	Flowers - purple colour; It scores over Co.1 in number of flowering shoots per plant and no of flower per plant.
	MDU.1	180-200	30.6 t/ha	Suitable for southern districts. Yield 30.6 t/ha inclusive of ratoon crops.
Gerbera	YCD.1	Perennial	60 flowers/plant/year	Suitable for cut flower, raising as borders in garden and for pot cultivation.
	YCD.2	Perennial	80 flowers/plant/year	Blooms throughout the year. Flowers are attractive rosy pink coloured born on long stalk without bend.
Hibiscus	CO 1 Thilagam	Perennial	3000 flowers/bush	The plant bears attractive crimson red double flowers; petals are arranged in three whorls. Profuse flowering variety and is suitable for specimen and foundation plantings.
	CO 2 (Punnagai)	Perennial	(1000 flowers/year/bush)	The flowers are large, very attractive and of apricot yellow colour. The petals have paper like texture with feeble veins radiating from the throat.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	CO .3	Perennial	1300 flowers/bush/year	Produce apricot yellow flowers with signal red throat. The flower colour gradually changes into Chinese yellow with turkey red throat in the afternoon.
Gladiolus	KKL.1	Perennial	21.1 t/ha	Longer spikes with 162 flowers per spike. Attractive red purple colour with white fleshed centre.
Barlaria	CO 1	Perennial	9.4 t/ha	The colour of the flower is attractive pink; plants are drought tolerant and free from pests and diseases. It is in full bloom when the other important commercial flower crops cease their flowering by November.

Part VIII
Drip irrigation for fruit crops

Drip irrigation offers scope for enormous savings in water usage and it is the most useful system to boost horticultural production in areas with limited water resources. Research work carried out at TNAU indicates the saving in irrigation water ranges from nearly 40 to 68 per cent with an additional yield benefit of 14-98 per cent over the conventional irrigation methods. Drip irrigation can be thought of in rainfed areas with meager water resources available during the periods other than the rainy seasons. Most of the fruit crops require drip irrigation during the period of flowering to fruit development in order to increase the fruit set and improve the fruit size reflecting on final yield. However, the drip irrigation has to be dispensed 10 – 15 days before the expected harvesting period in order to improve the sweetness of the fruits. Daily water requirement of various fruit crops are given below:

Crops	Water requirement (lit/day/plant)
Mango	30-50
Banana	20-25
Citrus	22-30
Guava	22-30
Sapota	20-30
Amla	15-25
Grapes	15-25
Papaya	15-25

For the young tree which are in their pre bearing stage, 1/3rd of the recommended dose of water may be given and slowly increase to reach the above level during full bearing.

Part IX
Organic Cultural Practices

1.FRUIT CROPS

Organic farming is a method of farming which avoids or largely excludes the use of harmful chemicals such as chemical fertilizers, pesticides and herbicides and use of natural resources such as organic matter, minerals and microbes to maintain the environment clean, ecological balance and to provide stability to the production level without polluting soil, water and air. Organic farming system relies on large-scale application of animal wastes or farm yard manure, compost, crop rotation, crop residues, green manure, vermicompost, bio-fertilisers, VAM, bio-pesticides and biological control. The primary requirement for organic manuring sources are presented below:

1.Farm yard manure

S.No.	Crop	First year (kg/tree)	Annual increase (kg/tree)	6th year onwards (kg/tree)
1.	Mango	10.00	10.00	50.00
2.	Sapota	10.00	10.00	50.00
3.	Citrus	10.00	5.00	30.00
4.	Guava	10.00	5.00	30.00
5.	Grapes	50.00	50.00	100.00 3rd year onwards
6.	Papaya	10.00	5.00	30.00

Besides FYM the following quantity of organic manures may be recommended (kg/tree)

Neem cake	**0.5**	**0.5**	**3.5**
Compost	0.5	0.5	3.5
Green leaf manure	0.5	0.5	3.5

Bio fertilizers

S.No.	Particulars	First year(kg/tree)	Annual increase (kg/tree)	6th year onwards (kg/tree)
1.	VAM	0.200	0.200	1.0
2.	Azospirillum	0.05	0.025	0.2
3.	Phosphobacteria	0.05	0.025	0.2

II VEGETABLES

Seed treatment

Seed treatment with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 10 g/kg of seeds.

Seed treatment with *Azospirillum* @ 200 g/kg of seeds.

Nursery

Apply 10 kg of FYM, neem cake 50 g, *Azospirillum* 5g, Phosphobacteria 5g and VAM 60g/m2.

Main field

Seedling dip with *Azospirillum* (400 g)

Apply *Azospirillum* 2kg, Phosphobacteria 2 kg and VAM 4 kg/ha

FYM 25 t/ha; composted coirpith 10 t/ha.

Vermi compost @ 2 tonnes, and neem cake 500 kg/ha

Application of Panchakavya 3% through irrigation water (Number of application and interval based on duration of crop)

Foliar spray

Panchakavya 3% number of sprays depends on the duration of the crop.

Moringa leaf extract 10% and the number of spray depends on the duration of the crop.

Part X
Protected Cultivation in Vegetables (for Information)

I. Tomato

Greenhouse structure: Low cost polyhouse with natural ventilation

Hybrids: SH 7711

Nursery: Protrays, Soil:Compost:Cocopeat (1:1:1) + *Azospirillum* (50 g/sq.m) + Phosphobacteria (50 g/sq.m) + VAM (200 g/sq. met.).

Growing medium: Soil:Compost :Cocopeat (2:1:1)

Irrigation regime: 20 KPa (Kilo Pascals)

Integrated Nutrient Management (INM)

a) Basal 50 Kg/ha K (MOP) + *Azospirillum* (10 g/m^2) + Phosphobacteria (10 g/m^2) + VAM (50 g/m^2).

b) Fertigation @ 250:250:250 Kg/ha NPK with water-soluble fertilizers.

Mulching: Black polyethylene mulch 50-micron (200 gauge) thickness.

Training: The plants have to be trained to 2 stems using rope or string.

Duration: 180 days including nursery period of 25 days.

Yield: 140-150 t/ha.

II. CAPSICUM (BELL PEPPER / SWEET PEPPER)

Greenhouse structure: Low cost polyhouse with natural ventilation

Hybrids: Indra

Nursery: Protrays, Soil:Compost:Cocopeat (1:1:1)

Growing medium: Soil:Compost:Cocopeat (2:1:1)

Irrigation regime: 20 KPa (Kilo Pascals)

Integrated Nutrient Management (INM)

a). Basal 50 Kg/ha NPK with straight fertilizers

b). Fertigation @ 150:150:150 Kg/ha NPK with water soluble fertilizers.

Mulching: Black polyethylene mulch 50 micron (200 gauge) thickness.

Training: The plants have to be trained to 4 stems using rope or string.

Duration: 180 days including nursery period of 35-40 days.

Yield: 120-130 t/ha.

Part XI
Seed Production Technology of Horticultural Crops

TOMATO

Season : November – March, June – July

Seed rate: 300 g/ha.

Nursery treatment: 15 days before sowing, drench the nursery with Metham sodium @ 28 ml/ sq.m.(VEPAM) for controlling the nematodes. After 7 days drench with Copper oxychloride @ 2.5 g/lit to prevent damping off.

Age of seedling 25 - 30 days.

Spacing

CO 1	:	60 x 60 cm
PKM 1	:	75 x 60 cm
CO 2	:	80 x 75 cm
Pusa Ruby	:	80 x 70 cm
CO 3	:	60 x 30 cm

Fertilizers

Basal		
FYM	:	25 t/ha
	:	75 : 100 : 100 NPK Kg/ha
Top dressing	:	At the time of flowering with 75 Kg N.

Foliar application: NAA @ 20 ppm at 65 and 75 days after transplanting.

Harvest: Seeds attain maturity 30 – 35 days after flowering.

Harvest fully matured, red, ripened and healthy fruits. First 7 - 8 pickings alone should be used for seed extraction.

Seed extraction: Well-matured fruits are crushed and made into pulp. For every 1 Kg of pulp add 25 - 30 ml of commercial HCL acid, leave for 30 min. with constant stirring. At the end of 30

min. wash the seeds 3 - 4 times with water and dry the seeds. (shade drying for one day followed by mild sun drying)

Grading

BSS : 12 x 12 wire mesh (2.1 mm) sieve are used.

Seed Yield : 150 Kg/ha

Storage: Dry the seeds to 7 - 8 % moisture and treat with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed. The treated seeds can be stored upto 12 months in paper bags and upto 24 months in moisture vapour proof containers.

BRINJAL

Season: June - July.

Seed rate: 450 g/ha.

Nursery preparation: 15 days before sowing drench the nursery with Metham sodium @ 28 ml/sq.m.(VEPAM) for controlling the nematodes. After 7 days, drench with Fytolan @ 2.5 g/lit of water against damping off disease.

Age of seedling : 30 - 35 days.

Fertilizers

Basal

FYM : 25 t/ha

: 50 : 75 : 75 Kg NPK/ha

Top dressing : 50 Kg N/ha just before flowering.

Spacing: 75 x 60 cm.

Foliar application: NAA @ 20 ppm at 65 and 75 days after transplanting.

Harvest: Seeds attain maturity in 40 - 45 days after flowering. The symptom of harvestable maturity is turning of the skin colour from green to bright yellow. Medium size fruits yield more quantity and quality seed than big or small fruits.

Seed extraction: The well-ripened fruits are cut into 4 – 6 pieces and softened by soaking in water overnight. On extraction the floaters are removed.

Grading:

Sieve size: 5/64" round perforated metal sieve or BSS 12 x 12 wire mesh sieve (2.1 mm)

Seed Yield: 250 Kg/ha

Storage: Treat the seeds with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and store upto 1 year in cloth bag and upto 2 years in moisture vapour proof containers.

BHENDI

Season: March, April and May.

Seed rate: 8 - 10 Kg/ha.

Spacing: 60 x 20 cm.

Fertilizers: Basal

FYM	:	25 t/ha
	:	40 : 50 : 30 Kg NPK/ha.
Top dress	:	20 : 50 : 30 Kg NPK/ha.

i). 10 Kg N/ha at first flowering

ii). 10 Kg N/ha 10 days after flowering.

Foliar application: DAP at 0.5 % thrice at 10 days interval commencing with first flowering enhances the yield of good quality seeds.

Harvest: Seed matures 28 - 30 days after anthesis. Harvest the pods when they dry and turn brown and develop hairline cracks along the ridges. In Bhendi, first formed two pickings can be used for vegetable purpose and the next 6 pickings can be used for seed purpose.

Seed extraction: Harvested pods can be dried in the sun for 2 - 3 days and seeds can be extracted in a machine thresher or by hand with pliable bamboo stick.

Grading

Sieve size	:	10/64" round. Perforated metal sieve or BSS 6 x 6 wire mesh sieve (4.2 mm)
Upgrading	:	To remove the empty seeds, water floatation technique is adopted. Air-dry the seeds.

Seed Yield: 700 Kg/ha

Seed storage: Seeds when dried to 8 % moisture content and treated with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can easily be stored upto 15 months in cloth bag and 24 months in moisture vapour proof containers.

CHILLIES

Season: June – July, November – December

Seed rate: 1 Kg/ha.

Nursery treatment: 15 days before sowing drench the nursery with Metham sodium @ 28 ml/ sq.m.(VEPAM) for controlling the nematodes. After 7 days, drench with Copper oxychloride @ 2.5 g/lit to prevent damping off.

Age of seedling : 35 – 40 days.

Spacing: 60 x 30 cm.

Fertilizer

Basal

FYM : 25 t/ha

: 0:70:70 Kg NPK/ha.

Top dress : 50 Kg N 15 days after transplanting, 50 Kg N 45 days after transplanting and 40 Kg N 90 days after transplanting.

Foliar application: NAA @ 20 ppm at 65 and 75 days after transplanting.

Harvest: Seeds mature in about 40 - 45 days after flowering. Harvest the fruits when they are capsicum red in colour. Fruits obtained from first 5 to 6 pickings alone used for seed extraction.

Seed extraction: Dried fruits are taken in gunny or cloth bag and threshed with a pliable bamboo stick or chilli seed extractor can be used. The seeds are separated and graded.

Grading: BSS 8 x 8 wire mesh sieve or 8/64 round perforated metal sieve (3.1 mm).

Seed yield: 350 – 400 Kg/ha

Storage: Intact pods can also be stored upto 20 months. Seeds dried to 7 - 8 % moisture content and treated with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be stored upto 10 months in cloth bag and upto 18 months in moisture vapour proof containers.

PUMPKIN

Season: June - July and January – February.

Seed rate: 1 Kg/ha.

Spacing: Pit size : 45 x 45 cm at 2.5 x 2.0 m.

Manuring: FYM 10 Kg/ pit. 100 g of the mixture (6:12:12) per pit as basal and 10 g N/pit 30 days after sowing.

Foliar application: Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the female flower production or application of Ethrel at 250 ppm four times at weekly interval commencing from 15th day after sowing.

Harvest: Seeds attain maturity 16 weeks after flowering. Harvest the fruits when surface of the fruits turn waxy and shiny. The colour changes to yellow or orange yellow at full maturity and fruits stalk become dry.

Fruits weighing less than 1.5 Kg should not be used for seed extraction.

Seed extraction: Fruits are cut and seeds with pulp are scooped out and seeds are separated, washed with water and dried.

Grading: BSS 4 x 4 wire mesh sieve (6.2 mm) or 16/64" round perforated metal sieve.

Seed yield: 250-300 Kg/ha

Storage: Seeds dried to 7 - 8 % moisture content and treated with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be stored for 10 months in cloth bag and 18 months in moisture vapour proof container.

SNAKE GOURD

Season: July - December and January - June.

Pre-sowing treatment: Pre-germination of seeds ,by soaking in double the volume of water for 4 hours, enhances the field stand.

Seed rate: 1.5 Kg/ha.

Spacing: Dig pits of size 45 x 45 cm at 2.5 x 2.0 m spacing.

Manuring: FYM 10 Kg/ pit. 100 g of the mixture (6:12:12) per pit as basal and 10 g N/pit 30 days after sowing.

Foliar application: Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of Ethrel at 250 ppm four times at weekly interval commencing from 15th day after sowing.

Harvest: Fruits can be harvested at yellow to orange skin initiation stage.

Seed extraction: Manual labour is to be employed.

Grading: The immature seeds can also be removed as water floaters during wet extraction. After drying the seeds, the immature and small sized should be removed as air blown rejects. 16/64" round holed sieve may be used or BSS 4 x 4 (6.2 mm)

Seed yield : 300-350 Kg/ha

Storage: Seeds dried to 7 - 8 % moisture content and dry dressed with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and stored in cloth bag upto 10 months and over 18 months in moisture vapour proof containers.

BITTER GOURD

Season: June-July and January-February.

Seed rate

2.5 Kg/ha

Sow three number of pre germinated seeds.

Pre germination technique: Soak the seeds in equal quantity of water for 4 hours and then cover the soaked seeds with double-layered moist cloth for 4 days. After 4 days the germinated seeds are separated and used for sowing for early and better establishment in the field.

Foliar applications: The number of female flowers decides the fruit yield. Hence, spraying of Ethrel @ 250 ppm for four times starting from 15 days after sowing, followed by weekly intervals is done (*i.e.,* 2.5 ml of ethrel in 10 liters of water).

Spacing

Pit distance : 2.5 x 2 meters

Pit size : 45 cm x45cmx45cm

Fertilizers: Apply 10 Kg FYM, 13 g Urea, 72 g Super phosphate and 19 g Potash / pit. Two split doses of urea as 22 g/pit at flowering stage and another 18 g Urea + 5 g Potash/pit, each at 20 and 40 days after flowering.

Harvest: 5 to 7 days after the maturity of vegetables in different pickings. After harvest, the fruits can be stored for 1 or 2 days for over ripening, this will facilitate easy seed extraction.

Seed Extraction: Split open the fruits longitudinally and collect the seeds along with the pulp. Crush the pulp with hands and wash with excess quantity of water to remove the pulp. The extracted seeds are to be dried properly.

Grading: BSS 4 wire mesh sieve is to be used.

Seed Yield: 250-300 Kg/ha.

Storage: Seeds dried to 6 - 7% moisture content and treated with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be safely stored in 700 gauge polythene bag.

BOTTLE GOURD

Season: June - July and January - February.

Seed rate: 3 Kg/ha.

Spacing: 2.5 x 2 meter

Foliar application: Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of Ethrel at 250 ppm four times at weekly interval commencing from 15th day after sowing.

Harvest: Fresh fruits at 65 days after anthesis (the skin of the fruit become woody rough and turn dull in colour) can be harvested. The immature seeds can be removed as floaters. Fruits weighing less than 50 g should be rejected as it contains more than 5 % immature seeds.

Seed extraction: Matured fruits are cut vertically and seeds are scooped and cleaned.

Grading: 16/64" round perforated metal sieves or BSS 4 x 4 wire mesh sieve (6.2 mm)

Seed yield : 250 Kg/ha

Storage: Seeds dried to 8 % moisture content and treated with Carbendazim 50 % WP @ 2 g / Kg seed and Halogen formulation (Bleaching powder + CaCo3 + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be stored upto 1 year in cloth bag and 2 years in moisture vapour proof containers.

ASH GOURD

Season: January - May and June - November.

Seed rate: 2.5 Kg/ha.

Spacing: 2 x 1.5 meter

Manuring: FYM 10 Kg/ pit. 100 g of the mixture (6:12:12) per pit as basal and 10 g N/pit 30 days after sowing.

Foliar application: Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of Ethrel at 250 ppm four times at weekly interval commencing from 15th day after sowing.

Harvest: Seeds can be harvested at 80 - 85 days after anthesis when fruit stalk becomes dry and ashy coat prominent. Under sized fruits should be rejected.

Seed extraction: Fresh fruits can be used for extraction. On fresh extraction immature seeds can be removed as floaters. Cutting the fruits into longitudinal bits and closed fermentation of scooped seeds in polythene bags for 72 hours followed by 4-5 times repeated washing with water.

Seed yield: 250-300 Kg/ha

Grading: The smaller seeds should be removed as air blown rejects in pneumatic seed blower and graded by using 16/64" dia. Round holed sieve round perforated metal sieves or BSS 4 x 4 wire mesh sieve (6.2 mm)

Storage: Fruit storage

Half matured fruits available at the last harvest stage can be removed and stored over sand bed at ambient condition. On dry storage seed develops and can be used for seed extraction. Facilitate early field release.

Fruits without bruises and proper protection from insect, pathogen and rodents can be stored over sand bed for more than 6 months.

Processed seeds weighing not less than 10 g/100 seeds at 10 % moisture content should be dried to 8 % moisture content and treated with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed for extended storage and packed in moisture vapour proof containers.

CLUSTER BEANS

Season: June - July (irrigated)

Seed treatment: Treated with Carbendazim 50 % WP @ 2 g/Kg.

Seed rate: 10 Kg/ha

Sowing: Seeds dibbled @ 2 seeds/hole on the sides of the ridges.

Spacing: 45 x 20 cm.

Manures and fertilizers: FYM : 25 t/ha.

Fertilizers	N	P	K	Remarks
Basal	25	50	25	Just before sowing
Top dress	25	-	-	At first flowering.

Foliar application: DAP 2 % spray at 50 % flowering stage.

Harvest: Attains physiological maturity at 55 - 60 days after anthesis and reaches harvestable maturity in 60 - 65 days. The harvest is done by two staggered pickings as soon as the pods turn brown in colour.

Grading: Seed should be graded by using 10/64" round perforated metal sieve or BSS 6 x 6 wire mesh sieve (4.2 mm).

Seed treatment: Slurry treatment with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed.

Seed yield: 900-1000 Kg/ha

Storage: Seeds dried to 8 % moisture content and treated with Carbendazim 50 % WP @ 2 g / Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be safely stored in moisture vapour proof container for two years.

VEGETABLE COWPEA

Season: June – July and February – March.

Seed rate: 20 Kg/ha

Spacing: 45 x 20 cm.

Fertilizers: 25:50:0 Kg NPK/ha.

Foliar application: Spray 2% DAP (Supernatant solution) at 50% flowering. The tendril clipping enhances flowering and fruit yield.

Harvest: 25 – 30 days after flowering the seed matures (fruit become straw yellow colour). The crop harvested in pickings with an interval of 15 days. The early pickings upto 4 can be used for seed extraction.

Seed extraction: By beating with pliable bamboo stick.

Grading: 12/64" dia round perforated metal sieve or BSS 5x5 wire mesh (4.8 mm).

Seed yield: 500 Kg/ ha

Storage: Seed treatment with activated clay @ 1:100 by weight or Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed. The treated seed can be stored upto 8 months in cloth bag and 16 months in moisture vapour proof container provided there is no bruchid infestation.

DOLICHOS LAB LAB (Bush type)

Season: Throughout the year

Seed rate: 25 Kg/ha

Spacing: 60 x 20 cm.

Fertilizers

Basal FYM : 25 t/ha

: 25 : 50 : 0 Kg NPK/ha.

Foliar application: NAA @ 20 ppm at 65 and 75 days after transplanting.

Preharvest sanitation spray: With Endosulfan 0.7 ml/lit 5 days prior to harvest reduces Bruchid damage.

Harvest: When the pods turn to straw yellow colour. Last two pickings can be used for vegetables.

Seed extraction: Threshing with pliable bamboo stick.

Grading: 18/64" dia round perforated metal sieve or BSS 3x3 wire mesh sieve (7.2 mm).

Seed yield: 600 Kg/ha

Storage: Seed treatment with activated clay @ 1:100 by weight or Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed. The treated seed can be stored upto 8 months in cloth bag and 16 months in moisture vapour proof container provided there is no Bruchid infestation.

ANNUAL MORINGA

Season: July- October

Seed rate: 0.5 Kg/ ha

Spacing: 3 x 3 m.

Sowing: 2 to 3 seeds/pit.

Fertilizers

Basal

FYM : 15 Kg/Pit

100:200:50 g NPK/tree. N applied in 3 split doses at flower initiation, flowering and fruit development stage.

Foliar application: 3 - 4 sprays of NAA @ 20 ppm at flowering at 10 days interval.

Seed maturation: Seed attains physiological maturity at 70 days after anthesis with maximum germination and vigour with a colour change of pod from green to brown. Fruits can be harvested from 70-75 days after anthesis and delayed harvest leads to shattering and loss in seed quality.

Seeds within the pod vary in colour and among these black coloured seeds have higher weight, germination and vigour when compared to light brown and white seeds.

Grading: Seed should be graded by using 24/64" round perforated metal sieve.

Seed yield: 100 Kg/ha

Storage: Seed treated with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be stored in cloth bag for one year.

RADISH

Season

Hills March – April

Plains September – October

Seed rate: 10 Kg/ha

Spacing: 30 x10 cm

Root to seed method: When the roots are fully matured, the crop is harvested. True to type roots are selected and transplanted in a well-prepared field.

Seed to seed method: Seeds are sown in well-prepared land. On 45th day, the roots are lifted out and then transplanted by giving one-third cut at the top.

Fertilizers

Basal

FYM	:	25 t/ha
	:	50:25:50 Kg NPK/ha.
Top dressing	:	50 Kg N just before flowering.

Foliar spray: DAP @ 2 Kg/ha thrice at 10 days interval during flowering increases the yield and quality of seeds.

Harvest: Seeds mature 35 - 40 days after anthesis. Harvest the pods when dried and turn creamy straw colour. Drying of pods intact in the plant enables a single harvest and does not affect quality.

Seed extraction: Thresh the seeds with a pliable bamboo stick.

Grading: The separated seeds should be graded by using 8/64" sieve or BSS 8 x 8 wire mesh sieve.

Seed yield: 600-700 Kg/ha

Storage: Treat with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and pack in cloth bags.

BELLARY ONION

Season: May – June

Seed rate: 6 - 8 Kg of graded seed/ha.

Transplanting: Seedlings of 35 - 40 days may be transplanted in the mainfield on both sides of the ridges.

Spacing: 20 x 10 cm.

Fertilizer application: FYM : 25 t/ha.

Application	N	P	K
Basal kg/ha	30	60	30
Top dress (30th day) kg/ha	30	-	-

Harvest: Harvest the well-matured bulbs at 110 - 115 days.

Bulb grading: Select medium sized bulbs of weighing 40 - 50 g.

Bulb treatment: Remove the top 1/4th of the bulb and treat with fungicides either Carbendazim or Mancozeb at 20 g in 10 lit of water for 5 – 10 minutes.

Bulb sowing: Sow the treated bulbs on the ridges during October - November.

Spacing: 50 x 20 cm.

Harvest: Harvest the earheads during March when 50 % of the seeds in umbels turn into black colour, to prevent the shattering loss.

Seed extraction: Dry the earheads under sun and extract the seeds.

Seed grading: Size grade the seeds by using BSS : 10 x 10 wire mesh sieve (2.5 mm) or 6/64" round perforated metal sieve.

Seed yield: 500 - 600 Kg/ha.

Seed storage: Dry the seeds to reduce the moisture content to 6 - 8 % and treat with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and store the seeds in polythene bags.

AMARANTHUS

Season: June – July.

Seed rate: 2.5 Kg/ha. Soaking the seeds in Ethrel 200 ppm for 12 hours will enhance germination.

Spacing: 45 x 20 cm.

Fertilizers

Basal

FYM : 25t/ha

40 : 40 : 20 Kg NPK/ ha .

Foliar spray: Foliar application of DAP 2% @ flowering and 10 days after first spray improved seed yield and quality.

Harvest: Seed attains maturity 35 – 45 days after flowering. When glumes turn brown in colour and seeds turn black.

Seed extraction: Seeds are extracted by beating with pliable bamboo sticks and dried to 7 – 8 % moisture content.

Grading: Seeds are graded using BSS 12 x 12 sieve.

Seed yield: 200 Kg/ha

Storage: Graded seeds are treated with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be stored for 10 months in cloth bag and 18 months in moisture vapour proof containers.

CARROT

Season: Hill area : July – February

Seed rate: 4 Kg/ha

Germination improvement: Remove empty seeds by density grading (using a seed blower) soak seeds in water for 72 hours with a change of water every 24 hours to leach out the inhibitors present on the seed coat. This will improve the germination upto 65 %.

Plant Protection – Root knot nematodes, *Meloidogyne spp*.

Application of neem cake @ 1ton/ha at planting.

Root to seed method: Stecklings weighing 150g and above can be used for planting. Stecklings having low weight reduce the seed yield and seed quality.

Fertilizers

Basal

FYM : 25 t/ha

50 : 50 : 10 Kg NPK/ha

Top dressing: 50 Kg N prior to flowering (30 days after stecklings planting)

Harvest: Seeds in the umbel mature 7 weeks after anthesis. Splitting of Schizocarp into two mericarp occurs at this time. Delayed harvest results in shattering.

Grading: BSS 12 x 12 wire mesh sieve.

Seed yield: 700-800 Kg/ha

Storage: Dry seeds to 8% moisture content and treat with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and pack in 700 gauge polythene bag,

CAULIFLOWER

Germination Improvement: Remove empty seeds by density grading (using a seed blower) soak seeds in water for 72 hours with a change of water every 24-hours to leach out the inhibitors present on the seed coat. This will improve the germination upto 65%.

Foliar application: Foliar application of DAP 2% at 30 days after curd formation as supplementary nutrition increases the yield of good quality seeds.

Harvest: Seed matures 7 weeks after flowering. Delayed harvest reduces germination significantly.

Seed yield: 150 Kg/ha

Storage: Cauliflower seeds produced at Nilgiris stored better at Coimbatore upto 10 months.

Dry the seeds to 8-10% moisture and mix with fine neem leaf powder (1:50 ratio)

Seeds treated with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be stored for 10 months in cloth bag.

PAPAYA

Germination improvement: Soak seeds in 100 ppm GA_3 for 16 hours or in 2% fresh leaf extract of Arappu or 1% pungam leaf extract or pellet the seeds with Arappu leaf powder.

Optimum depth of sowing: Sow seeds at 1 cm depth for better germination and seedling growth.

Seed extraction: Fruit size or weight has no association with seed quality except that the seed content is more in large fruits and less in small fruits. The seeds from different fruit weight or size classes did not differ in their quality. Hence, all ripened fruits can be used for seed extraction.

Grading: BSS 6 x 6 wire mesh sieve (4.2 mm).

Storage: Dry seeds to 8-10% moisture and treated with with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + CaCo3 + Arappu leaf powder @ 5:4:1) @ 3 g/Kg and pack in cloth bag to maintain viability upto 5 months.

Invigoration of old seeds. Stored seeds can be invigorated by soaking them in dilute solution of Disodium phosphate (10-4 M) adopting 1:8 seed to solution ratio for 4 hours followed by drying back to original moisture content.

BER: Seeds of ber attain physiological maturity 13 weeks after anthesis. It is indicated by yellowish red colour of fruit pericarp. Stones can be size graded using 22/64" round perforated metal sieve. The stones soaked in Thiourea 20 g/lit for 24 hours enhances the germination. Ber

stones can be stored upto 30 months without any treatment under ambient conditions. Stone grading done with 20% Sodium chloride removes illfilled and empty stones.

AMLA: Stratify the fresh seeds in sand moist to 60% with KNO_3 5 g/lit kept at 5°C for 10 days to remove the morphophysiological dormancy. Dry storage of fresh seeds for 10 months can also remove this dormancy.

Seeds attain physiological maturity 23 weeks after germination of fruit dormancy of 5 months when the fruit colour turns to yellowish green and seed colour chestnut brown. Amla seeds can be extracted by soaking the fruits in 30% brine solution during night followed by drying during the day and repeated for 3 days. The mesocarp following soaking in brine solution remained fresh and can be used for pickle/byproducts preparation.

Using 8/64" round perforated metal sieve with maximum seed recovery can be used to process seeds. The size-graded seeds can be further upgraded by density grading using water to remove the light weighted empty seeds. Seed treated with Carbendazim 50 % WP @ 2 g /Kg seed and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed can be stored upto 18 months in cloth bag and at 24 months in moisture proof container.

JAMUN: Jamun seeds attain physiological maturity 11 weeks after anthesis where the fruit colour changes to purplish black.

For better seed extraction, heap the collected fruits for one day and squeeze with. Seeds come out easily.

Fresh seed can be size graded using 20/64" round perforated metal sieve with maximum seed recovery. It is a recalcitrant seed and will loss viability upon storage due to desiccation (drying). When stored seeds are to be used for sowing, the dead seeds can be removed by density grading using water. The seeds lose viability completely with in one month in tropical condition when the moisture content of seed falls below 20%. The critical moisture for safe storage is around 45%. Packing of seeds in polythene bags containing 2% moist sand stored at 10^0C in refrigerator storage prolongs viability upto 3 months.

MEDICINAL PLANTS

GYMNEMA: Seeds will attain physiological maturity 100 days after anthesis with colour change of pods from green to dark brown. Leaching the seeds in tap water for 12 hrs followed by soaking in KNO_3 2 g/lit for 6 hours recorded higher germination. Density grading using South Decota air blower at 0.5" water pressure improves seed germination. Seed treatment with with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and packed in moisture vapour proof container prolongs viability.

SENNA

Season: November – December and June – July.

Seeds attain physiological maturity at 40 days after anthesis associated with colour change of pods from green to brown. Seed can be processed by using 8/64" round perforated metal sieve. Hard seededness can be effectively overcome by acid scarification with commercial sulphuric acid @ 100 ml/Kg seed for 10 minutes. Seed treatment with Carbendazim 50 % WP @ 2 g /Kg

of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and packed in moisture vapour proof container prolongs the viability upto 15 months.

PERIWINKLE

The physiological maturity of periwinkle seeds will attain at 40 days after anthesis with maximum dry weight, germination and vigour with a change of pod colour from green to yellow with translucence.

Seeds can be processed by using 4/64" round perforated metal sieve with maximum seed recovery.

Storage: Seed treatment with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and packed in moisture vapour proof container prolongs the viability upto 15 months.

ROSELLE

Seeds attain physiological maturity at 40 days after anthesis. Seeds can be processed by using 7/64" round perforated metal sieve (2.8 mm).

Pre-sowing seed treatment and Storage

Seed treatment with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and packed in moisture vapour proof container, prolong the viability upto 15 months.

ASHWAGANDHA

The seed attain physiological maturity at 35 days after anthesis when the colour of seeds changes from orange to deep red. Harvestable maturity of seed was reached at 42 days after anthesis when germination and vigour were at peak. Mechanical scarification of seeds with sand for six minutes followed by soaking in GA_3 500 ppm solution for five hours significantly improved the germination of seeds .

AROMATIC PLANTS

PALMAROSA Cv. Trishna

Seeds attain physiological maturity at 40th day after 50% flowering when the fluff (seed) moisture is around 20%. Leaching of fluffs in running water for 8 hours followed by soaking in KNO_3 at 0.5% for 6 hours recorded maximum germination.

Density grading using South Decota air blower at 0.5" water pressure improves seed germination. Seed treatment with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed and packed in moisture vapour proof container prolongs viability.

Storing of fluffs in 700 gauge polyethylene bags after seed treatment with Carbendazim 50 % WP @ 2 g /Kg of seeds and Halogen formulation (Bleaching powder + $CaCo_3$ + Arappu leaf powder @ 5:4:1) @ 3 g/Kg seed maintains the shelf life of fluffs upto 10 months.

SEED CERTIFICATION STANDARDS FOR FOUNDATION / BREEDER SEEDS

Sl.No.	Crop	Field standards					Seed Standards					WSS
		ID	OT	PS	OWP	DD	OCS	ODV	PP	GER	MC	
1.	Brinjal varieties	200	0.10	-	-	0.10	0	-	98	70	8	150
2.	Brinjal hybrids PL	200	0.01	-	-	0.10	0	-	98	70	8	15
3.	Bhendi	400	0.10	-	0.00	-	0	10.00	99	65	10	1000
4.	Tomato varieties	50	0.10	-	-	0.10	5	-	98	70	8	70
5.	Tomato hybrids PL	200	0.01	0.05	-	0.10	5	-	98	70	8	7
6.	Chillies	400	0.10	-	-	0.10	5	-	98	60	8	150
7.	Cluster beans	10	0.10	-	-	0.10	10	10.00	98	70	9	1000
8.	French beans	10	0.10	-	-	0.10	0	5.00	98	75	9	1000
9.	Indian beans	10	0.10	-	-	0.10	0	5.00	98	75	9	1000
10.	Bitter gourd	1000	0.10	-	0.00	-	0	5.00	98	60	7	1000
11.	Ash gourd	1000	0.10	-	-	-	0	-	98	60	7	1000
12.	Bottle gourd	1500	0.01	-	-	-	0	-	98	60	7	1000
13.	Pumpkin	1000	0.10	-	-	-	0	-	98	60	7	1000
14.	Ridge gourd	1000	0.10	-	-	-	0	5.00	98	60	7	1000
15.	Snake gourd	1000	0.10	-	0.00	-	0	-	98	60	7	1000
16.	Watermelon	1500	0.01	-	0.00	-	0	5.00	98	60	7	1000
17.	Amaranthus	400	0.10	-	0.01	-	5	10.00	95	70	8	70

PL-Parental lines of hybrid; ID-Isolation distance (Meter); OT-Off-type plants (%); PS-Pollen shedders (%); OWP-Objectionable weed plant (%)

DD-Designated diseased plants (%); OCS-Other crop seeds (No./kg); ODV-Other distinguishable varieties; PP-Physical purity (%); GER-Germination (%); MC-Moisture content (%); WSS-Weight of submitted sample (Gram)

Part XII
IMPORTANT PLANT NUTRIENTS THEIR DEFICIENCY SYMPTOMS AND REMEDIAL MEASURES

MACRONUTRIENTS

Nitrogen

Symptoms: Chlorosis beginning in older leaves. Tips and margins of leaves commonly become yellow first.

Stunted growth.

Early crop maturity and low production.

Remedial measures: Spray 500 g of Urea dissolved in 100 lit of water to leaves.

Phosphorus

Symptoms

1) Older leaves become dark green with purple coloration (due to anthocyanin development) in some species.
2) Stunted shoot growth and poor root development.
3) Delayed crop maturity.

Remedial measures: Use Super phosphate or bone meal in required quantities.

Potassium

Symptoms: Symptoms first appear on recently matured leaves and become pronounced on older leaves. Dark green foliage with necrotic spots appearing on older foliage, typically at tips and margins and entire leaf blade becomes scorched or necrotic.

Slow growth and susceptibility to wilting.

Potassium is important for fruit taste, size and colour.

Remedial measures: Spray 500 g of Muriate of Potash or Sulphate of Potash dissolved in 100 lit of water.

Calcium

Symptoms: Reduced growth or even death of apical meristems, often leading to multiple branching in tap root crops.

Young foliage may be abnormal, chloritic or even 'burned' at tips.

Softening of tissues and cell wall breakdown is common in fruits.

Remedial measures: Apply 2 to 4 kg of lime once in two years to each plant.

Magnesium

Symptoms: Deficiency symptoms first appear in older leaves with chlorosis between veins and along margins progressing inward intervenially.

Tips and margins and leaves turn upwards.

Leaves tend to be brittle and may fall prematurely.

Remedial measures: Spray 100 g of Magnesium sulphate in 100 lit of water or apply 25 - 125 kg of Magnesium sulphate to the soil.

Sulphur

Symptoms: Symptoms are similar to 'N' deficiency with plants tend to be small and spindly having slender and short stalks.

Young leaves chlorotic, principal veins typically green.

Delayed maturity.

Remedial measures: Apply 20 - 25 kg of Sulphur per ha.

MICRONUTRIENTS: Like the macronutrients such as Nitrogen, Phosphorous, Potassium, Calcium, Magnesium and Sulphur, a score of micronutrients play a pivotal role in growth, development and reproductory activities of any crop plant.

The micronutrients such as Iron, Manganese, Boron, Copper, Zinc, Molybdenum, Chlorine and Silicon, etc., are extremely essential for sustained growth and productivity. Their essentiality is there for both seasonal and perennial crops, and their shortage quite apparently manifests in visible deficiency symptoms characterised by stunted growth, narrow or little leaves, chlorosis, crinkling, cupping and other leaf deformities, flower drop, alteration of sex of flowers, poor pigmentation and quality, cracking of stem, die back and oozing of gum. Each micronutrient is capable of producing one or more specific deficiency symptoms if it is in short supply to the plant metabolism. Often the complex deficiency symptoms as a result of deficiency of more than two micronutrients are manifested in sensitive crops such as Limes, Sweet Oranges, Mandarins and Lemons, etc.

Iron: It is essential for the development of chlorophyll in crops.

General symptoms: Young leaves become chlorotic.

The principal veins typically green, with absence of green colour in the finest veins and progress of chlorosis may lead to leaves completely devoid of chlorophyll leading to stunted crop growth.

Remedial measures: Spray 250 - 500 g of Ferrous sulphate dissolved in 100 lit of water.

Citrus

Symptoms: Pale yellow and small sized leaves, stunted growth and small sized fruits.

Remedy: Foliar spray of 0.1 % Ferrous sulphate solution.

Grapes: Iron deficiency in grapes is due to the presence of excess Calcium in the soil.

Symptoms: Pale yellow small leaves with stunted growth.

Remedy: Apply Sulphur containing fertilizers.

Pineapple: The deficiency is prevalent in the soils with more Calcium and Magnesium.

Symptoms: Reddish green leaves.

Remedy: 0.1% Ferrous sulphate solution sprayed with an interval of one month.

Vegetables: Iron is essential for the initial growth of vegetable crops. So it is essential to apply Iron containing fertilizers at the initial stage of development to avoid iron deficiency in vegetable crops.

Iron deficiency is common in the crops like Beans, Cauliflower, Beetroot, Brinjal, Tomato and Tapioca.

Symptoms: Pale yellow leaves, drying of leaf tips and in severe deficiency drying of whole leaves may occur.

Remedy: Apply 25 kg Ferrous sulphate per ha or spray 0.5 % Ferrous sulphate solution 3 - 4 weeks after sowing/transplanting.

Manganese

Symptoms: Intervenial chlorisis which shows up in younger leaves first.

Dark green bands along midrib and main veins with lighter green areas between the bands.

Remedy: Spray lime mixed Manganese sulphate.

Boron

General symptoms

Stunted growth or death of apical meristems, followed by sprouting of lateral buds.

Leaves, petioles or stems may be thickened, wrinkled curled and chlorotic.

The fleshy part may show brown flecks, necrosis, cracks or dry rot.

Death of meristems causes reduced flower and fruit set.

It is essential for the translocation of photosynthesis in plant system. Its essentiality is obvious in Potato, Tapioca, Cabbage, Grapes, Citrus, Tomato and Guava.

Mango

Symptoms: Drying of leaves. This is more prevalent in the orchards, which are nearer to brick factories.

Remedy: Either by soil application of 500 g Borax per plant or by spraying 1 % Borax solution.

Citrus

Symptoms & Remedy

Red spots on newly emerged leaves, leaves become dry and brittle.

Spraying 0.3 % Boric Acid.

Guava

Symptoms: Splitting of fruits, gummosis at the splitted area, rough skin of the fruits.

Remedy: Spraying 1 % Borax solution.

Grapes

Symptoms: Small sized fruits. Presence of small sized fruits and large sized fruits in the same bunch is known as “Hen and Chicken” disease. The fruits are sour in taste.

Remedy: Spray 1 % Borax solution.

Vegetables

Cabbage

Symptoms: Leaves become crinkled, rough and brittle. Drying of leaf edges soft spots on the petioles and loose heads.

In hybrid cabbage varieties, heads will not be formed and the leaves become blue in colour.

Cauliflower

Symptoms: Browning of leaf margin in young buds. Pale yellow veins and drying of leaves, the flower heads are long and dried with hollow flower stalk.

Radish

Symptoms: Tip drying, pale yellow leaves at initial stages and bluish green leaves at later stages. The leaves become crinkled and brittle. Early flowering.

Carrot

Symptoms: Wilting of plants despite enough soil moisture in the field. Deformed leaves with pale yellow colour.

Potato

Symptoms: Leaves become small and it resembles virus disease infected plant. 30 - 40 % yield loss and sometimes 100 % loss may occur.

Remedial measures for vegetables to correct Boron deficiency

For Cabbage, Cauliflower, Tomato, Chillies, application of 40 g Borax per cent area in nursery will produce elite seedlings.

Borax 0.6 kg to 1.2 kg per ha is applied as fertilizer in the main field.

For root and tuber crops apply Borax @ 1.2 kg to 3.2 kg/ha

Coconut

Symptoms: Button shedding, hallownut and sometimes fruits without nut.

Remedy: Apply Borax 0.6 - 1.2 kg/ha.

Copper: Stunted growth, rosetting and dieback of young twigs in fruit trees.

White tipped leaves are early symptoms.

Reproductive growth strongly affected leading to sterility.

Banana

Symptoms: Leaf bud is crinkled and twisted. Delay in flower emergence.

Coconut

Symptoms: Stunted growth, non-splitting of leaves.

Citrus

Symptoms: Die back, splitting of bark, gummosis from fruits and browning of fruits with rough skin.

Remedial measures: Foliar application of 0.05 - 0.10 % Copper sulphate solution.

Zinc: Chlorosis often appears as yellow mottling, between the veins in younger leaves.

Reduced stem growth may cause ‘rosette’ condition of terminal leaves.

Mango

Symptoms: Stunted growth, leaves small brittle and intervenal chlorosis, little leaves – rosette appearance.

Remedial measures: Two sprays of 1 - 2 % Zinc sulphate, one at the time of flowering and the other at 1 month after the first spray.

Banana

Excess Phosphorous application leads to the deficiency of Zinc.

Symptoms: Narrow leaves with pale yellow colour.

Remedial measures: Spray 0.5 % Zinc sulphate or apply 30 g Zinc sulphate per plant.

Citrus

Symptoms: Small, narrow, pale yellow leaves. Small fruits with rough skin.

Remedial measures: Three sprays of 0.5 % Zinc sulphate at the time of new flush emergence. Apply 500 g of Zinc sulphate per tree.

Guava

Symptoms: Intervenal chlorosis, small leaves, rough leaf surface with cracks. Small rough skinned fruits and splitting of fruits.

Remedial measures: Spray 0.5 % Zinc sulphate solution 2 times before flowering with the interval of 15 days or apply 340 g Zinc sulphate before flowering.

Grapes

Symptoms: Small leaves, widened petioles and small sized fruits.

Correction: Smear 10 % Zinc sulphate on the pruned stem or spray 1 % Zinc sulphate solution 10 days before flower formation.

Vegetables

Beans

Symptoms: Dropping of leaves and flower buds and intervenal chlorosis.

Tomato

Symptoms: Stunted growth, thickening of leaves, intervenal chlorosis, shortened internode, dropping of flowers and immature fruits.

Radish

Symptoms: Intervenal chlorosis at the initial stage and drying of leaves at later stages.

Onion

Symptoms: Tip drying during initial stage and total drying of leaves at later stages.

Remedial measures

Seed treatment with 0.01 % Zinc sulphate.

Spray 0.25 - 0.50 % Zinc sulphate solution in the nursery five weeks after germination.

Foliar application of 0.1 % Zinc sulphate in the field.

Coconut: Button shedding is the common symptom. The deficiency can be corrected by application of 0.25 % Zinc sulphate per plant.

Molybdenum: Chlorotic interveinal mottling of the lower leaves followed by marginal necrosis and infolding of the leaves.

In severe conditions necrosis and wilting of leaves occur.

Flower formation is inhibited, and if flowers do form, they abscise before setting fruits.

Cauliflower

Symptoms: Drying of leaves from its edges at initial stages, later stages total drying. Leaves become long and narrow and this disorder is known as 'Whip tail' in Cauliflower.

Radish

Symptoms: Pale yellow leaves, wilting of leaves with onward crinkling.

Tomato

Symptoms: Interveinal chlorosis, inward crinkling of leaves.

Remedial measures: Spray 625 g Ammonium molybdate in 400 lit of water as foliar spray before flowering.

Chlorine: Leaves chlorotic and susceptible to wilting.

Deficiency is practically non-existent in nature because even rain water will carry sufficient Chlorine to provide the required amounts.

Remedy: Add Chlorine compound salts to soil.

Silicon

Wilting growth habit may result.

Abnormal accumulation of Fe + Mn may cause necrotic spots.

Plants become susceptible to diseases.

Correction: Apply Silicon salts to soil.

Foliar application: The deficiency of micronutrients can be corrected by either soil or foliar application. Since soil application is often encountered with the problems such as fixation, leaching, inabsorbtion and antagonism, foliar application has been a standard practice of application of micronutrients to plants. Spraying also overcomes the problem of immobility of certain metallic ions inside the plant system. Since the micronutrients are needed in very small quantity, the spray solution employed for foliar application is normally in terms of parts per million (ppm) and the chemical to be so employed is to be in neutralised form, or else scorching of leaves may occur or may prove toxic to plant system.

Employ right micronutrients in right concentration by consulting the extension workers or expert.

Mixing two or more micronutrients to be ensured only after proper consultation.

Take up spray preferably to young expanding foliage to ensure effective absorption. Old leaves absorb very little or nil.

Saline and alkaline water should not be employed for preparing micronutrient spray solution.

Pour the spray solution through fine filters or muslin cloth to prevent clogging of nozzle.

Ensure fine mist of spray evenly on both surfaces of leaves.

Avoid spraying during blossom period.

Spray preferably during morning or evening.

Do not mix plant protection chemicals or Urea with micronutrients.

Wash and clean the sprayer, nozzle with clean water after spraying to avoid corrosion and clogging.

Part XIII
MUSHROOM CULTIVATION

Mushrooms are well known for their delicacy and flavour. They are also a good source of nutrition with high quality protein considered superior to vegetable. There are several edible mushrooms cultivated on commercial scale in different parts of the world particularly in USA, France, China, The Netherlands, UK, South Korea, etc. At present, world mushroom production is estimated to be about 4 million tonnes per annum whereas in India it is hardly about 15,000 tonnes per annum.

Tamil Nadu with its diversified agroclimate and availability of Agricultural/Horticultural wastes in abundance is most suited for the cultivation of temperate, sub-tropical and tropical mushrooms *viz.,*

i) White button mushrooms	*Agaricus bisporus, A. bitorquis*
ii) Oyster mushrooms	*Pleurotus sajar caju*
	P. citrinopileatus (CO 1)
	P. djamor (MDU1)
	P. ostreatus (Ooty.1)
	P. eous (APK.1)
	P. florida
	P. platypas
iii) Paddy straw mushroom	*Volvariella diplasia*
iv) Milky mushroom	*Calocybe indica* (APK.2)

The Oyster mushroom and milky mushrooms can be grown in plains almost through the year. But, the white button mushrooms can be grown only in temperate climate preferably in hills. Paddy straw mushroom can be grown only during summer months (April – July).

Mushrooms are highly proteinaceous and tastes good. It is used for preparing soups and curries. Though more expensive than vegetables, it is preferred by some people as delicacy. It is very simple to grow, but care has to be taken to maintain hygiene in the growing place, since the contamination can ruin mushroom.

Raw materials: The spawn (seeds) has to be obtained from Plant-pathological laboratories where they are grown under strict laboratory conditions. Rice straw, Polythene bags, Antiseptic solution, and Iron rod with hook on one end, sand and water.

Market potential: This foodstuff is yet to be popular in the rural areas. This is due to high price

However, it has heavy demand in urban areas. It can also be dried and it regains shape on soaking in water. This is a big advantage as it can be marketed in big cities far away from the place of production.

Popularising mushroom cultivation and consumption in rural areas will greatly help in increasing the income and serve as a source of nutrition and improving the economic condition of the rural and urban people. It may also generate employment in several areas.

The targetted markets for mushrooms are

Hotels catering to high class society

Supermarkets in bigger cities

Vegetable vendors

Mobile catering units

Cultivation of Oyster mushroom

Varieties: CO 1, MDU.1, APK.1, M2 and *Pleurotus florida.*

Life Cycle Period: 30 – 45 days.

Production House: A thatched shed or room, preferably with optimum relative humidity of 80 - 95 % and room temperature of 24^0 C - 28^0 C with diffused light and ventilation is required. It does not make growth in places where the temperature goes below 24^0C. Hence, it is not suitable for cold latitudes and high elevations. The room should be kept cool by hanging gunny screens with periodical sprinkling water on the gunnies. Sand must be spread on the floor upto 2 - 3 cm and be kept moist.

Substrate: Dried Paddy straw @ 500 g per bed can be used as a substrate. Sugarcane trash, cotton waste, paper waste etc. also can be used.

Spawn requirement: One bottle containing 300 gm of spawn is required for two beds of straw. This can be obtained from selected Agricultural Research Stations and in Agricultural Universities.

Preparation of Bed: Take polythene bags of 30 cm diameter, 60 cm height and 70 - 100 gauge thickness. It is preferable to provide two vent holes of 1 cm diameter each in the middle of the bag at opposite directions. Chop paddy straw into small bits of 3 - 5 cm and soak in cold water for 2 - 3 hours. Then immerse in boiling water for 15 - 30 minutes, or steam sterilise it for 30 minutes under 15 psi pressure and drain off excess water from the straw. Shade dry for two hours until to reach 60 – 65% moisture and then use. Remove the spawn from the bottle using a small iron rod with hook on one side. Dip the iron rod in antiseptic solution before use.

Separate the spawn into two lots. Tie the bottom end of the polythene bag with country thread and fill first layer with straw bits upto 5 cm height in the bottom. Then sprinkle a handful of spawn over with entire surface of the straw layer. Add a second layer with straw upto 10 cm height and sprinkle spwan as done before. Similarly from the third and fourth layer of straw bits and repeat spawning. Then fill the top fifth layer with straw bits upto 5 cm height spread and tie the upper end of the polythene bag also with jute twines.

Spawn running: Allow it for spawn running for 15 days in. Keep it preferably in dark till mycelial growth appears. Observe periodically and discard contaminated beds having black or green mould growth. Spawn running will be completed within 10 – 18 days.

Cropping: After spawn running buds will appear in beds and continue for about two to three days. During this period maintain temperature (20-28^{0}C) and 75% humidity by spraying water on sand floor and in gunny cloth. First harvest will be ready on 15 - 21 days. After first harvest remove polythene cover and scrap out paddy straw approximately to a depth of 1 cm and spray water or keep moisture always 60 - 65% in beds. Second harvest may develop after one week. Totally four harvest can be taken from one bed within 35 - 45 days period.

Pest: Phorid flies.

Control measures

Install multi dimensional (sticky) trap to attract the phorid flies.

Regularly remove the waste materials and put it in a compost pit and convert them into manure.

Fix nylon net of 35 or > 35 mesh in the mushroom house to prevent the entry of flies.

Spray chlorpyriphos 20 EC 50 ppm in the compost pit and 25 ppm in casing to control the maggot.

Spray dichlorvos 76 WSC 30 ml/100 m^3 over the mushroom house, casings, walls and windows.

Avoid direct spray over the bed: The total yield is 500 – 700 grams of mushroom per bed depending upon spawn, substrate quality and climatic conditions.

Harvest: Pick up the buds after 48 hours of spraying.

Yield: The total yield is 500 – 700 grams of mushroom per bed depending upon spawn, substrate quality and climatic conditions.

Cost of cultivation (in Rs.)

Cost of shed with racks	4,200
Chaff cutter (fabricated)	2,500
Sprayer	1,400
Total	8,100

Recurring expenses for 3 months (in Rs.)

Paddy straw	@ 4/kg	1 kg per day	360
Cost of spawn	@ 4/bottle	1 bottle/day	360
Polythene bags	@ 55/kg	10 kg	550
Packing			250
Fungicides			100
Electricity & Miscellaneous			200
Total			1,820

Total investment (in Rs.)	
Fixed	8,100
Recurring	1,820
Total	9,920
Cost of production (in Rs.)	
Recurring expenditure for 9 months	5,460
Depreciation @ 10 % per year	710
Interest @ 12.5 % on working capital	230
Interest on term loan @ 12.5 %	890
Total	7,290

Revenue (in Rs.)	
7 crops @ 150 kg per crop - 1050 kg @ Rs.30.00	31,500
Profit	24,210

Percentage of profit on sales – 77.00 %

Part XIV
SEASON OF FLOWERING AND FRUITING OF FRUIT CROPS

Crop	Season of flowering	Season of fruiting
Mango		
Main season	November - December	April - June
Off season	August - September	January - February
Lime	October - November	January - March
Mandarin	July - August	November - December
Grapes	February - March June - July	April - May August - September
Papaya	Throughout the year	Throughout the year
Sapota	i. June - August ii. October - December iii. March	i. October - December ii. February - April iii. July
Guava	i. April - May ii. July - August iii. October - December	i. August - September ii. November - December iii. January - March
Pineapple	September - October	March - June
Jack		
Main seasons	September - October	March - June
Off season	May - June	October - December
Pomegranate	May - July	October - January
Custard apple	May - June	September - November
Ber	June - July	October - November

Crop	Season of flowering	Season of fruiting
Indian Gooseberry	i. July - August ii. February - March	January - February August - September
Jamun	March - April	August - September
Wood apple	May - June	January - March
Bael	May - June	April - May
Tamarind	September - October	March - April
Karonda	February - March	May - June
West Indian Cherry	August - September	December – January
Mangosteen	January - March	June - August
Passion fruit	i. February - March ii. June - July	June - July September - October
Carambola	i. April - May ii. July - August iii. September - October	July - September November - December January - February
Rambutan	February - March	June - August
Durian	December - January	May - September
Avocado	January - March	May - September
Fig	i. October - November ii. February - March	February - June July - September
Apple	February - March	May - July
Pear	February - March	June - September
Plum	February - March	May - June
Peach	January - February	May – June

Part XV - CHEMICAL AND COMMERCIAL NAMES OF INSECTICIDES AND NEMATICIDES

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
1.CHLORINATE-DHYDROCARB-ONS* Aldrin I	Agroaldrin, Alcrop, Aldrex, Aldrin, Kilter, Mildrin, Termalit	5 D, 30 EC,20 EC	C, S, F	67 (38)	200 for rats 15.25 for rabits
* Chlordane I	Agrosan,Chlordane, Chloroddra, Mitox, Starchlor, Termex, Termikil, Vegfrichlorbu	5 D, 10 D, 20 EC	S, C, F	250-500	217 rats, 780-840 rabbits
* DDT I	950,Agdit,Carox, Corodet, DDT, DEE,Deetol,Entomit,Hildit-Dinex,IntoxD-DT,Kilpest, Ramdit, Starrdit, SulBit-5 D, Tafarol, Tafeidex, TOL, Topdit,	18.5 EC	S, C	250-300 (113)	2510
Dicofol I/A	Banmite, Delcofol, Dicofol, Hilfol,Kelthane,Micothane, Tagfol, Vikofol,	18 EC	C,	809(575)	1000-1230
* Dieldrin	Dieldrin	18.5 EC	C,S	40-87 (46)	90
*Banned. See the Gazette Notification.					
Endosulfan I/A	Agrosulfan,Agirosulfan, Bangsulfs,Cacosulfan, Citosulfan, Endocel, Endocid, Endohit, Endomil, Endosol, Endostar, Endosulfan, Endotaf, Ensocrop, Ensosulfan, Entacid, Fisulfan, Hexasulfan, Hildan, Hysulphan,Kemsulfan, Kilexantisulpass,Luslfan, Marvel, Parasulfan, Parry sulfan, Ramfan, Sicosulfan, Solasulfan, Sujadane, Tagsulfan, Thiokill, Thiodan, Thiotox, Vegfro, Vikasulfan	35 EC 4 D	C, S	40-50 (18)	360 for rabbits

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50 Oral	Dermal
*HCH (BHC)	Agrobenz, Benzichlor, Corohex, Entemix, Gammaxene, Hexido, Hilbech, IntoxBHC, KeroBHC, KilpestBHC, Premodole, Ramacholare, Solchlor, Submar, Sulbez-50	10 D, 50 WP	C, F	200(100)	1000
Heptachlor 1	Agrochlor, Heptachlor,Heptaf, Heptar, Heptox, Heptox, Vegfov	2D, 20 EC	C, S	130 (40)	195-250 2000 rabbits
Lindane 1	Agrodone, Canon, GammaBHC, Knodane, Lindon, Lindone, Lindane, Lin sulpn, Micodane, Rasayan	6 G 20 EC 0.65 D 1.3 D	S, F, C	88-125 (76)	900-1000
Tetradifon I/A	Agrodifon, Hexamiton, Tedion, Treat	8 EC	C	500-15000(566)	10,000
*. Banned. See Government Notification.					
2. ORGANOPHOSPHATES					
Acephate I	Acemil, Agrophate, Asataf, Orthene, Start thenet Lancer, Torpedo, Tremor.	25 EC 75 SP	Sy, S, C	605-1100 (700)	2000
Carbophenoth-ion I/A	Trithion	25 WP, 3 D, 10 G	C	32-90 (10) 166 mouse	1270 rabbits
Chlorfenvinph-os I/N/A	Birlane	24 EC 10 G	C,F	24-39 (20)	1250-2500 rats 400-4700 rabbits
Chlorpyriphos I	Agrofos, Bangspan, Chlorofos, Coroban, Danusban, Durmet, Dursban, Gilphos, Hyban, Lethal, Radar, Ruban, Strike, Suban, Sulban-20	20 EC	C,S,F	135-163 (163)	2000 rabbits
Diazinon I/N/A	Agroziron, Basudin, Bazanon, Delzinon, Suzinnon, Zionovl	5 G 20 EC	C,S,F	300-850(75)	2150,3600 rabbits
Dichlorvos I/A	Agrovan-76, Bangvos, Bargros, Dichlorvos, Divipan, Divipan, Divisol, Nukem 776, Nuvan, Nuvasul, Paradeep, Vapona	76 WSC	C,F	50-8(56-80)	500

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
Dimethoate I/A	Agrodimet-30, Agromat, Champ, Cifor, Corothiate, Cropgor, Cygon, Hygro, Devigon, Dimor, Dimer, Dimethoate I/A, Dimethote, Dimex, Entogor, Hexagor, Kemithoate, Kilxdimethoate, Kilterx, Micor, Milgor, Paragor, Parrydimate, Rogor, Sicothate, Sulgor, Tagor, Tara 909, Vikagor	30 EC	Sy,C,F	250 (152)	600-1200
Disulfoton I/A	Solvirex, Disyston	5 G	Sy, C, S	26-125(2)	41 (for 4 hrs)
Ethion I/A;	Demite, Dhanumit, Ethiosul, Fosmite, Fieathion, Force, Fosmite, Miti cil, MIT 505, Novathion, Tafethion, Vegfru fosmite.	50,EC	C	208 pure (13)	915 guinea pigs
Fenitrothion I/A	Accothion, Agrothion, Fenitox, Fenitrogil-50,Fenitrothion, Fethiol,Folithion,Hexafen, Sumithion	5 D 50 EC	C, S, F	570-740 (250)	1300,300 mice
Fenthion I/A	Lebaycid, Fenthion	100 EC	C, S	241-316 (215)	345-410
Formothion I/A	Anthio	25 EC	Sy, C, S	375-535 (250)	400-1680
Malathion I	Agrolmal,Agromala, Bangmal,Bugtax,Corothion, Cythion,Entomol,Hilthion, Kathion, Kpmalathion, Malahi-90,Malamar,Malathion, Malatox,Malzone, Svlmalathion, Taimal	5D, 25WDP 50,EC	C, S	1375-2800 (885)	4100 rabbits
Menazon I	Sayfos	70 WP	Sy, C, S	1950	500-800 rabbits
Mephosfolan, I	Cytrolane	5 G	C, Sy	9-11	28 rabbits
Methamidophos I/A	Monitor, Metataf, Tamaron	50 EC, 40 WSC,	CSy	30-50	50-10
Methyldemeton I/A	Hexasystox, Himax, Knockout, Metasystox, Parasystox.	25 EC	Sy, C, S	40-60	250

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50 Oral	Dermal
Methyl paration	Agropara, Agrotex, Corocid, Devithion, Dhanumar, Entocid, FolidolM, Dagrodal, Kempar, Kildet, Kilex, Klofos, Luthion, Milon, Metacid, Metapar, Methyl parathion, Metpar-760, M.Devithio, Paracrop, Parahit, Paramar, Paramet, Parasul, Parataf, Parathol, Paratox, Ramcidd, Ramthion, Tagpar, Vegfro, Vika cid	2 D, 50 EC 46.7 EC	C, S, F	12-42 (6)	67-420 rabbits
Monocrotophos	Azodrin,Agrocron, Agromohare, Balwan,Corophos,Croton, Entofos,Glorephos,Hilcron, Hycrophos,Kagrophos, Kileximonocrotophos,Luphos, Macrophos, Micophos, Milphos, Mondhit,Monocid,Moncil, Monocron,Monocroto, Monogil,Monosect,Monosil, Monostar,Nuvacron, Paracron,Parryfos,Phosill, Ramphos,Rasayanaphos, Sicocil, Triphos, Vegfrokadett, Vimonfos	36 WSC, 36 SL	Sy, C	21	354 rabbits
Phenthoate I/A	Agrophen,Aimsan, Cilphenthoate, Delsan, Dusab, Elsan, Fenthoate, Phendal, Phenthasul, Phentox, Tagsan	2 D, 50 EC	C,F	200-300 mice	-
Phorate I/N/A	Aelmet,Agrophorate, Cifphorate, Dragnet, Forate-10G, Foratox, Fortan, Fortox, Glorate, Granutex,Grenade,Kamet, Luphate,Milate,Phorate, Starphor-10G, Starphos, Thimet, Vegfro, Volphor	10 G	Sy, C	16-37(1.1)	20-30 (24hrs) Guinea pigs
Phosalone I/A	Agrosalone, Micozons, Phosal, Phosalone, Sugalone, Zolone	4 D, 36 EC	S, C	135 (120)	390 female rats

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50 Oral	Dermal
Profenofos I	Curocron, Carina	50 EC	S, C	-	-
Propetamphos I	Safrotin (Pesticides)	20 EC	S, C	380-490	4000
Phosphamidon I/A	Agromidon,Agrophos, Bangdon, Cildon,Daron,Dimecron, Entocron, Kilrodon, Phamidon, Phoskil, Sicomidon, Sudon, Sumidon, Vimidon	85 WSC	Sy, C, F	17.9-30 (17)	374-530 267 rabbits
Quinalphos I	Agriphos,Agroquin, Agroquinal, Award,Desalux,Ekalux, Entolux,Gilquin,Hyquin, Keterphos,Kilex,Krush, Quinalphos,Kinalux,Milux, Pharulux,Quinal,Quinalphos, Quinaltaf, Quinotox, Ramlux, Sicophos, Sicophosa, Smash, Solux, Starbrand, Tagquin	1.5 D, 25 EC, 5 G	C, S	62-137(26)	1250-1400
Thiometon I/A	Ekatin, Hexatin, Thiotox	25 EC	Sy, C, S	86-225 (25)	-
Triazophos I/A	Hostathion	25 EC	S, C	(64)	-
Trichlorfon I	Dipterex, Trichlorfon, Tugon	5 D, 5 EC, 50 WDP	S, C	450-630(450)	2000
Vamidothion	Kilval, Vamidothion, Valoson	40 EC	S	64-105	1160 rabbits
3. CARBAMATES					
Aldicarb I/N/A	Temik (Production stopped)	10 G	Sy, C	0.9	400-3200
Carbaryl I	Agrovin, Agroyl, Bangwin, Carbamate, Carbaryl, Carvint, Corovit, Devicarb, Hexavin, Kervin, Kildiryl, Kilexcarbaryl, Sevidol, Sevimo, Sevin	5D, 10D,50,80,85 WDP 85 S, 40 LV, 4G	C	400-850 (250)	4000-2000 rabbits
Carbofuran, I/N/A	Furadan,Hexafuran, Vegfrodiafuran	3 G	Sy (?), C, S	8-14(5.3)	2550,10200 rabbits (24hrs)
Methomyl I/N	Dunet, Lannate	12.5 L	C, Sy, S	17-24 (60)	1500 rabbits

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50 Oral	Dermal
Oxamyl I/N	Vydate	24 WSC, 10G	Sy, C	5.4	2960 rabbits
Propoxur I	Baygon	20 EC, (PH)	C	100(83)	600-1000
4. PYRETHROIDS					
Cypermethrin	Agrocyper, Bilcyp, Bullet, Challenger, Cilcord, Cymbush, Cymet, Cymetd, Cyper 10,Cyperhit,Cyperkil, Cypermil, Cypersul, Cyporin, Hilcyperin, Hipower, Hycyper, Lacer, Mortal, Parathrin, Ralothrin, Ramagper, Ripcord, Shakti Ustod, Sicorin, Sirex, Starcyprin, Superkiller, Tackle, Trofy, Ustadd, Vegfrocolt	10 EC, 25 EC	C, S	200-800 (251)	>1600
Deltamethrin I	Decis, Decametherin, Decathrin	28 EC	S, C	128-139 (4)	>2000 rabbits
Lambda Cyhalothrin I	Karate	5 EC	C	56-79	632-696
Fenvalerate I/A	Agrofen, Bangrenn, Capvalerate, Fenkil,Fenval,Fencid, Fenicidin, Fenhit, Fenis, Fenoron, Fenrio, Gilten, Hitten, Hyfen, Kagrofen, Lufen,Milfen,Parafen, pavshafen,Pensil,Ramfen, Sicofen,Starfen,Sujafen, Sumicidin,Tagfen,Trifen, Triumpheard,Valour,Vegfro, Vikafen	20 EC	C, S	3200(451)	5000,2500 rabbits
Fluvalinate I	Marverick, Starfen	-	-	-	-
Pyrethrin I	Pyrocone E	-	C	570-1500 (584-900)	Not determinable
Alphacypermethrin I	Alphaguard Fastac, Stop	10 EC	C	-	-
5. MISCELLANEOUS COMPOUNDS					
Aluminium Phoshide I/R/A	Al-phos, Celphos, Phostoxin, Quickphos,	3 g tablet	F	32-90	-
Bromadiolone R	Bromadiolone, Bromadiolone R	0.25 SP, SL 0.005 CAKE,0.005 bait	Anticoagulant	1.25 (rats)	21.mg/l g (rabbits)

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50 Oral	Dermal
Diflubenzuron IGR	Dimilin	25 WP	C, S	4630 mouse	-
2000 rabbits					
Sulphur I/A/F	Sulphotox, Wetsulf, Devisulfan, Hexsasul, Sulfex, Wetsul,	40,80,85, WP	C	Non-toxic mild laxative action	Skin and eye irritant
Warfarin, R	Warfarin,Rotafiin,Rotafin, Ragumin	0.5 SP	Anticoagulant	1.3 (1550)	-
Zinc phosphide R	Zinc phosphide, Zincox, Ratol, Agrosphos	50 WP Granules	F	45.7 (45)	-
6. NEEM PRODUCTS					
Neem Oil	GodrejAchoo, Biosol, Kemissal, Margocide OK, Margosal, Neem plus, Neemguard, Neem pure, Nimbecidine, Phytowin, TNAU Neem	EC 1 K	Antifeedant Repellent, Oviposition deferrant, IGR	-	-
Neem kernel	Ecomak, Margocide-OK, Neemax, NeemactinNeemicide	-	-	-	-
Note: Oil based emulson contains 0.03% and neem kernel based emulsion contains 0.15% azadirachtin					
7. BIOCIDE					
Bacillus thuring iensis Var *kurstaki* (B.t.k)	Delfin (Serotype 3 A&B), Biolep (BTK-I), Bioasp (BTKII), Biobit, Dipel 8 L, Halt, Lupin, Spectrin.	-	-	-	-
8. NICOTINYL					
1. Acetamiprid I	Pride	20 SP	C, S, Sy	146 - 270	>5000
2. Imidacloprid	Gaucho, Confidor, Imidacloprid, Tatamida	70 WS, 600 FS, 17.8 SL, 200 SL	Sy	450	5000
3. Nitenpyram	Best guard	SP, GR	Sy	1680	>2000

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50 Oral	Dermal
4. Thiamethoxam	Actra, Cruiser	25 WG, 70 WS	Sy	5000	>2000
5. Chlothianidine	Poncho	600 FS	Sy	2000	2000
6. Thiacloprid	Calypso	240 SC	Sy		
9. NERISTOXIN					
Cartap Hydrochloride	Padan, Caldan	4G, 50SP	C,S, Sy	345	>2000
10. PYRAZOLE					
Chlorfenapor I/A	Pirate, Stalker	EC, SC	S, C	441-1152	>2000
Fenpyroximate A	Danitoron, Ortus, Pamanrin	SC	C, S	245 - 480	>2000
Tebufenpyrad A	Comanche, Masai, Oscar, Pyranica	EC, WP, WG	S, C	595 - 997	>2000
Fipronil I	Prince, Regent	SC, GR, FS, EC, WG	C, S, Sy	97	345 (rabbit)
11. AVERMECTINS					
Emamectin I/A	Proclaim	5 SG	C, S	>5000	>2000
Spinosyn I/A	Spinosed, Success, TracerNaturalyte	48 SC	C, S	>5000	>2000
Spiromesifen I/A	Regent, Oberon	240 SC	C, S, Sy	>2000	>2000

Abbreviations

A-Acaricide, C-Contact poison, F-Fumigant, I-Insecticide; IGR-Insect Growth Regulator, D-Dust; EC-Emulsifiable Concentrate; G-Granules; LV-Low Volume; N-Nematicide; R-Rodenticide, S-Stomach poison, SL-Soluble Liquid; SP-Soluble Powder, Sy-Systemic poison; ADP-Water Dispersible Powder; WP-Wettable Powder, WSC-Water Soluble Concentrate.

Fenthion 100 w/v but 80 EC w/w.

NOTE: LD_{50} values are units for rats unless specified

Source:

The Agrochemicals Handbook-1983 (eds) Dougals Hartely and Hamish Kidd. The Royal Society of Chemistry (Pub.), England. In parentheses, the values from EPA, 1984 Analytical Reference Standards and Supplemental Data-The Pesticides and Industrial Chemical Repository; Pesticides Annual 1989-90

Part XVI
CHEMICAL AND COMMERCIAL NAMES OF FUNGICIDES

Copper Sulphate preparations

Bordeaux mixture It is prepared by mixing Copper Sulphate and lime in water (To get 1 % mixture, mix 1 kg of $CuSO_4$ and 1 kg of lime in 100 litres of water.

Bordeaux paste It is prepared by mixing 1 kg of $CuSO_4$ and 1 kg of lime in 10 litres of water.

Burgundy mixture It is prepared by mixing of 1 kg of $CuSO_4$ and 1 kg of Sodium Carbonate in 100 litres of water. Burcop, Taytox.

Cheshunut compound It is prepared by mixing 2 parts of Copper sulphate and 11 parts of Ammonium Carbonate.

Organomercurials

Methoxy ethyl mercury chloride, Agallol, Aretan, Emisan, Ceresan Wet (India) Chloride, Phenyl mercury chloride, Ceresan Dry (India), Ceresol, Leytosan.

Inorganic Sulphur

Elemental Sulphur

a. Sulphur dust : Sulphur dust**.**

b. Wettable Sulphur : Cosan, Wetsulf, Microsul. Microsul 80 % Thiovit, Thiosulf, Sulfex, Sulphux.

Organic Sulphur (Dithiocarbamates)

Ziram — Cuman L, Ziram, Ziride 80 WDP, Hexazir 80% WP, Corozate, Fuklasin, Karbamwhite, Milbam, Vancide 51Z, Zerlate, Ziram, Zirberk, Zitox 80 % WDP.

Ferbam — Coromet, Ferbam, Ferberk, Fermate, Fermate D, Fermocide, Hexaferb 75% WP, Karbam black, Ferradow.

Thiram (TMTD, Thiuram) — Thiride 75 WDP, Thiride 750, Thiram 75 % WDP, Hexathir, Normersan, Panoram 75, Thiram, TMTD, Arasan, Tersan 75, Thylate, Pomarsol.

Zineb	Hexathane 75 % WP, Dithane Z 78, Funjeb, Lonocol, Parzate C, Du Pant fungicide A, Polyram.
Mancozeb (Maneb + Zinc ion)	Dithane M 45, Indofil M 45, Manzeb
Vapam	Vapam, VPM, Chemvape, 4-S, Karbation, Vita Fume.

Heterocyclic Nitrogen Compounds

Captan	Captan 50 W, Captan 75 W, Essofungicide 406, Orthocide 406, Vancide 89, Deltan, Merpan, Hexacap.
Captafol	Foltaf, Difoltan, Difosan, Captaspor, Folcid, Sanspor.

Systemic fungicides

Carbendazim (MBC)	Bavistin 50 WP, MBC, Derosol B.sten 50, Zoom, Tagstin, Lignasan, Agrozim, Jkestin.
Thiophanate	Topsin 50 WP, Cercobin 50WP, Enovit
Thiophanatemethyl	Topsin-M 70WP, Cercobin-M 70 WP, Enovit-Methyl, Mildothane
Carboxin(DCMO)	Vitavax 10% D, Vitavax 75% WP,Vitavax 34% liq. Vitaflow.
Oxycarboxin(DCMOD)	Plant vax 5G, Plantvax 5% liq. Plantvax 12.5 EC, 10% dust, 75 WP
Tridemorph	Calixin 75 EC, Bardew, Beacon
Triadimefon	Bayleton, Amiral
Metalaxyl	Apron 35 SD
Metalaxyl + Mancozeb	Ridomil MZ 72 WP
Fosetyl Al. (Aluminium-Tris)	Aliette 80 WP
Tricyclazole	Beam
Hexaconazole	Contaf 5 EC
Propiconazole	Tilt 25 EC
Penconazole	Topax 10 EC

Miscellaneous Fungicides

Dinocap	Karathane, Arathane, DNOPC, Mildex, Crotothane, Crotothane 25%, Crotothane 48% Liq.
Chinomethionat (Oxythioquinox)	Morestan 25% WP, Morestan 2% D

Quintozene (PCNB)	Brassicol, Terraclor, Tritisan 10%, 20% 40%D and 75% WP, PCNB 75% WP
Fenaminsosulph	Dexon 5% G and 70% WP
Ediphenphos (Edifenphos, EDPP)	Hinosan 50% EC and 2% D
Chlorothalonil	Kavach 75WP, Bravo, Daconil, Termil, Chlorothalonil 40SC Safeguard, Spektrum
Fentin hydroxide(TPTH)	Du-Ter WP 20% or 50% WP, Du-Ter Extra-WP Farmatin 50 WP, Du-Ter forte WP, Tubotin.
Fentin acetate(TPTA)	Brestean WP 40% and 60% WP
Antibiotics:	
Streptomycin + Oxytetracycline (Terramycin)	Agrimycin-100, Streptomycin, Agristrep, Embamycin Phytomycin, Phytistrep.
Streptomycin + Hydrochloride Tetracycline	Streptocycline, Paushamycin
Aureofungin	Aureofungin-sol
Cycloheximide	Actidione, Actidione PM

Part XVII
WEED MANAGEMENT AND HERBICIDES USAGE IN HORTICULTURAL CROPS

Weed management has become an integral part of Agriculture. There is little doubt that with the progressive modernisation of Indian Agriculture involving intensive inputs, herbicide use will steadily gain an importance in the coming years. In the recent decades, the growth of herbicides took place principally at the expense of fungicides, which declined from a market share of 40 per cent in 1960 to 25 per cent in 1995. About 72 per cent of the herbicide consumption out of the total took place in the developed countries, viz., USA, Western Europe and Japan. As against the growth of 2.5 per cent for insecticides and 3.3 per cent for fungicides, the herbicides grew at the rate of 5.0 per cent per annum.

In India, commercial use of herbicides came in 1980. During the period, the herbicides registered a significant growth than insecticides and fungicides. From a mere 2 per cent share of the total pesticide consumption in the seventies in India, herbicides now account for about 11 per cent of the pesticides market. While this is a very encouraging development, the herbicide consumption in our country is still much less than that in developed countries, where herbicides constitute 40-50 per cent of the total pesticide consumption.

Conjunctive use approach:

There are several advantages of using soil applied herbicides in conjuction with fertilizers. Trials on impregnated of fertilizers with herbicides have been highly successful and fertilizers impregnated with several herbicides are now commercially available in USA. Herbicides like Treflan, Sutan, Sencor and Bladox are being efficiently used through this technique. Adequate research efforts need to be undertaken in this regard to develop appropriate technology for the different agroclimatic conditions including herbigation.

System approach:

Integrated weed management (IWM) practices for individual crops have been developed by several workers. There is a need to study the various components of IWM into a systems approach.

Integrated weed management system

This approach includes the use of high yielding varieties that resist weed competition and reduce the weed-seed reserve in the soil. Practices like preplanting seed bed tillage, effective seed-bed preparation and seeding methods enhance crop growth and minimise weed growth. The use of crops that form early canopy with optimum plant population are integrated to optimize the crop growth and thus to minimise the weed growth. Precision in placement and timing of fertilizer application maximise stimulation of crops and minimise stimulation of weeds. The IWM system also includes the use of judicious irrigation practices, timely and appropriate cultivation, sound crop rotation, crop diversification, field sanitation and harvesting methods that do not spread weed seeds, use of biological agents and effective chemical methods. However, the crop-weed interactions are complex and needs application of recent advancements for the development of future weed management strategies.

Crop-weed competition

Experimental results have shown that crop-weed competition at critical stages of crop life has reduced the yields in several crops. Often this period is approximately the first one fourth to one third of crop like for annual vegetables and for perennials flowering to maturity periods. Estimation of crop-weed interactions through mathematical models is being attempted.

Modelling of crop-weed interactions

Competition between crop and weed for growth inputs (light, water and nutrients) is a critical process in agricultural ecosystems. The mechanisms of competition are not simple. Models on weed invasion, population growth and control will be useful for organizing biological informations on weeds and for developing weed control strategies. Conventional field trials cannot answer several of the key questions in weed control because of the constraints of cost, time or complexity. Hence models are essential as an integral part of weed management research and advice.

Bio-herbicide approach

Fungi are most useful and hence the term ‘mycoherbicide’ is also used to refer bio-herbicides. ‘De vine’ containing a formulation of soil borne fungus *Phytophthora palmivora* and Collegue containing spores of *Colletrotrichum gloeosporioides* an endemic anthrocnose fungus are commercialised bio-herbicides. Other fungal bio-herbicides have been developed including ‘Velgo’ based on *Fusarium leteriteum* and ‘Casst’, which is based on *Alternaria cassiae*.

Naturally occurring herbicides

Many chemicals have been found to possess good herbicidal activity. ‘Bialophos’ is the first herbicide developed by this method and commercially marketed in Japan under the trade name ‘Herbiace’ isolated from fermentation broths of *Streptomyces agroscopius* and *S. viridochromogens* enhibits acidity against wide spectrum of grasses and broad leaved weeds on foliar application.

I. FRUITS

GRAPES

Application of Diuron @ 3.5 kg/ha or Glyphosate @ 2 kg/ha.

Herbicide application in grapevines must be done carefully with low pressure nozzle to prevent drift.

BANANA

Pre-emergence application of Atrazine or Simazine or Diuron at 1.5 to 2 kg/ha soon after planting would keep the ground weed free for 3 to 5 months. At post emergence, Paraquat or Salapon or 2,4 – D or Glyphosate can be used.

PINE APPLE

Pre-emergence herbicides like Simazine or Atrazine or Diuron 3 to 4 kg/ha application 4 - 6 weeks before planting and ploughing the field 2 weeks before the leaves of the crop began to curled down to prevent weed establishment. Weed growth emerging later is treated with post emergence herbicides such as PCP 3 to 5 kg/ha or Glyphosate 0.5 kg/ha or Dalopon 3 to 4 kg/ha or 2,4 - D 0.5 to 1 kg/ha depending upon the predominant weed species. Dalapan spray drift can cause chlorosis on outer leaves and necrosis on leaf tips when pineapple plants are young. It should be applied carefully any time from 6 months.

II. VEGETABLES

TOMATO

In Tamil Nadu, tomatoes are being grown in three seasons namely June-July, December January and March.

The critical period of weed competition in tomato is the first 30 days after transplanting. For the control of annual grasses, preplanting soil incorporation of Trifluralin 3 to 5 kg/ha or Nitralin 3 to 5 kg/ha or Diphenamid 2 to 4 kg/ha is best. Similar application of EPTC 2 to 3 kg/ha controls nutgrass. Effective pre emergence herbicides are Alachlor 1 to 2 kg/ha Metribuzin 1 to 2 kg/ha, Fluchloralin 0.75 to 1.5 kg/ha, Nitrofen 1.5 to 2.5 kg/ha Chloramben 2 to 3 kg/ha. Generally, a pre emergence herbicide followed by one hand weeding in the later period of crop growth gives complete weed control.

Herbicides which need preplant incorporation are particularly useful in the nursery. In the transplanted field they are applied 3 to 4 weeks before planting seedlings.

BRINJAL

Fluchoralin @ 1.5 kg/ha as pre sowing incorporated spray + one Hand weeding at 6 weeks after transplanting or Pre emergence Metolachlor @ 1 kg/ha at 3 days after transplanting followed by 1 hand weeding at 60 days after transplanting.

ONION

Onion germinates and grows relatively slow and hence weed competition is more critical upto 40 days after sowing. Pendimethalin @ 1.5 kg/ha or Fluchloralin 1.0 kg/ha or Oxyflourfen 0.25 kg/ha followed by one hand weeding at 45 days after sowing.

CHILLIES

Pre-emergence application of Pendimethalin 1.25 kg/ha or Butachlor @ 1.0 kg/ha supplemented with one hand hoeing at 30 days after transplanting.

BHENDI

The most critical period of weed competition in bhendi is between 30 and 60 days after sowing.

Pre-emergence herbicides Alachlor 1 to 1.5 kg/ha, Nitrofen 0.5 to 1 kg/ha, Fluchloralin 0.5 to 1 kg/ha followed by one hand weeding 6 to 8 weeks after sowing.

COLE CROPS (Cabbage and Cauliflower)

Either Fluchloralin @ 0.9 kg/ha or Pendimethalin @ 1.0 kg/ha along with one hand weeding at 40 days after planting.

CARROT

Preplant incorporation of EPTC 3 to 4 kg/ha or Trifluralin 0.5 – 1 kg/ha or pre-emergence Metribugine at 1.0 kg/ha to control annual weeds.

BEANS

The critical period of weed competition is the first 40 days after sowing. Pre-plant incorporation of EPTC 3 to 4 kg/ha or Trifluralin 0.5 to 1 kg/ha or pre-emergence application of Fluchloralin @ 1.0 or 1.5 kg/ha.

RADISH

Application of pre-emergence Metolachlor 1.0 – 2.0 kg/ha or Alachlor 1.5 – 2.0 kg/ha or Isoproturon 1.0 – 1.25 kg/ha or Pendimethalin 1.2 kg/ha or Fluchloralin 0.9 – 1.35 kg/ha.

PEAS

Pre-emergence application of Alachlor 1 to 2 kg/ha or pre-plant soil application of EPTC 2 to 3 kg/ha.

Dalapan is applied as post emergence when Peas are 5 to 15 cm tall but not within 25 days of harvest. MCPA and MCPB are applied when broad leaved weeds are at 10 to 15 cm tall.

GARLIC

Pendimethalin 1.0 kg/ha + one hand weeding at 40 days after sowing.

III. SPICES

CORIANDER

Pendimethalin at 0.75 kg/ha or Butachlor 1.0 kg/ha supplemented with one hand weeding.

IV. PLANTATION CROPS

COFFEE

Single tank mix application of Diuron 1 kg/ha with Paraquat 0.4 kg/ha or Glyphosate 0.8 kg/ha.

In coffee nurseries, apply Simazine 2 to 2.5 kg/ha immediately after planting coffee in polythene sleeves.

At post emergence Paraquat or Dalapan or Glyphosate are used to control many perennial weeds.

Sequential application of Dalapan 1 to 2 weeks later by Paraquat and subsequently by Dalapan controls perennial grasses effectively.

TEA

Although herbicides are now used over 60% of the area under tea, manual methods like cheeling, sickling and mulching are extensively used wherever labour is available than by chemical method. Cheeling removes the above ground weed growth and prepares the ground for pre-emergence herbicide application. Sickling is done to remove the tall growth of perennial weeds and cut it back to the ground level for a follow up application of foliage applied herbicides on the regrowth.

The weed growth emerging later can be eliminated by foliage application of Paraquat + MSMA or 2,4 – D or Paraquat + 2,4 – D or Glyphosate depending on the weed spectrum and this would keep tea weed-free for the rest of the year.

Nursery:

Weed control in clonal nursery is done by (2 to 3 weeks before planting cuttings) application of Simazine at 2 kg/ha. After 6 months Simazine is applied once again at the same dose.

In the case of seed nurseries hand removal is done for 6 months after planting and then Simazine applied at 2 kg/ha.

Young tea (Until 3 years)

Application of Simazine 1.5 to 2 kg/ha or Paraquat 0.3 – 0.4 kg/ha at pre-emergence and 2,4 – D 0.5 to 1 kg/ha at post emergence.

Matured tea (Above 3 years)

Simazine 1.5 to 2 kg/ha or Diuron 2 kg/ha as pre-emergence herbicides. Paraquat or 2,4 – D or Paraquat + MSMA or Glyphosate are applied as post emergence.

Common Name	Trade Name	Time of application
Trifluralin	Hexatox; Toxa-phone	Preplant; pre-em
Nitralin	Planavin	Preplant; pre-em
Diphenamide	Dymid, Enide	Preplant; pre-em
Alachlor	Lasso	Pre-em
Metribuzin	Sencor	Pre-em; Post-em
Fluchloralin	Basalin	Pre-em
Nitrofen	Tok-E 25	Early post; Pre-em
Chloramben	Amiben, Vegiben	Pre-em
Metolachlor	Dual	Pre-em; Early post
Pendimethalin	Procol, Herbadox stomp	Pre-plant; Pre-em
Oxyfluorfen	Goal	Pre-em; Post-em
Butachlor	Machete	Pre-em
EPTC	Agrothion, Eptam	Pre-plant; Pre-em
Isoproturon	Arelon, Toplkan	Post-em
Dalapan	Dowpan	Post-em
Diuron	Karmex	Post-em
MSMA	Daconate, Ansar	Post-em
Atrazine	Atrataf	Post-em; Early-post
Simazine	Tafazine / Gesatop	Post-em; Post-em
Paraquat	Gramaxone	Post-em
Glyphosate	Roundup	Post-em

Part XVIII
Cultural tips for F-1 hybrid vegetables

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Numb-er of plants/ ha	Farmy-ard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Brinjal	Arka Navneet, Suphal, Ajay, Vijay, Kirti, Mhb1, Mhb2, Mhb3, Mhb9, Kalpa Tharu, Ravayya	Planted during May - June Oct - Nov Jan - Feb	200	90 x 60	18,520	25	200:150:100	200 - 500	150	25	-
2	Tomato (Deter-minate)	Mangala, Rajani, Rashmi, Rupali, Sheetal, Vaishali, Hybrid No.10,Varla-kshmi, Ruchi, Avinash - 2	Planted during March - April Nov - Dec Sep - Dec	175	75 x 45	29,630	40	200:250:250	80	120	35	Suitable for mechanic-al harvest, tolerant to Fusarium and Verti cillium wilt

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Numb-er of plants/ ha	Farmy-ard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
3	Tomato (Indeter-minate)	Karnataka, Naveen, Suruchi, Sangam, Amrut, Cross-B, Sonali, Sadabhakar Preethi, Gulmohar, S-28, S-29, Morning Sun, SH -771	Planted during May - June Oct - Nov Jan - Feb	120 - 150	75 x 60	22,220	40	200:250:250	80 - 200	150 - 165	100 - 110	Tolerant to Fusarium Verticillium and Nematode
4	Bhendi	Shobha 110, Shoba 111, Badsha, Hybrid-6, Hybrid-7, Varsha, Vijaya, Vishal, HYb.135, Mahyco. Hy.10	Sown in Feb - March June - JulyOct - Nov	15000	60 x 15	1,11,1-10	40	200:100:100	-	90	12 - 15	Tolerant to yellow vein mosaic and powdery mildew.

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Numb-er of plants/ ha	Farmy-ard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
5	Cabba-ge	Hybrid No.10, Hybrid No.20, Indu, Pooja, Namratha, Sumathi, Lakshmi, Iahs-I, Iahs-Ii, Iahs-Iii, Kranthi, Kalyani, Sriganesh Khol, Kaveri, Ganga, Hariranigol, NSC .10	Planted during May - Feb	300 - 550	60 x 30	55,550	25	200:125:150	2000 - 3500 (Head)	105	50 - 75	Heat tolerant (upto 38· C)
6	Cauliflo-wer	Iahs-12, Iahs-18, Snowball, Improved, Swati, Himani, Subarna, Serena , Subasini.	Planted during Jan - Feb June - July	300 - 350	60 x 30	55,550	25	200:125:125	500 - 700 (Curd)	105	25 - 30	

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Numb-er of plants/ ha	Farmy-ard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
7	Capsic-um	Barath, Heera, California Wonder, Yolo Wonder, Hybrid No.10, Hybrid No.11, Midway, Indira,	Planted during June - July Sep - Oct Jan - Feb	375	60 x 30	55,550	30	250:150:150	100 - 150	165	35 - 40	Tolerant to T.M.V.
8	Chillies	Sujatha, Surya, MHB-55, MHB-58, MHB-59, Cayennelar-ge Red Thick, Cayenne Long Slim, Divya, Rathna, Samrat, Prithivi	Planted during June - July Sep - Oct Jan - Feb	200 - 250	75 x 60	22,220	30	120:80:80	-	150	13 - 16	Wide adaptabili-ty for fresh market high degree uniformity, Lateblight & bacterial leaf spot resistant

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Numb-er of plants/ ha	Farmy-ard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
9	Water-melon	Madhu, Milan, Mohini, Arka Jyoti, Amruth, MHW-11, Sunthrupthi, MHW-15, MHW-6, Apoorva, Madhuri	Sown inNov - Jan	1500 - 2750	150 x 30	22,220	30 - 40	200:100:100	5000 - 8000	90 - 105	100 - 110	Tolerant to Fusarium wilt
10	Musk Melon	Swarna, MHC-2, MHC-5, MHC-6, Honeydew, Sona, Earli-Dew, Magnum-45	Sown inNov - Jan	525 - 800	150 x 30	22,220	30 - 40	200:100:100	800 - 1000	120	25 - 30	Tolerant to Fusarium wilt
11	Cucum-ber	Priya, Bliiz, Lucky Strike, Poinstt-76, Harsha, Calypso,	Sown inNov - Jan	373	150 x 60	25	150:75-:75	300	90	20 - 25		Tolerant to downy mildew, powdery mildew and mosaic

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Numb-er of plants/ ha	Farmy-ard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
12	Bitter Gourd	Hybrid-49, While Long, Greenlong, MPDH-101, MPDH-102	Sown inJune - july	1800	180 x 60	9,259	25 - 30	200:100:100	100 - 120	90 - 105	60 - 65	Thick flesh with less seeds, attractive colour
13	Bottle Gourd	Pusa Megdooth, MGH-1, Varath, Hybrid-204	Sown through-out the year. Yield will be more if it is sown during June - July	1800	180 x 60	9,259	25 - 30	200:100:100	3000 - 5000	90 - 105	45 - 60	Suitable for long distance transport
14	Ribber Gourd	Sureka, MSGH-1, Haritha	Sown inJune - July	1800	180 x 60	9,259	25 - 30	250:100:100	125 - 150	105 - 120	40 - 45	Attractive green colour.

Part XIX
FARM IMPLEMENTS FOR HORTICULTURAL CROPS

TRACTOR DRAWN LOW DRAFT CHISEL PLOUGH

1. Function : Suitable for deep tillage up to a depth of 40 cm for opening hard soil pan.

2. Specification :
   - i. Type : Mounted implement
   - ii. Power requirement : 35 to 45 hp tractor
   - iii. Overall dimensions : 450 x 940 x 1250 mm
   - iv. Weight : 42 kg
   - v. Capacity : 1.4 ha / day at a spacing of 1.5m between rows

3.General Information :

The chisel plough has a sturdy but light structure made of 3mm thick hollow rectangular tubular mild steel sections. The implement has only three components namely frame, standard and share. The implement is protected by shear pin, which prevents damage from overloading.

4.Cost of the unit : Rs. 7,750/-

5. Salient features :

The implement could be used for deep tillage up to 40 cm depth. Easily operated by any 35-45 hp tractor.

TRACTOR DRAWN TRENCHER

1. Function : To form rectangular trench of 30 x 30 cm

2. Specification :
   - i. Type : Mounted implement
   - ii. Power requirement : 35 to 45 hp Tractor
   - iii. Overall dimensions : 160 x 940 x 1250 mm
   - iv. Weight : 240 kg
   - v. Capacity : 1700 m run per hour

3. General Information :

The unit consists of two mould board bottoms placed in line one behind the other. The front and rear bottoms operate at a depth of 0-15 cm and 15-30 cm respectively. The two bottoms throw

the removed soil in opposite directions and form vertical walls one on each side of the trench. A safety pin is provided to protect the unit from over loading.

4. Cost of the unit : Rs. 17,000/-

5. Salient features :

Can also be used for laying drip irrigation pipes by opening trenches Application of manure in coconut fields Cost of operation is Rs. 0.10 per m run of trench as against Rs. 2.00 per m run using manual labour

TRACTOR DRAWN CHANNEL FORMER

1. Function : To form channels and beds at regular intervals for irrigation.
2. Specification :
   - i. Type : Mounted implement
   - ii. Power requirement : 35-45 HP
   - iii. Overall dimensions : 2200 x 1126 x 900 mm
   - iv. Weight : 90 kg
   - v. Capacity : 1.2 to 1.5 ha/hr
3. General Information :

The unit consists of two inner blades of size 100 cm x 25 cm and two outer blades of size 130 cm x 25 cm. The front portions of the two inner blades are joined together such that they form an angle of 30 in between them. At the junction of these two inner blades a cultivator shovel is fixed to penetrate into the soil. The two outer blades are placed one on each side of the inner blades and at an angle of 60 to the direction of the travel. The soil collected in 105 cm width is formed as bund of size 35 cm on both the sides of the irrigation furrow formed by the inner blades.

4. Cost of the unit : Rs. 8,500/-

5. Salient features :

Saving in Cost of forming irrigation channel at 5 m interval is 57%

POWERTILLER OPERATED HEAVY DUTY AUGER DIGGER

1. Function : To dig holes for planting tree saplings
2. Specification :
   - i. Type : Screw auger type
   - ii. Power requirement : 8 to 10 hp power tiller
   - iii. Overall dimensions : 400 x 635 x 1635 mm
   - iv. Weight : 50 kg
   - v. Capacity : 25 -30 holes per hour
3. General Information :

It consists of a spiral auger of 300 mm dia and 150 mm pitch actuated by a rack and pinion arrangement. A shaft mounting worm gear box has been designed and fabricated to accommodate the sliding auger shaft. This gear box provides a speed reduction of 10:1 to reduce the engine

speed. The auger bit was fabricated as a double start auger having two cutting edges. The hand wheel provided at the side of the unit can be effectively used for the depth control.

4. Cost of the unit : Rs. 18,000/-

5. Salient features :

Results in 16.0 and 91.0 per cent saving in cost and time when compared to manual digging of holes

Application of manure in coconut fields. Cost of operation is Rs. 0.10 per m run of trench as against Rs. 2.00 per m run using manual labour

POWERTILLER OPERATED AXIAL FLOW PUMP

1. Function : To lift water from open water sources
2. Specification :
   - i. Type : Axial flow type
   - ii. Power requirement : 8 to 10 hp power tiller
   - iii. Overall dimensions : 300 x 750 x 620 mm
   - iv. Weight : 26 kg
   - v. Capacity : 2500 litres per minute at 3.0 m head
3. General Information :

The unit consists of a axial flow impeller, pump shaft casing pipe, pump stand and swiveling mount for hitching to the power tiller. A telescopic swivel assembly facilitates the pump to be mounted to the power tiller front. The pump as a whole is supported by a pump stand at the discharge end. The main pump shaft of two sections is supported by the spider armed bracket and a simple bushed bearing with a stuffing box to prevent leakage of water.

4. Cost of the unit : Rs. 12,000/-

5. Salient features :

Highly suitable for lifting water from open water sources

POWERTILLER OPERATED BOOM SPRAYER

1. Function : For row crop spraying
2. Specification :
   - i. Type : Power tiller mounted
   - ii. Power requirement : 8 to 10 hp power tiller
   - iii. Overall dimensions : 1550 x 5000 x1550 mm
   - iv. Weight : 100 kg
   - v. Capacity : 1 ha per hr
3. General Information :

The boom sprayer attachment consists of spray boom mast, spray pump, pressure regulator, chemical tank, and double tail wheel and foliage deflectors. The tail wheels are carried on a

separate frame and length 75 cm and hitched to the power tillers' hitch bracket. The spray boom of length 6 m was chosen with 3 m either side of the power tiller. The boom had 16 hollow cone nozzle with a total discharge rate of 7.3 lit/min. the nozzle spacing was made continuously adjustable. A cut off valve is also provided on the discharge line to the boom to avoid dripping from the nozzle while closing the spray. Two number of foliage deflectors were provided on both the front of the power tiller drive wheels and the tail wheels to deflect the crop canopy to spread in the rows.

4. Cost of the unit : Rs.14,000/-

5. Salient features :

Light in weight and suited for row crops

SPRAYER FOR TALL TREES

1. Function : To spray chemicals in orchard trees

2. Specification :
   - i. Type : Mounted implement
   - ii. Power requirement : 35 hp tractor
   - iii. Overall dimensions : 65 x 65 x 1950 mm
   - iv. Weight : 200 kg
   - v. Capacity : 35 trees per hour

3. General Information :

The unit has a telescopic (62 and 37 mm) G.I. pipes which can extend from 9 m to 14 m height by winding a cable. At the base of the frame, a 200 lit capacity chemical tank is mounted. A reciprocating pump is mounted on a base plate near the PTO shaft of the tractor. At the top of the 37 mm G.I. pipe, two spray guns with nozzles for cone or jet spray are hinged so that they can be moved up and down by ropes from the ground level. In addition the spray guns can be rotated about the vertical axis of the telescopic pipe arrangement. These features ensure that the entire canopy area of the tree is easily sprayed.

4. Cost of the unit : Rs. 40,000/-

5. Salient features :

The total height of spray is 55 feet. The sprayer can be used in orchard trees and for spraying in field crops, by bifurcating the delivery section into spray lines with spray lances and spray guns.

POWERTILLER OPERATED LAWN MOWER

1. Function : For mowing lawn grass

2. Specification :
   - i. Type : Mounted type
   - ii. Power requirement : 8 -10 hp power tiller
   - iii. Overall dimensions : 400 x 636 x 1665 mm
   - iv. Weight : 79 kg
   - v. Capacity : 0.8 ha per day

3. General Information :

The cylindrical lawn mower attachment to power tiller consists of 750 mm width and 235 mm diameter cylinder fitted with 12 numbers of helical steel blades on its periphery. A horizontal ledger plate with a concave groove is provided beneath the cylinder. The power is transmitted from the power tiller rotary drive shaft to the cylinder shaft through chain and sprocket. A tail wheel is provided for controlling the height of cut. The unit is attached to the power tiller rotary hitch bracket assembly of the transmission case and the rear portion of the unit derives support from the power tiller handle through two support arms.

4. Cost of the unit : Rs.10,000/-

5. Salient features :

The unit is simple to operate and easy to handle. Results in 50 per cent and 64 per cent saving in cost and time respectively

POWERTILLER OPERATED TURMERIC HARVESTER

1. Function : For harvesting turmeric rhizomes
2. Specification :
   - i. Type : Mounted type
   - ii. Power requirement : 8 -10 hp power tiller
   - iii. Overall dimensions : 400 x 636 x 1665 mm
   - iv. Weight : 67 kg
   - v. Capacity : 0.6 ha per day
3. General Information :

The unit consists of a blade with three bar points for easy penetration into the soil. To the rear end of the blade six slats spaced at mm apart are hinged at both ends. The oscillating motion for the slats is obtained through eccentric provided on either side of the unit. The power is transmitted from the clutch pulley of the power tiller to a reduction gearbox mounted near the hitch bracket assembly of the power tiller. From the gear box the power is transmitted to the shaft of the turmeric digger unit through V belt transmission. The pneumatic wheels are replaced with a pair of special type cage wheels to accommodate the height of ridges.

4. Cost of the unit : Rs. 11,000/-

5. Salient features :

65 % saving in cost and 90 % saving in time. Damage caused to the rhizomes is 0.5 % as compared to 4.2 % in manual harvesting.

TRACTOR DRAWN TURMERIC HARVESTER

1. Function : For harvesting Turmeric rhizomes
2. Specification :
   - i. Type : Mounted type
   - ii. Power requirement : 35 - 45 hp Tractor
   - iii. Width of the digger : 120 cm
   - iv. Capacity : 1.6 ha per day

3. General Information :

The unit consists of a blade with five bar points for easy penetration into the soil. The blade is fixed at an inclination of 20^0 to a cultivator frame with straight tynes at both ends. It can be hitched to the tractor through three – point linkage connection provided in the front portion of the unit. The rake angle of the blade can be adjusted by moving the blade through a clevis provided at the bottom of the two tynes. At the rear end of the clevis two converging slats are fixed to convey the harvested turmeric with the soil on to the lift rods without spilling to the side ways. To the rear end of the blade seven lift rods of 250 mm length are provided. For digging, the bar points with the blade penetrate into the soil, lift the turmeric rhizomes from the soil. The soil slip back to the ground and the dug out rhizomes deposited at the centre of the unit.

4. Cost of the unit : Rs. 10,000/-

5. Salient features :

Results in 70 per cent saving in cost and 90 per cent in time. Extent of damage caused to the rhizomes is very much less (2.83 per cent).

TAPIOCA HARVESTER

1. Function : For harvesting tapioca tubers.

2. Specification :
   - i. Type : Mounted type
   - ii. Power requirement : 35 - 45 hp Tractor
   - iii. Width of the digger : 68 cm
   - iv. No. of rows : Two
   - v. Capacity : 1.6 ha per day

3. General Information :

The tapioca harvester consists of a main frame with three point hitch system, shank with depth adjustment and digging blade incorporated with pegs. The shank is made up of mild steel material and the digger blade is attached to it. Provision has been given to the shank section for changing the depth of digging, according to the tube geometry and moisture condition of the soil. The digging blade is of trapezoidal shape made up of 13mm thickness M.S sheet. Five pegs were provided at the front end of trapezoidal digging blade for easy penetration into the soil. Before digging operation the top portion of the plant has to the removed.

4. Cost of the unit : Rs. 10,000/-

5. Salient features :

Harvesting efficiency is 98 per cent. Easily attached to any make of 35 hp tractor. Reducing in harvesting cost is 66 per cent compared to manual harvesting. Additional irrigation for manual digging is eliminated. Drudgery involved in manual digging is removed.

POWER ROTARY WEEDER

1. Function : For mechanical control of weeds in crops such as sugarcane, tapioca, cotton and orchards.

2 , Specification :
   - i. Type : Self propelled

ii. Power requirement : 8.38 hp Diesel engine
iii. Overall dimensions : 2400 x 1750 x 1100 mm
iv. Weight : 200 Kg
v. Capacity : 1 - 1.2 ha per day

3, General Information :

A 8.38 hp diesel engine operates the weeder. The engine power is transmitted to ground wheels through V belt-pulley. A tail wheel is provided at the rear to maintain the operating depth. Weeding is done by the rotary weeding attachment. The rotary weeder consists of three rows of discs mounted with 6 numbers of curved blades in opposite directions alternatively in each disc. The width of coverage of the rotary tiller is 500 mm.

4, Cost of the unit : Rs. 60,000

5. Salient features :

Useful for weeding between rows of crops like tapioca, tomato and crops whose rows spacing is more than 45 cm.

POWERTILLER DRAWN BUND FORMER

1. Function : For forming bunds
2. Specification :
   i. Type : Trailed type
   ii. Power requirement : 8 -10 hp power tiller
   iii. Overall dimensions : 1080 x 770 x 520 mm
   iv. Weight : 15kg
   v. Capacity : 2.5 ha per day at 3 m interval
3. General Information :

The unit consists of two converging steel blades fixed to a frame which can be attached to a power tiller. The size of the bund is regulated by the size of the wings and adjustable holes provided on the wings. Three sizes of the bunds can be formed with the unit.

4. Cost of the unit : Rs. 750/-
5. Salient features :

It forms bunds in irrigated lands and across the slope of dry land to conserve soil moisture.

Mechanical thresher for pepper (*Piper nigrum* L.)

Pepper (*Piper nigrum L.*), the king of spices is the most important spice of India. It is the dried fruit of perennial climbing vine, mostly found in hot and moist parts of Southern India. Kerala alone contributes 96% of the total production in India.

The spikes of well-matured, unripe berries are manually picked when they are blackish green and most pungent by climbing on the ladders. Normally two women jointly do the harvesting. Threshing of pepper berries is done by manual trampling, which involves either a man / woman labour. A labourer will be able to trample about 200 kg of spikes and separate the berries. The

empty spikes are disposed to the compost pit and used as manure. To overcome the drudgery to the labourer, a mechanical thresher has been developed at the Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore.

This pepper thresher consisted of a metallic drum provided with rasp bars, concave, oscillating sieve, power source and power drive. On the periphery of the drum, 8 numbers of rasp bars made of wood are mounted. The drum is placed inside a concave provided with an opening and a suitable cover. A feed hopper is provided for easy feeding of spikes into the concave. An oscillating sieve is provided with an eccentric to separate the berries and spikes after threshing. The power to the drum is transmitted through V pulley arrangement from a 2 hp motor.

The pepper spikes fed through the hopper reach the threshing drum and undergoes threshing. The separated berries and empty spikes fall on the sieve and separated. The performance of the thresher was evaluated in the plantations for the capacity, breakage and threshing efficiency at various speeds of operation. The capacity of the thresher is 320 kg/hour. The percentage of broken berries was negligible and the threshing efficiency was above 95% at 300 rpm of drum speed.

Salient features:

- Suitable for threshing black pepper from the pepper vine
- Operated by a 2 hp electric motor/ suitable power drive
- Efficiency - 95%
- Capacity - 320 kg/hour
- Cost of the thresher - Rs.20,000/-
- Cost of operation - Rs.125/- per tonne of pepper

Fluidised Bed Dryer for Mushroom

Mushroom, contains about 90% moisture and is highly perishable. To reduce the spoilage and increase the shelf life of the mushroom, drying is one of the techniques. By the traditional sun drying method it takes about 10 to 14 hours to dry the mushroom to a final moisture content of about 8 per cent. By mechanical drying, mushroom is dried at higher temperature and faster which preserves the colour and the quality of the final product. Hence, a mechanical dryer suitable for drying of oyster and milky mushroom by the medium and large growers has been developed in the Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore.

The developed dryer is of fluidised bed type, as this type of drying is faster and uniform compared to that cabinet drying and tray drying. The fluidised bed dryer consists of a centrifugal blower, holding bin, heating coils, motor and thermostat control. The blower is run by a 3 hp, three phase motor. The delivery of the blower is connected to the heater drum, provided four numbers of fin type electrical heaters of each 500 Watts and controlled through a stem type thermostat. At the other end of the heater drum, the drying chamber is placed. Hot air of 50 to 90°C temperature at a flow rate of 9 to 32 m^3/ minute can be obtained in this dryer. The whole assembly is placed on a suitable frame made of mild steel.

The atmospheric air discharged by the blower reach the heater drum and come in contact with the heaters and heated. The hot air entering into the drying chamber dries the mushroom. The velocity of air is controlled by adjusting the position of the shutter in the suction of the blower, so that the mushroom pieces float over the bin surface during drying. It takes about 2 and 6 hours to dry the oyster and milky mushroom to a final moisture of 8-10 %(w.b) from an initial moisture content of 70-80%(w.b).

Salient features:

- Suitable for drying oyster and milky mushroom
- Dries oyster mushroom in 2 hours and milky mushroom in 6 hours
- 5 hp power is required for the blower and heaters
- Capacity is 6 kg of mushroom per batch
- Cost of the dryer is Rs.30,000/-
- Cost of drying is Rs.50/- per kg of dry mushroom

Pulper cum Washer for Coffee

Coffee is an important commercial and high altitude crop grown in southern and north- eastern parts of our country. Its annual production is 2.1 lakh tonnes. Pulping and washing are the important unit operations in the coffee processing. The coffee pulper and washers available at present are of higher capacities and the cost is beyond the reach of small farmers. To meet the requirement of small and marginal farmers an integrated unit with pulping and washing mechanism has been developed by Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore - 3.

The unit essentially consists of a trapezoidal hopper, drum type pulper and a screw auger model washer. The hopper holds and feeds the coffee fruits to the pulper uniformly through a fluted roller mechanism. The pulper has a drum with projections and two breastplates. Provisions are made to adjust the clearance between the breastplate and drum so as to pulp different sizes of fruits. The pulper removes the skin from the matured ripened fruits. The skin is discharged over the perforated inclined tray fitted below the pulper and collected separately.

The washer has an inner roller and a perforated outer cylinder. The inner roller is made of mild steel pipe with screw auger and helical bars with cross stoppers for conveying the parchment. The inner roller is mounted on bearings inside the perforated outer cylinder. During operation, the parchment is moved in between the perforated outer cylinder and inner roller. Friction and abrasion developed due to movement of beans remove the mucilage present over the parchment. By adjusting the counter weight provided at the discharge end, the pressure inside the washer is regulated and thorough washing of the bean is achieved.

Water for washing is provided on the top of the perforated outer cylinder through five nipples placed at equal intervals and is regulated by a valve. Both pulper and washer are operated by a 3-hp electric motor through suitable pulleys and belt.

Salient features:

- Capacity of the unit is 500 kg of fruits per hour
- Water requirement is only 4 litres of water per kg of fruits.
- The approximate cost of the unit is Rs.50,000/-.

Mechanical Chipper for Tapioca

Tapioca (*Manihot esculenta)* is a root crop cultivated for use of food, animal feed and production of starch. In India tapioca is grown in 0.35 million ha. area and produces about 6 million tonnes annually. The physiological deterioration of tapioca root is related to accumulation after the harvest within a shorter period of one week. This spoilage can be prevented by chipping and drying of tapioca tubers. At present the tuber is sliced manually which is highly time consuming and in-efficient, besides causing drudgery to the personworking. Therefore a vertical feed type motorised tapioca chipping machine has been developed in the Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore.

The developed tapioca chipper consists mainly of a feed hopper with guides, chipping disc with knives, chips outlet and a 0.5 HP single phase electric motor. The feed hopper is provided with vertical guides made of pipes of diameter 25 to 80 mm for 100 mm length to facilitate feedings of tubers of varying diameters. Through these guides the tubers reach the chipping disc having three blades, rotating at 300 rpm. The radially mounted blades on the chipping disc slice the tuber and the chip is collected through the outlet.

Salient features:

- Suitable for varying diameters of tubers
- Thickness of chips can be varied
- Also suitable for slicing other tuber crops like radish, carrot, potato °etc.
- The capacity of the unit is 270 kg per hour.
- The cost of the unit is Rs.5000/-.

Tomato Seed Extractor

Tomato is one of the important commercial crop ranking second in importance to potato in India. At present, seed extraction from tomato is carried out manually by squeezing the fruits and by scooping the seeds, with hands. Manual method is unhygienic, tedious, highly labour intensive and time-consuming process. In certain places, mechanical seed extraction is practiced using a juicer or pulper. The juice is filtered out while the pulp and seeds are separated by acid, alkali, or fermentation methods. The pulp is discarded since the whole fruit is pulped and the seed is separated by filtration with repeated washing. In order to make use of the flesh in the tomato for further processing, the extraction of the seed has to be done by crushing the fruits in a hygienic way. Considering all these facts, a tomato seed extractor has been developed by Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore- 3. The newly fabricated tomato seed extractor consists of a feed hopper, fruit crushing chamber, seed separation unit, water recycling system and seed collecting trough. The fruit crushing chamber consists of a rotating shaft with a screw auger of 90 mm diameter and 45 mm pitch. In the crushing chamber the tomato fruits are crushed and squeezed by the rotating screw auger. As the squeezed fruit crosses the squeezing zone seed separation starts. The seed separation unit consists of a rotating shaft with studs (arranged in a helical fashion throughout its length), a perforated outer cover, water distribution nozzles, rectangular trough, seed outlet and squeezed fruit outlet.

As the squeezed fruit enters the seed separation unit, the studs open the squeezed fruit, exposing the seeds to the stream of water. The water separates the seed from the flesh and

comes down along with the seed through the perforated outer cover and is collected in a rectangular trough, placed at the bottom of seed separation unit. The water collected in the trough is recycled by means of a centrifugal pump. The flesh coming out of the seed separation unit is collected separately. The power for the crushing the fruits and water recycling is taken from the 0.5-hp electric motor fitted at the bottom of the unit.

Salient features:

- Capacity of the unit is 180 kg of fruit (1.8 kg of seed) per hour.
- The cost of unit is Rs.10,000/-.
- Cost of seed extraction per kg is Rs.10/-.
- The saving in cost is 90 per cent
- Saving in time is 97 per cent.

Brinjal Seed Extractor

Brinjal, a non-seasonal important vegetable crop is grown all over India throughout the year, in an area of 0.45 million ha had recorded about 5.8 million tonnes of production. Seed is one of the important inputs and plays a key role in the productivity and production of any crop and brinjal too. At present, seeds are extracted from brinjal fruits, manually by beating the fruits with mallet, trampling under feet, squeezing with hands, splitting the fruits and scooping seeds, etc. The manual methods of extraction of seed are tedious, highly time and labour consuming process. Sometimes delayed seed extraction resulted in decreased seed quality and increased cost. Keeping this in view, a new gadget for the extraction of seeds from brinjal has been developed.

The brinjal seed extractor consists of a fruit crushing chamber and seed separation unit. In the fruit crushing chamber, 70 mm length crushing rods are fixed in the shaft which crushes the fruit into pulp with the help of feed water and discharges the same into the bottom portion of the seed separation unit. The seed separation unit houses a horizontal sieve bottom, sloping solid bottom below the sieve bottom, seed outlet, agitator, pulp outlet and drain cock. The inclined bottom of the seed separation unit helps for easy collection of seeds towards the seed outlet. Seeds are collected along with water by opening the value and keeping a sieve tray with 3 mm holes. The brushes fixed in the agitator move over the sieve surface, remove the lodged seeds if any and keep the sieve always clean for easy passage of seeds through the sieve.

The brinjal fruit pulp with seeds is introduced into the seed separation unit at the bottom in a standing column of water. The rotating agitator with radial arms, agitates and separates the denser healthy seeds from pulp and ill filled light seeds. Due to the difference in specific weight, the good seeds are moving towards the bottom, pass through the sieve and get collected through seed outlet. The lighter pulp and other ill filled seeds rise to the surface and discharged through the pulp outlet.

Salient features:

- Capacity of the unit is 120 kg of fruits or 2 kg of seeds per hour.
- The cost of the unit is Rs.15,000/-.
- The cost of seed extraction is Rs.10/- per kg of seed.
- Savings in cost is 88.9%.
- Savings in time is 97.5%.

Part XX
APPENDICES

Appendix - I

Number of plants per acre

Distance in feet	No.of plants per acre	Distance in feet	No. of plants per acre
1 x 1	43560	12 x 12	302
1½ x 1½	19460	13 x 13	257
2 x 2	10890	14 x 14	222
2½ x 2½	6960	15 x 15	193
3 x 3	4840	16 x 16	170
3½ x 3½	3556	17 x 17	150
4 x 4	2722	18 x 18	134
4½ x 4½	2151	19 x 19	120
5 x 5	1742	20 x 20	108
6 x 6	1210	22 x 22	108
7 x 7	889	24 x 24	55
9 x 9	537	28 x 28	55
10 x 10	435	30 x 30	48
11 x 11	360	40 x 40	27

1 Acre = 4840 sq. yard
1 Acre = 43.560 sq.ft.
1 Acre = 40 Guntas
1 Acre = 4046.80 sq.mt.
1 Hec = 10000 sq.mt.
1 Hec = 250 cents
1 Hec = 2.47 acres

Appendix - II

Number of trees per acre

Spacing(ft)	Square	Quincunx	Hexagonal
10	435	870	500
16	170	340	195
20	109	218	125
24	75	150	86
28	56	112	64
36	34	68	39
40	27	54	31

Appendix - III

Number of plants per acre

Distance in metre	No. of plants per acre
1 x 1	4000
2 x 2	1000
3 x 3	444
4 x 4	250
5 x 5	160
6 x 6	111
7 x 7	81
8 x 8	62
9 x 9	43
10 x 10	40

Appendix - IV

Germination and purity standards

Sl. No.	Variety	Germination minimum percentage	Purity minimum percentage
1	Cowpea	75	98
2	Cluster beans	70	98
3	Field beans	75	98
4	Beans	75	98
5	Ladies finger	65	99
6	Bitter gourd	60	99
7	Sponge gourd	60	99
8	Bottle gourd	60	99
9	Cucumber	60	99
10	Snake gourd	60	99
11	Watermelon	60	99
12	Pumpkin	60	99
13	Cauliflower	65	98
14	Cabbage	70	98
15	Knol-khol	70	98
16	Carrot	60	95
17	Radish	70	98
18	Brinjal	70	98
19	Tomato	70	98
20	Chillies	60	98
21	Capsicum	60	98
22	Greens	70	95
23	Fenugreek	70	98
24	Basella	60	96
25	Onion	70	98

Appendix - V

Viability of Horticultural seeds

s.no	Name of seed	Max. viability period	
A. Vegetables			
1	Onion	6	Months
2	Beans, Pea, Cowpea	1	Year
3	Brinjal, Tomato, Chillies, Capsicum, Cucumber, Squashes, Pumpkin, Carrot, Radish, Turnip, Cole crops.	1.5	Years
4	Bhendi, Lettuce, Amaranthus, Methi, Beet root, Palak.	2	Years
B. Fruits and root stock plants			
1	Lime, Mandarin, Citrus rootstock species	1	Week
2	Mango stones, Litchi, Passion fruit, Butter fruit, Rose apple, Jambulana.	1	Month
3	Papaya, Kirni seeds	3-4	Months
4	Guava	4	Months
5	Watermelon, Musk melon	1	Year
6	Custard apple, Ramphal and other Annona sp.	1.5	Years
C. Plantation and Spices			
1	Clove, Nutmeg, Cinnamon, Curryleaf	1	Month
2	Arecanut, Cashewnut	3	Months
3	Coconut	4	Months
4	Coriander and other annual spices	1	Year
D.Flowers			
1	Aster seeds, Gladioli corns	1	Year
2	Marigold	1.5	Years
3	Other annual flower seeds	1 to 2	years

Appendix VI

Average composition of manures and fertilisers

Materials	Percentage of Nutrients		
	N	P	K
Ammonium sulphate	20.5	-	-
Ammonium sulphate nitrate	26.0	-	-
Ammonium nitrate	33.5	-	-
Ammonium phosphate	16.0	20.0	-
Calcium ammonium nitrate	20.5	-	-
Nitrate of soda	16.5	-	-
Urea	46.0	-	-
Superphosphate-single	-	18.0	-
Superphosphate-double	-	35.0	-
Superphosphate-triple	-	45.0	-
Ultraphos	-	28.3	-
Mussoriephos	-	20-24	-
Rock phosphate	-	28.4	-
Bone meal	3.5	21.0	-
Muriate of Potash	-	-	50 or 60
Poultry manure	1.2 - 1.5	-	-
Sheep manure	0.8 - 1.6	-	-
Farm yard manure	0.4	0.3	0.2
Compost	0.5	0.25	0.5

Appendix VII

Conversion of pure nutrients to various N, P and K fertilisers

Rate of application (kg/ha)	Ammonium sulphate (20% N)	Urea(46% N)	Super phosphate (18% P)	Muriate of potash	
				(50 % K)	(60 % K)
10	50	22	56	20	17
20	100	44	112	40	34
30	150	66	168	60	51
40	200	88	224	80	68
50	250	110	280	100	85
60	300	132	336	120	102
70	350	154	392	140	119
80	400	176	448	160	136
90	450	198	504	180	153
100	500	200	560	200	170
110	550	242	616	220	187
120	600	264	672	240	204
130	650	286	728	260	221
140	700	308	784	280	238
150	750	330	840	300	255

Appendix VIII

Neutralising value of liming materials

Calcium carbonate or lime stone	$CaCO_3$	100
Burnt lime	CaO	179
Slaked lime	$[Ca(OH)_2]$	136
Dolomite	$[CaMg(CO_3)_2]$	109

Source: Package of Practices recommendations ‘crops’ 1993, KAU.

Appendix IX

Schedule for preparation of 10 litre standard spary solution

a.i.	0.02	0.04	0.05	0.06	0.08	0.1	0.2	0.3	0.4	0.5
Quantity of plant protection chemical required to be added to 10 litres of water (in ml or gm)										
20	10	20	25	30	40	50	100	150	200	250
25	8	16	20	24	32	40	80	120	160	200
30	7	13	17	20	27	33	67	100	133	167
35	6	11	14	17	23	29	57	86	114	143
40	5	10	13	15	20	25	50	75	100	125
45	4	9	11	13	18	22	44	67	89	111
50	4	8	10	12	16	20	40	60	80	100
55	4	7	9	10	15	18	36	55	73	90
60	3	7	8	10	13	17	33	50	67	83
65	3	6	8	9	12	15	30	46	62	77
70	3	6	7	9	11	14	29	43	58	71
75	3	6	7	8	11	13	27	40	53	67
80	3	5	6	8	10	13	25	36	50	63
85	2	5	6	7	9	12	24	35	47	59
90	2	4	6	7	9	11	22	35	44	56
95	2	4	5	6	8	11	21	32	42	53
100	2	4	5	6	8	10	20	30	40	50

Source: Horticultural Technical Guide, GOK

Appendix X
Vernacular names of Horticultural Crops

Crop	Scientific name of the crop	Tamil	Telugu	Malayalam	Kannada
Mango	*Mangifera indica* L.	Ma	Mamidi	Manga	Marinna
Guava	*Psidium guajava* L.	Koyya	Jama	Pera	Seba
Pomegranate	*Punica granatum* L.	Madulam	Danimma	Madulam	Dalimbari
Jack	*Artocarpus heterophyllus*	Pala	Panasa	Pilavu	Alasu
Jamun	*Eugenia jambolana*	Naval	Neerudu	Navil	Neredu
Tomato	*Lycopersicon esculentum* Mill.	Thakkali	Seemavanga	Thakkali	Vanga
Bhendi	*Abelmoschus esculentus* L.Moench.	Vendakkai	Bhendakaya	Bhendakayi	Vendakai
Onion	*Allium cepa* var. *aggregatum* L.	Vengayam	Neerulli	Bawanj	Nirulli
Cluster beans	*Cyamopsis tetragonolobus* L.	Kothavarai	Goruchikkudukaya	Kothavarakka	Govardanakayi
Pumpkin	*Cucurbita moschata* Poir.	Poosani	Gummidikaya	Mattanga	Kumblakayi
Ribbed gourd	*Luffa acutangula* Roxb.	Peerkankai	Nunnabheera	Peechinga	Heerekkai
Bitter gourd	*Momordica charantia* L.	Pavakkai	Kakarakaya	Kaipakka	Hagalakkai
Snake gourd	*Trichosanthes anguina* L.	Pudalankai	Potlakaya	Padavalanga	Padivalakkai
Ash gourd	*Benincasa hispida* Cogn.	Kalyanapoosani	Budeethagummidi	Kumbalam	Budikumbla
Bottle gourd	*Lagenaria siceraria* Standl.	Sorakkai	Anapakaya	Churakkai	Soarekkai
Cucumber	*Cucumis sativus* L.	Velliri	Dosakaya	Vellirikkai	Southikadi
Cowpea	*Vigna sinensis* L.Walp.	Karamani	Alasandalu	Kottapairu	Avadai
Lablab	*Lablab purpureus* var.*typicus* L.	Avarai	Chikkudukayalu	Avarakka	Avaraikkai
Potato	*Solanum tuberosum* L.	Urulaikizhangu	Urulaigadda	Urulakizhangu	Urulagadda
Sweet potato	*Ipomoea batatas* L.Lam.	Sakkaraivalli	Genusagaddalu	Chakkaraikizhangu	Genusa
Tapioca	*Manihot esculenta* Crantz.	Maravalli	Karrapandalam	Kappakka	Maragenusa
Elephant yam	*Amorphophallus companulatus* Blume.	Shenaikizhangu	Thiyyakanda	Chenai	Suvarnagadda

Crop	Scientific name of the crop	Tamil	Telugu	Malayalam	Kannada
Colocasia	*Colocasia esculenta* L.Scott.	Seppankizhangu	Chamagadda	CHEMBU	KERUGADDA
Amaranthus	*Amaranthus* sp.	Keerai	Thotakoora	Cheera	Arivesoppu
Coccinia	*Coccinia indica*	Kovaikkai	Donda	Kovaikkai	Thondikkai
Curryleaf	*Murraya Koenigii*	Karuveppilai	Karepaku	Kariveppillai	Kariberu
Mint	*Mentha* sp.	Pudina	Pudina	Muthina	Pudina
Pepper	*Piper nigrum* L.	Milagu	Mirialu	Kurumulagu	Karimenasu
Nutmeg	*Myristica fragrans* Hoult.	Jathikkai	Jajikaya	Jatikka	Jajikayi
Cinnamon	*Cinnamomum zeylanicum* Blume.	Lavangapattai	Sannalavanga	Erikkolam	Dalacinnicakke
Coriander	*Coriandrum sativum* L.	Kothamalli	Dhaniyalu	Kothumpalari	Kothumpari
Garlic	*Allium sativum* L.	Vellaipoondu	Tellagadda	Vellulli	Bellulli
Tamarind	*Tamarindus indicus* L.	Puli	Chintha	Puli	Hunase
Ginger	*Zingiber officinale* Rosc.	Inji	Allam	Inji	Shunti
Fennel	*Foeniculum vulgare* Mill.	Perunjeeragam	Saompu	Peerunjeeragam	Sompu
Fenugreek	*Trigonella foenumgraeum* L.	Venthayam	Menthulu	Uluva	Menthya
Cardamom	*Elettaria cardamomum* Maton.	Yelakkai	Yelakayalu	Elathari	Yelakki
Cumin	*Cuminum cyminum*	Seeragam	Jeelakkara	Jiragam	Jeerigae
Turmeric	*Curcuma domestica* Val.	Manjal	Pasupu	Manjal	Arashina
Mustard	*Brassica juncia* L. Czern. Coss	Kadugu	Avalu	Katuka	Sasive
Clove	*Eugenia caryophyllus* Spregel.	Kirambu	Lavangam	Grambu	Lavanga
Cashew	*Anacardium occidentale* L.	Munthiri	Jeedimamidi	Parangimavu	Geru
Betelvine	*Piper betle*	Vethalai	Tamalapakulu	Vettala	Veeluvadele
Senna	*Cassia augustifolia* Vahl.	Surathnilavakai	Nilathangadu	Sunnamukki	Sunnamukki
Ajowan	*Trachyspermum ammi* L.	Omum	Vamu	Omum	Oma

Appendix XI

WAITING PERIODS FOR THE SAFE HARVEST OF HORTICULTURAL PRODUCE

	Crops	Pesticide	Concentration (%)	Waiting period (Days)
1.	Mango	Dimethoate	0.06%	14
		Fenthion	0.05	14
		Cypermethrin	0.01	6
		Quinalphos	0.05	12
		Methyl demeton	0.05	14
		Mancozeb	0.20	7
		Lindane	350 g a.i/ha	---
2.	Acid lime	Chlorpyriphos	0.05	9
		Methyl demeton	0.05	12
		Methyl parathion	0.05	7
		Monocrotophos	0.04	12
3.	Grapes	Carbaryl	0.10	5
		Dimethoate	0.06	5
		Fenthion	0.05	4
4.	Guava	Malathion	0.10	7
		Methyl parathion	0.05	9
		Monocrotophos	0.05	9
		Phosalone	0.07	4
		Quinalphos	0.05	12
5.	Ber	Endosulfan	0.07	5
			0.04	15
		Quinalphos	0.05	7
6.	Tomato	Phosalone	0.05	3
		Fenitrothion	0.07	2
		Methyl parathion	0.05	5
		Quinalphos	0.05	5
		Mancozeb	0.20	5

	Crops	Pesticide	Concentration (%)	Waiting period (Days)
7.	Brinjal	Phosalone	0.07	2
		Fenitrothion	0.10	5
		Endosulfan	0.07	3
		Carbaryl	0.10	3
		Methyl parathion	0.05	5
		Mancozeb	0.20	2
		Disulfoton	1 kg a.i/ha	60
		Aldicarb	1 kg a.i/ha	60
8.	Bhendi	Phosalone	0.07	5
		Fenitrothion	0.05	6
		Endosulfan	0.07	3
		Carbaryl	0.10	3
		Methyl parathion	0.05	7
		Triazophos	350 g a.i/ha	5
		Lindane	350 g a.i/ha	5
		Disulfoton	1 kg a.i/ha	55
		Aldicarb	1 kg a.i/ha	55
9.	Chillies	Dicofol	0.05	1
		Quinalphos	0.05	8
		Mancozeb	0.20	6
		Lindane	350 g a.i/ha	2
		Aldicarb	1.25 g a.i/ha	60
		Carbofuran	1.25 g a.i/ha	60
		Dimethoate	0.03	5
		Acephate	0.06	7
			0.075	5
			0.151	8
10.	Lablab	Endosulfan	0.07	6.8
			0.14	9.9
		Monocrotophos	0.05	12, 0
			0.1	16.5
11.	Cardamom	Methyl parathion	0.05	Fresh capsules : 18-20
				Cured capsules : 24-31
		Endosulphan	0.07	16
12.	Betelvine	Carbofuran	0.75 kg a.i/ha	33

About . . .

Government Botanical Gardens, Udhagamandalam

The Government Botanical Gardens, nestled in a beautiful ravine with its entire splendor lies adjacent to the Raj Bhavan within the town. It covers an area of 22 ha ascending the slope on the hill at an elevation of 2400 - 2500 metres above MSL.

The gardens enjoys a cool temperate climate with an average rainfall of 140 cm per annum most of which is received during South-West monsoon with frostly nights from November to February. The maximum and minimum temperatures are 29^0 C to 0^0 C respectively.

Before the garden was laid out, the area was then a patch of vegetable Garden. The upper portion was a wildness of Shola and shrubs, the lower part a swamp traversed by deep ravines. Early in 1847 at the aspiration of Marquis of Tweedale who was then the Governor of Madras, a fund was raised by donations and subscriptions to start a public garden.

In 1848, Mr. C. Mc Iver who had the training at the Royal Botanic Gardens Kew, London was appointed as Superintendent of the Government Botanic Gardens, Udhagamandalam.

The main garden is divided into six different sections, viz.,

- The front gardens
- The band stand
- The conservatory and its surroundings
- The fountain terrace and picnic gardens
- The new band stand and its surroundings
- And the nurseries

The Government Botanic Gardens, Udhagamandalam had played an important role in the earlier years by introducing many crops in the Nilgiris. Systematic introduction and maintenance of plants has resulted in the collection of about 2000 spices of plants representing 119 natural orders.

The Government Botanic Gardens, Udhagamandalam is from the inception the primary centre of Horticulture development in the Nilgiris.

In the recent past studies on various aspects of ornamental plants such as propagation techniques, cultivation methods, etc., are undertaken apart from introduction of new species of plants enriching the existing collection.

The special feature of the Government Botanic Gardens, Udhagamandalam is the conduct of flower show in the middle of May every year. Exhibitions and competitive shows on various collections of flowers are held during the show. The show draws an immense crowd of enthusiasts and tourists every year.

(For information only)

Growth and development of moringa under organic and inorganic systems of culture

An experiment was conducted to find out the efficacy of organic manures viz., FYM, poultry manure, neem cake biofertilizer viz.*, azospirillum*, VAM and natural organic product panchakavya on the growth and yield of moringa. The treatment combinations of poultry manure + neem cake + panchakavya (2% spray) out yielded other treatments for the growth and yield characters. Days to 50% flowering was advanced to 14.93 days in the above treatment. The yield attributes viz., number of pods / tree (225.57), pod weight (95.37g), pod yield 35.67 kg / tree were highest in the above treatment combination of poultry manure + neem cake + panchakavya. The nutrient contents viz., Carotene (144.97 mg / 100), ascorbic acid (131.53mg / 100 and soluble protein (5.74 g/100) were found to be highest in the same treatment combination of poultry manure + neem cake + panchakavya. It was also found that the treatment combination of poultry manure + neem cake + panchakavya was very effective in controlling the fruit fly incidence (26.4%), when compared to control (38.22%).

Studies on the manipulation of source – sink relationship for increasing the fruit size of tomato hybrid H24 x CLN 2123 A

In tomato, the hybrid H2s x CLN 2123 A showed greater response for the application of panchakavya. It was found that the treatment combinations of panchakavya 5% at nursery state and 40 days after transplanting + tender coconut spraying (10% once in a week for 3 times) (T8) recorded highest number of fruits per plant of 71.40, followed by 71.0 in the panchakavya 5% spray at nursery stage alone (T4) whereas the control registered the lowest number of fruits of 43.25. Similarly, the fruit weight and yield per plant were also highest in the treatment T8 (59.4g and 3.65 kg respectively). Fruit quality parameters viz., TSS ,Total acidity and ascorbic acid contents were also highest in the treatment T8 (7.5, 0.73% and 16.8 mg/100g respectively).

Organic production package of *Coleus forskohlii*

In a study conducted with *Coleus forskohlii* revealed that application of panchakavya 4% spray was found to be superior in respect of root yield 12.40 kg / plot. When compared to control 5.23 kg / plot. Similarly, number of roots same (14.99), root length (13.73 cm), root diameter (2.49 cm) and root weight (459.35 g/ plant) was maximum in the above treatment when compared to control.

Standardization of organic production package of *Withania somnifera*

An experiment was conducted for the standardization of organic production package of *Withania somnifera* at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Panchakavya 2%, 3% and 4% sprays and moringa leaf extracts 10 ml /plant, 20 ml / plant and 30 ml/ plant and chemicals cytozyme 1%, A tonic -1% and Miraculan – 1% sprays were given. Panchakavya 4% was found to be the best among all the treatment for growth and yield characters viz., plant height (145.63 cm), shoot fresh weight (976.24g), number of fruits 498.46, fruit yield 64.74 g / plant and root length (54.21cm) it whereas in the control, was only 98.48 cm, 720.61 g, 348.67, 36.23g /plant, 38.62 cm respectively.

Effect of organics on growth and yield of Bhendi var. Varsha Uphar

An experiment was on conducted to study the effect of panchakavya and moringa leaf extract on growth and yield of bhendi var. Varsha Uphar at Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Four sprays panchakavya 3% and moringa leaf extract (25 ml/plant) were used started from 2 weeks after sowing and then the subsequent sprays at 15 days interval. Both the treatments viz., panchakavya and moringa leaf extract were revealed the higher plant height, number of branches per plant, number of fruits per plant and fruit yield than the control (water spray). Moringa leaf extract revealed the higher plant height and numbers of branches buy the number of fruits and fruit yield were highest in panchakavya treated plants.

Physiology of petal shedding in Rose

A study was conducted on the physiology of petal shedding in two cultivars of rose, viz., Edward rose and Red rose. It was found that the treatment calcium acetate 0.5% + panchakavya 5% significantly influenced the morphological characters, such as the height of the bush, length of the flowering shoot and the floral characters, such as the flower diameter, pedicel length, receptacle diameter, number of petals and petal : receptacle ratio. The treatment panchakavya 5% resulted in earlier flowering of 45.6 days and 53.31 days in cv. Edward rose and cv. Red rose respectively.

Studies on the effect of pinching, spacing and growth regulators on growth, yield and quality of Ashwagandha (*Withania somnifera)*

Ashwagandha the yield attributes viz., root length (50.67 cm), root girth (4.93cm), root primaries (6.50 cm), root fresh (96.33g), dry weight (38.27 g) and root bark weight (22.33g) per plant were highest under the treatment pinching + wider spacing + panchakavya (3% spray).

However the treatment pinching + closer spacing (60 x 30cm) + panchakavya (3%) registered the highest root yield of 1350 kg / hectare.

Biodynamic Agriculture *

Pfeffer(1984) has defined “Biodynamic Farming” refers to working with energies, which create and maintain life. The term derives from Greek Works “Bios (life) and ‘dynamics’ (energy). The use of world “method” indicates that one is not dealing merely with the production of another fertilizer, organic though it is, but rather that certain principle are involved which in the practical application secure a healthy soil and plants which in turn produce healthful food for man and healthy feed for animal . Biodynamic agriculture works on the following principles.

- To restore to the soil, the organic matter in the form of humus, which holds it’s fertility.
- To establish, maintain and increase soil living system.
- Organic matter as the basic factor for the soil life.
- Biodynamic method is not only fertilizing the soil but skillfull application of the factors contributing to soil life and health.

Courtesy : R.K. Pathak and R.A.Ram (2003). Approaches for green food production in horticulture. Precision Farming in Horticulture

- Establish a system that brings into balance all factors which maintain life.
- In biodynamic way of treating manure and composts, the knowledge of enzymatic, hormone and other factors are also included.
- The biodynamic method puts special emphasis on the importance of crop rotation, green manuring and cover crops.
- The soil is not only a chemical, mineral or organic system, but it also has a physical structure. Maintenance of a crumbly, friable, deep, well-aerated structure is essential feature of fertile soil.

Efforts are being made to elaborate the concept and brief account of preparations used in biodynamic agriculture with a few explanations and experiences with the cultivation practices.

Cosmic integration

Zodiac Principles

The ultimate fine tuning of biodynamic principles lies in harnessing cosmic influences for cultivation. Only at particular times of month or year, the cosmic influences are most supportive to growth of a particular part of a plant. (Schilthuis 2000).

The cosmic factor that determines a month is the Moon. The movement of the Moon in relation to the Zodiac is more interesting. These Zodiac symbols are Greek in origin. The system has 12 constellations though represented by different archetype figures and animals. Within these 12 signs, there are four groups of these constellations, each of which have same qualities. They are related to basic four elements, i.e. earth, water, fire and air. These four elements can be placed in relation to influencing the four parts of the plant, the root, leaf, flower, and fruit as summarized below.

- Root is associated with the earth. There is no root growth without earth,
- Leaf is associated with water because it contains more than 80 per cent water,
- Flower corresponds to air and light. There is no light without air (no light on the Moon) because there is no atmosphere,
- Fruit and seed associated with fire, there is no fruit seed maturity without warmth.

Performing farm operations on specific days means harnessing these cosmic influences for development of a particular plant part.

The earth is emerged in the planetary spheres of solar system and these forces stamp themselves for example, morphology of the plants. The earthly forces of Moon, Mercury and Venus soak into the earth form the air above and the cosmic forces of Mars, Jupiter and Saturn moves upward from the rocks below. They interact in the region of clay so that the plants grow out of it. The light of the Sun, Moon, Planets and stars reaches to the plants in regular rhythms. Each contributes to the life, growth and form of the plant. Planets impress effect on metals, rocks, plants, animals and man, so called “astral influences” coined from Greek where astar means, “star”. Just as sunshine contributes to the growth of plants and moon affect water content of all organisms, the planet also influences the earth and all who dowell on her. Since olden time, they have been divided as inner planet (Moon, Mercury and Venus between earth and Sun) and outer

planets (Mars, Jupiter and Saturn). The inner planets work directly through atmosphere are indirectly via water, humus or calcium (limestone, potassium and sodium) on growth of plants.

The influences of Mars, Jupiter and Saturn are channeled through warmth and silica (quartz, feldspar and mica), they stream in through silica contents of soil and on plants being expressed in colours of flower and in fruit and seed production.

By understanding the gesture and effect of each rhythm, agricultural activities like soil preparation, sowing, intercultural operations and harvesting need to be programmed accordingly.

Biodynamic Calendar

Biodynamic farmers use the knowledge practically by choosing time to show on plant, to use various plant husbandry techniques. Agricultural practices, i.e. field preparation, sowing, manuring, harvesting etc. performed as per constellation are more effective and beneficial. Every constellation has dominant elemental influence and affects four specific parts of the plants as enumerated below in Table 1.

Table 1. Showing interaction of element and constellation on plant parts

Element	Plant part	Constellation
Earth	Root	Virgo, Capricorn, Taurus
Air	Flower	Germini, Libra, Aquarius
Water	Leaf	Cancer, Scorpio, Pisces
Fire	Fruit	Aries, Leo, sagittarius

Agricultural practices for better root activity (manuring and rooting), flowering, growth and fruiting/ seed is to be done as per constellation.

Ascending period of moon: During this period, cosmic forces are active above the *earth /* ground. Any agricultural practice (spray, propagation etc.) performed during the period show beneficial effect.

Descending period of moon : During this period, cosmic forces are active below the earth. Therefore, agricultural practices (field preparation, sowing, manuring and harvesting of root crops) performed during the period shows better success.

Agricultural Operation as per Movement of Moon : The moon moves regularly around earth and it travels monthly through each of the 12 signs of the Zodiac, staying approximately two-and-a half days in each sign. As it does so, it forms an angular relationship with the sun that is known as a Phase of the Moon, which means the angle between moon, earth and sun. Moon orbits the earth and the earth orbits the sun. It is the earths orbit that defines the ‘ecliptic’, which is divided symbolically into the zodiac. (Table 2)

Table 2. Showing position of earth and moon for harnessing cosmic forces.

Ascending moon	Descending moon
The earth is breathing out- the development occurs in upper parts of the plant	The earth is breathing in - the development of the plant occurs parts below the ground, eg. root
Cosmic energy works above the rhizosphere	Cosmic energy works below the rhizosphere
Spring and summer season	Autumn and winter season
Foliar applications, propagation activities, harvesting and sowing	Root development, transplanting, manure application and harvesting of tuber crops

Phases occur in two stages – waxing and waning

The moon is "waxing" (ascending period) – growing during these phases stages are :

New moon, crescent moon, first quarter moon, gibbous moon.

The moon is waning (descending period) – shrinking – during these phases

Full moon disseminating second quarter balsamic.

As a general thumb rule, when moon is waxing plants develop leaves above the ground systems and when moon is waning, plants develop their root system.

Planting leafy crops that grow above ground are best sown at waxing moon and those that will require strong root system or grow below ground should be snow after full moon, in the waning phase.

Perigee (Poornima : full moon) when the moon is nearest to the earth, this occurs after every 29 and half day. In 48 hours, proceeding to full moon, there appears to be distinct increase in the moisture content of the earth and in the atmosphere. Growth promoting activities of the plants seems to be enhanced and plants are more susceptible to fungal attack because of relatively higher moisture content in the rhizosphere and atmosphere.

Apogee (new moon) – when the moon is farthest from the earth. This occurs every 27th and ½ days. Owing to moisture deficiency, harvesting and seed storage practices show better response.

Moo opposite to Saturn – this is favourable period, agricultural operation performed during this period show better response.

Lunar Node

Imaginary point when moon crosses path of sun. It occurs twice in 27.2 days of a month and known as Rahu and Ketu

Rahu - Lunar node in ascending period of moon not suitable for agricultural activities.

Ketu - Lunar node in descending period, not suitable for agricultural activities.

Biodynamic preparations

Basically there are two types of biodynamic preparations.

- Biodynamic field sprays (BD-500-501).
- Biodynamic compost preparations (BD-502-507).

Biodynamic Field Sprays (BD 500-501)

Cow horn manure (BD-500) : This is fundamental biodynamic field spray preparation. The cow is an earthy creature with a very strong digestive system. The cow horn has the ability to absorb life energies during decomposition of the dung being incubated in winter months.

Steps in preparation

- Cow horns are cleaned properly with water. While collecting the horn it should be ascertained that only cow horn to the picked which is solid from proximal end their rings are at distal end.
- Cleaned cow horns are filled with fresh cowdung (especially from lactating and indigenous one) and buried at 30 cm depth in the soil in root free zone in descending period of moon during October – November.
- After 6 months of incubation, horns are taken out in descending period from moon during March- April.
- If decomposition of dung is not proper, cow horns should not be taken out and should be left for some more period and again is to be taken out during descending period of moon.
- Properly decomposed compost is to be stored at cool and dry place in earthen pot.

Specially prepared manure is made into a spray to vitalize the soil, enhance seed germination, root formation and primary root development. For spraying, 25g of BD-500 is dissolved in 13.5 litres of water in wooden / plastic bucket by making vortext in clock and anti-clockwise for one hour in the evening and the solution is spread either with the help of natural brush or with a tree twig. Spraying of BD-500 is done at the time of field preparation in descending period of the moon. Stirring small quantities of material in large amount of water is called Dynamization. This process transfers the forces and energy from the preparation to the water.

Thimmaiah (2001) observed the microbial activity of BD-500 during stirring and very interesting response has been obtained. (Table. 3)

Table.3. Microbial analysis of BD 500

Stirring interval (minutes)	Bacteria (cfu/g)	Actionmycetes (cfu/g)	Fungi (cfu/g)
15	26×10^3	22×10^3	10×10^3
30	35×10^3	35×10^3	14×10^3
45	58×10^3	60×10^3	12×10^3
60	66×10^3	88×10^3	35×10^3

It is interesting to observe that during stirring period, there was a corresponding increase in number of cfu's of bacteria, actinomycetes and fungi during one hour of stirring. The CISH, Lucknow, has also identified the following microorganisms (fungi) from BD-500 preparation.

* *Fusarium semitatum*
* *F. sporotrichiodes*
* *Syncephalastrum racemosum*

Cow horn silica (BD-501) : In this, ground mountain quartz (silica) after proper incubation is made in to spray on plants. It helps them to achieve optimum development and maturity and particularly affects taste, colour and aroma.

Steps in preparation

- After taking out of cow horn manure (BD-500), cow horns are thoroughly cleaned with water.
- Cow horns are filled with silica with powder paste, and buried in same pit where cow horns were buried for the preparation of BD-500 during ascending period of moon in March-April.
- After 6 months of incubation, horns are taken out in October-November during the ascending period of moon.
- Light yellowish silica powder is taken out from the horn and stored in light near the house window in glass jars.

BD 501 works on photosynthetic process in the leaf. Its action is to strengthen the effect of light and warmth on the plant and promotes healthy growth. It strengthens the quality of plant and the plant product and encourages the development of fruit and seeds. For maximum effect, the BD 501 should be applied once at the beginning of a plant's life, at the four-leaf stage and again at the flowering or fruit maturation stage. BD 501 should be applied on the leaves in the form of 'mist' in the morning at the sunrise and the best constellation is moon in opposite to Saturn.

Following fungi are isolated from BD -501 at this Insitute.

* *Fusarium monliformae*
* *Penicilium chrysogenum*
* *Syncephalastrum racemosum*

Biodynamic Field Sprays

Biodynamic sets (BD-502-507) are prepared from six herbal plants, which have healing properties and influence the fermentation processes in the compost, liquid manure and Cow Pat Pit. These are also associated with particular constellations as summarized in Table.4. All these preparations are made in descending period of the moon, except BD-507, which is best prepared in air / light day. The BD sets are used in the Cow Pat Pit (CPP), BD – compost, Biodynamic liquid manure and Biodynamic liquid pesticides.

Table 4. Basic BD sets used CPP, BD compost, liquid manures and pesticides

Preparation	Constellation	Substances from which preparation is prepared	Role
BD-502	Venus	Fermented flower heads of Yarrow (Achillea millefolium)	Rich in S, K and N
BD-503	Mars	Fermented Chamomile (Matricaria recutita) blossom	Rich in S, K and N
BD-504	Mercury	Whole shoot of Stinging Nettle (Urtica dioica) with flower, fermented in the soil	Rich in Fe
BD-505	Moon	Fermented oak (Ouercus robur) bark	Rich in Ca
BD-506	Jupiter	Fermented flower heads of Dandelion (Taraxacum officinale)	Rich in K and Si
BD-507	Saturn	Valerian (Valeriana officinalis) flower extract	Rich in P

These work to regulate the composting process and enable the different elements (calcium, nitrogen and phosphorus) needed for healthy plant growth to be present in a living way. The specifications of BD sets used in these preparations are described in the Table.5.

Table.5 Showing number of sets used for specific preparation.

Specific preparation	No. of sets used
Cow Pat Pit (CPP)	2 sets per 60 kg of cow dung
Liquid manure	2 sets per 200 litres
Biodynamic compost	1 set per 5 m^3

Cowdung and urine are important components of Cow Pat Pit (CPP), BD liquid manure and BD pesticides. Their brief account are summarized below.

Cow Pat Pit (CPP) or Barrel Manure

It is a biodynamic field preparation also called as soil shampoo. Cow Pat Pit (CPP) is a strong soil conditioner. It enhances seed germination, promotes rooting in cutting and grafting, improvement in soil texture, provides resistance powers to the plants against pests and diseases, replenishes and rectifies the trace element deficiency. CPP is increasingly used for improving soil biological activities in the seed treatment and foliar applications. The CPP may be prepared throughout the year.

Steps in preparation

- Preparation of a pit of 60cm x 90cm size in shade and root-free zone. Precaution is to be taken that pit should be 15cm higher than plane surface.
- Pasting of inner wall of the pit with fresh cowdung paste.
- Dung of lactating cow (60kg) mixed thoroughly with 250g each of bentonite and egg shell powder and filled in the pit.
- Compost gets ready in 75-90 days depending upon the temperature.

One kg CPP dissolved in 40-45 litres of water overnight and sprinkled in the next morning as field sprays on the plants. This should be applied at the time of field preparation and on plants. CPP can also be applied in BD compost and with FYM for improving their nutritive value. The preparation is ready for use when it is dark brown, friable and has lost the smell of cowdung.

Biodynamic Compost Heap

Biodynamic compost is an effective soil conditioner and is an immediate source of nutrient for a crop. Biodynamic Compost Heap can be prepared by using green leaves (nitrogenous material) and dry leaves (carbonaceous material) in 8-12 weeks. Integrating with cowdung slurry is always good in the decomposition process. The composition of air, moisture and warmth is very important in the breakdown and decomposition of material. The enrich compost is ready in 75-100 days depending upon the prevailing temperature.

Steps in preparation

- Five-meter long thick wood is placed on higher elevation where waterlogging does not occur during rainy season.
- Thick layer (20 cm) of dry grasses is spread on the area of 5 m x 2.5 m on the ground.
- Water (100-150 litres) mixed with dung sprinkled on the grasses.
- Again 20 cm thick layer of green grasses are sprayed equally on the heap and 100 to 150 litres of water mixed with dung sprinkled on the heaps.
- Above process (putting 20 cm thick layers of dry and green grasses alternatively) is repeated to the height of 1.5m.
- For enriching the compost with different nutrients as per the need, rock phosphate (P), slacked lime (Ca) wood ash (K) etc. can also be used in between the layers of dry / green grasses.
- Two B.D sets (502-507) are incorporated and the heap is plastered with mixtures of dung and clay.

The BD compost is said to be more fertile with a stronger ability to improve soil than the conventional compost. When the specially prepared CPP and BD compost have been applied to the soil, the plants become more sensitive to their environment and responsive to the rhythms of the day, seasons and planets.

Vermicompost

Vermiculture technology is an aspect involving the use of earthworms as versatile natural bioreactors for effective recycling of non-toxic organic wastes to the soil. They effectively harness the beneficial soil microflora, destroy soil pathogens, and covert organic wastes into valuable products such as biofertilizers, biopesticides, vitamins, enzymes, antibiotics, growth hormones and proteinous biomass (5).

Earthworms participate in soil farming system in following ways :

- Through their influence on soil pH
- As agents of physical decomposition of organic wastes
- Promoting humus formation

- Improving soil structure
- Enriching soil and water-holding capacity.

Steps in composting

Vermicomposting on plane surface

- Partially decomposed organic wastes are piled up on 2 m x 1 x 0.5 m areas at cool and elevated place.
- Two to five thousand red worms (*Eisenia foetida*) are released in the middle of bed by putting 2-4 kg one week-old dung.
- Water (2-5 litres) is sprayed everyday to keep the earthworms active. To protect earthworms from the excessive heat and rain, shade should be provided.
- Depending upon the weather conditions complete heap of the organic waste get converted into fine compost within 75-120 days.
- Ready compost is sieved to separate the earthworms.
- Separated worms are released in another heap of partially decomposed organic waste.
- As the time passes population of worms and vermicompost production increases very fast.

Vermicomposting in pit

- Brick structure (3 cm x 1.5 cm x 5 cm) is prepared in shade.
- One brick wall made of cement is preferred.
- After putting 5 cm thick layer of concrete and sand, each 40 cm thick layer of partially decomposed or soften organic waste is spread equally above the sand.
- One –week-old cowdung (1-2 kg) is kept at 6-8 places on the organic waste and 50-100 earthworms are released in each heap of cowdung.
- Water (2-5 litres) is sprayed in the bed and covered with 5 cm thick layer of organic waste.
- The bed is covered with thatch to protect earthworms from excessive heat, rain and cold.
- To keep the worms active, light spray of water is essential everyday.
- Worms convert all the organic waste into compost. Again 30-40 cm thick layer of partially decomposed organic waste is spread equally in the bed and moistened and it takes another 30-45 days for full conversion of organic waste into compost within 45-60 days.
- Prepared compost is taken out and sieved to separate earthworms from the compost.
- Pit is again filled up with organic waste and earthworms are released as discribed earlier.
- As earthworm's population increases very fast, a few more pits are to be required to increase the verimicompost production.

Vermiwash

Vermiwash is prepared from the heavy population of earthworms reared in earthen pots or plastic drums. The extract contains major, micronutrients, vitamins (such as B 12) and hormones (gibberellins) secreted by the earthworms. Earthworms produce bacteriostatic substances and

it was found the vermiwash can protect the bacterial infections. Vermin wash can be sprayed on crops and trees for better growth, yield and quality.

Steps in preparation

- Bio earthen pot / plastic drum with capacity of 200 litres (provided with tap in the bottom) is placed in shade.
- Five cm each of concrete and coarse red sand (Morang) is laid in the bottom of the pot for effective drainage.
- Layer of soften kitchen waste or one-week-old dung (30-40cm) is filled in the pot.
- Red worms (200-300) are released in the waste / dung.
- An earthen pot with minute hole in the bottom from where water comes out in the form of drops is hanged over the pot / drum after 30 days of worms inoculation.
- After 2-3 days, extract collected in earthen pots from the tap provided in the bottom of pot / drum which is called 'Vermiwash'.
- Extract diluted in the water (1:5 ratio) can be used as a foliar spray.

Precaution : Continuous pouring of water in the pot / drum having hole in the bottom and the organic waste in the pot / drum should be changed regularly, after its full conversion into the compost.

Nadep Compost

A farmer at Indore developed this method of aerobic composting. Because of aerobic respiration, composting is very fast and nutritional status of the compost is better than the ordinary compost. In this method of composting, farm wastes (cow-dung, green / dry grasses, wheat / paddy straw and weeds and garden soil) are used and the technique has been summarized below. The compost can be enriched through incorporation of rock phosphate, wood ash, slacked lime, Azotobacter and Rhizobium. Incorporation of two BD sets (BD 502-507) further improves the nutritive status of NADEP compost, Thimmaiah (2001) named it as hybrid compost.

Methods of composting

- Brick aerobic structure (2m x 3.30m x 1m) is constructed at elevated place in farm area. First and the last two rows are provided without any gap to strengthen the structure.
- Length of the structure can be altered as per the requirement
- Thick layers (18-20 cm) of organic wastes are piled and water 100-150 litres mixed with cowdung is drenched on the waste.
- Again 18-20 cm thick layer of organic waste pile, covered with thick layer (2-3cm) of garden soil is sprayed and sprinkled with water (100-150 litres).
- The above processes are repeated till the piling goes 30-45 cm higher than the structure. Total heap is plastered with mixture of dung and mud.
- After 10-15 days heap gets settled leaving 15-30 cm gaps from the top.
- Process of filling and plastering are again repeated.

Incorporation of any of these preparation and the following other associated activities will suffice the nutritive requirement for production of horticultural crops, which can be summarized as below.

In green food production nutritional requirement can be taken care through

- Regular incorporation of organic waste through NADEP, Vermi, Biodynamic Compost (BD) or Microbe Mediated Compost (MM compost).
- Use of cakes (neem, mahuwa, pongamia, castor, groundnut etc) as per availability need to be promoted.
- Promotion of green manuring and legumes as inter and cover crops whenever and wherever possible.
- Promotion of mulching with organic wastes which can be further promoted by spread of 5-20 kg vermin / BD compost or 100g CPP and incorporation of 50-100 earthworms.
- In order to encourage soil biological properties, regular use of Cow Pat Pit (CPP), Cow Horn Manure (BD -500) are also helpful.

Need-based use of liquid manure prepared from cowdung, cow urine, leguminous leaves or vermin wash are also effective in promotion of growth and fruiting.

Wide variations in nutrient status of composts and CPP have been observed as evident from Table 6. This can be further enriched through incorporation of rock phosphate, bone-meal, slacked lime, blood and fish meal. Various combination of green vs dry leguminous non-leguminous may be helpful. These need to be worked out for meeting the nutritional requirement of various horticultural commodities.

Biodynamic Tree Paste

In a biodynamic process for the management of orchards and gardens, the “biodynamic tree paste” is prepared by mixing of cowdung, bentonite (clay), BD 500 and sand. The tree paste is polished on the tree trunks and cut surfaces

Table 6. Nutrient status of compost and CPP

Preparation	N (%)	P (%)	K (%)
General compost	0.3 - 0.5	0.20 - 0.35	0.50-1.50
Vermi compost	1.12-1.75	0.214-0.285	0.506-1.72
Cow Pat Pit	0.70-2.24	0.214-0.428	0.718-0.925
Nadep compost	1.33-2.03	0.202-0.389	0.775-2.35

The important properties of biodynamic tree paste are :

- It nourishes, strengthens and protects the bark and cambium of tree to make it healthy.
- Seals and heals wounds.
- Helpful in prevention and control of disease.
- On application after pruning, stimulates tree growth.

In rejuvenation of mango orchard, copper oxychloride pasting (CoC) is very expensive. Pasting with the above paste on tree trunk and cut surfaces, alone has shown better response compared with CoC pasting. Similar to tree paste, cowdung has been found to be rich in actionmycetes. Cowdung paste and actionmycetes isolated from cow dung paste has also shown positive response in control of dieback, stem end rot and anthracnose in mango and guava. Similarly, BD pesticides have shown effective control of bacterial fruit canker and tent caterpillar in mango. These need to be validated for control of pest and diseases of horticultural crops.

Biodynamic system is almost new, but the preliminary observation over 4 years by the authors and overview of world literature including personel communications have shown very encouraging response with number of horticultural and field crops and following interferences can be drawn at this juncture.

If appears to be sustainable, economic and eco-friendly

There is minimum risk of residual toxicity

There has been continuous improvement in soil fertility and produce quality including self-life. Considering these experiences, following strategies are proposed to be initiated.

Strategies for green food production

- Various aspects of green food production particularly for horticultural commodities need to be standardized.
- Promotion of establishment of demonstrations for preparation of biodynamic compost, cow horn manure (BD0-500), horn silica (BD-501), Cow Pat Pit (CPP), liquid manures and liquid biodynamic pesticides.
- Promotion for field demonstrations for organic biodynamic system of cultivation.
- Organizing intensive training to farmers, NGO representative, entrepreneurs, and extension personnel of Department of Horticulture for biodynamic preparations and their applications.
- Scientific explanation for responses of the above materials with reference to soil physical and microbiological properties and their impact.
- Helping State Agriculture Universities (SAUs) to initiate a few courses on Organic / Biodynamic Agriculture.
- Facilitation for certification / Demeter for organic /biodynamic production.
- Establish national standards for covering marketing of certain agricultural products as green produced products.
- Assure consumers that these meet a consistent standard.
- Market promotion for ‘Green Food’ and their processed products.
- Regular monitoring of nutrients status of the soil.
- Study on various combination of locally available waste recycling for meeting the nutrient requirement and techniques of compost enrichment.
- Impact of organic / biodynamic farming on flora and fauna of the area.
- Impact analysis of organic /biodynamic farming on agro-ecosystem of the region over the years.

References

01. Pathak, R.K and Ram, R.A (2002). Approaches for green good production. In : Souvenir, National Seminar-cum-workshop on Hi-Tech Horticulture and Precision Farming, held at Taj Residency, Lucknow, pp.33-35.
02. Pathak, R.K and Ram, R.A (2001). Approaches for biodynamic farming. Approaches for Sustainable Development of Horticulture. Singh, H.P., Negi, J.P and Samuel, J.C. (Eds), NHB, Gurgaon, pp. 113-19.
03. Pfeffer, E. (1984). Using the bio-dynamic compost preparation and sprays in garden, orchard and farm. Biodynamic Farming and Gardening Association, Inc, Kimberton, PA, 64 pp.
04. Schilthuis W. (2000). Biodynamic Agriculture, S&H Home Ag. Library Biodynamic Agriculture.
05. Sharma, A.K.(2001). A Hand Book of Organic Farming. Agrobios, India, Jodhpur,pp.193-215.
06. Thimmaiah, A. (2001). Studies on biodynamic system and vermitechnology for sustainable Agriculture. Ph.D thesis, IIT, New Delhi.

HIGH DENSITY PLANTING IN FRUIT CROPS

High density planting is the current concept by which productivity of the fruit crops can be enhanced per unit area . As most of the perennial fruit crops takes long years to attain a bigger canopy, it is possible to accommodate and maintain more trees per unit area till such canopy development interferes with general cultural operations or performance of the nearby plants by competing for light, water , nutrients and other inputs. High density planting of similar kind of fruit trees is also advantageous as it will not require much labour as required for intercropping with seasonal crops to make use of the alley spaces available otherwise. The following are some of the advantages of high density planting.

- The yield per unit area could be increased.
- Reduced labour cost and labour involvement towards weeding and desuckering.
- Efficient utilization of land, water, fertilizer and solar radiation.
- Cost of production per unit quantity of fruits could be reduced considerably.

The methods by which, the HDP can be practiced in different fruit crops are mentioned briefly below.

Mango

Mangoes can be planted at a spacing of 5m x 5m and maintained till such time canopy overlapping is noted. The alternate rows can be removed if necessary at later stage when canopy overlapping interferes with the normal gowth and performance of the plants or with cultural operations. Mangoes can be also maintained at HDP system by proper pruning and regulating the canopy. Dwarf statured varieties with narrow canopy are much suitable for HDP system. Experiments with mango varieties like Amrapali, Dashehari and Mallika in Indian Agricultural Research Institute, New Delhi have indicated that even a spacing of 2.5-3m either way can be maintained in the initial years accommodating nearly 1300 plants per ha.

Sapota

Similar to mango, sapota is usually planted at 8-9m spacing conventionally. However, it is advisable to use a spacing of 5-6 m either way under HDP as it takes many years for the plants to assume the full canopy coverage. The recently released varieties like CO 3 sapota and PKM 4 sapota can be planted under HDP owing to their upright growth habit.

Banana

Banana is grown normally at a spacing of 1.8 x 1.8 m (6' x 6') by planting one sucker per pit, in India. A new concept of increasing the plant density by planting more number of suckers per pit at a wider spacing has proven successful in increasing the productivity of banana. This system of high density planting in banana was devised at Horticultural College and Research Institute, Coimbatore and has proved efficient in increasing the productivity of banana. Interestingly, it has also showed that possibility of reducing the water and fertilizer to a tune of 30-40% without affecting the yield.

Based on a series of research trials on HDP on banana taken up in the Department of Fruit crops, TNAU, Coimbatore it is recommended that HDP can be acheived by planting three suckers / hill spacing of 1.8 x 3.6 m which (4629 plants/ha). On per plant basis, instead of full dosage of fertilizer (i.e. 110: 35 : 330 g of NPK) only 75 % of the fertilizer needs to be applied on per plant. By this method 25-40 % enhanced yield can be obtained from an unit area. Though a slight reduction in individual bunch weight was observed when compared to conventional planting, the bunch grade was found to be similar indicating no difference in the market appeal of the bunch/hands.

Pineapple

It is possible to accomodate 43,000-50,000 plants per ha in pineapple by planting in double rows either in beds or in trenches with the plants into the second rows set in the middle of the plants in the first row. The spacing between two trenches will be 90 cm. Row to row spacing in the same bed per trench can be 45- 60 cm and plant spacing within the row is 30 cm.

HDP systems are not without disadvantages. Some disadvantages of high density planting are high initial capital investment, extended cropping cycle in herbaecious crops like banana or pineapple and occasionally quick spread of pest and diseases. But if managed properly, the HDP system will prove to be economically advantageous to the grower in the long run.