Crop Production Techniques of
Horticultural Crops

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HORTICULTURAL COLLEGE AND RESEARCH INSTITUTE

TAMIL NADU AGRICULTURAL UNIVERSITY

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Contents

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 varieties : 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 plantable size grafts propagated through approach, soft wood or epicotyl grafting.

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

Planting: Plant the grafts at the centre of the pits with ball of earth intact and keeping the graft union 15 cm above the ground level. Stake and water the plants immediately after planting.

Spacing: Adopt any one of the following spacing depending on requirements.

1. Under conventional system of planting: 7-10 m either way
2. High Density Planting : 5 m x 5 m (400 plants / ha)
3. Double hedge row system : Adopt a spacing of 5 m x 5 m within double rows and 10 m between sucessive double rows (266 plants / ha)

Irrigation: Regular watering till establishment. For cultivation under irrigated conditions, adopt drip system of irrigation.

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	1st Year	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 tip and incorporated.

Fertigation technology under HDP

Apply 1.0:0.5:1.0 kg of NPK / bearing tree / year under HDP through drip fertigation adopting the following schedule:

Nutrient	Stage of application *				
	Immediately after harvest (2 months)	Pre-flowering (2months)	Flowering to fruit set (2 months)	Fruit development (4 months)	Total
N	25 %	40 %	20 %	15 %	100 %
P	50 %	30 %	20 %	-	100 %
K	25 %	20 %	25 %	30 %	100 %

* At each stage, the above schedule has to be split into six or more doses and applied at weekly intervals
* Avoid irrigation and fertigation for 30 days for induction of stress before flowering season; resume as soon as flowering commences.

Canopy management:

Remove root stock sprouts and low lying branches nearer to ground to facilitate easy cultural operations. Remove overlapping, intercrossing, diseased, dried and weak branches in old trees to get good sunlight and aeration. Carry out judicious pruning of the internal branches during August – September, once in three years. Do not allow flowering upto three years by removing the inflorescences as and when they appear. Retain two healthy shoots by trimming away the weak shoots among the crowded terminal shoots during August-September annually. Prune back 20 cm of annual growth of the terminals immediately after harvest.

Top working of senile orchards for rejuvenation:

Use scions of choice varieties like Alphonso and Banganapalli for top working. Behead the trees to be top worked portion during July- August leaving the main trunk at a convenient height and allow for new shoots to develop. Adopt cleft method of grafting or softwood grafting on the emerging shoots on the main stem from the cut end during September- October.

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 (10 g / 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. Spray 2 % Sulphate of potash at pea stage and 15 days after to improve yield and quality.

Apply Paclobutrazol @ 0.75 g a.i. per meter of canopy radius in full bearing tree during first fortnight of September to get maximum number of fruits and yield during off years.

Off-season crop induction: This technology is recommended only for irrigated conditions to shift production from on- season to off- season. To induce off-season flowering**,** heading back of 10 cm terminal growth after the emergence of new growth (vegetative and floral growth) during December to January along with soil application of Paclobutrazol @ 0.75g a.i. per tree during March and April is recommended for mango cv.Neelum. Keeping good soil moisture conditions and nutrient health status of the plant are very important when Pacloburazol application is resorted.

Plant Protection

Pests

- Removal of criss-cross branches, infested shoots, dense branches and proper training and pruning reduces the hopper infestation
- Apply *Metarhizium anisopliae* @ 1x 10 ^{8} cfu/ml or *Beauveria bassiana* @ 10^{8} cfu /ml on tree trunk once during off season and twice at 7 days interval during flowering season
- Spray any of the following insecticides first at the time of panicle emergence and the second two weeks after first spray. Neem oil @ 5 ml/lit of water can be mixed with any insecticides for the control of hopper.

Insecticide	Dose
Buprofezin 25 % SC	1.5 ml/lit.
Dimethoate 30 % EC	1.6 ml/lit.
Imidacloprid 17.8 % SL	3.0 ml/10 lit.
Malathion 50 % EC	1.5 ml/lit.
Oxydemeton –Methyl 25 % EC	1.0 ml/lit.
Phosalone 35 EC	1.5 ml/lit
Phosphamidon 40 SL	2.0 ml/lit

Spray volume of 5-15 litres of water per tree is required

Leaf galls and Aphids:

Spray monocrotophos 36 % SL @ 1.0 ml/lit

Mealy bug:

- Dissolve Fish oil rosin soap @ 25g /lit, initially in luke warm water, then in required quantity of spray fluid in the sprayer.
- Release Australian ladybird beetle, *Cryptolaemus montrouzieri* @ 10 beetles/tree or 1500/ha
- Band the trees with 20 cm wide 400 gauge polythene sheets
- Spray chlorpyriphos 20 EC @ 2.5 ml/lit or any one of the following insecticide

Insecticide	Dose
Dimethoate 30 % EC	1.6 ml/lit.
Malathion 50 % EC	1.5 ml/lit.
Monocrotophos 36 % SL	1.0 ml/lit.

Flower webber: Spray phosalone 35 EC @ 2ml/lit.

Stem borer:
Padding with monocrotophos 36 WSC @10 ml in 25 cm² 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.

Shoot borer: Spray monocrotophos 36 % SL @ 1.0 ml/lit

Fruit fly:

- Plough the inter spaces to expose pupae.
- Prepare bait with methyl eugenol 1% solution mixed with malathion @ 2.0 ml/lit. 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.
- Spray *Neem oil* @ 3.0 % as need based

Sooty mould:
Spray Maida 5% (1 kg Maida or starch) boiled with 1 lit of water and diluted to 20 litres. Avoid spraying during cloudy weather.

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 2 g / lit or Carbendazim 1 g / lit or Thiophanate methyl 1 g / lit or Chlorothalonil 2 g / lit as pre-harvest spray, 3 times at 15 days interval (or) Spray chitin based *Pseudomonas fluorescens* (Pf 7) immediately after flowering @ 5 g / lit five times at 21 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^{o} ± 1^{o}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 0.2% 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

Market Information

Growing Districts	Krishnagiri, Vellore, Dindigul, Thiruvallur, Dharmapuri, Theni
Major Markets in Tamil Nadu	Theni, Dharmapuri, Salem, Tirunelveli.

Preferred Varieties and Hybrids	Banganapalli, Bangalora, Neelum, Rumani, Mulgoa, Alphonso, Totapuri
Grade Specification	Firmness, lack of decay / defects, uniformity of size and shape, skin color, flesh color and flavor Small - Less than 200 g Medium - 201- 400 g Large -401- 600 g Extra-large - 601 - 800 g
Export Market	UAE, Kuwait and other Middle East countries.

Banana: *Musa* sp; Musaceae

Varieties

Dessert : Grand Naine, Robusta, Dwarf Cavendish, Rasthali, Vayal vazhai, Poovan, Nendran, Red Banana, Karpooravalli, Udhayam, CO 1, Matti, Sannachenkadali and Ney poovan. Cavendish groups are generally preferred 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 Ney poovan.
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 well hardened tissue cultured banana plants with 5-6 leaves. At the time of planting, apply 25 g *Pseudomonas fluorescens* / 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.

Digging pits

Garden land, Padugai and Hill Banana: Dig pits of 45 cm x 45 cm x 45 cm in 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 (Conventional method)

	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
Wet land	Poovan, Monthan, Rasthali, Neyvannan, Ney poovan	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 wet lands. 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 month 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
Wet land	210	35	450
Nendran, Rasthali	210	50	390
Poovan,Robusta	160	50	390

Hill bananas
After forming semi circular 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 g 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.

Fertigation
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 along with 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 (%)	P_2O_5 (%)	K_2O (%)
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. The plants at flowering may be propped. Cover the peduncle with flag leaf to prevent stalk end rot. Cover the bunches with banana leaves to avoid sun scald.

Wet land: 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 sun scald. 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 garden land.

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 4^{th} and 6^{th} month after planting. Spray Plantozyme @ 2ml / l at 6^{th} and 8^{th} 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^{rd}, 5^{th} and 7^{th} MAP to increase yield and quality of banana.

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

Inter cropping: Leguminous vegetables, Beet root, Elephant foot yam and Sun hemp. 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.
- Do not dump infected materials in the manure pit. Infected trees should be uprooted, chopped into pieces and burnt.
- 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.

Rhizome weevil:
Trap adult weevils with pseudostem chopped into small pieces.
Apply carbofuran 3 % G @ 35 g /sucker or carbaryl @ 20 g/plant in the soil around the stem.

Banana aphid:
Administer injection of monocrotophos 36 WSC 1 ml/plant (1 ml diluted in 4 ml of water) at 45 days interval from the 3^{rd} month till flowering. Use 'Banana injector' devised by the Tamil Nadu Agricultural University.

Avoid injection of monocrotophos after flowering.
Apply carbofuran 3 % G @ 35 g /sucker or phorate 10% G @ 15 g/sucker or spray any one of the following insecticide. The spray may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice.

Insecticide	Dose
Dimethoate 30%EC	1.0 ml/lit.
Oxydemeton –Methyl 25% EC	2.0 ml/lit.

Thrips and Lace wing bugs: Spray any one of the following insecticide

Insecticide	Dose
Dimethoate 30 %EC	1.0ml/lit.
Oxydemeton –Methyl 25% EC	1.0ml/lit.
Quinalphos 25%EC	2.0ml/lit.

Bunchy-top:

The Banana Aphid *Pentalonia nigronervosa* is the vector of Bunchy-top virus disease. Spray phosphamidon 40 SL @ 2 ml/lit or methyl demeton 25 EC @ 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 at least 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.

iv) 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.

Nematode:

- Pare the corm and sprinkle 40 g of Carbofuran 3 G cover the corm. Before sprinkling, corm should be dipped in mud slurry (or) pare and dip the corm into 0.75 % (15 ml / lit water). Monochrotophos solution; shade dry and plate (or) Pare the corms and coat (Pralinage) with *Bacillus subtilis* (BbV 57) and *Pseudomonas fluorescens* (Pf1) each at 10 g / corm followes by soil application @ 1.25 kg each/ha.
- If pre-treatment is not done, apply 40 g Carbofuran around each plant twice at 1st and 3rd month after planting.
- Grow Sunhemp in and around the basin of plants and incorporate their biomass one month later (or) apply press mud @ 15 t per ha one month after planting (or) apply neem cake 1.5 t per ha one month after planting (or) Apply *Pseudomonas fluorescens* (Pf1) liquid formulation @ 4 lit/ha at 2nd, 4th and 6th MAP through drip system to manage panama wilt and nematode complex.

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. Alternatively Alternatively spray Propiconazole 1 ml/lit or 0.5 ml/lit along with petroleum based mineral oil 10ml / lit or *Pseudomonas flourescens* (0.5%),

three times at 15 days interval to effectively control sigatoka leaf spot incidence. 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,

1. Use virus-free suckers.
2. 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).
3. 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 g / lit of water) into the pseudostem by using the injection gun. The plant collapses and topples in 3 – 5 days.

Panama Disease (Fusarium wilt): Uproot and destroy severely affected plants. Apply lime at 1 – 2 kg in the pits after removal of the affected plants.

Corm injection

Remove a small portion of soil to expose the upper portion of the corm. Make an oblique hole at 45° angle to a depth of 10 cm. Immediately insert a gelatin capsule containing 60 mg of Carbendazim or of 50 mg of *Pseudomonas fluorescens* or inject 3 ml of 2 % Carbendazim solution into the hole with the help of 'corm injector' on 2nd, 4th and 6th month after planting. Apply press mud at 5 kg per tree to reduce the wilt incidence (or) apply *Pseudomonas fluorescens* (Pf1) liquid formulation @ 4 lit/ha at 2nd, 4th and 6th MAP through drip system to manage panama wilt and nematode complex.

Kottaivazhai in Poovan: Spray 2,4 – D @ 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 altitude.

Yield (t / ha / year):

Poovan & Rasthali	:	40 – 50 t / ha
Monthan	:	30 – 40 t / ha
Ney Poovan	:	30 – 35 t / ha
Robusta	:	50 – 60 t / ha
Grand Naine	:	70 – 80 t / ha; under HDP: 115-130 t / ha

Market information

Growing Districts	Coimbatore, Erode, Thoothukudi, Tirunelveli, Trichy, Vellore, Kanyakumari and Karur districts
Major Markets in Tamil Nadu	Trichy, Coimbatore, Theni
Preferred Varieties and Hybrids	Grand Naine, Dwarf Cavendish, Robusta, Rasthali, Poovan, Nendran, Red Banana, Ney Poovan, Pachanadan, Monthan, Karpuravalli
Grade Specification	The hands are graded based on the number and size of fingers in each hand. Over ripe and injured fruits are discarded. Banana is sent to the local market as bunches.

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

Varieties: PKM1, Vikram

Soil and Climate: Tropical and sub tropical. 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. Adopt drip system for new plantations.

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	Ist year	Annual increase	From 6th year
FYM	10 kg	5 kg	30 kg
N	200 g	100 g	600 g
P	100 g	25 g	200 g
K	100 g	40 g	300 g

Spray Zinc sulphate @ 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 (200 mg / 10 l) during flowering. For fruit retention, spray 2, 4 – D @ 20 ppm or NAA 30 ppm (300 mg / l) after fruit set (marble size).

Plant protection

Pests

Leaf miner:

Apply carbofuran 3 % G @ 50 kg /ha or phorate 10 % G @ 15 kg/ha or spray neem seed kernel extract (NSKE) 5 % or neem cake extract or neem oil 3 % or imidacloprid17.8% SL @ 2.0 ml in 10 lit of water or Thiodicarb 75 WP @ 1g /lit.

Aphids :

Spray neem oil @ 3 ml/lit or Fish oil rosin soap 25 g/lit.

Rust mite :

Apply carbofuran 3 % G @ 50 kg /ha or phorate 10 % G @ 15 kg/ha or dicofol 18.5 EC @ 2.5 ml/lit or imidacloprid 17.8% SL @ 2.0 ml in 10 lit of water

Fruit sucking moth:

- Destroy *Tinospora* weed host.
- Bait with fermented molasses plus malathion 50 EC @ 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, Plug the fresh holes with cotton soaked in monocrotophos solution mixed @ 5 ml/20 ml of water.

Citrus Butterfly:

Spray two rounds of *Bacillus thuringiensis* @ 1g/lit or neem oil @ 10 ml/lit during new flush formation is recommended for the management of citrus butterfly

Fruit fly

1. Set up bait with methyl eugenol 0.1% solution mixed with malathion 50 EC @ 1 ml/lit 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.

3.Neem oil @ 3.0 % as foliar spray as need based

Mealy bugs

- Debark the branches
- 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.
- Dissolve Fish oil rosin soap @ 25g /lit, initially in luke warm water, then in required quantity of spray fluid in the sprayer.

Tree banding:

- Band the trees with 20 cm wide alkathene or polythene (400 gauge) 50 cm above the ground level and just below the junction of branching and secure them with jute thread.
- Apply a little mud or fruit tree grease on the lower edge of the band. Or, put a band of carbaryl 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 predator, *Cryptolaemus montrouzieri* beetles @ 10 beetles/tree once the patrolling of the ants on the trunk is stopped. Make one to three releases per annum depending on the mealy bug populations. 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.

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.

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 Streptocyclin 100 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.

Market information

Growing Districts	Dindigul, Tirunelveli, Trichy, Perambalur
Major Markets in Tamil Nadu	Dindigul, Tirunelveli, Trichy, Perambalur
Preferred Varieties and Hybrids	PKM 1, Vikram
Grade Specification	Size and colour

Sweet Orange: *Citrus sinensis;* Rutaceae

Varieties: Sathugudi.

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.

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 in 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	Ist 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	0.020	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 Zinc Sulphate (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 Zinc Sulphate, Manganese and Iron per tree per year.

Plant protection

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 5% of Neem Seed Kernel Extract (NSKE) or Neem oil 3%.

Citrus root nematode: Apply *Pseudomonas fluorescens* at 20 g 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 / 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 following 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: Sub tropical climate with an elevation of 500– 1500 m above MSL. 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	1st year	2nd year	3rd year	4th year	5th year	6th 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 AM fungi (*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.

After cultivation: Remove water shoots, root stock 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 5% of neem seed kernel extract (NSKE) or neem cake extract or neem oil 3%.
Aphids :
Spray neem oil 3 ml/lit or Fish oil rosin soap @ 25 g/lit
Fruit sucking moth: Destroy *Tinospora* weed host. Bait with fermented molasses plus malathion 50 EC @ 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
Stem borer: Prune the branches containing grubs.
Fruit fly:
Collection and destruction of fallen fruits.
Set up methyl eugenol trap 0.1% solution mixed 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
.*Neem oil* @ 3.0 % as foliar spray as need based
Green scale: Apply Carbofuran 3% G @ 15 g/plant
Safe waiting period: Methyl demeton and monocrotophos – 12 days.
Sooty mould
Boil 1 kg Maida or starch with 5 lit of water, cool, dilute to 20 lit and spray. Avoid spraying during cloudy weather.
Diseases

Powdery mildew

Apply Sulphur dust 25 – 30 kg (350 mesh) in the early morning hours 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: Budded plants start bearing from 3 – 5 years after planting while seedlings take 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 the major variety grown in Tamil Nadu.

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. Withheld 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. Do not disturb the soil for atleast 15 days. Thereafter normal manuring may be done. Apply of neem cake 200 g / vine or alternatively apply *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 to control nematodes.

Flea beetles: Spray Phosalone 35 EC (2 ml / lit of water) immediately after pruning and followed with The loose bark may be removed at the time of pruning to prevent egg laying. Spray Malathion 50 % EC @ 7.0 ml in 10 litres of water

Thrips:

Spray methyl demeton 25 EC or dimethoate @ 30 EC 2 ml/lit of water.

Mealy bug:

Release Coccinellid beetle, *Cryptolaemus montrouzieri* @ 10 per vine. Spray methyl demeton 25 EC or monocrotophos 36 WSC @ 2 ml/lit of water or spray dichlorvos 76 WSC @ 1 ml/lit with fish oil rosin soap @ 25 g/lit or Buprofezin 25 % SC @ 1.0 ml/lit.

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 @ 6-12 Kg / ha in the morning or Azoxystrobin @ 150 ai / ha (600 ml / ha) 30 days after pruning 5 sprays at 10 days interval.

Downy mildew: Spray *Pseudomonas fluorescens* @ 20 g / lit on 25th and 45th days after pruning followed by spraying of Azoxystrobin @1 ml / lit on 35th and 55 days after pruning. Remove infected tendrils and spray *Pseudomonas fluorescens* @ 20 g / lit at 65 days after pruning (Or) Apply FYM @ 20 kg + Pf1 100 g/vine after pruning followed by spray with *Pseudomonas fluorescens* (Pf 1) on 25, 35, 45, 55 and 65 days after pruning to check the Downy mildew.

Anthracnose: Spray 1 % Bordeaux mixture or Copper fungicide 0.25 % or Fluopicolide and Forestyl aluminium formulation (Profiler-Fluopicolide 4.44% + Fosetyl Aluminium 66.7% - 71.14% WG) @ 0.225 % three times [First spray 15 days after pruning (at 4-5 leaf stage) and the second and third spray at 10 days interval depending upon disease severity]. Depending upon the weather conditions the sprays have to be increased

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

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

Yield

Seedless	:	15t / ha / year
Muscat	:	30t / ha / year
Pachadraksha	:	40t / 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**,** Banarasi, TRY(G) 1, Arka Kiran, Lalit.

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 – 6 m 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 (30 g / l) during flowering and fruit set stages.

Micronutrients spray for controlling bronzing of leaves: Spraying of a combination spray containing $ZnSO_4$, $MgSO_4$ and $MnSO_4$ @ 0.5% and $CuSO_4$ and $FeSO_4$ @ 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

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

After cultivation: 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 malathion 50 EC @ 2ml/lit or Spray Neem formulations @ 2ml/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.

Aphid:
Spray Monocrotophos 36 WSC @ 1ml/lit or dimethoate 30EC @ 2ml/lit.
Mealy bug:
Release *Cryptolaemous* predatory beetles @10/tree.
Fruit fly:
Collection and destruction of fallen fruits.
Set up methyl eugenol 0.1% solution mixed 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.
Stir the soil around the tree during pest incidence and dust carbaryl 10 D @ 10 kg/ac.
Neem oil @ 3.0 % as foliar spray as need based
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 / litre.

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

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

Yield: 25 t / ha.

Market information

Growing Districts	Dindigul, Madurai, Virudhunagar,Villupuram, Vellore, Tirunelveli
Major Markets in Tamil Nadu	Palani, Madurai, Koyambedu Wholesale Market

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 500 m to 700 m is ideal. A light well drained soil with pH of 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 6^{th} and 12^{th} month after planting. Apply as foliar spray 0.5% - 1.0 % Zinc sulphate and Ferrous solutions at 15 days interval to overcome the deficiencies in the early crop phase.

After cultivation: 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, provide adequate shade.

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.

Market information

Growing Districts	Namakkal, Dindigul, Kanyakumari
Major Markets in Tamil Nadu	Koyambedu Wholesale Market, Coimbatore
Grade Specification	Size, Shape, Maturity, free from disease, pest and blemishes Crowns should be trimmed to less than 10 cm and the stalk end trimmed to 5 -7 cm

Sapota: *Manilkhara achras;* Sapotaceae

Varieties: Oval, Cricket Ball, Kirtibarti, Guthi, CO 1, CO 2, CO 3**,** PKM 1, PKM 2, PKM 3, PKM 4, PKM (Sa) 5 and Kalipatti.

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

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

Season of planting: June – December

Spacing: 8 x 8 m (156 plants / ha) for conventional planting.
Adopt high density planting at 8 x 4 m (312 plants / ha) for high productivity

Planting: Dig pits of 1 m x 1 m x 1 m in 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 center 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	Ist 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 tip and incorporated.

After cultivation: Remove the root stock sprouts, water shoots, criss-cross and lower branches.

Inter cropping: Legumes and short duration vegetable crops may be raised as inter crop during pre-bearing stage.

Plant protection
Pests

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

Hairy caterpillars: Spray Chloropyriphos 20 EC or Phosalone 35 EC 2 ml / lit of water.
Bud worm: Spray 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 in air tight room 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). Alternatively, fruits can be exposed to ethylene gas at 100 – 200 ppm for 18 – 20 hrs to induce ripening.

Yield: 20-25 t / ha / year.

Market information

Growing Districts	Dindigul, Coimbatore, Virudhunagar, Theni, Namakkal
Major Markets in Tamil Nadu	Dindigul, Coimbatore, Anna fruit market, Koyambedu, Chennai
Preferred Varieties and hybrids	Cricket ball, PKM 1, Kalipatti, PKM 4
Grade Specification	Based on size and shape, large, medium and small

Papaya: *Carica papaya* L.; Caricaceae

Varieties: CO 2, CO 3 , CO 4, CO 5, CO 6, CO 7 and TNAU Papaya CO 8, CO 3 and CO 7 are gynodioecious (bisexual + female) types highly suitable for table purpose and CO 2, CO 5, CO 6 and CO 8 are dual-purpose varieties for table and papain production.
'Red Lady' is also being grown for commercial purposes.

Soil and Climate: It is a tropical fruit and grows well in regions where summer temperature ranges from 35^{o} C – 38^{o} 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 5-6 seeds in dioecious varieties and 3-4 seeds in gynodioecious varieties in polythene bags at a depth not exceeding one cm. Raise the seedlings in a protected structure to avoid Papaya Ring Spot Virus incidence. 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. Avoid planting in severe summer as well as in peak rainy season. Avoid water stagnation in the basin.

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.

Fertigation technique
Apply 10 litres of water per day + 13.5 g urea and 10.5 g muriate of potash / week through drip irrigation and soil application of super phosphate 300 g per plant at bimonthly intervals starting from 3-4 months after planting immediately after thinning of plants is recommended.

After cultivation: 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 0.5% Zinc sulphate and 0.1% Boric acid at 4^{th} and 8^{th} MAP to improve growth and yield.

Plant protection

Nematodes: To control in the nursery, apply Carbofuran 3 G @ 1 g / polythene bag after germination. Apply Neemcake @ 250 g per plant + Carbofuran 3G 1 g a.i / plant + *P. fluorescens* @ 4 g / plant to minimize reniform nematode population.

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.

Papaya ringspot virus disease: Raise papaya seedlings in insect proof net house. Grow two rows of border crop of maize one month before transplanting of seedlings. Apply FYM @10 kg / plant. For vector management, spray Dimethoate @1.5 ml / lit at monthly intervals up to 5 months after planting followed by Zinc sulphate(0.5%)+ Boran 0.1% at 4^{th} and 7^{th} month.

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
CO 8: 220 - 230 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 to 55^{o}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 sieves 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 “tuity fruity” or they can be allowed to ripen and made into other products. The CO 2, CO 5 and CO 8 varieties of papaya released by Tamil Nadu Agricultural University, Coimbatore are ideal for papain production.

Yield: The yield of crude papain is as follows: CO 2: 600 kg / ha, CO 5 & CO 8: 800 kg / ha.

Seed Technology

Germination improvement: Store the seeds in airtight containers. Soak the 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.

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) @ 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.

Pomegranate: *Punica granatum* L.; Punicaceae

Varieties: Jyothi, Ganesh, Araktha, Rudhra, Mirudhula, Bhagwa, Ruby.

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 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 (kg / plant)

Manures and Fertilizers	1st year (kg)	2nd to 5th year (kg)	6th year onwards (kg)
FYM	10.00	20.00	30.00
N	0.20	0.40	0.60
P	0.10	0.25	0.50
K	0.40	0.80	1.200

Training and pruning: Fruits are borne terminally on shoot 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 criss-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 predator *Chrysopherla carnea* @ 50 grubs/flowering branch four times at 10 days interval starting from flower initiation during April.
Fruit Borer:

- Remove calyx to discourage egg laying wherever possible
- Cover fruits with neem oil dipped cloth bags during flowering period to prevent egg-laying when the fruits are upto 5 cm diameter.
- Spray neem oil 3 % or NSKE 5% or spinosad @ 0.4 ml/lit at the time of butterfly activity. Repeat it if necessary twice at an interval of 15 days.
- Adopt ETL (5 eggs/plant with bearing capacity of 60 fruits)
- When the fruits are in marble stage, release *T. chilonis* @ 1 lakh/acre

Scales: Spray quinalphos 25 EC @ 2.5 ml per lit. of water

Yield: 20-25 t / ha / year.

Market information

Growing Districts	Dindigul, Erode, Coimbatore, Tirunelveli
Major Markets in Tamil Nadu	Coimbatore, Chennai
Preferred Varieties and Hybrids	Bhagwa, Ruby (IIHR)
Grade Specification	Size, Shape , Colour, Softness of seeds

Jack: *Artocarpus heterophyllus;* Moraceae

Varieties: Velipala, Singapore, Hybrid jack, Panruti selection, Thanjavur jack**,** Burliar 1, PLR 1 and PLR (J) 2 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.

Propagation

Soft wood grafting: Large scale propagation of jack can be done by cleft grafting during July - August on 4 month old seedling rootstock

Preparation of field and planting: Dig pits of 1 m x 1 m x 1 m in size. 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.

Sl. No	Manures & Fertilizers	1 year old (kg)	Annual Increase (kg)	6th year and above (kg)
1	FYM	10.00	10.00	50.00
2	N	0.15	0.15	0.75
3	P	0.08	0.08	0.40
4	K	0.10	0.10	0.50

Plant protection

Pest

Fruit borer*:* Apply Carbaryl 50 WP @ 2 g / lit.

Spittle bug: Spray Methyl parathion 50 EC @ 2 ml / lit or Methyl demeton 25 EC @ 2 ml / 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.

Market information

Growing Districts	Cuddalore, Kanyakumari, Dindigul, Pudukottai, Namakkal, Tirunelveli, Nilgiris
Major Markets in Tamil Nadu	Panruti, Coimbatore
Preferred Varieties and Hybrids	PLR 1 and Local

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 (kg / plant / year)

Manures and Fertilizers	1st year (kg)	2nd year onwards (kg)
FYM	20.00	50.00
N	0.20	0.50
P	0.10	0.20
K	0.20	0.50

Manuring to be given immediately after pruning. Spray 2% KNO_3 thrice at monthly intervals in January, February 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.
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.
.*Neem oil* @ 3.0 % as foliar spray as need based
Scale insects:
During pruning all the affected materials should be collected and burnt.
Spray quinalphos 25 EC @ 2.5 ml /lit of water
Leaf hopper: Spray chlorpyriphos 20 EC @1.5 ml per litre of water

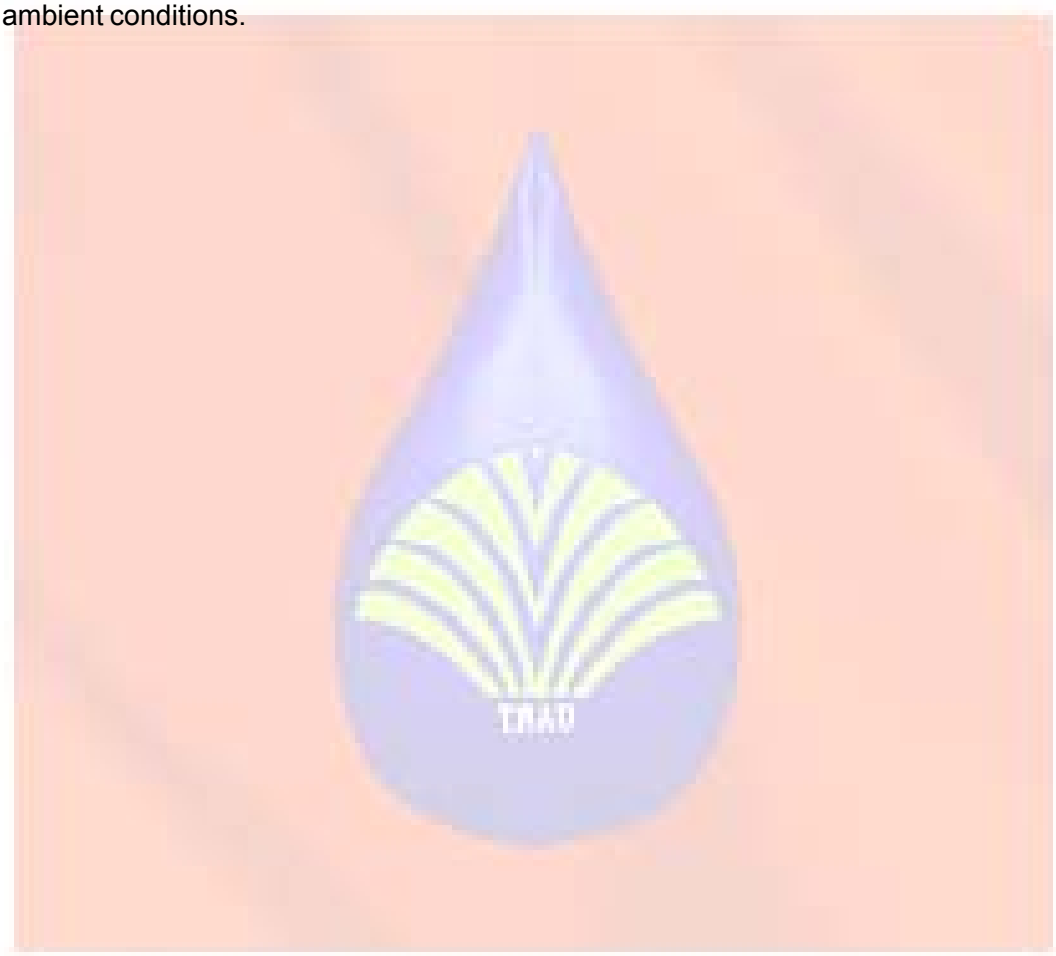
Diseases

Black leaf spot: Spray Carbendazim 1 g / lit or Chlorothalonil 2 g / lit or Propiconazole or Difenconazole 1 g / lit twice 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 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 sub tropical 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 m x 6 m in pits of 1 m x 1 m x 1 m or 1.25 m x 1.25 m x 1.25 m.

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

Manures and fertilizers (kg / plant / year)

Manures and Fertilizers	Bearing tree (kg)
FYM	10.00
N	0.20
P	0.50
K	0.20

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

Pests

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

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

Market information

Growing Districts	Tirunelveli, Dindigul, Sivagangai, Thoothukudi
Major Markets in Tamil Nadu	Koyambedu market, Chennai, Ottanchathiram
Preferred Varieties and Hybrids	BSR 1, NA-7

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: Irish Peach and Zouches Pipin.
Yield: April – May.

Mid season varieties: Carrington and Winterstein.
Yield: June – July.

Late varieties: Rome Beauty, Parlin's Beauty and KKL 1.
Yield: August – September.

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 center system. Prune the tree every December – January.

Plant Protection
Pests
Wooly aphids:
Use resistant rootstalks M 778, M 799, MM 104, MM 110, MM 112, MM 113, MM 114 and MM115.
The parasite *Aphelinus mali* and the coccinellid predators should be conserved in the field.
Apply carbofuran 3 % G @ 166 g/tree or phorate 10 % G @ 100 g/tree or spray any one of the following insecticide

Insecticide	Dose
Chlorpyrifos 20%EC	2.5 ml/lit.
Malathion 50%EC	1.0 ml/lit.
Oxydemeton –Methyl 25% EC	1.0 ml/lit.
Quinalphos 25%EC	2.0 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 - December.

Spacing: 5 x 5 m or 6 x 6 m in pits of 60 cm x 60 cm x 60 cm in 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: Prophylactic spraying with 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 and 30 to 40 kg per tree per year in William and Jargonelle.

Plum: *Prunus salicina L. ;* Rosaceae

Varieties

Early: Rubio.

Mid - season: Hale, Gaviota and Abundance.
(June – July)

Late: Shiro, Kelsey and Satsuma. Hale has to be planted along with other varieties to enhance pollination and fruit set (July – August).

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 in size.

Planting season: June - 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: 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.
Neem oil @ 3.0 % as foliar spray as need based

Yield: 25 – 30 kg / tree / year.

Peach: *Prunus persica;* Rosaceae

Varieties

Early: Floridasun.
(April – May)

Mid season: Shaw Pasand.
(June – July)
Late: Red Shanghai.
(July – August)

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.

Pest

Fruit Fly: 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.
.*Neem oil* @ 3.0 % as foliar spray as need based
Leaf curl aphids
Apply carbofuran 3 % G @ 33 kg /ha or spray Oxydemeton –Methyl 25 % EC @ 1.0 ml per litre of water

Diseases

Leaf curl: To control aphids spray Methyl dimeton 25 EC @ 2 ml / lit.

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

Yield: 10 – 15 kg / tree / year.

Trade Mark of TNAU

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 – June August - October	500 - 600 fruits / tree	-
Straw berry *(Fragaria vesca)*	Phenomen-al, Majestic, Chandler, Labella, Sujatha, Winter, Sweet charley	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 cavery	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 Swuarna roopa	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*)	Sour and sweet	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, Phosphobac-teria 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. Afte 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	-	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	Harvest from 3rd year onwardsFeb -- Mar-June-Au- gust	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: *Solanum lycopersicum* L.; Solanaceae

Varieties

PKM 1, CO 3 (Marutham) and Paiyur 1

Hybrids

COTH 2 and TNAU Tomato Hybrid CO 3

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

Nursery bed preparation

Apply FYM 10 kg, Neemcake 1 kg, VAM 50 g, enriched Superphosphate 100 g and Furadon 10 g per square metre before sowing.

Seed rate

Varieties	:	300-350 g / ha
Hybrids	:	100-150 g / ha

Seed treatment

Treat the seeds with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 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.

Protected nursery

- Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- Cover the nursery area with 50 % shade net and cover the sides using 40/50 mesh insect proof nylon net.
- Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- Mix sterilized cocopeat @ 300 kg with 5 kg neem cake along with *Azospirillum* and Phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protray. 238 protrays (98 cells) are required for the production of 23,334 seedlings, which are required for one hectare adopting a spacing of 90 x 60 x 60 cm in paired row system.

- Sow the treated seed in protrays @ one seed per cell.
- Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts
- After six days, place the protrays with germinated seeds individually on the raised beds inside the shade net
- Water with rosecan everyday and drench with NPK 19:19:19 @ 0.5% (5g/l) at 18 days after sowing

Field preparation

Plough the land to fine tilth. 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/ha of *Azospirillum* and 2 kg/ha of Phosphobacteria by mixing with 50 kg of FYM. Irrigate the furrows and transplant 25 days old seedlings on the sides of ridges. Life irrigation to be given on 3rd day of planting.

Spacing for varieties

PKM 1, Paiyur 1, COTH 2, TNAU Tomato Hybrid CO 3 : 60 x 45 cm
CO 3 : 45 x 30 cm

Mulching

Mulch with black LDPE sheets of 25 micron thickness and bury both the ends into the soil to a depth of 10 cm

Weed control

Apply Pendimethalin 1.0 kg a.i./ha or Fluchloralin 1.0 kg a.i / ha as pre-emergence herbicide, followed by hand weeding once at 30 days after planting.

Irrigation

After establishment of seedlings, irrigate at weekly intervals.

Layout and planting for drip irrigation & fertigation

- Apply FYM @ 25 t / ha as basal before last ploughing.
- Apply 2 kg/ha of *Azospirillum* and 2 kg/ha Phosphobacteria by mixing with 50 kg of FYM.
- Apply 75 % total recommended dose of superphosphate ie 1172 kg / ha as basal.
- Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of each bed.
- Before planting, wet the beds using drip system for 8-12 hrs.
- Planting to be done at a spacing of 90 x 60 x 60 cm in the paired row system, using ropes marked at 60 cm spacing.
- Spray Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i / ha as pre-emergence herbicide at 3rd day after planting.
- Gap filling has to be done at 7th day after transplanting.

Manuring

Varieties

Basal dose : FYM 25 t/ha, NPK 75:100:50 kg / ha
Borax 10 kg and Zinc sulphate 50 kg / ha

Top dressing : 75 kg N/ha on 30th day of planting or during earthing up.

Hybrids

Basal dose : FYM 25 t/ha, NPK 50:250:100 kg/ha
Borax 10 kg and Zinc sulphate 50 kg/ha

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

Fertigation schedule for tomato hybrids

Recommended dose: 200:250: 250 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient applied			% of requirement		
					N	P	K	N	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 13:0:45 Urea (46%N)	65.78 27.77 8.44	12.50 3.61 3.88	12.50 - -	12.50 12.50 -	10.00	5.00	10.00
					19.99	12.50	25.00			
2.	Flower initiation to flowering	30	12:61:0 13:0:45 Urea (46%N)	40.98 222.22 100.27	4.92 28.89 46.12	25.00 - -	- 100.00 -	40.00	10.00	40.00
					79.93	25.00	100.00			
3.	Flowering to fruit set	30	19:19:19 13.0:45 Urea (46%N)	65.78 138.88 63.90	12.50 18.05 29.39	12.50 - -	12.50 62.50 -	30.00	5.00	30.00
					59.94	12.50	75.00			
4.	Alternate day from picking	80	12:61:0 13:0:45 Urea (46%N)	20.49 111.11 50.14	2.46 14.44 23.06	12.50 - -	- 50.00 -	20.00	5.00	20.00
					39.96	12.50	50.00			
					199.82 or 200.00	62.50	250.00	100	25	100

75% of RD of P applied as superphosphate as basal application= 1172 kg/ha

1. 19:19:19 = 132 kg / ha
2. 12:61:0 = 62 kg / ha
3. 13:0:45 = 500 kg / ha
4. Urea = 223 kg / ha

Growth regulators

- Spray 1.25 ppm (625 ml in 500 litres of water) Triacontanol at 15 days after transplanting and at full bloom stage to increase the yield.

Training of hybrids

- Stake the plants 30 days after planting with 1 - 1.5 m tall stakes.
- Remove the side branches up to 20 cm from ground level.

Micronutrient spray

- Foliar spray of $ZnSO_4$ @ 0.5 per cent thrice at 10 days interval from 40 days after planting.
- Spray 19:19:19 + Mn @ 1 % at 60 days after planting.

Protected cultivation

Production practices for cultivation of tomato under shade net

During summer, the hybrid tomato can be grown in a shade level of 35 per cent under paired row planting system (80 x 40 x 60 cm - between pairs, rows and plants) with a basal application of 50 kg each of N and K and 250 kg of P / ha and fertigation of 200 kg each of N and K through straight fertilizers.

Protected cultivation of tomato in polyhouse

During rainy season, the indeterminate tomato hybrid has to be grown in the medium consisting of FYM : composted coir pith: sand (2:1:1) with irrigation regime of 20kPa and basal application of 50kg each of NPK/ha as straight fertilizers and 250 kg each of NPK as water soluble and straight fertilizers through fertigation along with black polyethylene mulch (50 microns)

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.
- Set up pheromone traps @ 12/ha.
- Collect and destroy damaged fruits and grown up caterpillars.
- Release *Trichogramma pretiosum* @ 1 lakh. /ha/release at an interval of 7 days starting from flower initiation stage.
- Release *Trichogramma chilonis* @ 50,000/ha/ release, coinciding with flowering time and based on ETL of 10% damage.
- For *Helicoverpa armigera:* H.a.NPV 1.5 x 10^{12} POBs/ha ie NPV of *H. armigera* 0.43% AS @ 3.0 ml/l or 2 % AS @ 1.0 ml per l
- For *Spodoptera litura*: S.l. NPV 1.5 x 10^{12} POBs/ha.
- Provide poison bait with carbaryl 50 WP 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 l/ha.
- Spray *Bacillus thuringiensis* 2g/l or any one of the following insecticide.

Insecticide	Dose
Azadirachtin 1.0 % EC (10000 ppm)	2.0 ml/ l
Indoxacarb 14.5 % SC	8 ml/10 l
Flubendiamide 20 WG	5 g/10 l
Flubendiamide 480 SC	2.5 ml/10 l
Novaluron 10 % EC	7.5 ml/10 .
Phosalone 35 % EC	13 ml/10 l
Quinalphos 20 % AF	1.5 ml/ l
Quinalphos 25 % EC	1.0 ml/ l

Serpentine leaf miner

Spray Neem Seed Kernel Extract 5 %.

Whitefly

1. Install yellow sticky traps @ 12 /ha to attract the adult.
2. Remove alternate weed host *Abutilon indicum*
3. Apply carbofuran 3 G @ 40 kg /ha or spray any one of the following insecticides

Insecticide	Dose
Dimethoate 30 % EC	1.0 ml/l.
Malathion 50 % EC	1.5 ml/ l.
Oxydemeton –Methyl 25 % EC	1.0 ml/ l.
Thiamethoxam 25 % WG	4.0 ml/10 l.

Nematode

Soil application of *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* as seed treatment @ 10 g/kg of seeds and soil application (SA) @ 2.5 kg / ha for the management root knot and reniform nematode infestation in soil and root.Application of liquid formulation of *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* @ 1000 ml/ha through drip irrigation for the management of root knot nematode in tomato.

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* through soil @ 2.5 kg/ha mixed with 50 kg of FYM. Avoid stagnation of water. Drench with Copper **Oxychloride at 2.5 g/l @ 4 l/sq.m.**

Leaf spot: Spray Zineb or Mancozeb @ 2 g/l.

Fusarial wilt and Root knot nematode: Soil solarization before preparation of nursery bed. Seed treatment with *Pseudomonas fluorescens* (PF) @ 10 g /kg of seed, followed by nursery application of Pf1@ 20 g/m^2 and seedling dip with Pf1 @ 5g/l along with soil application of Pf1 @ 2.5 kg mixed with 50 kg FYM /ha at 30 days of transplanting.

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

Tomato spotted wilt virus:

Carbofuran 3 G @ 33 kg/ha in nursery at sowing and second application @ 40 kg /ha on 10 days after transplanting in main field and 3 sprays of phosalone 35 EC @ 1.5 ml/lit @ 25, 40, 55 days after transplanting.

Peanut bud necrosis virus: Selection of healthy seedlings and rouging of PBNV infected plants up to 45 days of planting. Apply 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 Dimethoate 30 EC 1 ml/l or Methyl demeton 25 EC 1 ml/l or Phosphomidan 1.0 ml/l @ 25, 40 and 55 days after transplanting.

Duration

110- 115 days from transplanting (135 - 140 days from sowing)

Yield

Varieties : 30-40 t / ha
Hybrids : 80-95 t / ha

Boom flower – N spray at 2ml / litre in three sprays – 30 days, 55 days and 75 days after planting increase the yield.

IPM Package for Tomato

- Seed treatment with *Pseudomonas fluorescens* @ 10g/kg of seeds
- Nursery application with *Trichoderma viride* and *Pseudomonas fluorescens*
- Application of Neem cake @ 250kg/ha
- Soil application of *Pseudomonas fluorescens* @ 2.5kg/ha
- Selection of good and virus disease free seedlings for planting
- Roguing out of virus infected plants upto 45 days of transplanting
- Grow marigold as a border crop
- Set up *Helicoverpa* / *Spodoptera* pheromone traps @ 12 numbers / ha
- Release *Trichogramma chilonis* @ 50000/ha
- Install yellow sticky traps
- Spraying Neem formulations (1%) / Neem seed kernel extract (5%)

Brinjal: *Solanum melongena L. ;* Solanaceae

Varieties

CO 2, MDU 1, PKM 1, PLR 1, PLR (B) 2, KKM 1, PPI 1, Annamalai and TNAU Brinjal VRM 1, hybrids coBH 2.

Soil

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

Season of sowing

December – January and May – June

Nursery bed preparation

Apply FYM 10 kg, neem cake 1 kg, VAM 50 g, enriched super phosphate 100 g and furadon 10 g per square metre before sowing. Area required for raising seedling for planting 1.0 ha is 100 sq.m.

Seed rate

Varieties : 400 g / ha
Hybrids : 200 g / ha

Seed treatment

Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g / kg of seed. Treat the seeds with *Azospirillum* @ 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.

Protected nursery

- Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- Cover the nursery area with 50 % shade net and cover the sides using 40 / 50 mesh insect proof nylon net.
- Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- Mix sterilized cocopeat @ 300 kg with neem cake 5 kg along with *Azospirillum* and phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protray. 200 protrays are required for the production of 18,700 seedlings, which is required for one hectare adopting a spacing of 90 x 60 x 75 cm in paired row system.
- Sow the treated seeds in protrays @ 1 seed per cell.
- Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts.
- After 6 days, place the protrays with germinated seeds individually on the raised beds inside the shade net.
- Water with rose-can everyday and drench with 19:19:19 @ 0.5% (5g/l) at 18 days after sowing.

Field preparation

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 / ha of *Azospirillum* and 2 kg / ha of Phosphobacteria by mixing with 50 kg of FYM. Irrigate the furrows and transplant 30-35 days old seedlings at 60 cm apart on the ridges.

Spacing

Varieties **:** 60 x 60 cm

Hybrids : 90 x 60 cm

Mulching

Mulch with black LDPE sheets of 25 micron thickness and bury both the ends into the soil to a depth of 10 cm.

Weed control

Apply Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i / ha as pre-emergence herbicide, followed by hand weeding once at 30 days after planting.

Irrigation

After establishment of seedlings, irrigate at weekly intervals.

Layout and planting for drip irrigation and fertigation

- Apply FYM @ 25 t / ha as basal dose before last ploughing.
- Apply 2 kg/ha of *Azospirillum* and 2 kg/ha Phosphobacteria by mixing with 50 kg of FYM.
- Apply 75 % total recommended dose of superphosphate i.e. 703 kg / ha as basal.
- Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of the each bed.
- Before planting, wet the beds using drip system for 8-12 hrs.
- Planting to be done at a spacing of 90x60x75 cm in the paired row system, using ropes marked at 75 cm spacing.
- Spray Pendimethalin 1.0 kg a.i./ha or Fluchloralin 1.0 kg a.i/ha as pre-emergence herbicide at 3rd day after planting.
- Gap filling to be done at 7th day after transplanting.

Manuring

Apply 2 kg each of *Azospirillum* and *Phosphobacteria* in the mainfield at planting.

Varieties

Basal dose : FYM 25 t/ha, NPK 50:50:30 kg/ ha.
Top dressing : 50 kg N/ha on 30th day of planting or during earthing up.

Hybrids

Basal dose : FYM 25 t/ha, NPK 100:150:100 kg/ha.
Top dressing : 100 kg N/ha on 30th day of planting or during earthing up.

Fertigation schedule for hybrids

Recommended dose: 200:150: 100 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient applied			% of requirement		
					N	P	K	H	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 +MN 13:0:45 Urea	39.47 5.50 25.65	7.50 0.70 11.80	7.50 - -	7.50 2.50 -	10.00	5.00	10.00
				Subtotal	20.00	7.50	10.00			
2.	Vegetative stage	30	12:61:0 13:0:45 Urea	24.50 88.89 142.4	2.94 11.56 65.50	15.00 - -	40.00 - -	40.00	10.00	40.00
				subtotal	80.00	15.00	40.00			
3.	Flower initiation to first picking	30	19:19:19 +MN 13.0:45 Urea	39.47 50.00 100.00	7.50 6.50 46.00	7.50 - -	7.50 22.50 -	30.00	5.00	30.00
				subtotal	60.00	7.50	30.00			
4.	Harvesting	80	12:61:0 13:0:45 Urea	12.30 44.40 71.13	1.48 5.80 32.72	7.50 - -	- 20.00 -	20.00 - -	5.00	20.00
				subtotal	40.00	7.50	20.00			
					200.00	37.50	100.00	100	25	100

75% RD of Phosphorus applied as superphosphate = 703 kg / ha.

1. 19:19:19 = 79 kg / ha
2. 13:0:45 = 189 kg/ ha
3. 12:61:0 = 37 kg / ha
4. Urea = 340 kg / ha

Growth regulators

Spray 2 ppm (1 ml in 500 lit) Triacontanol plus Sodium Borate or Borax 35 mg/l of water 15 days after transplanting and at the time of full bloom to increase the yield.

After cultivation

Hand weeding, top dressing and earthing up on 30th day of planting.

Plant protection

Pests

Epilachna beetle

1. Collect the beetles, grubs, pupae and destroy.
2. Spray any one of the following insecticide

Insecticide	Dose
Azadirachtin 0.03 % WSP (300 ppm)	5.0 g/lit.
Quinalphos 20 % AF	1.7 ml/lit.
Triazophos 40 % EC	2.5 ml/lit.

Whitefly

Monitor the whitefly with yellow sticky trap @ 12/ha. Spray Neem oil 3% plus Teepol 1 ml/lit or spray Neem Seed Kernel Extract 5 % or spray any one of the following insecticides.

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Insecticide	Dose
Diafenthiuron 50 % WP	8.0 g/10 lit.
Phosphamidon 40 % SL	1.5 ml/lit.
Thiamethoxam 25 % WG	4.0 g/10 lit.

Shoot & fruit borer

1. Remove the affected terminal shoot showing boreholes.
2. Remove the affected fruits and destroy.
3. Avoid using synthetic pyrethroids.
4. Spray Neem Seed Kernel Extract 5 % or any one of the following chemicals starting from one month after planting at 15 days interval

Insecticide	Dose
Azadirachtin 1.0% EC (10000 ppm)	3.0 ml/lit.
Azadirachtin 0.03 % WSP (300 ppm)	5.0 g/lit.
Chlorpyrifos 20 % EC	1.0 ml/lit.
Dimethoate 30 % EC	7.0 ml/10 lit.
Emamectin benzoate 5 % SG	4 g/10 lit.
Flubendiamide 20 WDG	7.5 g/10 lit.
Phosalone 35 % EC	1.5 ml/lit.
Quinalphos 20 % AF	1.7ml/ lit.
Quinalphos 25 % EC	1.5 ml/lit.
Thiodicarb 75 % WP	2.0 g/lit.
Thiometon 25 % EC	1.0 ml/lit.
Trichlorofon 50 % EC	1.0 ml/lit.
Triazophos 40 % EC	2.5 ml/lit.

Aphid: Release 1st instar larvae of Green lace wing predator (*Chrysoperla carnea*) @ 10,000/ ha. Apply phorate 10 % G @ 15 kg /ha or spray any one of the following insecticide.

Insecticide	Dose
Phosphamidon 40 % SL	1.5 ml/lit.
Thiometon 25 % EC	1.0 ml/lit.

Red Spider mite:

Apply phorate 10 % G @15 kg /ha or spray any one of the following insecticide

Insecticide	Dose
Dicofol 18.5 % SC	2.0 ml/lit.
Spiromesifen 22.9 % SC	8.0 ml/10 lit.

Diseases

Damping off: Treat the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* @ 10g /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 dimethoate 30 EC @ 1.0 ml/lit. to control the vector**.**

Yield:
Varieties : 25 - 30 t/ha
Hybrids : 60 - 80 t/ha

Market information

Crop Growing districts	Vellore, Salem, Krishnagiri, Dindigul, Coimbatore
Major markets in Tamil Nadu	Ottanchatram, Dindigul, Tirunelveli, Tuticorin and Nagercoil
Grade Specification	Colour, Size, Glossy, smooth and tender. Colour: light purple or dark purple, green, purple coloured with white stripes. Size: 25-30 cm long, oblong or round.

IPM Package for Brinjal

- Seed treatment with *Trichoderma viride* (4g/kg) and *Pseudomonas* @ 10 g/ kg of seed
- Nursery + seedling dip treatment with *Pseudomonas* @ 10 g/ lit of water
- Soil application with Neemcake @250 kg/ha
- Maize as boarder crop against movement of whiteflies/ *Liriomyza*
- Use of yellow sticky traps against White flies and *Liriomyza*
- Clipping of shoot borer infested terminals
- *Leucinodes* adult monitoring with pheromone traps
- *Trichogramma* release after each brood emergence of *Leucinodes*
- Application of Neem oil formulations 10000ppm @1% / Neem seed kernel extract (5%)

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

Varieties

Arka Anamika, Arka Abhay and Parbhani Kranti

Hybrid

COBhH 1

Soil

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

Season of sowing

June - August and February

Seed rate

Varieties **:** 8.0 kg / ha
Hybrids **:** 2.5 kg / ha

Seed treatment

Seed treatment with *Tricoderma viride* @ 4 g/kg or *Pseudomonas fluorescens* @ 10 g/ kg of seeds and again 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.

Field preparation

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

Sowing

Sow three seeds per hill at 30 cm apart and then thin to 2 plants per hill after 10 days.

Spacing : 45 x 30 cm

Layout and sowing for drip irrigation and fertigation

- Apply FYM @ 25 t / ha as basal before last ploughing.
- Apply 2 kg/ha of *Azospirillum* and 2 kg/ha Phosphobacteria by mixing with 50 kg of FYM.
- Apply 75 % total recommended dose of super phosphate ie 469 kg / ha as basal.
- Form raised beds of 120 cm width at an interval of 30 cm.
- Install the drip irrigation with main and sub main pipes and place lateral tubes at the centre of the each bed at an interval of 1.5 m.
- Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- Before planting, wet the beds using drip system for 8-12 hrs.
- Sowing to be done at a spacing of 90 x 45 x 45 cm in the paired row system, using ropes marked at 45 cm spacing.
- Spray Oxyflourfen at 0.15 kg ai / ha or Fluchloralin @ 1.0 kg ai / ha or Metolachlor @ 0.75 kg a.i / ha as pre emergence application on third day of sowing.
- Gap filling to be done at 7th day after transplanting.

Irrigation

After germination, irrigate at weekly intervals.

Application of fertilizers

Apply *Azospirillum* and *Phosphobacteria* each at 2 kg/ha mixed with 100 kg of FYM before sowing.

Varieties

Basal dose FYM @ 25 t/ha, N @ 20 kg, P @ 50 kg and K @ 30 kg/ha as basal and 20 kg N/ha at 30 days after sowing.

Hybrids

Basal dose FYM @ 40 t / ha, N @ 100 kg, P @ 100 kg and K @ 100 kg/ha as basal and 100 kg N / ha 30 at days after sowing.

Foliar nutrition

1 % urea (10 g/l) + muriate of potash (10 g/l) on 30 and 45 days after planting.
For hybrids, foliar application of water soluble fertilizer 19-19-19 three times @ 0.5% (5 g/l) at 10 days interval from 30 days after planting.

Fertigation schedule for hybrids

Recommended dose: 200:100: 100 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient applied			% of requirement		
					N	P	K	H	P	K
1.	Sowing to plant establishment stage	10	19:19:19 +MN 13:0:45 Urea	26.30 5.50 25.65	7.50 11.10 29.48	5.00 - -	5.00 5.00 -	10.00	5.00	10.00
				Subtotal	20.00	5.00	10.00			
2.	Flower initiation to flowering stage	30	12:61:0 13:0:45 Urea	16.39 88.88 144.52	1.97 11.55 66.48	10.00 - -	- 40.00 -	30.00	10.00	30.00
				Subtotal	80.00	10.00	40.00			
3.	Flowering to fruit set	30	19:19:19 +MN 13.0:45 Urea	26.30 55.55 103.87	5.00 7.22 47.78	5.00 - -	5.00 25.00 -	30.00	5.00	30.00
				Subtotal	60.00	5.00	30.00			
4.	Alternate days from picking	30	12:61:0 13:0:45 Urea	8.20 44.44 72.26	0.98 5.78 33.24	5.00 - -	- 20.00 -	30.00 - -	5.00	30.00
				Subtotal	40.00	5.00	20.00			
	Total duration	100			200.00	25.00	100.00	100	25	100

75% RD of Phosphorus applied as super phosphate = 469 kg/ha.

1. 19:19:19 = 54 kg / ha
2. 13:0:45 = 200 kg / ha
3. 12:61:0 = 25 kg / ha
4. Urea = 350 kg / ha

Weed control

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

Plant protection

Pests

Fruit borers

Integrated pest management

1. Set up pheromone trap @ 12 / ha.
2. Collect and destroy affected fruits.
3. Release egg parasite *Trichogramma chilonis* @ 1.0 lakh / ha.
4. Release 1st instar larvae of green lace wing predator *Chrysoperla carnea* @ 10,000/ha.
5. Dust carbaryl 10 % DP @ 25 kg / ha or spray *Bacillus thuringiensis* @ 2 g/l or spray any one of the following insecticide:

Insecticide	**ml or g / l.**
Azadirachtin 0.03% WSP (300 ppm)	5.0 g / l.
Azadirachtin 5% Neem Extract Concentrate	5.0 ml /10 l.
Emamectin benzoate 5 % SG	3.0 g /10 l.
Phosalone 35 % EC	1.5 ml / l.
Pyridalyl 10 % EC	1.0 ml / l.
Quinalphos 20 % AF	1.5 ml / l.
Quinalphos 25 % EC	8.0 ml /10 l.

Leaf hopper

Treat the seeds with imidacloprid 48 % FS or 70 % WS @ 7 g / kg or Thiamethoxam 70 % WS @ 2.8 g / kg of seed.

Dust carbaryl 5 % DP @ 20 kg /ha or carbaryl 10 % DP @ 25 kg /ha or apply carbofuran 3 % G @ 33 kg /ha or spray any one of the following insecticides.

Insecticide	**ml or g / l.**
Imidacloprid 70% WG	0.7 g /10 l.
Imidacloprid 17.8% SL	2 ml/10 l.
Thiamethoxam 25%WG	1.0 g /10 l.
Azadirachtin 0.03% WSP	5.0 g / l.
Azadirachtin 5% Neem Extract Concentrate	5.0 ml /10 l.
Dimethoate 30 % EC	2.0 ml / l.
Malathion 50 % EC	1.25 ml / l.
Oxydemeton – Methyl 25 % EC	1.6 ml / l.
Quinalphos 25 % EC	1.0 ml / l.

Diseases

Yellow vein mosaic virus: Spray systemic insecticides like Methyl demeton or Dimethoate @ 2 ml / l to kill the insect vector, whitefly.

Powdery mildew: Dust Sulphur 25 kg / ha or spray Dinocap 2 ml / l or Tridemorph 0.5 ml / l or Carbendazim 1 g / l or Wettable sulphur 2 g / l or Triademephon 0. 5g / l immediately after noticing the disease and repeat after 15 days if necessary.

Yield

12 - 15 t / ha

Market information

Crop Growing districts	Vellore, Salem, Coimbatore, Dindigul
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	Light green or dark green, hairy or tender smooth surface, 5-ridged and remain tender for a longer period, medium length.

IPM **practices** Package for Bhendi

- Seed treatment with *Trichoderma viride* (4g/kg) and *Pseudomonas (*10 g/ kg)
- Soil application of *Pseudomonas* and *Trichoderma* (each2.5kg/ha)
- Soil application with Neem cake @250 kg/ha
- Maize as border crop against movement of whiteflies/ *Liriomyza*
- Use of yellow sticky traps
- Periodical removal of yellow vein mosaic virus infected plants
- *Helicoverpa* and *Earias* adult monitoring with pheromone traps
- *Trichogramma* release after each brood emergence of *Helicoverpa* and *Earias*
- Application of Neem oil formulations 10000ppm @1% / Neem seed kernel extract (5%)

Chillies: *Capsicum annuum* L.; Solanaceae

Varieties

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

Hybrids

TNAU Chilli Hybrid CO 1

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

Season of sowing : January – February, June – July and September - October

Seed rate

Varieties	**:** 1.0 kg / ha.
Hybrids	: 200 - 250 g / ha.
Nursery area	: 100 sq.m / ha.

Seed treatment

Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 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 @ 2.5 g/l of water at 15 days interval against damping off disease. Apply Carbofuran 3 G at 10 g/sq.m. at sowing.

Protected nursery

- Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- Cover the nursery area with 50 % shade net and cover the sides using 40 / 50 mesh insect proof nylon net.
- Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- Mix sterilized cocopeat @ 300 kg with 5 kg neem cake along with *Azospirillum* and phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protay. 300 protrays (98 cells) are required for the production of 29,000 seedlings, which are required for one hectare adopting a spacing of 90 x 60 x 45 cm in a paired row system.
- Sow the treated seed in protrays @ 1 seed per cell.
- Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts.
- After 6 days place the protrays with germinated seedlings individually on the raised beds inside the shade net .
- Water with rose can everyday upto seed germination. Drench with 19:19:19 @ 0.5% (5g/l) at 18 days after sowing.

Field preparation

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/ha of *Azospirillum* and 2 kg / ha of Phosphobacteria by mixing with 20 kg of FYM. Irrigate the furrows and transplant 40-45 days old seedlings, with the ball of earth on the ridges.

Spacing

Varieties	**:** 60 x 45 cm
Hybrids	: 75 x 60 cm

Weed control

Apply Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i. / ha as pre-emergece herbicide followed by hand weeding once 30 days after planting.

Irrigation

Irrigate at weekly intervals.

Layout and planting for drip irrigation and fertigation

- Apply FYM @ 25 t / ha as basal before last ploughing.
- Apply 2 kg / ha of *Azospirillum* and 2 kg/ha Phosphobacteria by mixing with 20 kg of FYM.
- Apply 75 % total recommended dose of superphosphate *i.e.* 375 kg / ha as basal.
- Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of the each bed.
- Before planting wet the beds using drip system for 8-12 hrs.
- Planting to be done at a spacing of 90 x 60 x 45 cm in the paired row system, using ropes marked at 60 cm spacing.
- Spray Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i / ha as pre-emergence herbicide at 3rd day after planting.
- Gap filling to be done at 7th day after transplanting.

Manuring

Varieties

Basal dose	: FYM 25 t/ha, NPK 30:60:30 kg/ ha. Potassium as K_2SO_4 for quality improvement. Application of potassium in the form of potassium sulphate will increase quality of chilli.
Top dressing	: 30 kg N/ha in equal splits on 30, 60 and 90 days after planting.

Hybrids

Basal dose	: FYM 30 t / ha, NPK 30:80:80 kg / ha.
Top dressing	: 30 kg N / ha in equal splits on 30, 60 and 90 days after planting.

Fertigation schedule
CHILLI F1 HYBRID
Recommended Dose: 120:80:80 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient supplied			% requirement		
					N	P	K	H	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 MN 13:0:45 Urea	21.05 8.88 14.86	4.00 1.15 6.83	4.00 - -	4.00 3.98 -	10.00	5.00	10.00
				Subtotal	11.98	4.00	7.98			
2.	Flower initiation to flowering	30	12:61:0 13:0:45 Urea	13.11 71.04 80.72	1.57 9.24 37.13	8.00 - -	- 31.97 -	30.00	10.00	20.00
				Subtotal	47.94	8.00	31.97			
3.	Fruit set to first picking	30	19:19:19 13.0:45 Urea	21.05 44.40 56.91	4.00 5.77 26.18	4.00 - -	4.00 19.98	30.00	5.00	20.00
				Subtotal	35.95	4.00	23.98			
4.	Alternate day from picking	80	12:61:0 13:0:45 Urea	6.52 35.52 40.38	0.75 4.62 18.57	3.81 - -	- 15.98 -	30.00	5.00	50.00
				Subtotal	23.94	3.81	15.98			
					119.81 (or) 120.00	19.81 (or) 20.00	79.91 (or) 80.00	100.00	25.00	100.00

75% RD of Phosporous applied as superphosphate = 375 kg / ha

1. 19:19:19 = 42 kg/ha
2. 13:0:45 = 160 kg/ha
3. 12:61:0 = 20 kg/ha
4. Urea = 193 kg/ha

Effect of Endo root soluble and Mycorrhizae on Chilli

Apply 250g of Endo Roots Soluble in two splits doses at 15 DAT and 45 DAT along with 100 % N and K and 50% P for higher yield and saving of Phosphorous.

Apply 250g of Mycorrhiza in two splits at transplanting and 30 DAT along with 100% N and K and 50% P for higher yield and saving of Phosphorous.

Growth regulators

- Spray Triacontanol @ 1.25 ml/l on 20, 40, 60 and 80th day of planting. Spray NAA 10 ppm (10 mg/l of water) on 60 and 90 days after planting to increase fruit set.

Micronutrient spray

- Foliar spray of Zn SO_4 @ 0.5 per cent thrice at 10 days interval from 40 days after planting.
- Spray 19:19:19 + Mn @ 1 % at 60 days after planting.

Weed control

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

Plant protection
Pests

Fruit borer: Integrated pest management of fruit borer:

1. Set up pheromone traps for *Helicoverpa armigera / Spodoptera litura* @ 12 no. / ha.
2. Collection and destruction of damaged fruits and grown up caterpillars.
3. Spray *Bacillus thuringiensis* @ 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 or spray any one of the following insecticide.

Insecticide	Dose
Emamectin benzoate 5 % SG	4 g/10 lit.
Fipronil 5 % SC	2.0 ml /lit.
Flubendiamide 20 WDG	6.0 g /10 lit.
Flubendiamide 480 SC	2.5 ml /lit
Indoxacarb 14.5 % SC	6.5 ml /10 lit.
Novaluron 10 % EC	7.5 ml /10 lit.
Spinosad 45 % SC	3.2 ml /10 lit.
Thiodicarb 75 % WP	2.0 g /lit.

Thrips:

- Grow Agathi as Intercrop.
- Treat seeds with imidacloprid 70% WS @ 12 g /kg of seed.
- Apply carbofuran 3% G @ 33 kg /ha or phorate 10 % G @ 10 kg/ha or spray any one of the following insecticide.

Insecticide	Dose
Imidacloprid 17.8 % SL	3.0 ml /10 lit.
Dimethoate 30 % EC	1.0 ml /lit.
Emamectin benzoate 5 % SG	4 g /10 lit.
Ethion 50 % EC	2.0 ml /lit.
Fipronil 5 % SC	1.5 ml /lit.
Oxydemeton –Methyl 25 % EC	1.0 ml /lit.
Phosalone 35 % EC	2.0 ml /lit.
Spinosad 45 % SC	3.2 ml /10 lit.
Thiacloprid 21.7 % SC	6.0 ml /10 lit.

Aphids:

- Treat seeds with imidacloprid 70% WS @12 g /kg of seed.
- Apply phorate 10 % G @ 10 kg/ha or spray any one of the following insecticide.

Insecticide	Dose
Carbosulfan 25 % EC	1.0 ml /lit.
Fipronil 5 % SC	1.0 ml /lit.
Imidacloprid 17.8 % SL	3.5 ml /10 lit.
Oxydemeton – Methyl 25% EC	1.6 ml /lit.
Phosalone 35 % EC	2.0 ml /lit.
Quinalphos 25 % Gel	1.0 ml /lit.
Quinalphos 25 % EC	1.0 ml /lit.

Yellow Muranai mite:

Apply phorate 10 % G @ 10 kg/ha or spray any one of the following insecticide:

Insecticide	Dose
Buprofezin 25 % SC	8.0 ml /10 lit.
Diafenthiuron 50 % WP	8.0 g /10 lit.
Dimethoate 30 % EC	1.0 ml /lit.
Ethion 50 % EC	2.0 ml /lit.
Fenazaquin 10 % EC	2.0 ml /lit.
Fenpyroximate 5 % EC	1.0 ml /lit.
Hexythiazox 5.45 % EC	8.0 ml /10 lit.
Milbemectin 1 % EC	6.5 ml /10 lit.
Oxydemeton –Methyl 25 % EC	2.0 ml /lit.
Phosalone 35 % EC	1.3 ml /lit.
Propargite 57 % EC	2.5 ml /lit.
Quinalphos 25 % EC	1.5 ml /lit.
Spiromesifen 22.9 % SC	5.0 ml /10 lit.

Aphids and Thrips:

Spray neem oil 1% or neem cake extract 5% to control aphids and thrips.

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 controlling the vector.

Yield

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

Hybrids : 25 t / ha of green chillies.

Market information

Crop Growing districts	Ramanathapuram (samba), Thoothukudi (gundu), Sivagangai (samba), Virudhunagar (samba), Tirunelveli (samba)
Major markets in Tamil Nadu	Virudhunagar, Chennai, Ramanad, Paramkudi, Thoothukudi
Grade Specification	i. Dry Chilli Well dried -12 % moisture Big size Bright red colour without white chillies Uniform size Length - 1.5-2 inches ii. Green Chilli Pungency

Capsicum (Sweet pepper / Bell pepper): *Capsicum annuum ;* Solanaceae

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

Soil **:** Well drained loamy soil rich in organic matter.

Season of sowing **:** September - February

Seed rate

Varieties **:** 1.25 kg/ha
Hybrids : 200 g / ha

Nursery **:** 3 cents /ha

Treat the seeds with of Carbendazim @ 2 g /kg of seed and sow in lines across the bed at a spacing of 2.5 cm and then cover with top soil and then paddy straw. Watering with rose can has to be done daily. On 20th day of sowing, 300g of carbofuran 3G granules have to be applied in between the seedling lines across the bed, the soil has to be stirred and then the beds are irrigated.

Protected nursery

- Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- Cover the nursery area with 50 % shade net and cover the sides using 40/50 mesh insect proof nylon net.
- Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- Mix sterilized cocopeat @ 300 kg with 5 kg neem cake along with *Azospirillum* and phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protray. 238 protrays (98 cells) are required for the production of 23,334 seedlings, which are required for one hectare adopting a spacing of 90 x 60 x 60 cm in a paired row system.
- Sow the treated seed in protrays @ 1 seed per cell.
- Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts.
- After 6 days, place the protrays with germinated seeds individually on the raised beds inside the shade net.
- Water with rose-can everyday and drench with 19:19:19 @ 0.5% (5g/l) at 18 days after sowing.

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.

Layout and planting for drip irrigation and fertigation

- Apply FYM @ 25 t / ha as basal before last ploughing.
- Apply 2 kg/ha of *Azospirillum* and 2 kg/ha of Phosphobacteria by mixing with 20 kg of FYM.
- Apply 75 % total recommended dose of super phosphate ie 703 kg / ha as basal.
- Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of the each bed.
- Before planting, wet the beds using drip system for 8-12 hrs.
- Planting to be done at a spacing of 90 x 60 x 60 cm in the paired row system, using ropes marked at 60 cm spacing.
- Spray Pendimethalin 1.0 kg a.i. /ha or Fluchloralin 1.0 kg a.i/ha as pre-emergence herbicide at 3rd day after planting.
- Gap filling to be done at 7th day after transplanting.

Application of fertilizers

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

Fertigation schedule for capsicum F1 Hybrid
Recommended dose: 250:150:150 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient supplied			% requirement		
					N	P	K	N	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 MN 13:0:45 Urea	39.47 16.66 33.28	7.50 2.16 15.30	7.50 - -	7.50 7.50 -	10.00	5.00	10.00
				Subtotal	24.96	7.50	15.00			
2.	Vegetative stage	30	12:61:0 13:0:45 Urea	24.60 133.33 173.00	2.95 17.33 79.58	15.00 - -	- 60.00 -	30.00	10.00	20.00
				Subtotal	99.86	15.00	60.00			
3.	Flower initiation to first picking	30	19:19:19 13.0:45 Urea	39.47 83.33 122.97	7.50 10.83 56.57	7.50 - -	7.50 37.50 -	20.00	5.00	20.00
				Subtotal	74.90	7.50	45.00			
4.	Harvesting stage	95	12:61:0 13:0:45 Urea	12.30 66.66 86.51	1.48 8.67 39.79	7.50 - -	- 30.00 -	40.00	5.00	50.00
				Subtotal	49.94	7.50	30.00			
	Total	165			249.66 (or) 250.00	37.50	150.00	100.00	25.00	100.00

75% RD of Phosporous applied as super phosphate = 703 kg / ha

1.	19:19:19	=	79 kg /ha
2.	13:0:45	=	300 kg /ha
3.	12:61:0	=	37 kg /ha
4	Urea	=	416 kg /ha

Weed control

On 30th day, hoeing and weeding has to be done once and the plants are earthed up.

Growth regulator

Spray 1.25 ppm Triacontanol (12.5 mg /10 l of water) on 20th, 40th, 60th and 80th day after transplanting. Spray NAA 10 ppm (10 mg/l of water) on 60 and 90 days after planting.

Diseases

Powdery mildew: Spray wettable sulphur @ 2g /l

Dieback and fruit rot: Spray Mancozeb @ 2g /l

Harvest and yield

Harvest fully matured green fruits before ripening. Yield: 15 tonnes/ha in 150-160 days.

Paprika: *Capsicum annuum* var. *grossum*; 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 of sowing **:** 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 fertilizers

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 and 40 kg N and 40 kg K / ha six weeks after transplanting as top dressing.

Diseases

Anthracnose: Spray Mancozeb 2 g/l.

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

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 (3 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 mixture as basal and 10 g of N per pit after 30 days of planting. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha such and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

After cultivation

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

Quality seedling production

Nursery raising

In hi-tech horticulture, use 12 days old healthy seedlings obtained from shade net houses for planting. Raise the seedlings in protrays having 98 cells. Use well decomposed cocopeat as medium. Sow one seed per cell. Water regularly twice a day.

Fertigation

Apply a dose of 60:30:30 kg NPK/ha throughout the cropping period through split application. Apply 75% of the phosphorus as superphosphate as basal dose.

Pests and diseases

Beetles and caterpillars: Spray Dichlorvos 76% EC @ 6.5 ml/10 l or Trichlorofen 50% EC @ 1.0 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 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 absorbent cotton. 50 traps are required per ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.
5).Neem oil @ 3.0 % as foliar spray as need based

Do not use, copper and sulphur dust. These are phytotoxic

Diseases

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

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

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

Market information

Crop Growing districts	Coimbatore, Tiruppur, Theni, Dindigul
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	Clean and glossy, bright appearance, peel changes from green to yellow, yellowish flesh colour

Snake gourd: *Trichosanthes cucumerina.* L. Cucurbitaceae

Varieties: CO1,CO 2, PKM 1, PLR 1 and PLR 2.

Soil

Sandy loam rich in organic matter with good drainage and a pH range of 6.5-7.5.

Season and sowing: July and January.

Sow the seeds (3 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 mixture as basal dose per pit and N @ 10 g pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

After cultivation

Hoe and weed thrice. Provide stakes for the plants to reach the pandal (2 m). Spray Ethrel 100 ppm (1 ml in 10 l of water) four times starting from 10 to 15 days after sowing at weekly intervals.

Quality seedling production

Nursery raising

Sow the snake gourd seeds in protrays containing well decomposed cocopeat medium. Sow only one seed per cell. Keep the trays under shadenet house. Water regularly with the help of rose can. Transplant about 12 days old seedlings to main field.

Planting

Spread the lateral tubes on the raised beds of 120cm wide at 150cm spacing. Irrigate the beds by operating the drip system continuously for 8-12 hrs. Plant the seedlings in the holes made at 60cm spacing.

Fertigation

Apply a dose of 75:100:100 kg NPK/ha throughout the cropping period through split application. Apply 75% of the phosphorus as superphosphate as basal dose.

Plant protection

Pests

Leaf beetles and leaf caterpillars: Spray Dichlorvos 76% EC 6.5 ml/10 lit or Trichlorofon 50% EC 1.0 ml/l.

Fruit fly

- Collect the damaged fruits and destroy.
- The fly population is low in hot day conditions and it is peak in rainy season. Hence, the sowing time may be adjusted accordingly.
- Expose the pupae by ploughing.
- 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.
- *Neem oil* @ 3.0 % as foliar spray as need based
- For management of Aphid vector, spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apsa etc., for better adhesion and coverage.

Do not use copper and sulphur dust. These are phytotoxic.**Diseases**

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

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

Yield: 18 t/ha in 135 – 145 days.

Market information

Crop Growing districts	Cuddalore, Coimbatore, Dindigul
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

Ribbed gourd: *Luffa acutangula* Roxb; Cucurbitaceae

Varieties: CO 1, CO 2 and PKM 1.

Soil

Sandy loam rich in organic matter with good drainage and a pH range from 6.5-7.5.

Season of sowing

July and January.

Seed rate

1.5 kg/ha. Sow the seeds (3 seeds/pit) treated with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* @ 10g/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 a week.

Application of fertilizers

Apply 10 kg of FYM, 100 g of NPK 6:12:12 mixture as basal per pit and N @ 10 g per pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @2 kg/ha and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

Drip irrigation

Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5 m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

Sowing

Dig pits of size 45 x 45 x 45 cm at spacing of 2 m in row spaced at 1.5 m. Sow three seeds in each pit. After germination, thin to 2 healthy seedlings. Instead of direct sowing, the seeds can be sown in poly bags @ 2 seeds / bag and 15 days after germination, they can be planted @ 2 seedlings per pit.

Fertigation

Apply a dose of 250:100:100 kg NPK/ha throughout the cropping period through split application.

Fertigation Schedule- Ribbed gourd (Hybrid)

Recommended dose: 250:100:100 Kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	12-61-0 13-0-45 Urea	32.79 22.00 39.49	3.93 2.87 18.20	5.00 - -	- 10.00 -	10.00	5.00	10.00
				Subtotal	**25.00**	**5.00**	**10.00**			
2.	Vegetative stage	30	19:19:19 + MN Urea	157.89 97.67	29.99 45.00 -	7.50 - -	- 29.99 -	30.00	7.50	30.00
				Subtotal	**74.99**	**7.50**	**29.99**			
3.	Flower initiation to first picking	20	12-61-0 13-0-45 Urea	49.17 44.00 137.52	5.91 5.72 63.84	7.50 - -	- 20.00 -	30.00	7.50	20.00
				Subtotal	**75.47**	**7.50**	**20.00**			
4.	Harvesting stage	60	12-16-0 13-0-45 Urea	32.79 88.00 129.39	3.93 11.44 59.63	5.00 - -	- 40.00 -	30.00	5.00	40.00
	Total duration	**120 days**		**Subtotal**	**75.00**	**5.00**	**40.00**			
Total					**250.46 (or) 250.00**	**25.00**	**99.99 (or) 100.00**	**100**	**25**	**100**

***75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.**

1. 19:19:19 = 158 kg/ha
2. 13:0:45 = 154 kg/ha
3. 12:61:0 = 115 kg/ha
4. Urea = 405 kg/ha

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 of sowing at weekly interval to increase yield.

Plant protection

Pests

Beetles, fruit flies and caterpillars: Spray Dichlorvos 76% EC 6.5 ml/10 lit or Trichlorofon 50% EC 1.0 ml/l

Do not use copper and sulphur dust, which are phytotoxic.

Diseases

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

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

Yield: 14 – 15 t/ha in 125 days.

Market information

Crop Growing districts	Erode, Coimbatore, Tiruppur
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai, Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

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

Varieties

Pusa Summer Prolific Long, Pusa Summer Prolific Round, Pusa Manjari, Pusa Megdoot and Arka Bahar.

Soil

Sandy loams rich in organic matter with good drainage and a pH range from 6.5 to 7.5.

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

1.5 kg/ha

Preparation of field

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

Irrigation

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

Application of fertilizers

Apply 10 kg of FYM (20 t/ha) and 100 g of NPK 6:12:12 mixture as basal and 10 g of N per pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* 2 kg/ha and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

Drip irrigation

Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers at an interval of 60 cm and 50 cm spacing with 4LPH and 3.5LPH capacities respectively.

Field preparation

Form raised beds of 120cm width and place laterals in the centre of bed.

Nursery raising

In hi-tech horticulture, plant 15 days old healthy seedlings raised in shade net houses. Raise the seedlings in protrays having 98 cells or in polythene bags. Transplant about 15 days old seedlings in the main field.

Fertigation

Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application.

After cultivation: Hoe and weed thrice.

Plant protection

Pests

Mites: Spray dicofol 18.5 % SC @ 2.5 ml per litre of water
Aphid: Spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apsa etc., for better adhesion and coverage.
Diseases

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

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

Yield: 15 – 20 t/ha in 135 days.

Market information

Crop Growing districts	Dindigul,Thiruvallur,Coimbatore,Thoothukudi
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

Fertigation Schedule-Bottle gourd (Hybrid)

Recommended Dose: 200:100:100 Kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				Subtotal	**19.78**	**5.00**	**9.95**			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.50 - -	- 29.70 -	30.00	7.50	30.00
				Subtotal	**60.19**	**7.50**	**29.70**			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.50 - -	- 19.80 -	30.00	7.50	20.00
				Subtotal	**60.09**	**7.50**	**19.80**			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	Total duration	**115 days**		**Subtotal**	**60.00**	**5.00**	**40.10**			
Total					**200.06**	**24.98 (or) 25.00**	**99.35 (or) 100.00**	**100**	**25**	**100**

***75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.**

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351 kg/ha

Bitter gourd; *Momordica charantia* L.; Cucurbitaceae

Varieties: CO 1, MDU 1, Arka Harit, VK1, Priya and Preethi.

Hybrids : COBgoH1

Soil

Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

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

1.8 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 (20 t/ha) and 100 g of NPK 6:12:12 mixture per pit as basal and 10 g of N per pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

Quality seedling production

Bitter gourd is a direct sown vegetable but polythene bag nursery is more advantageous to get early marketing and to avoid more gap filling. Use 200 gauge poly bags of 10 cm diameter x 10 cm height for sowing the seeds. Transplant about 15 days old seedlings to the main field.

Drip irrigation

Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4LPH and 3.5 LPH capacities respectively.

Field preparation

Form the raised beds of 120cm width (120 cm) and spread the lateral tubes in the centre of each bed. Irrigation is done in the beds by operating the drip system continuously for 8-12 hrs. Spray pre emergence herbicide like Pendimethalin @ 1 Kg a.i/ha just before planting. Planting or sowing is done at the holes made at 2 m distance.

Fertigation

Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application.

After cultivation

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

Plant protection

Pests

Mites: Spray dicofol 18.5 % SC @ 2.5 ml per litre of water
Aphid: Spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apsa etc., for better adhesion and coverage.

Diseases

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

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

Yield
Varieties : 14 t/ha in 140 - 150 days.
Hybrids : 40 t/ha in 180 days

Market information

Crop Growing districts	Coimbatore, Dindigul, Cuddalore, Thoothukudi, Tiruppur
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	20-25 cm long green fruits with short neck and tubercles are preferred

Fertigation Schedule- Bitter gourd (Hybrid)

Recommended dose: 200:100:100 kg/ha

Sl. No	Crop Stage	Duration in Days	Fertilizer grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				Subtotal	**19.78**	**5.00**	**9.95**			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.49 - -	- 29.70 -	30.00	7.50	30.00
				Subtotal	**60.19**	**7.49**	**29.70**			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.49 - -	- 19.80 -	30.00	7.50	20.00
				Subtotal	**60.09**	**7.49**	**19.80**			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	Total duration	**115 days**		**Subtotal**	**60.00**	**5.00**	**40.10**			
Total					**200.06**	**24.98 (or) 25.00**	**99.35 (or) 100.00**	**100**	**25**	**100**

***75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.**

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351 kg/ha

Ash gourd: *Benincasa hispida* Cogn; Cucurbitaceae

Varieties

CO 1 and CO 2.

Soil

A deep loamy soil with pH range of 6.5-7.5 is suitable.

Season and sowing

July and January. Three seeds are sown in each pit. The seeds are treated with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* @ 10 g or 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 of 2 x 1.5 m and form basins.

Irrigation

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

Application of fertilizers

Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing. Apply 10 kg FYM and 100 g of 6:12:12 NPK mixture/pit as basal and 10 g N/ pit at 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.

Quality seedling production:

Nursery raising

In hi-tech horticulture, use 12 days old healthy seedlings obtained from shade net houses for planting. Raise the seedlings in protrays having 98 cells. Use well decomposed cocopeat is used as medium. Sow one seed per cell. Water regularly twice a day. Transplant about 12 days old seedlings in the main field

Fertigation

Apply 60:30:30 kg of NPK/ha throughout the cropping period through split application. 75% of phosphorus, is applied through superphosphate as basal dose.

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 20 x 15 cm 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.
5. *Neem oil* @ 3.0 % as foliar spray as need based

Aphid: Spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apsa etc., for better adhesion and coverage.
Do not use copper and sulphur dust, as these are phytotoxic.

Diseases

Powdery mildew
Spray Dinocap 1 ml/l or Carbendazim 0.5 gm/l.

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

Yield: 20 t/ha in 140 days.

Market information

Crop Growing districts	Erode, Coimbatore, Villupuram
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Natchipalayam vegetable market, Coimbatore
Preferred Varieties and hybrids	Co 1 and Co 2

Fertigation Schedule- Ash gourd (Hybrid)

Recommended Dose: 200:100:100 kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				Sub total	**19.78**	**5.00**	**9.95**			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.50 - -	- 29.70 -	30.00	7.50	30.00
				Sub total	**60.19**	**7.50**	**29.70**			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.50 - -	- 19.80 -	30.00	7.50	20.00
				Sub total	**60.09**	**7.50**	**19.80**			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	 26.31 78.00 97.52	 5.00 10.14 44.86	 5.00 - -	 5.00 35.10 -	 30.00	 5.0	 40.00
	Total duration	**115 days**		**Sub total**	**60.00**	**5.00**	**40.10**			
Total					**200.06**	**25.00**	**100.00**	**100**	**25**	**100**

***75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.**

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351 kg/ha

Cucumber: *Cucumis sativus* L.; Cucurbitaceae

Varieties: Japanese Long Green, Straight Eight and Poinsette.

Soil: Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

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 or carbendazim 2g/kg 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. Apply Azospirillum and Phosphobacteria 2 kg/ha and Pseudomonoas 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

Drip irrigation: Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

Field preparation: Form raised beds of 120 cm width at an interval of 30 cm and the laterals are placed at the centre of each bed.

Sowing: Sow the seeds at an interval of 60 cm distance at the centre of the bed along the laterals. Sow the seeds in polybags @ one per bag for gap filling. Spray pre emergence weedicide like fluchloralin 1 kg a.i. or metalachlor 0.75 kg a.i./ha on third day of sowing.

Fertigation: Apply a dose of 150:75:75 kg NPK/ha throughout the cropping period through split application for F_1 hybrid. In respect of phosphorous, 75% has to be applied as a basal dose.

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 20 x 15 cm 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.
5. *Neem oil* @ 3.0 % as foliar spray as need based

Do not use copper and sulphur dust, as these are phytotoxic.

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

Market information

Crop Growing districts	Kanyakumari, Dindigul, Tirunelveli,Theni
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

Fertigation Schedule - Cucumber (Hybrid)
Recommended Dose: 150:75:75 Kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	19.72 8.24 22.11	3.75 1.07 10.19	3.75 - -	3.75 3.75 -	10.00	5.00	10.00
				Subtotal	**15.01**	**3.75**	**7.50**			
2.	Vegetative stage	20	12-61-0 13-0-45 Urea	9.21 49.49 95.27	1.09 - 43.91	5.63 - -	- 22.49 -	30.00	7.50	30.00
				Subtotal	**45.00**	**5.63**	**22.49**			
3.	Flower initiation to first picking	20	19:19:19 + MN 13-0-45 Urea	29.61 20.61 80.00	5.62 2.62 36.71	5.63 - -	5.63 9.37 -	30.00	7.50	20.00
				Subtotal	**45.00**	**5.63**	**15.00**			
4.	Harvesting stage	40	19:19:19 + MN 13-0-45 Urea	6.13 66.00 77.47	0.73 8.57 35.69	3.75 - -	- 30.00 -	30.00	5.00	40.00
	Total duration	**90 days**		**Subtotal**	**44.99**	**3.75**	**30.00**			
Total					**150.00**	**18.75**	**75.00**	**100**	**25**	**100**

***75% RD of Phosphorus applied as superphosphate = 352 Kg/ha**

1. 19:19:19 = 55 kg/ha
2. 13:0:45 = 144 kg/ha
3. 12:61:0 = 9 kg/ha
4. Urea = 275 kg/ha

Gherkin: *Cucumis sativus* var. *anguria;* Cucurbitaceae

Hybrids.

Soil: Well-drained sandy loam with a pH range of 6.0 to 6.8 is optimum.

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.

Drip irrigation: Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

Field preparation: Raise beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of each bed.

Fertigation: Apply the recommended dose of fertilizers viz., 150:75:100 Kg NPK / ha fertigate on every third day after sowing.

Plant protection

Pest

Minor pest: To control leaf miner, white fly, aphids and thrips spray Dimethoate 1.5 ml/l or Monocrotophos 1.5 ml/l or Malathion 1.5 ml/l.

Diseases

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

Harvest: The crop is ready for harvest in 30-35 days. As the tender immature fruits are meant for canning the price of the produce is decided by the stage of maturity. Smallest fruit (stage 1) which will weigh approximately 4.0g (250 fruits per kg) will fetch the maximum price followed by stage 2 and stage 3. To maintain the grade the harvesting of fruits should be done every day. A day's break would end up with outsized or overgrown gherkin means loss to farmer.

Avoid sharp sun and high temperature while harvesting. For this picking of fruits must be none in the very early morning or late evening. Harvest the fruits by retaining the stalk on the plant. Harvested fruits must be collected under shade. Flower head has to be removed from fruit. Water should not be sprinkled on harvested fruits at any stage. Even if there is surface water during harvest it should be dried by aeration. For collection of fruits jute bags alone have to be used and plastic bags should be totally avoided. The harvested produce should be transported to the factory on the same day before dusk. Leaving the gherkin unprocessed overnight would result in poor quality produce.

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

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

Varieties: Sugar Baby and Arka Manik.

Hybrids: Arka Jyoti and Pusa Bedana.

Soil: Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

Season and sowing: Treat the seeds with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* 10 g or carbendazim 2g/kg of seed. Sow the seeds during November-December @ 3.5 kg/ha 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 channels 2.5 m apart.

Irrigation: Irrigate the field before dibbling the seeds and thereafter once 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. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonoas* @ 2.5 kg/ha along with FYM 50 kg and neem cake 100 kg before last ploughing.

Nursery preparation: Nursery for watermelon can be prepared either with polythene bags of 200 gauge, 10 cm diameter and 15 cm height size or through protrays under protected nursery. In polybag nursery, fill the bags with 1:1:1 ratio of red soil, sand and farmyard manure mixture. Use protrays, each having 98 cells for raising seedlings. Transplant about 12 days old seedlings in the main field.

Drip irrigation: Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5 m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

Field preparation: Raise beds of 1.2 m width and 30cm height for sowing.

Planting: Spread the lateral tubes in the centre of each bed. Irrigate the beds by operating the drip system continuously for 8-12 hrs. Spray pre-emergence weedicide (Pendimethalin @ 1 kg a.i/ha) just before planting. Plant the seedlings in the holes made at 60 cm distance.

Fertigation : Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application

After cultivation: Spray ethrel 250 ppm (2.5 ml/10 l of water) 4 times at weekly intervals commencing from 15 days after sowing. Hoe and weed 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 20 x 15 cm 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.
5. *Neem oil* @ 3.0 % as foliar spray as need based
Do not use copper and sulphur dust, as these are phytotoxic

Yield: 25 – 30 t/ha in 120 days.

Market information

Crop Growing districts	Kancheepuram, Villupuram, Thiruvallur
Major markets in Tamil Nadu	Coimbatore, Chennai
Preferred Varieties and hybrids	Mithila, Suganthi, Kiran, Simran, Vishal
Grade Specification	Symmetrical and uniform in appearance. The surface should be waxy and bright in appearance devoid of scars, sunburn, transit abrasions or other surface defects.

Fertigation Schedule
Watermelon

Recommended Dose: 200:100:100 Kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				Subtotal	**19.78**	**5.00**	**9.95**			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.49 - -	- 29.70 -	30.00	7.50	30.00
				Subtotal	**60.19**	**7.49**	**29.70**			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.49 - -	- 19.80 -	30.00	7.50	20.00
				Subtotal	**60.09**	**7.49**	**19.80**			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	Total duration	**115 days**		**Subtotal**	**60.00**	**5.00**	**40.10**			
Total					**200.06**	**24.98 (or) 25.00**	**99.35 (or) 100.00**	**100**	**25**	**100**

***75% RD of Phosphorus applied as superphosphate = 469kg/ha.**

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351kg/ha

Muskmelon: *Cucumis melo* L; Cucurbitaceae

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

Soil: Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

Season of 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 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, NPK 40:60:30 kg/ha as basal and N @ 40 kg/ha 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake 100 kg before last ploughing.

Nursery preparation: Nursery for muskmelon can be prepared either with polythene bags of 200 gauge, 10 diameter and 15 cm height size or through protrays under protected nursery. Use protrays, each having 98 cells for raising seedlings. Transplant about 12 days old seedlings in the main field.

Drip irrigation: Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes are at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

Sowing: Around 250 protrays are required for the production of 23,334 (22,223 + 5%) seedlings, which are required for one hectare at spacing of 1.5 m x 30 cm in a raised bed single row system. Raise beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of each bed. Direct sowing or transplanting is done at a spacing of 1.5 m along the laterals and 30 cm interval in the raised bed single row system, using ropes marked at 30 cm spacing.

Fertigation : Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application.

After cultivation: Hoe and weed thrice.

Plant protection

Pests

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 20 x 15 cm 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.
5. *Neem oil* @ 3.0 % as foliar spray as need based

Do not use copper and sulphur dust, as these are phytotoxic.

White fly: Spray neem seed kernel extract 5 %.

Yield: 20 t/ha in 120 days.

Fertigation schedule-Muskmelon

Recommended dose: 200:100:100 Kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.0	10.00
				Sub total	**19.78**	**5.00**	**9.95**			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.49 - -	- 29.70 -	30.00	7.50	30.00
				Sub total	**60.19**	**7.49**	**29.70**			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.49 - -	- 19.80 -	30.00	7.50	20.00
				Sub total	**60.09**	**7.49**	**19.80**			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	Total duration	**115 days**		**Sub total**	**60.00**	**5.00**	**40.10**			
Total					**200.06**	**24.98 (or) 25.00**	**99.35 (or) 100.00**	**100**	**25**	**100**

***75% RD of Phosphorus applied as superphosphate = 75 x 6.25 = 469 kg/ha.**

1. 19:19:19 = 53kg/ha
2. 13:0:45 = 199kg /ha
3. 12:61:0 = 25kg/ha
4. Urea = 351kg/ha

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

Varieties: Annamalai and Arka Tinda.

Soil: Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.
Season of sowing: January-February Sow the seeds on one side of the channel
Seed and rate: 3.5 kg/ha.Treat the seeds with *Trichoderma viride* @ 4g or *Pseudomonas @ fluorescens* 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 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. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

After cultivation: Hoe and weed thrice.

Plant protection

Pest

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

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 20 x 15 cm 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.
5. *Neem oil* @ 3.0 % as foliar spray as need based

Do not use 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; Cucurbitaceae*

Varieties: Green fruited and White fruited.

Soil and climate: 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 - 1500m. In plains, it comes up well during winter season.

Preparation of field: Dig 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 superphosphate 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 2m. Prune the plants to ground level during winter from second year after planting. In hills, pruning period is January. Apply 250 g of urea to 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/l.

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 20 x 15 cm 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.
5) *Neem oil* @ 3.0 % as foliar spray as need based

Diseases

Mosaic: Spray dimethoate 30 EC @ 1.5 ml/lit or methyl demeton 25 EC @ 1.5 ml/lit. thrice at fortnightly intervals

Yield: 25 - 35 tonnes/ha.

Cluster beans: *Cyamopsis tetragonoloba* L; Fabaceae

Varieties: Pusa Mausmi, Pusa Sadabahar and Pusa Naubahar.

Soil: Well drained sandy loam with pH range of 7.5-8.0. The crop tolerates salinity.

Season and sowing: June - July and 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 hoppers, aphids, and glasshouse whitefly
Spray methyl demeton 25 EC or dimethoate 30 EC @ 1 ml/lit.
Ash weevils
Spray phosalone 35 EC @ 1.5 ml/lit.

Diseases
Leaf spot: Spray Mancozeb @ 2 g/l.

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

Yield: 5 – 7 t/ha in 90 days.

Market information

Crop growing districts	Dindigul,Coimbatore,Namakkal
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

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

Varieties: CO 2, VBN 2, Pusa Komal and PKM 1

Soil: Well drained soil with high organic matter.

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 and 60 x 30 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. Fertilizers can be applied in several split doses at fortnightly intervals.

Pinching : Before flowering, the tendrils should be pinched thrice for getting bushy plants.

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

Plant protection

Pests
Aphids: Spray Dimethoate 30 EC 1 ml/l or Methyl demeton 25 EC 1 ml/l.

Diseases

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

Yield: 25t/ha 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, COGB 14, 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 packets (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 sowing: 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 bean 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 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 *Azospirillium* and *Phosphobacteria* per ha at the time of sowing.

Plant protection

Pests

Pod borer: Spray Carbaryl 50 WP thrice at fortnightly intervals @ of 2 g/l. Dust Carbaryl 10 D @ 25 kg/ha.

Sucking pests: Spray Malathion 50 EC @ 1 ml/l or Dimethoate 30 EC @ 1 ml/l or Methyl demeton 25 EC @ 1 ml/l or Fenthion 1000 EC @ 1 ml/l at 15 days interval to control aphids and other sucking insects.

Diseases

Powdery mildew
Spray Wettable sulphur @ 2 g/l or Carbendazim @ 0.5 g/ litre.

Yield
Pandal type : 12 – 13 t/ha
Bush type : 8 – 10 t/ha

Market information

Crop growing districts	Dindigul, Erode, Salem, Theni
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

French bean: *Phaseolus vulgaris* L; Fabaceae

Bush type varieties

Hills: YCD 1, Ooty 2 and Premier.

Plains: Arka Komal, (Sel.9) and Premier.

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

Season

Hills : February – March

Plains : October - November

Sowing: Treat the seeds with *Trichoderma viride* @ 4 g/kg or Thiram or Carbendazim @ 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 on 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 Phosphorus as superphosphate and with another half of 62.5 kg/ha Phosphorus 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

Whitefly: Place 20 yellow sticky traps coated with castor oil in polythene sheet to attract the white flies.

Leaf hoppers, aphids, and glasshouse whitefly

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

Ash weevils

Spray phosalone 35 EC @ 1.5 ml/lit.

Pod borer: Spray Carbaryl 50 WP thrice at fortnightly intervals at @ 2 g/l. Dust Carbaryl 10 D @ 25 kg/ha.

Diseases
Powdery mildew: Spray Wettable sulphur @ 2 g/l or dust sulphur @ 25 kg/ha.

Rust: Dust Sulphur at 25 kg/ha.

Anthracnose: Spray Mancozeb @ 2 g/l or Carbendazim @ 1 g/l or Chlorothalonil @ 2 g/l.

Leaf spot: Spray Mancozeb @ 2 g/l.

Root rot: Drench Carbendazim @ 1 g/l.

Mosaic : Select disease free planting materials**.** Spray Dimethoate 30 EC @ 2 ml/l or Methyl Demeton @ 25 EC 2 ml/l thrice at fortnightly intervals.

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

Pole type

Varieties: TKD 1, KKL-I, Ooty 1, Murungai beans.

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

Season and sowing

Hills: February – March and 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 a 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 thereafter 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
Whitefly: Place 20 yellow sticky traps coated with castor oil in polythene sheet to attract the white flies.

Leaf hoppers, aphids, and glasshouse whitefly
Spray Methyl demeton @ 25 EC or Dimethoate 30 EC @ 1 ml/l.

Ash weevils
Spray Phosalone 35 EC @ 1.5 ml/l.

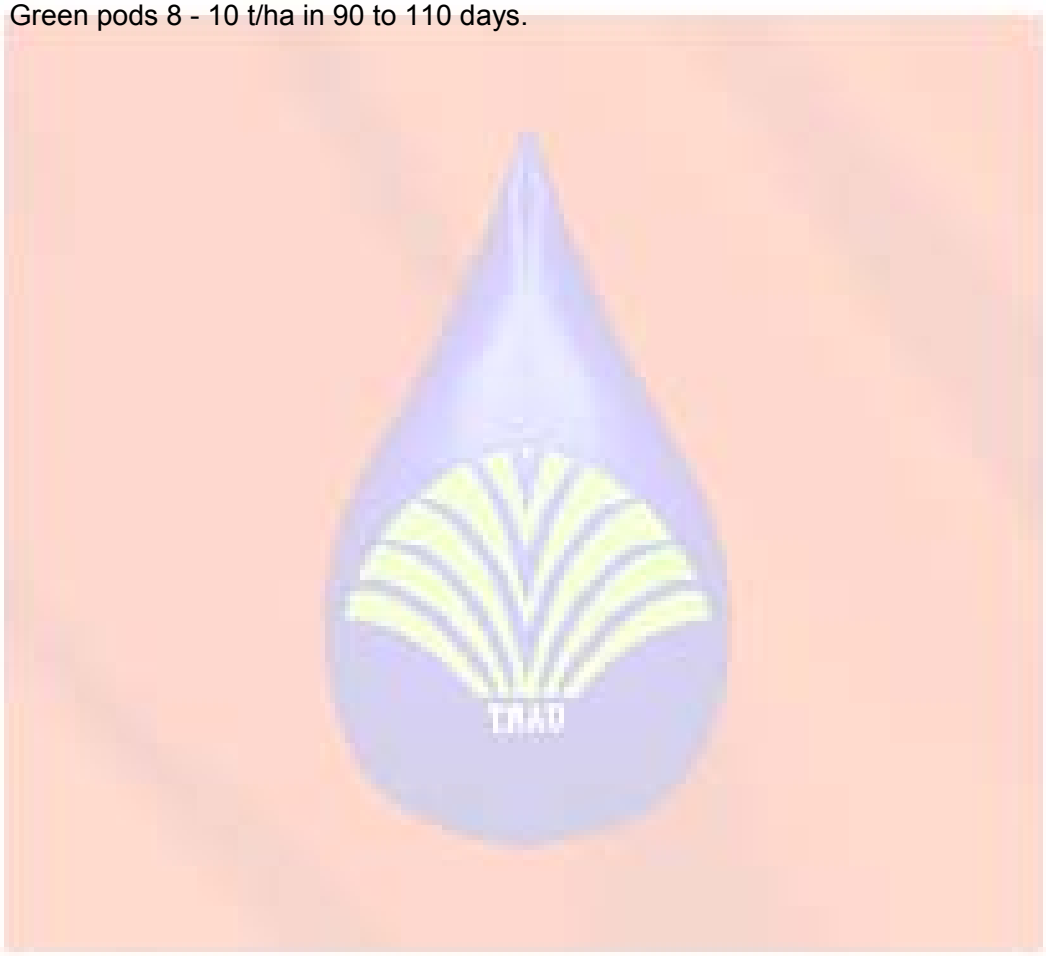
Diseases
Mosaic: Remove the affected plants and spray systemic insecticides to control insect vectors.

Powdery mildew: Spray Wettable sulphur @ 2 g/l or dust sulphur @ 25 kg/ha.

Rust: Dust sulphur @ 25 kg/ha.

Anthracnose: Spray Mancozeb @ 2 g/l. 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: SWS 1 (Suttan White Seeded), BR 1 (Bihar Black Seeded) and BR 2 (Bihar Yellow Seeded).

Soil: Thrives in almost all soils with a pH range of 6.5-7.5 in hills only.

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

Preparation of field: Plough the land to a fine tilth, level 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 and 45 days.

After cultivation: Earthing up is done on 45th day after sowing. As soon as the plants grow, flowering 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.

Season and sowing: Sow the seeds during February - March and October - November in plains. Treat the seeds with *Trichoderma* @ 4 g/kg or Thiram or Captan @ 2 g/kg of seeds a to avoid seed borne diseases. Treat the seeds with *Rhizobium* culture @ 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 @ 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 on 30th day of sowing.

Harvest

Harvest can be done on 75 days after sowing. High temperature during harvest affects the quality of peas.

Plant protection

Pests

Pod borer: Spray Carbaryl 50 WP thrice at fortnightly intervals @ 2 g/lit. Dust with Carbaryl 10 D at the rate of 25 kg/ha.

Aphids: Spray Methyl demeton 25 EC or Dimethoate 30 EC or Monocrotophos 36 WSC or Phosphamidon 40 SL @ 1 ml/l of water.

Diseases

Powdery mildew: Spray wettable sulphur @ 2 g/l or Dinocap @ 1 ml/l or Tridemorph @ 0.5 ml/l or dust sulphur @ 25 kg/ha three rounds at 15 days interval.

Yield: 8 -12 t/ha

Market information

Crop growing districts	Nilgiris, Dindigul
Major markets in Tamil Nadu	Mettupalayam, Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	The edible-pods should be uniformly bright green (light to deep green but not yellowgreen), fully turgid, clean, and free from damage.

Annual moringa: *Moringa oleifera* L.; Moringaceae

Varieties: PKM 1 and PKM 2.

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

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 polybags 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.

High density planting and fertigation in moringa PKM 1

High density planting at 1.5 X 1.0 m spacing with two plants/hill and plant population 13,333 / ha along with the application of fertilizer dose of 135: 23 :45 g of NPK/pit (150%) through drip increases the yield of moringa. In this phosphorus should be applied basally as soil application. N and K can be applied in the form of urea and muriate of potash through drip.

- For PKM-2, the closest spacing of 1.2 x 1.2 m is ideal to obtain the highest yield of 138 t/ha. The pinching of main shoots on 80th day after sowing will also help register the highest yield of fruits.

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.

- For perennial moringa, medium pruning of shoots at 70 cm from the tip has to be followed to regulate flowering and obtain the highest yield of 37 kg/ tree.

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, on 3rd day after sowing and subsequently at 10 to 15 days interval according to soil type.

Plant protection

Pests
Moringa pod fly management

Soil application of Thiamethoxam 25 WG @ 200g a.i. / ha on 150, 180 and 210 days after planting; placement of fermented tomato fruit trap @ 25 / ha; and need based foliar spray of Spinosad 45 SC @ 56g a.i. / ha followed by Profenophos 50 EC@ 250g a.i. / ha
Bud worm, leaf caterpillar and leaf webber: Dust Carbaryl 10 D @ 25 kg/ha or spray Carbaryl 50 WP @ 2 g/l.

Hairy caterpillar
Use flame torch when the caterpillars settle on the tree trunk

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. Two ratoon crops can be taken. 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 time.

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

Market information

Crop growing districts	Dindigul, Thoothukudi, Theni, Karur, Tiruppur
Major markets in Tamil Nadu	Dindigul, Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Preferred Varieties and hybrids	PKM 1, PKM 2 and KM 1

Baby corn: *Zea mays;* Poaceae

Variety: COBC 1

Soil: All maize growing soils with a pH range of 6-7.

Season
Irrigated : Throughout 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 and sow the seeds at a spacing of 25cm on one side of the ridge.

Irrigation: First irrigation after sowing, second on third day and thereafter once in ten days.

Application of fertilizers: 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)	: 40 - 45 days before pollen shedding

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 and Maha Rani.

Soil: It is grown in varied types of soils ranging from sandy loam to clay. It requires a pH range of 5.5 to 6.5.

Season of sowing

Hills: January – February, July – August and 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 in rows drawn at 10 cm spacing in raised seed beds after drenching it with Copper oxychloride (2.5 g/l). Seedlings will be ready for transplanting in 40-45 days after sowing. Avoid land infected with 'club root disease'.

Protected nursery

Raise the seedlings in shade net house. A nursery area of 5 cents with a slanting slope of 2% is required for the production of seedlings for 1 ha. Cover the nursery area with 50 per cent shade net and the sides with 40/50 mesh insect proof nylon net. Form the raised beds of 1m width and convenient length inside the nursery and above the beds, the portrays are placed.

Protray

The Protrays of 98 cells are ideal for cabbage seedling production. Around 600 protrays are required for the production of 28.333 seedlings required for one hectare at spacing of 60x45x45 cm in three row planting

Growing medium

The sterilized cocopeat @ 720kg / ha is mixed with 10kg of neem cake and Azospirillum and Phosphobacteria each @ 1kg. About 1.25 kg of the cocopeat medium is required for each tray.

Seed treatment

250 g of hybrid cabbage seed is required for the production of seedlings for 1 ha. Treat the seeds in hot water @ 50°C for 30 minutes. 25g of Azospirillum is required for the seed treatment of 250g cabbage seeds.

Sowing

Sow the seeds in protrays @ 1 seed per cell. Cover the seeds with cocopeat and keep the tray one over the other (8-10Nos) and covered with polythene sheet for 5 days or till germination starts. After 5 days when the seeds are germinated arrange the protrays on the raised beds inside the shade net nursery. Water the tray by rose can everyday (twice / day) upto seed germination. Drench with 19:19:19 + MN @ 0.5 % (5g/lit) solution using rose can or spray micro nutrient of 0.5 % at 18 days after sowing. The cabbage seedlings are ready for transplanting in 25 days

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.

Drip irrigation

Install drip system with main and sub-main and place the inline laterals at the interval of 1.5. Place the drippers at the interval of 60 cm for 4 LPH or 50 cm for 3.5 LPH in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

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. Apply departmental micronutrient mixture (borax & molybdenum) @ 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.

Fertigation

Fertigation requirement for F1 hybrid: 200: 125:150 kg of NPK / ha. Apply once in three days throughout the cropping period.

Spacing : 60x 45x45cm in paired row system

Fertigation schedule

Recommended Dose: 200:125:150 kg/ha

Sl.No.	Crop Stage	Duration in days	Fertilizer grade	Total fertilizers	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Transplanting to plant establishment	10	19:19:19+ MN 13-0.45 Urea	32.87 19.42 24.36	6.25 2.52 11.21	6.25 - -	6.25 8.74 -	10.00	5.00	10.00
				Sub total	19.98	6.25	14.99			
2	Head initiation stage	30	12-61-0 13-0-45 Urea	20.37 133.20 130.74	2.44 17.32 60.14	12.50 - -	- 59.94 -	30.00	10.00	30.00
				Sub total	79.90	12.50	59.54			
3	Head initiation to development stage	30	19:19:19+ MN 13-0.45 Urea	32.87 86.02 92.37	6.25 11.18 42.49	6.25 - -	6.25 38.71 -	20.00	5.00	20.00
				Sub total	59.92	6.25	44.96			
4	Harvesting stage	35	12-61-0 13.0-45 Urea	10.18 66.60 65.38	1.22 8.66 30.07	6.25 - -	- 29.97 -	40.00	5.00	40.00
	Total duration	105		Sub total	39.95	6.25	29.97	100.00	25.00	100.00
				Total	199.75 (or) 200.00	31.25	149.85 (or) 150.00			

75% RD of Phosphorus applied as superphosphate in plains and rock phosphate in hills (589 kg/ha)

1. 19:19:19 = 66 kg / ha
2. 13:0:45 = 305 kg / ha
3. 12:61:0 = 31 kg / ha
4. Urea = 313 kg / ha

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

Plant protection

Pests

Aphids:

Install yellow sticky trap @12 no/ha to monitor “macropterous” adults (winged adult).

Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide

Insecticide	Dose
Azadirachtin 0.03% WSP (300 ppm)	5.0 g/lit.
Dimethoate 30 % EC	6.0 ml/10 lit.
Malathion 50 % EC	1.5 ml/lit.
Phosalone 35 % EC	1.5 ml/lit.
Quinalphos 25 % EC	1.0 ml/lit.

Diamond backmoth

1. Grow mustard as intercrop at 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 @ 12/ha.
3. Spray cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* @ 2 g/lit at primordial stage (ETL 2 larvae/plant).
4. Release parasite *Diadegma semiclausum* @ 50,000/ha, 60 days after planting.
5. Spray NSKE 5 % after primordial stage or any one of the following insecticide

Insecticide	Dose
Azadirachtin 0.03% WSP (300 ppm)	5.0 g/lit.
Bacillus thuringiensis var *kurstaki* 5 % WP	1.0 g/lit.
Chlorantraniliprole 18.5 % SC	1.0 ml/10 lit.
Chlorfenapyr 10 % SC	1.5 ml/lit.
Chlorpyrifos 20 % EC	2.0 ml/lit.
Diafenthiuron 50 % WP	8.0 g/10 lit.
Emamectin benzoate 5 % SG	4 g/10 lit.
Fipronil 5 % SC	1.6 ml/lit.
Flubendiamide 20 WDG	2.5 g/10 lit.
Flufenoxuron 10 % DC	4 ml/10 lit.
Indoxacarb 14.5 % SC	3.5 ml/10 lit.
Indoxacarb 15.8 % SC	2.7 ml/10 lit.
Lufenuron 5.4 % EC	1.2 ml/ lit.
Metaflumizone 22 % SC	1.5 ml/lit.
Novaluron 10 % EC	7.5 ml/10 lit.
Pyridalyl 10 % EC	1.0 ml/lit.
Spinosad 2.5 % SC	1.2 ml/lit.
Thiodicarb 75 % WP	1.5 g/lit.
Trichlorofon 50 % EC	1.0 ml/ lit.

Diseases

Club root:

Biological control

Seed treatment with *Pseudomonas fluorescens* at 10 g/ kg of seeds, followed by seedling dip @ 5g/ l and soil application @ 2.5 kg/ha along with 50 kg FYM before planting

Chemical control

Dip the seedlings in Carbendazim solution 2 g/l for 20 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/l of water. Follow crop rotation. Crucifers should be avoided for three years.

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

Leaf Blight: Spray Mancozeb @ 2.5 g/ l.

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

Downy mildew: Spray combination of Metalaxyl + Mancozeb 2 g/l 3 sprays at 10 days interval.
Black rot: Dip the seeds in 100 ppm Streptocycline for 30 minutes. Two sprays with 2 g/l 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.

Market information

Crop Growing districts	Nilgris, Krishnagiri, Theni, Erode
Major markets in Tamil Nadu	Mettupalayam, Ottanchathiram, Hosur and Dindigul
Grade Specification	Size and Weight

Cauliflower: *Brassica oleracea var. botrytis;* Brassicaceae

Varieties

Hills: Ooty 1, Pusa Dapoli.

Plains: Early Synthetic, Pawas, NS131.

Climate and Soil: It requires cool moist climate. Deep loamy soils are good with high organic matter and good drainage. It can be grown in a pH range of 5.5 to 6.6.

Season and sowing: The early varieties may tolerate higher temperature and long days. This can be grown in plains during September to February. Late Varieties Snowball types can be grown in hills.

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 with Copper oxychloride (2.5 g/l). 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 (late varieties) old seedlings at 45 cm apart

Protected nursery

Raise the seedlings in shade net house. A nursery area of 5 cents with slanting slope of 2% is required for the production of seedlings for 1 ha.Cover the nursery area with 50 per cent shade net and the sides with 40/50 mesh insect proof nylon net. Form the raised beds of 1m width and convenient length inside the nursery and above the beds, place the protrays.

Protray

The Protrays of 98 cells are ideal for cauliflower seedling production. Around 600 protrays are required for of 28,333 seedlings required for one hectare at a spacing of 60 x 45 x 45 cm in three row planting

Growing medium

The sterilized cocopeat @ 720kg / ha is mixed with 10kg of neem cake and Azospirillum and Phosphobacteria each @ 1kg. About 1.25 kg of the cocopeat medium is required for each tray.

Seed treatment

250 g of hybrid cauliflower seed is required for the production of seedlings for 1 ha. Treat the seeds in hot water @ 50°C for 30 minutes. 25g of Azospirillum is required for the seed treatment of 250g cauliflower seeds.

Sowing

Sow the seeds in protrays @ 1 seed per cell. Cover the seeds with cocopeat, keep the tray one over the other (8-10Nos) and cover with polythene sheat for 5 days or till germination starts. After 5 days when the seeds are germinated, arrange the protrays on the raised beds inside the shade net nursery. Water the tray by rose can everyday (twice / day) and drench

with 19:19:19 + MN @ 0.5 % (5g/l) solution using rose can or spray micronutrient at 0.5 % 18 days after sowing. The cauliflower seedlings are ready for transplanting in 25 days

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.

Drip irrigation

Install drip system with main and sub-main and the inline laterals placed at the interval of 1.5 m. Place the drippers at the interval of 60 cm for 4 LPH or 50 cm for 3.5 LPH, in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

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.

Fertigation

Fertigation requirement for F1 hybrid: 200: 125: 125 kg of NPK / ha. Apply once in every three days throughout the cropping period.

Spacing: 60x 45x45cm in paired row system

Fertigation schedule

Recommended Dose: 200:125:125 kg/ha

Sl. No	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Transplanting to establishment stage	10	19:19:19+ MN 13-0-45 Urea (46% N)	62.66 7.33 15.33	11.906 0.953 7.866	11.906 - -	11.906 3.300 -	10.00	9.70	12.00
Sub total				85.333	19.913	11.906	15.206			
2	Curd initiation stage	25	13-0-45 12-61-0 Urea (46% N)	111.333 31.333 204.00	14.473 3.760 93.84	- 19.113 -	50.100 - -	56.00	15.30	40.00
Sub total				346.666	112.073	19.113	50.100			
3	Curd development stage	35	Urea (46% N) 0-0-50	148.00 120.666	68.08 -	- -	- -	34.00	-	48.00
Sub total				268.666	68.080	-	60.333			
	Total Duration	70		Total	200.06	31.019	125.63	100	25	100

75% of RD of P applied as superphosphate = 586 kg/ha

1.19: 19: 19+MN = 63 kg
2.13: 0: 45 = 119 kg
3. Urea = 368 kg
4. 0-0-50 = 121 kg
5. 12:61:0 = 32 kg

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

Aphids:

Install yellow sticky trap @ 12 no/ha to monitor Macropterous adults (winged adult).

Apply phorate 10 % G @ 20 kg /ha or spray neem oil 3 % with 0.5ml teepol/lit or spray any one of the following insecticide

Insecticide	Dose
Azadirachtin 5% Neem Extract Concentrate	5.0 ml/10 lit.
Dimethoate 30 % EC	7.0ml/10 lit.

Diamond backmoth

1. Grow mustard as intercrop at 20:1 ratio.
2. Install pheromone traps @ 12 No/ha.
3. Release larval parasite *Diadegma semiclausum* @ 50,000/ ha, 60 days after planting

4. Spray NSKE 5 % or cartap hydrochloride @ 1 g/lit or *Bacillus thuringiensis* @ 1g/lit at primordial stage (ETL 2 larvae/plant) or any of the following insecticides

Insecticide	Dose
Azadirachtin 5% Neem Extract Concentrate	5.0 ml/10 lit.
Lufenuron 5.4 % EC	1.2 ml/lit.
Spinosad 2.5 % SC	1.2 ml/lit.
Trichlorofon 50 % EC	1.0 ml/lit.

Diseases
Club root:

Biological control
Seed treatment with *Pseudomonas fluorescens* at 10 g/ kg of seeds, followed by seedling dip @ 5g/ l and soil application @ 2.5 kg/ha along with 50 kg FYM before planting

Chemical control
Dip the seedlings in Carbendazim solution 2 g/l for 20 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/l of water. Follow crop rotation. Crucifers should be avoided for three years

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

Leaf Blight: Spray Mancozeb @ 2.5 g/ litre.

Blanching: Blanching refers to covering of curds. A perfect curd 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 change into rusty brown. Spray one kg of borax in 500 l 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 l 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 of 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

Market information

Crop Growing districts	Dindigul, Theni, Coimbatore, Tiruppur
Major markets in Tamil Nadu	Mettupalayam, Coimbatore, Ottanchathiram, Koyambedu
Grade Specification	Size and colour

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.

Climate and 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 soil pH range of 6.0 to 7.0.
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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. 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 of FYM and 90:90:90 kg of NPK per ha as basal dose and 45:45:45 kg of NPK after 45 days. Apply 25 kg of ZnSO4/ha as basal.

After cultivation: Spray Fluchloralin 1 l 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.

Splitting of roots is a physiological disorder which is usually seen when there is a sudden increase in soil moisture after prolonged drought. Forking is another phenomenon where in the hard soil does not allow the straight growth of tap root which results in formation of forked root.

Forked roots and split roots fetch poor price in market. Keeping the soil moisture at optimum condition will help to keep the soil also loose thereby help to avoid splits and forked roots.

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/l.

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

Root and Tuber vegetables

Market information

Growing districts	Nilgiris, Dindigul and Krishnagiri
Major markets in Tamil Nadu	Mettupalayam, Dindigul, Coimbatore and Chennai
Grade Specification	Size, diameter or length.

Radish: *Raphanus sativus* L; Brassicaceae

Varieties

Hills: White Icicle, Scarlet globe, Rapid Red White Tipped

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.

Drip irrigation

Install the drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5. Place the dripper in lateral tubes at an interval of 60cm and 50cm spacing with 4LPH and 3.5 LPH capacities respectively. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

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.

Fertigation

Fertigation requirement :50:100:50kg of NPK / ha. Apply once in three days
Spacing : 30x15x10 cm in paired row system. A total of 10 rows is accommodated in one bed.

After cultivation: Weeding and hoeing should be done 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/l twice or thrice at 10 days intervals.

Diseases
White rust: Spray Mancozeb 2 g/l or Copper oxychloride 2 g/l.
Yield: 20 – 30 t/ha in 45 – 60 days.

Market information

Crop Growing districts	Vellore, Dindigul, Thanjavur, Nilgris
Major markets in Tamil Nadu	Mettupalayam, Dindigul, Coimbatore and Chennai
Grade Specification	Size, Shape

Fertigation schedule

Recommended Dose: 50:100:50 kg/ha 100% of TRD: 50: 25: 50 NPK kg/ha

S.No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Vegetative stage	15	19:19:19 +MN 13-0.45 Urea	40 5.5 4.0	7.5 0.7 1.8	7.5 - -	7.5 2.5 -	20	7.50	20
				subtotal	10	7.5	10			
2	Early Root development stage	20	19:19:19 +MN 13-0.45 Urea Urea	66 28 20	12.5 3.6 8.9	12.5 - -	12.5 12.5 -	50	12.50	50
				subtotal	25	12.5	25			
3	Root maturity stage	10	19:19:19 +MN 13-0.45 Urea	26 22 16	5.0 2.9 7.1	5.0 - -	5.0 10.0 -	30	5.0	30
	Total	45		subtotal	15	5	15			
4				Total	50	25	50	100	25	100

75% RD of Phosphorous applied as super phosphate = 500kg /ha.

1. 19:19:19 = 125 kg / ha
2. 13:0:45 = 50 kg / ha
4. Urea = 50 kg / ha

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 form ridges and furrows 30 cm apart.

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

Drip irrigation

Install the drip system with main and sub main pipes and place the inline lateral tubes at an interval of 1.5 m. Place the drippers in lateral tubes at an interval of 60 cm and 50cm spacing with 4 LPH and 3.5 LPH capacities respectively. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

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.

Fertigation:
Fertigation requirement: 120:160:100kg / ha

Spacing: 30 x30 x10 cm as four rows in each paired row / raised bed system.

Fertigation schedule
Recommended Dose: 120:160:100 kg/ha

S.No.	Crop Stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Vegetative stage	30	19:19:19+ MN 13-0.45 12-61-0 Urea	42.11 4.44 19.67 80.44	8.00 0.58 2.36 37.00	8.00 - 12.00 -	8.00 2.00 - -	40.00	12.50	10.00
				subtotal	48.00	20.00	10.00			
2	Early phase of Root development	60	13-0-45 12-61-0 Urea 0-0-50 Urea	88.89 19.67 73.96 40.00	11.55 2.36 34.02 -	- 12.00 - -	40.00 - - 20.00	40.00	7.50	60.00
				subtotal	48.00	12.00	60.00			
3	Maturity stage	30	12-61-0 13-0-45 Urea	13.12 66.67 29.85	1.57 8.67 13.76	8.00 - -	- 30.00 -	20.00	5.0	30.00
				subtotal	24.00	8.00	30.00			
				Total	120.00	40.00	100.00	100	25	100

*75% RD of P applied as super phosphate=810 kg/ha.

1. 19:19:19 = 42 kg / ha
2. 12:61:0 = 52 kg / ha
3. 13:0:45 = 160 kg / ha
4. 0:0:50 = 40 kg / ha
5. Urea = 184 kg / ha

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/l.

Diseases
***Cercospora* leaf spot:** Spray Mancozeb at 2 g/l.
***Rhizoctonia* root rot:** Spot drenching with Carbendazim at 1 g/l.

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

Market informtion

Crop Growing districts	Tiruppur, Coimbatore ,Nilgiris, Dindigul ,Theni,
Major markets in Tamil Nadu	Mettupalayam, Coimbatore, Erode
Grade Specification	Size

Potato: *Solanum tuberosum* L.; Solanaceae

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

Soil and climate: 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 g. Use Carbon disulphide 30 g/100 kg of seeds for breaking the dormancy and inducing sprouting of seeds. Plant the tubers 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.

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

Drip irrigation

Install drip system with main and sub-main and place the inline laterals at the interval of 1.5. Place the drippers at the interval of 60 cm for 4 LPH or 50 cm for 3.5 LPH in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

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.

Fertigation

Fertigation requirement - 120: 240:120 kg of NPK / ha. Apply once in every three days throughout the cropping period.

Spacing: 60 x 30 x 20cm in paired row system

Fertigation schedule: Potato (Variety)
Recommended dose: 120:240:120 kg/ha

S. No.	Crop Stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Planting to crop establishment	20	19:19:19 +MN	63.15	12.00	12.00	12.00	10.00	5.00	10.00
				subtotal	12.00	12.00	12.00			
2	Vegetative stage	30	12-61-0 13-0-45 Urea	39.34 106.67 63.82	4.72 13.87 29.36	24.00 - -	- 48.00 -	30.00	10.00	30.00
				subtotal	47.95	24.00	48.00			
3	Tuber formation stage	35	19:19:19 +MN 13-0-45 Urea	63.15 53.33 37.04	12.00 6.93 17.04	12.00 - -	12.00 24.00 -	40.00	5.00	30.00
				subtotal	35.97	12.00	36.00			
4	Tuber development stage	35	12-61-0 13-0-45 Urea	19.67 53.33 31.92	2.36 6.93 14.68	12.00 - -	- 24.00 -	20.00	5.0	30.00
				Sub total	23.97	12.00	24.00			
				Total	119.89	60.00	120.00	100.00	25.00	100.00

75% RD of Phosphorus applied as superphosphate = 1125 kg/ha as basal dose.
In hills rock phosphate is the source for P

1. 19:19:19 = 126 kg/ha
2. 13:0:45 = 213 kg / ha
3. 12:61:0 = 59 kg / ha
4. Urea = 133 kg / ha

After cultivation

Weed control: Spray of Gramaxone @ 2.5 l/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 and second hoeing and earthing up on 60th day.

Plant protection

Pests

Cut worms:

- Fork the soil during summer months to expose the larvae and pupae for avian predators.
- Set up light trap between 7-10 pm to attract the adults.
- Set up pheromone traps @ 8/acre to monitor and attract male moths.
- Collect the first instar larvae from lace-like damaged leaves.
- Collect the grown up larvae from the soil (near the damaged stem) and destroy.
- Set up sprinkler system during day time to expose the hidden larvae for predation by birds.
- Apply NSKE 5% or neem oil @ 2 lit/acre using 500 lit of spray fluid.
- Collect grownup caterpillars mechanically and spray *Bacillus thuringiensis* @ 2g/lit.

Potato tuber moth

- Select healthy tubers and plant at 15 cm depth to avoid oviposition.
- Set up pheromone traps @ 5/acre. Septa can be replaced once in a year.
- Release egg-larval parasite,C*helonus blackburnii* @12,000 parasites/acre twice (on 40 and 70 days after planting)
- Earth up and cover the tubers to prevent oviposition in exposed tubers.
- Cover the top layers of seed tubers with *Lantana* or *Euclayptus* branches to repel the ovipositing female moths.
- Spray quinalphos @ 1 lit /ha at ETL of 5% leaf damage

Aphids:

Apply carbofuran 3 % G @ 17 kg /ha or Phorate 10% G @ 10 kg /ha or drench thiamethoxam 25 % WG @ 200 g in 500 lit of water per ha or spray any one of the following Insecticide

Insecticide	Dose
Dimethoate 30%EC	7.0 ml/10 lit.
Oxydemeton –Methyl 25% EC	1.0 ml/lit.
Thiamethoxam 25 % WG -Foliar	2.0 gl/10 lit.

Diseases

Late blight: Carefully select seed tubers. Remove ground creepers which serve as a source of infection. Spray Mancozeb 2 g/l or Chlorothalonil 2 g/l 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/l or Chlorothalonil 2 g/l 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 30 EC or methyl demeton 25 EC @ 2 ml/lit

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

Market information

Crop Growing districts	Dindigul, Nilgiris
Major markets in Tamil Nadu	Ottanchathiram, Koyambedu, Mettupalayam, Coimbatore
Preferred Varieties and hybrids	Kufri Jyoti, Kufri Swarna
Grade Specification	Hardness, higher shelf life, pure yellow colour Thala – 40-60 mm Rasi- 20-40 mm Podi – 10-20 mm

Sweetpotato: *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.

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 60 cm apart or beds.

Irrigation: Irrigate before planting, on 3rd day and then after once 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 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 earthing up to prevent root formation at nodes and to make the originally formed roots to increase in size. Spray Ethrel five times at 250 ppm at fortnightly intervals commencing from 15 days after planting.

Plant protection

Pests

Sweetpotato weevil

1. Remove previous sweetpotato crop residues and alternate host *i.e., Ipomoea* sp. and destroy them.
2. Install sex pheromone trap right from beginning of the crop establishment.
3. Use pest free planting materials.
4. Dip the planting material in fenthion 100 EC or Fenitrothion 50 EC or Monocrotophos 36 WSC @ 2 ml/l.
5. Rake up the soil and earth up at 50 days after planting.
6. Drench the soil with Endosulfan 35 EC or Fenthion 100 EC at 2 ml/l. Spray any one of the insecticides, if needed.
7. Harvest the crop immediately after maturity and destroy the crop residues.

Diseases

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

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 Visakham (H.1687), Sree Sahya (H.2304), Sree Prakash (S. 856), Sree Vijaya, Sree Jaya, Sree Rekha and Sree Prabha.

CTCRI CO (Tp) 5 (Sree Padmanabha)

Resistance to cassava mosaic disease. Season June – July ; October – November. Fairly good starch content (28%). Moderate tuber yield (38 t/ha). Erect and top branching habit. Regular flowering and seed setting. Tubers long, cylindrical, white flesh and low in cyanoglucoside. Duration 270 – 300 days.

Climate and 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 l 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 planting one ha. For rainfed conditions, treat the setts with a mixture of potassium chloride @ 5 g/lit and micronutrients viz., ZnSO4 and FeSO4 each @ 0.5%for 20 minutes.Dip the setts for 20 minutes in *Azospirillum* and phosphobacteria each at 30 g/l.

Virus elimination through tissue culture in cassava

The protocol for virus elimination through tissue culture has been standardized for the varieties MVD 1 and H 226 by using meristem culture. The Murashige and Skoog (MS) medium supplemented with BAP at 0.1 mg/l for meristem establishment and shoot growth, and MS medium without growth regulators for rooting have to be followed. The *in vitro* plantlets are to be hardened in sterile pot mixture (sand : soil : FYM in 1 : 1: 1) under mist chamber for 10-15 days and later kept under shade net for 10 days before transferring them to the open field.

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.

Drip irrigation

Install drip system with main and sub-main and place the inline laterals at the interval of 1.5 m. Place the drippers at the interval of 60 cm for 4 LPH and 50 cm for 3.5 LPH in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

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

Fertigation

Fertigation requirement :90: 90 :240 kg of NPK / ha. Apply once in every three days throughout the cropping period.

Spacing : 60 x 90cm in paired row system.

Fertigation schedule: Tapioca (variety)

S. No	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Planting to crop establishme ntstage	20	19:19:19+MN 13-0-45 0-0-50	23.57 34.67 7.87	4.48 4.50 -	4.48 - -	4.48 15.60 3.93	10.00	5.00	10.00
				subtotal	8.98	4.48	24.01	47.39		
2	Vegetative stage	70	12-61-0 13-0-45 Urea	11.40 105.33 26.80	1.34 13.69 12.33	6.80 - -	- 47.39 -	30.00	7.50	20.00
				subtotal	27.36	6.80	47.39			
3	Tuber formation stage	60	12-61-0 0-0-50 Urea	11.40 144.00 55.73	1.34 - 25.64	6.80 - -	- 72.00 -	30.00	7.50	30.00
				subtotal	26.98	6.80	72.00			
4	Tuber development stage	90	19:19:19+MN 0-0-50 Urea	23.57 182.67 48.87	4.48 - 22.48	4.48 - -	4.48 92.34 -	30.00	5.00	40.00
	Total duration	240		sub total	26.96	4.48	96.82			
Total					90.28 (or) 90	22.56(or) 22.50	240.2 2 (or)24 0	100	25	100

- 75% RD of Phosphorus applied as superphosphate 421.88 kg/ha.
    1. 19:19:19 = 47. kg / ha.
    2. 13:0:45 = 140kg/ha.
    3. 12:61:0 = 23kg/ha
    4. 0:0:50 = 335kg / ha
    5. Urea = 132 kg / ha.

Chlorosis: Foliar spray of 1% FeSO4 + 0.5% ZnSO4 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 from planting date upto 60 days

Plant protection

Pests

Mites: Soaking spray with dicofol 18.5 EC 2.5 ml/l 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/l or Methyl demeton 25 EC 2 ml/l. While using neem oil, teepol or sandovit should be added at 1 ml/l for better contact with foliage. Apply Methyl demeton in the early stage and Phosalone in the later stages of crop growth.
6. Avoid use of synthetic pyrethroids.
7. Avoid extending the crop growth beyond its duration.

Spiralling whitefly
1. Install sticky cum light trap and operate between 4 and 6 am to attract adults.
2. Spray Dichlorvos 76 WSC @ 1 ml/l or Triazophos 40 EC 2 ml/l. Add wetting agent.
3. Conserve parasitoids *Encarsia haitiensis* and *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/l twice at 15 days interval.

Tuber rot: Avoid water stagnation. Give good drainage facilities. Spot drench with Copper oxychloride 2.5 g/l or apply through soil *Trichoderma viride* @ 2.5 kg/ha as basal and at 3rd and 6th month after planting

Crop duration: 9 to 11 months.

Yield
Irrigated : 40 - 50 t/ha
Rainfed : 20 - 25 t/ha

Market information

Crop Growing districts	Salem, Namakkal, Erode, Dharmapuri, Villupuram
Major markets in Tamil Nadu	Salem, Dharmapuri, Erode

Elephant foot yam: *Amorphophallus campanulatus* Blume; syn: *A. paeoniifolius*; Araceae

Varieties: Gajendra, Sree Padma

Soil and climate: Rich red-loamy soil with a pH range of 5.5-7.0 is preferred. It is a tropical and subtropical crop. It thrives well with a mean annual temperature of 30-35^{0}C. It requires well distributed rainfall of 1000-1500 mm spread over a period of 6-8 months, with humid and warm weather during vegetative phase and with cool and dry weather during the corm development period.

Season and planting: It undergoes a dormancy period of 45 to 60 days. Traditionally farmers take advantage of the dormancy period by planting during February-March so that the setts would sprout with the pre-monsoon showers. April – May is the planting season.

The tuber is cut into 750-1000g small bits in such a way that each bit has atleast a small portion of the ring around each bud. Whole corms of 500 g size can also be used as a planting material. Use of cormels and minisett transplants of 100 g size as planting material at a closer spacing of 45 x 30 cm is also suggested. 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 or pit of 60 x 60 x 45 cm size is dug and planted. The pit should be filled with top soil and farm yard manure (2kg/pit) prior to planting. 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 beds of convenient size are formed.

Intercropping: Vegetable cowpea var. CO 2 is recommended as suitable intercrop in elephant foot yam. It can be intercropped profitably in coconut, arecanut, rubber, banana and robusta coffee plantations at a spacing of 90 x 90 cm. Half quantity of FYM (12.5 t/ha) and one third of NPK (27:20:33) will be sufficient for the intercrop.

Irrigation: It is mostly raised as a rainfed crop. However, irrigation is required when monsoon fails, where it is grown on a large scale. Water stagnation is harmful to the crop. Wherever irrigation facility is available, irrigation can be given once a week.

Mulching: Mulching immediately after planting not only conserves soil moisture and regulates soil temperature but also suppresses weed growth.

Application of fertilizers: Apply 25 tonnes of FYM/ha during last ploughing. The recommended dose of NPK/ha is 80:60:100 kg. Apply 40:60:50 kg NPK/ha at 45 days after planting along with weeding and intercultural operations. Top dress with 40:50 N and K one month later along with shallow intercultural operations.

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

Collar rot : The disease is caused by a soil borne fungus *Schlerotium rolfsii.* Water logging, poor drainage and mechanical injury at collar region favour the disease incidence. Brownish lesions first occur on collar regions, which spreads to the entire pseudostem and cause

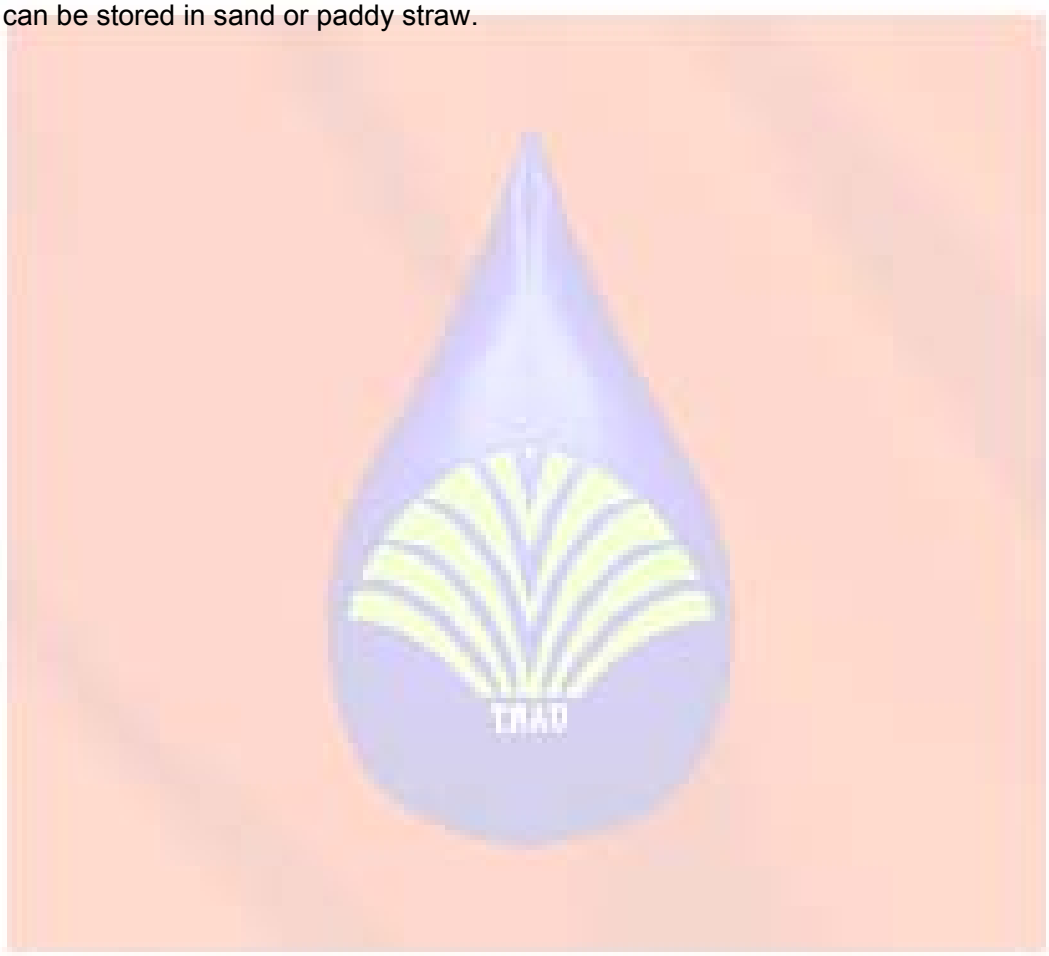
complete yellowing of the plant. In severe case, the plant collapses leading to complete crop loss.

Management: Use disease free planting material, remove infected plant materials, improve drainage conditions, incorporate organic amendments like neem cake, drench the soil with carbenilazim or apply biocontrol agents like *Trichoderma harzianuml* @ 2.5 kg/ha mixed with 50kg of FYM (lg/l of water).

Harvesting: It becomes ready for harvest in about 8-9 months after planting. The crop attains maturity when total senescence takes place.

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.



Taro: *Colocasia esculenta* L. Scott; Araceae

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

Soil and climate: It comes up well in loamy soils with a pH range of 5.5-7.0 and a combination of warm and moist climate with a mean temperature of 21-27^0 C. It can be grown up to 1500 m elevation with well distributed rainfall of about 1000 mm during growth period. In areas where rainfall is less, a good amount of supplementary irrigation is required for successful production.

Planting material and seed rate: Cormels weighing about 20-25 g form good planting material. Seed rate of 800 kg/ha is required.

Season: Under rainfed condition, planting during April to June is ideal. June – July and February – March. If grown as irrigated crop, it can be raised throughout the year.

Preparation of field: Plough the field to a fine tilth and form ridges and furrows at a spacing of 45 cm.In sandy loam soil, pit method is followed. Plant at a spacing of 45 cm in furrows.The cormels may be planted to a depth of 2.5 to 7.5 cm.

Mulching:
Planted seed tubers take 30to 45 days for sprouting. Mulching helps to hasten sprouting and control weed growth.

Gap filling:
Under field condtions, 5-10 per cent of the seeds fail to sprout. To overcome this situation, about 2000-3000 corms / cormels per hectare may be planted in a nursery at a close spacing so that sprouted tubers from the nursery can be used for gap filling.

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 be done 45 to 60 days after planting. Deep cultivation should be avoided. Small inefficient suckers from the mother plants have to be removed along with the second weeding.It requires profuse irrigation and shade.

Crop protection:

Aphids and worms are pests attacking the leaves.
Control: Spray Quinalphos or Dimethoate 0.05%.
Mealy bugs and scale insects damage cormels and corms and hence select cormels free of these pests for planting. If infested, the seed cormels should be dipped in Dimethoate or Monocrophos 0.05% solution for 10 minutes.

Leaf blight (*Phytophthora colocasiae*): Oval or irregular purplish or brownish necrotic lesions with watersoaked periphery appear on leaves. In severe cases, the entire leaf lamina and the petioles are affected giving a blighted appearance and collapse of the plant. Heavy incidence causes up to 50 per cent crop loss.
Management : Use of field resistant varieties *viz.,* Muktakeshi and Jankhri, early planting to avoid heavy monsoon rains, use of healthy planting materials, removal of self-grown colocasia

plants, spray with fungicides *viz.,* Mancozeb (0.2%) or Ridomil MZ 72 @ 2 g/l of water and treating the seed tubers with biocontrol agents *viz., Trichoderma viride*

Harvesting

Crop will be ready for harvest in 6-8 months after planting. One month prior to harvest, all the suckers may be wrapped around the base of the mother plant and covered with soil by earthing up, for arresting further vegetative growth and sprouting of tubers. After this, irrigation has to be withheld to hasten maturity. Harvesting is done by carefully uprooting the plants and the mother corms and cormels are separated.

Yield: 8 – 10 t/ha in 180 days.

Dioscorea: *Dioscorea alata and* L.; *Dioscorea esculenta* L. Dioscoreaceae

Varieties

Peruvalli (*D.alata*) : CO 1, Sree Roopa, Sree Keerthi, Sree Shilpa.
Siruvalli (*D.esculenta*) : Sree Latha, Sree Kala.

Soil and climate: It requires warm and humid conditions with a mean temperature of 30^0C and a well distributed annual rainfall of 1200-2000 mm. Sandy loam soil with a pH of 6.0 to 6.5 is preferred with good drainage and cool weather.

Season and planting: March - June.

Use mature tubers or pieces of 250-300 g tubers taken from the previous crop as seed material at the rate of 1875 – 2500 kg/ha. Mini setts of 25 g are recommended for planting directly in the field or raising a nursery and planting plants after 60 days. For planting lesser yam, medium sized tuber of 100-150 g is sufficient. 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 for raising lesser yam. Ridges and furrows at 75 cm spacing or pits of 45 x 45 x 45 cm for planting greater yam at 90 x 90 cm. Fill the pits with top soil and FYM.

Method of planting : To plant greater yam, 3000-3700 kg and for lesser yam 1800-2700 kg of seed material is required.

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 and 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. Go for weeding before top dressing, followed by earthing up.

After cultivation: The vines should be trained on bamboo poles. Weeding as and when necessary. It can be intercropped profitably in coconut, arecanut, rubber, banana and robusta coffee plantations at a spacing of 90 x 90 cm. In Robusta banana + *Dioscorea* system, banana should be manured at the full recommended dosage and for yams, manuring at the 2/3rd recommended level is sufficient.

Trailing

Trailing is necessary to expose the leaves to sunlight. It is done within 15 days after sprouting by coir rope attached to artificial supports in the open area or to the trees where it is raised as an intercrop.

Crop protection

Yam scale is found to occur on the tubers both under field and storage conditions. As a prophylactic measure, dip the planting material in Monocrotophos 0.05 per cent. Use scale free seed tuber for planting.

Harvesting

Greater yam and white yam become ready for harvest by 9-10 months after planting. Lesser yam takes 8-9 months for attaining maturity. Carefully dig out the tubers without causing injury.

Yield: 20 – 25 t/ha in 240 days.

Chinese potato: *Coleus parviflorus* L.; Syn : *Solenostemon rotundifolius*; Labiatae

Varieties: CO 1, Sree Dhara.

Soil and climate: Red, loamy and well drained soils. Comes up well in shade with warm humid climate. It requires very good rainfall for its growth and cannot withstand drought conditions. In case rains are not received, irrigation has to be provided for satisfactory growth.

Raising nursery : Raise a nursery, approximately one and half months prior to planting. An area of 500 m^2 is required to produce vines for planting one hectare of land. Cattle manure or compost may be applied @ 1 kg/m^2 and ridges / mounds may be prepared at a closer spacing of 45/60 cm. Healthy tubers that weigh about 15-20 g may be planted at 5cm spacing on the ridges / mounds so as to accommodate 750-1200 kg tubers in 500 m^2 area during March- April. Top-dress with urea (5 kg / 500 m^2) at about three weeks after planting to encourage good vine growth. Stem cutting of 15-20cm length from these sprouts also used as planting material. To enable rapid multiplication of the planting material, single node cuttings can be planted directly in the secondary nursery. Such single node cuttings produce axillary shoots within one week can be planted in the main field.

Preparation of main field and planting: The field is ploughed 4 to 5 times to a fine tilth and form ridges and furrows 60 cm apart. Use herbaceous cuttings of 10 cm length taken from the nursery beds and plant in the main field during July – October at a spacing of 30 cm on the ridges either in vertical or horizontal position. Horizontal planting of vines to a depth of 4-5 cm and exposing the terminal bud ensures quick establishment and promote tuber yield. In loose soils having good drainage, planting can also be done on flat beds with provision for drainage.

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*. In case, the soil has eroded from the base of the plant, give one more earthing up at 30 days later to promote tuber formation.

After cultivation: 2 or 3 weedings and earthing up 2 months after planting.

Crop protection : Root knot nematode is a serious pest on coleus and the infested plants exhibit serious swellings or galls in the roots resulting in suppressed roots, stunted growth and wilting. Less than a millimetre long, the nematodes are tiny worms that enter the plant roots of the seedling when the plant is most vulnerable. Therefore, emphasis may be given for the selection of seed tubers free of nematodes.

Deep ploughing of the field immediately after harvest exposes the soil and kills the nematodes. We can also control the nematodes by practising summer fallowing and soil solarization. Cultivation of sweet potato (Sree Bhadra) as a preceding crop in May-June enables trapping of root knot nematodes in the soil. To control leaf folding caterpillars and vine borers, dipping the vines in insecticide solution (Dimethoate or Rogar 30 EC ie. 1.7 ml/litre) for 10 minutes prior to planting is helpful. In case, severe damage is noticed in the field, field spraying may be adopted with Malathion (or) Fenthion (or) Fenitrothion 50 EC 1 ml/litre).

Harvesting: Harvest the crop when the vines dry up at 4-5 months after planting. Pull out the plants and dig out the left over tubers in the field. Separate the tubers from the plant and destroy the crop residues by burning.

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 is a free flowering and seed setting type.

Soil: Red loam to black soils with good drainage facilities. The germination and bulb maturation is affected in clayey soil. It grows well in pH range of 6- 7 and a mild season without extremes of heat and cold.

Season and sowing: Sow the medium sized bulbs during April – May and October – November. It requires sufficient soil moisture during its growing period but heavy rains during bulb germination and bulb formation affects the crop growth.

Seed rate: Seed bulbs 1000 kg/ha. Medium sized bulbs are to be chosen for planting. Seeds @ 8kg/ha.

Raising seedlings and transplanting

This is the most common method practiced for irrigated crop as it results in high yield and large size bulbs. In plains, seeds are sown during October-November for a rabi crop. In hills, seeds are sown from March to June. Seeds are first sown in well prepared nursery beds of 90-120 cm width, 7.5-10.0 cm height and convenient length. Ratio between nursery area and main field is about 1:20. Seed rate varies from 8 to 10 kg/ha. Seedlings of 15 cm height and 0.8 cm neck diameter are ideal for transplanting and this is achieved in 8 weeks. However, it varies from 6-10 weeks depending on soil, climate and receipt of rain. There is a practice of topping seedlings at the time of transplanting if seedlings are over-grown.

Preparation of field: Plough the land four times to a fine tilth. Form ridges and furrows at 45 cm spacing. Sow the bulbs or plant the seedlings on both the sides of the ridges at 10 cm apart.

Irrigation: Irrigate at the time of planting of seedlings and third day and later at weekly intervals. With hold 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.

Fertigation : Apply a dose of 75% of the total recommended dose of superphosphate i.e. 285 kg/ha as basal dose. Azospirillum and Phosphobacteria each @ 2 Kg/ha along with FYM 50 Kg and Neem cake @ 100 kg are applied before last ploughing. Raised beds of 120 cm are formed at an interval of 30 cm and the laterals are placed at the centre of each bed.

Planting design: Bulbs or seedlings are planted in rows of 20 cm spacing and 12 cm between plants. Planting is done at 6 rows in each bed, thereby it accommodates 55,560 plants in one hectare. Irrigation is done after transplanting or planting the bulbs. Complete wetting is necessary to maintain uniform moisture level.

Plant protection - Pests

Thrips and onion fly: Spray any one of the following insecticides based on the ETL of 1 maggot/hill

Insecticide	Dose
Dimethoate 30 % EC	7.0 ml /10 lit.
Oxydemeton –Methyl 25 % EC	1.2 ml/lit.
Quinalphos 25 % EC	1.2 ml/lit.

Cutworm: Drench the soil with chlorpyriphos @ 2 ml/l.

Diseases

Leaf spot: Spray Mancozeb 2 g /l or Copper oxychloride 2.5 g/l. Add Teepol 0.5 ml/l of spray fluid.

Basal rot: Seed or bulb treatment with *Trichoderma viride,* @ 4g/kg and basal application *of T. viride,*@2.5kg/ha along with VAM 12.5 kg/ha.

(or)

Follow the following IPM practices for pest and disease management

- Growing two rows of maize as barrier crops around field border.
- Selection of healthy onion seed bulbs.
- Bulb treatment –*Pseudomonas fluorescens* (5 g/kg) + *Trichoderma viride* (5 g/kg)
- Soil application of *P.fluorescens* (1.25 Kg/ha) + *T.*viride (1.25 kg/ha) + AM Fungi (VAM) (12.5 kg/ha) + Azophos (4kg/ha) + Neem cake 250 kg/ha.
- Installation of Yellow sticky traps 12/ha for thrips and leaf miner trapping.
- Installation of Pheromone traps 12/ha for cut wrom (*S.litura*).
- Spray application of *P.fluorescens* (5 g/l) + *Beauveria bassiana* (10 g/l) on 30 DAP.
- Spray application of Azadairachtin 1% (2 ml/l) on 40 DAP.
- Need based application of Profenophos (2 ml/l) or Dimethoate (2 ml/l) or Triazophos(2 ml/l) for thrips/leaf miner/cut worm management.
- Need based application of Tebuconazole (1.5) ml/l) or Mancozeb (2 g/l)/Zineb (2g/l) for purple blotch disease management.

Harvest and Yield

Spray Cycocel @ 200ppm + carbendazim @ 1000 ppm 30 days before harvest to extend the shelf life of onion. Harvesting is done by pulling out plants when tops are drooping but still green. During hot days when soil is hard, bulbs are pulled out with a hand-hoe.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.

Market information

Crop Growing districts	Perambalur, Trichy, Dindigul, Namakkal, Coimbatore, Erode, Tirunelveli
Major markets in Tamil Nadu	Dindigul, Palani, Palladam, Madurai, Trichy, Ottanchathiram, Coimbatore and Chennai
Preferred Varieties	Co (On) 5
Grade Specification	Shape, Size, skin colour, moisture content

Big onion or Common onion: *Allium cepa var. cepa;* Alliaceae

Varieties: Bellary Red, Pusa Red, NP 53, Arka Niketan, Arka Kalyan, Agri Found Light Red, Agri Found Dark Red and Rose onion (small).

Soil: Red loam to black soils with good drainage facilities. The optimum pH is 5.8-6.5.

Season: May – June. Mild season is preferred.

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 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: Irrigate at planting and third day and later 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 topdressing 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: Spray methyl demeton 25 EC @ 1 ml/lit or dimethoate 30 EC @ 1 ml/lit with Teepol 0.5 ml/lit.

Cutworm: Drench the soil with chlorpyriphos @ 2 ml/l.

Nematode: Application of Carbofuran 3 G or Phorate 10G @ 1 kg a.i./ha at 10 days after transplanting.

Disease

Leaf spot: Spray Mancozeb 2 g/l or Copper oxychloride 2 g/l . Add 1 ml of Teepol to per l of spray fluid.

Yield: 15 – 18 t/ha in 140 – 150 days.

Bellary onion – Market information

Crop Growing districts	Perambalur,Trichy,Thiruppur,Dindigul,Namakkal,Tirunelveli
Major markets in Tamil Nadu	Ottanchathiram, Koyambedu, Dindigul, Coimbatore
Grade Specification	Colour and Size Extra large onion (>6 cm dia.), Medium (4-6 cm dia.), Small (2-4 cm dia.), Light Red, light purple colour

Big onion and aggregatum onion production through fertigation

Quality seedling production:

- The seedlings of big / common bellary onion are produced in raised nursery beds. Nursery area of 12.5 cents with slanting slope of 2% is required for the seedling production to cover 1 ha.
- Unlike other transplanted vegetables, the nursery area of open / protected – raised beds may be used since, the seeds are too small and the number of seedlings requirement is also very high.
- Raised beds of 30cm height and convenient length at an nterval of 30cm between beds must be formed for sowing the seeds.
- The beds are inoculated with Arbuscular mycorrhizae @ 1 kg / sq. m.

Seed treatment and seed rate:

- 8-12kg of onion seeds are required to raise seedlings for one hectare of land. The seeds are treated with *Pseudomonas fluorescens* @ 10g/ kg of seeds.

Sowing :

- The seeds of onion are small, and hence the seeds should be mixed with fine sand and sown in lines 10 cm apart.
- After sowing, the seeds are covered by thin layer of sand and then by paddy straw. The nursery is watered through rose can twice a day regularly.
- On tenth day, copper oxychloride @ 2g / litre of water is sprayed to protect the seedlings from damping off disease.

Drip irrigation

- Installation of drip system is done with main and sub-main pipes and the inline lateral tubes are placed at an interval of 1.5 m.
- The drippers in lateral tubes are placed at an interval of 60 cm and 50cm spacing with 4LPH and 3.5 LPH capacities respectively.

Field preparation

- The field selected for planting should be ploughed thoroughly by using chisel plough, disc plough and cultivator.
- FYM @ 25t / ha and 75% of the total recommended dose of single superphosphate (285kg.) Azospirillum, phosphobacteria 2 kg / ha and Pseudomonos 2.5 kg / ha along with FYM 50 kg and neem cake @ 100g are applied before last ploughing.
- Along with biofetilizers 50kg each of zinc suphate and ferrous sulphate are applied before last ploughing.
- Raised beds of 1.2 m width and 30 cm height are formed for transplanting.
- Drip irrigation is done @ 8-12 hours depending upon the soil condition to get field capacity.

Planting:

- Transplanting is done in rows at the spacing of 15 cm between rows (of 7 rows within the bed) and 10 cm between plants.
- A total population of 4,70,000 seedlings are required to cover one hectare of land.

After care:

- Drip irrigation is done @ 1-2 hours per day depending upon the soil and climatic condtion.
- Weeding: First weeding is done on 30th day after transplanting. Then weeding is done as and when necessary.

- Fertigation: For big onion, 60:60:30kg of NPK/ha is applied throughout the cropping period. The splits are approximately once in every 3 days.

Harvesting and post harvest management.

- The harvesting is done 75 to 160 days depending upon the varieties.
- The irrigation is stopped 15 days before harvesting and sprayed with 2500 ppm of maleic hydrazide. This will prevent sprouting of the bulbs in storage, by which they can be stored even for 6-7 months.
- The correct time of harvest is one week after 50% top fall. After lifting, the bulbs with tops should be cured in shade for 10-15 days before storage to remove field heat. Then proper sorting and grading is done.

FERTIGATION SCHEDULE Recommended dose: 60:250: 250 kg / ha

Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)						
				N	P	K	H	P	K
Sowing to establishment Stage	10	19:19:19 MN Urea	15.79 6.50	3.00 3.00	3.00 -	3.00 -	10.00	5.00	10.00
			Subtotal	6.00	3.00	3.00			
Vegetable stage	25	12:61:0 13:0:45 Amm.So4	7.46 13.20 76.67	0.89 1.72 15.33	4.55 - -	5.94	30.00	7.50	20.00
			Subtotal	17.94	4.55	5.94			
Bulb formation stage	25	12:61:0 13:0:45 Amm.So4	7.46 19.80 72.33	0.89 2.57 14.47	.4.55 - -	- 8.99 -	30.00	7.50	30.00
			Subtotal	17.93	4.55	8.99			
Bulb development stage	30	19:19:19 MN Amm.So4	15.79 19.80 62.00	3.00 2.57 12.40	3.00 - -	3.00 8.91 -	30.00	5.00	40.00
			Subtotal	17.97	3.00	11.91			
Total duration	90			59.84 (or) 60.00	15.00	27.76 (or) 30.00	100	25.00	100.00

75% of RD of Phosporous applied as super phosphate = 45 kg x 6.25 = 281.25 kg/ha

1. 19:19:19 = 32 kg/ha
2. 12:61:0 = 14.92 kg / ha (or) 15.00 kg /ha
3. 13:0:45 = 53 kg / ha
4. Urea = 7 kg / ha
5. Ammonium SO4 = 211 kg / ha

Effect of Endo root soluble and Mycorrhizae on Onion

Apply 1000g Endo Roots Soluble in two splits doses at 15 DAT and 45 DAT along with 100% N and K and 50% P for higher yield and saving of phosphorous

Apply mycorrhiza roots 1000g in two splits at transplanting and 30DAT along with 100% N and K and 50% P for higher yield and saving of phosphorous.

Chapter E
Leafy vegetables

Amaranthus: *Amaranthus* sp *L.;* Amaranthaceae

Varieties

CO 1 (Mulaikeerai and Thandukeerai)
CO 2 (Mulaikeerai and Thandukeerai)
CO 3 (Clipping type)
CO 4 (Grain type)
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/l .

Diseases

Leaf spot: carbendazim @ 1 g/l of water. Spraying sulphur compounds should be avoided.

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 Kaambu, Dharwad-1, Dharwad-2

Soil and climate: Red sandy loam with good drainage will be ideal for its normal and fleshy growth, which will result in better leaf yield. The optimum temperature requirement is 26 to 37°C.

Season of sowing and planting: The main season of availability of curry leaf fruits is July-August within 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. Pits of 30 x30x30cm 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 a week.

Application of fertilizers: After each harvest, 20 kg of FYM/plant is applied and mixed with soil.

Inter cultivation: Periodical hoeing has to be given. During 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.

Diseases

Leaf spot: Spray carbendazim @ 1 g/l 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	Fertilizer 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*)	i**Temperate Types**: Purple top White Globe Snow. ii.**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*)	Brassic- 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
Major Spices

Pepper: *Piper nigrum* L.; Piperaceae

Varieties: Panniyur 2, Karimunda, Sreekara, Subhakara, Panchami, Pournami, IISR Thevam, IISR Malabar Excel, IISR Girimunda, IISR Sakthi, PLD-2.

Lower elevation and less shady areas- Panniyur 1.
Higher elevation and more shady areas - Karimunda.
Inter cropping in Arecanut – Panniyur 5.

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 and the crop can be grown 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 (Panniyur 1 - 3 x 3 m).
5 to10 kg of FYM/Compost is mixed with top soil and the pits are filled. Rooted cuttings of black pepper are planted in June-July @ two per standard. Silver oak, Dadap and Jack can be used as standards and should be planted at a spacing of 7–8 m.

Manuring: Apply cattle manure or compost @ 10 kg/vine - before the onset of South West monsoon. 100:40:140 g of NPK per vine in two split doses during May - June and September - October. Slaked lime at 500 g per vine is applied in alternate years during May - June.
Apply *Azospirillum* @ 100 g/vine one month after the application of chemical fertilizers.
Integreted nutrient management - Inorganic N 50 % of the recommended dose + FYM 10 kg + 50 g *Azospirillum* + 50 g *Phosphobacteria* + 200 g VAM per plant.
The manures and fertilizers are applied around the vine at a distance of 30 cm from the base and incorporated into the soil.

Irrigation: Protective irrigation in basins during December - May at 10 days interval.

Aftercultivation: Two weedings are given during the months of June - July and October - November. The vines are to be trained to the standards. Excessive foliage of the standards may be pruned and the height of the standards may be limited to about 6 m. To increase the berry size spray NAA @ 40 ppm.

Fruit drop: The spike shedding can be reduced by foliar spray of Diammonium Phosphate 1.0 % four times *viz.,* before flower initiation (May), during new leaves and flower emergence (June) before spike initiation (July) and pinhead stage of berries (August).

Plant protection

Pests
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.

Pollu beetle and leaf caterpillars: Spray quinalphos 25 EC @ 2 ml/lit.

Diseases

Foot rot

Nursery: Apply *Trichoderma viride* @ 1 g/kg of pot mixture. Mulch the pot mixture with 150 gauge polythene sheet for 30 days and inoculate with *Pseudomonas.*

MAIN FIELD: Any of the following formulation can be drenched in the soil twice (May – June and October - November).

- Neem cake 1/2 kg per vine + Swabbing of Bordeaux paste upto 1 m from the ground level.
- *Trichoderma viride* @ 20 g/vine + FYM or Bordeaux mixture 1 % or Metalaxyl-Mancozeb @ 2 g/lit.
- Neem cake 2 kg per vine + 0.1% Metalaxyl (pre monsoon foliar spray and soil application).
- *Pseudomonas fluorescens* (50 g) (pre and post monsoon) + neem cake (2 kg) (post monsoon) + metalaxyl 0.1 %.

Slow wilt: Apply Phorate 10 G @ 30 g or Carbofuran 3 G @ 100g per vine (May – June and September - October) + Copper oxy Chloride @ 0.2 % (Soil drenching) or Potassium phosphonate @ 0.3% or Metalaxyl @ 0.1 %.

Anthracnose: Foliar spray with Bordeaux mixture @ 1 % or Mancozeb @ 0.2 %.

Nematode : Soil application *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* @ 10 g/vine is recommended for the management of root knot and reniform nematode population in Black pepper.

Harvest: Harvesting commences from third year onwards. 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.

Market information

Growing districts	Kanyakumari, Nilgiris, Kolli Hills, Lower pulneys
Major markets in Tamil Nadu	Kanyakumari, Nagarkovil
Preferred varieties	Tellichery, Alleppey and Malabar Garbled (MGI)
Grade specification	Pungency and aroma

Bush Pepper

Planting material: One year old lateral branches with 2-3 nodes with the bit of orthotropic portion intact.

Planting: 3-5 well rooted cuttings per pit or pot

Manures and Manuring:

- 1:0.5:2 g of NPK per pot at bi monthly intervals
- 15 and 33 g of groundnut cake and neem cake per pit or pot.

Pruning: Pruning of hanging shoots to maintain the bushy nature, repeating at every two years interval.

Cardamom: *Elettaria cardamomum* (Maton.); Zingiberaceae

Varieties:
Malabar- Mudigree-1 and 2, PV 1, ICRI 1, ICRI 3, TKD 4,IISR Suvarna, IISR Vijetha, IISR Avinash, Mysore - ICRI 2, Vazhukka – PV2, Njallani (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:

Propagation through Seeds:
Collect seeds from healthy and high yielding plants.
Seed rate – 600g/ha (fresh seeds).
Treat with commercial grade Sulphuric acid or Hydrochloric acid for 20 minutes.
Wash with water.
Prepare the beds with equal quantity of well rotten cattle manure, wood ash and jungle soil.
Sow the seeds in beds and cover with a thin layer of fine sand.
Mulching and shading may be provided to seed beds. The beds should be kept moist but not too wet. Germination starts usually a month after sowing and continues upto three months. One year old seedlings are transplanted to secondary nursery.

Secondary nursery:
Prepare the beds. As that of primary nursery, shade is provided by erecting overhead pandal.
Seedlings planted at a distance of 20 x 20 cm.
18-22 months old seedlings are used for transplanting.
Polybags of 20 x 20 cm size can be used

Propagation from suckers:
Suckers from high yielding plants are planted in clonal gardens.
Spacing 1.8 m x 0.6 m (6800 plants/ha of clonal nursery)
Shade and Irrigation is provided, 32 – 42 suckers obtained from each planting unit in 12 months

Preparation of the field: Dig pits of 60 cm^3 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 sprinkler irrigation may be provided during summer for increased yields.

Manuring: Apply compost 25 t/ha; 75:75:150 kg of NPK per ha in two split doses during June - July and October - November.

After cultivation:
Shade regulation. Moderate shade – 50-60 %
Rainfed – 40 – 50 %
Irrigated – 55-60 %
Mixed population of medium sized shade trees- Karona, Red cedar, konikonna, Jack, Vellakil, Thempavu, Thambahom, Bolongi, Elangi.

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:

Pesticide	Dose
Diafenthiuron 50 % WP	8 g/10 lit
Monocrotophos 36 % SL	10 ml/10 lit
Phenthoate 50 % EC	5.0 ml/10 lit.
Quinalphos 25 % EC	12 ml/10 lit.

Capsule and shoot borer
Set up pheromone trap @ 12/ha to attract and destroy the female moths.
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 @ 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.
- *Pythium*: prophylactic drenching with 0.25 % Mancozeb or 1 % Bordeaux mixture immediately after germination
- *Rhizoctonia* : Soil drenching with 0.05 % Carbendazim - 15 days after germination.

Capsule rot or panicle rot or Azhukal: Three sprays with 1 % Bordeaux mixture or 0.25 %. Copper oxychloride or 0.2 % Mancozeb (August – September).
Drench soil with 1 % Bordeaux mixture.

Harvest: Harvesting commences from third year onwards. Economic yields from 5th year. Harvesting is 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.

Market information

Growing districts	Theni
Major markets in Tamil Nadu	Bodinayakanur, Kumily, Thekkady, Kumbum
Preferred varieties	Alleppey Green Extra Bold' (AGEB),
Grade specification	Freshness, colour, aroma and size

Turmeric: *Curcuma longa* Val.; Zingiberaceae

Varieties: CO 1, BSR 1, BSR 2, Roma, Suvarna, Sudarshana, Suguna, Sugandham, Ranga, Rasmi, Rajendra Sonia, Krishna, Suroma and Allepy Supreme, Kedaram, Prabha, Prathiba.

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:

- Seed rhizomes dipped in phosalone 35 EC 2ml/lit or monocrotophos 36 WSC 1.5 ml/lit. 0.3% Copper oxychloride for 30 min or
- Seed treatment with *P. fluorescens* 10 g/kg and *T. viride* as 4 g/ Kg.

Propagation: Mother rhizome & finger rhizomes. Seed rate of finger rhizome-2000kg/ha.

Main Field Preparation:

Main field is ploughed four times with chisel and disc plough each one time and cultivator twice. Ridges and furrows are formed at spacing of 45 cm (or) raised beds of 120 cm width are formed at an interval of 30 cm and the laterals are placed at the centre of each bed.
The beds are wetted for 8-12 hours through drip irrigation depending upon soil moisture level.

Spacing: 45 x 15 cm. 25-30 g weight rhizomes are to be dibbled at a depth of 4 cm.

Manures and manuring

Basal: FYM - 25 t /ha, neem or groundnut cake - 200 kg/ha, 25:60:108 kg of NPK per ha; 30 kg of $FeSO_4$ and 15 kg of $ZnSO_4$, 10 kg in each of *Azospirillum* and *Phosphobacteria* per ha to be applied at the time of planting.

Top dressing: 25: 108 kg of N and K/ha applied on 30, 60, 90, 120 and 150 days after planting.

Micronutrient application: Apply 375 g each of Boron, Iron and Zinc, at rhizome development stage, as Borax, Ferrous sulphate, Zinc sulphate + 375 g of Urea in 250 lit of water/ha. Spray twice at 25 days interval.

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.

Fertigation:

Fertigation is done as per the recommended dose with 150:60:108 kg of NPK/ha
and is applied throughout the cropping period once in three days.
75 % of the recommended dose of phosphorous is applied as basal dose. Water soluble fertilizers like 19:19:19, Mono ammonium phosphate (12:61:0), Multi K (13:0:45) and urea are used.

Fertigation schedule for turmeric

Crop Stage	Duration (in days)	Nutrients requirement (%)			Quantity applied (kg/ha)	
		N	P	K		
Planting to establishment stage	15	10	20	10	19:19:19 Multi K Urea	15.78 17.33 21.20
Vegetative stage	60	40	30	20	19:19:19 Multi K Urea	9.83 96.00 100.57
Rhizome initiation stage	60	30	30	30	19:19:19 Multi K Urea	4.91 71.28 76.29
Rhizome maturation stage	135	20	20	40	19:19:19 Multi K Urea	15.78 40.42 47.06
Total Duration	270	100	100	100		

Inter cultivation: Onion, Coriander and Fenugreek can be planted as intercrop on the sides of the ridges 10 cm apart. 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 for controlling rhizome rot and scales.

Pests

Pre planting treatment: The seed rhizomes are dipped in carbendazim @ 1 g/lit and phosalone
35 EC @ 2 ml/lit or for controlling rhizome rot and scales.

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.

Nematode: Avoid planting turmeric after Banana or solanaceous vegetables. Apply Carbofuran 4 kg a.i./ha twice on the third and fifth month after planting the rhizomes.

Diseases

Rhizome rot:

- Treat the seed rhizomes with 0.3% Copper oxychloride for 30 min or Drench with Bordeaux mixture 1 % or Copper oxychloride 0.25 % or Ridomil 0.1 % or
- Seed treatment with *P. fluorescens* 10 g/kg and *T. viride* 4 g/ Kg and soil application of 2.5 Kg/ha each of *P. fluorescens* and *T. viride* in 50 kg of FYM as basal and top dressing on 150 Days after Planting.

Leaf spots: Spray Carbendazim 500 g/ha or Mancozeb 1 kg/ha or Copper oxychloride 1.25 kg/ha or Propiconazole 500ml/ha.

Harvest: The plants will start lodging, yellowing and drying on crop maturity. The rhizomes are dug 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 partial shade.

Market information

Growing Districts	Karur, Villupuram, Coimbatore, Salem, Dharmapuri, Krishnagiri, Erode
Major markets in Tamil Nadu	Erode, Karur, Coimbatore, Salem and Dharmapuri
Preferred varieties	Erode local, BSR, Salem variety
Grade specification	Bright Yellow colour, size above 3cm length, hard, when broken gives metal sound , smooth skin , without impurities

Ginger: *Zingiber officinale* Rosc.; *Zingiberaceae*

Varieties: Rio de Janeiro, Maran, Nadan, Suruchi, Surabi, Suprabha, IISR Varadha, IISR Rejatha, IISR Mahima, Athira & Karthika

Season: May-June.

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 under tropics. Ginger can be grown from sea level to an altitude of 1500 m.

Seed rate: 1500 - 1800 kg of rhizome/ha.

Seed treatment:

- Treat the seed rhizomes with Mancozeb or Copper oxychloride 3 g/lit or 200 ppm Streptocycline for 30 minutes

Spacing: Irrigated crop – 40 x 20 cm in ridges and furrows.
Rainfed crop – Raised beds of 20 x 20 cm or 25x 25 cm

Manures and Manuring

Basal: FYM 25-30 t + 30 tonnes green leaves as mulch in three splits : 15 tonnes-immediately after planting, 7.5 tonnes – 60 days and 120 days after planting, 50: 25 kg of P and K per ha.

Top dressing: 37.5: 12.5 kg of N and K per ha applied on 45th and 90th day after planting.

Aftercultivation: Mulching is done at the time of planting with green leaves. After each top dressing, earthing up of plants is done.

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.):

- Provide adequate drainage facilities
- Select healthy and disease-free seed rhizomes
- Treat the seed rhizomes with Mancozeb or Copper oxychloride 3 g/lit or 200 ppm Streptocycline for 30 minutes.
- In the field, drench the beds with 2.5 g/lit of Copper oxychloride or 1% Bordeaux mixture or Metalaxyl - mancozeb 4 g/lit..

Rhizome rot

Rhizome treatment with Pseudomonas fluorescens @ 20g/kg rhizome + soil application @ 10kg/ha immediately after planting and 45 days after planting followed by pre monsoon drenching with Metalaxyl 0.1%.

Leaf spot: Spray with 1 % Bordeaux mixture or Copper oxy chloride 0.25%.

Harvest: The crop can be harvested after 8 - 9 months when leaves start yellowing and drying.

Yield: 12 - 15 t/ha.

Chapter B
Tree Spices

Clove: *Syzigium aromaticum* (L.) Merrill & Perry; Myrtaceae

Varieties: Local.

Soil and climate: Deep rich loams with high humus content and lateritic soils are best suited. Humid tropical climate with an annual rainfall of 150 - 250 cm and a mean temperature range of 20^0C to 30^0C and elevation up to 1000 m are suitable.

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 in poly bags.
The seeds germinate in five to six weeks.
Take 30 cm^3 pits @ 6m x 6m spacing. Fill the pits with top soil, 50 g *Azospirillum* and FYM 10 kg/pit. Two years old seedlings are planted in pits.

Aftercultivation:

- Provide shade for seedlings.
- Mulch the basins with dried leaves.
- Weed the basins as and when necessary.
- Provide shade during the initial establishment by raising banana.
- Small temporary pandal may also provide partial shade during initial establishment.

Irrigation: Frequent watering is essential in the initial stages in the absence of rains. Apply 8 litres of water either through drip or through basin during the months of January – May.

Manuring:
One year old plants can be applied with FYM 15 kg, 20:20:60 g of NPK per plant 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, 300:300:960 g of NPK per plant
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. Apply Phorate 60g/tree in the soil or trunk implantation of Monocrotophos 1ml/tree.
Black scale: Foliar spray with Monocrotophos 1.5 ml/l or Dimethoate 1ml/l.

Diseases
Leaf spot: Pre-monsoon spray of *Pseudomonas fluorescens* (Pf_{PPB}) @ 0.2 % + Lawsonia leaf extracts (5 %) or Spray with Copper oxy chloride @ 0.25 % .
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 Houtt.; Myristicaceae

Varieties: Vishwashree, Konkan Sugandha and Konkan Swad.

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 under humid tropical climate.

Propagation: Seeds /grafts/ budded plants.

Seed Propagation: Seeds are collected from regular bearing and high yielding trees (more than 10,000 fruits per tree per year) and having 30 g weight/fruit, 1 g wet mace /fruit and 10 g wet weight of nuts / fruit. Seeds are harvested during June – July. Sown immediately after extraction in beds at a spacing of 30 cm and 2.5 – 5.0 cm deep. Germination commences from 40 days and extends up to 90 days after sowing. Transplanted to poly bags (35 x 15 cm) one year old seedlings are transplanted to bigger poly bags (35 x 20 cm). Seedlings transplanted to main field from 18-24 months.
Vegetative propagation: Grafting (approach method) or budding (Patch method) is recommended to perpetuate high yielding nutmeg types. Best season is from October to January. Use only orthotropic shoots as scion materials.

Season and planting: Plant 12 - 18 months old seedlings/ grafts/ budded plants in pits of 60 cm^3 size. Take pits at a spacing of 8 m x 8 m. Fill with equal parts of forest soil and cattle manure. Season of planting is June – December.

Manuring: Apply FYM 15 kg, 20:20:60 g of NPK per tree during first year and FYM 50 kg, 300:300:960 g of NPK for adult trees (15 years onwards) in two splits June - July, September - October. Apply 50 g in each of *Azospirillum* and *Phosphobacteria* 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. 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. Mechanically remove the plant parasite.Remove severely affected branches and twigs of nutmeg trees.Paint with Bordeaux paste.

Harvest: The bearing starts from six to seven years after planting. The mature fruits are harvested when they start splitting. The aril commonly known ‘mace’ and ‘seed’ are separated and dried.

Yield
Fruits: 1000 - 2000 Nos./tree
Dried nuts: 5 - 7 kg/tree
Dried mace: 0.5 - 0.7 kg/tree.

Cinnamon: *Cinnamomum zeylanicum* Blume.; Lauraceae

Varieties: YCD 1, PPI – 1, Nithyasree, Navasree, Konkan Tej, Sugandhini

Soil and climate: Sandy or lateritic soils with high humus are suitable. Can be grown at an altitude of 800 - 1000 m from MSL with an annual rainfall of 150 to 250 cm.

Season: June - December.

Propagation: Seeds / Semi hardwood cuttings
Nursery: Seeds collected from selected mother trees are sown immediately in nursery beds in rows of 12 cm apart. July – August is the best season for sowing.
From beds, seedlings are transplanted to polythene bags when they attain a height of 15 cm.

Planting: Take pits of 60 cm^3 at 2 m x 2 m spacing. Fill the pits with top soil and FYM 10 kg. One year old seedlings or rooted cuttings are transplanted under partial shade.

Irrigation: Protective watering during summer is in beneficial.

Manuring per plant

Manures and fertilizers	1st year	Annual increase	10th year onwards
FYM (kg)	-	2.0	20
N (g)	20	20	200
P (g)	18	18	180
K (g)	25	25	250

After cultivation: Provide temporary shade after transplanting.
Weeds are removed as and when necessary.
Young trees are cut close to the ground to produce side shoots from second or third year onwards. 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 SL 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 Methyl parathion 1.3%.

Diseases

Leaf spot: Spray 1 % Bordeaux mixture or 0.25 % copper oxy chloride.
Harvest: The harvest starts from 4th or 5th year after planting. Cut the shoots in May and November for bark harvest.
Young shoots spring up from the stump ready for removal in subsequent season within 18 months when they attain one metre long and 1 to 2 cm thick.
Terminal ends of shoots are removed.
Peeling is done by knives after scraping off the outer bark.
Harvested produce is called as ‘Quills’.
From leaves, Cinnamon oil can be extracted by steam distillation.

Yield : 100 g of dried bark/ bush/ year. 35 kg of leaf oil/ ha/ year.

Tamarind: *Tamarindus indicus* L.; Caesalpiniaceae

Varieties: PKM 1, Urigam, Hasanur and Tumkur, Prathisthan, DTS 1, Yogeshwari
Soil and Climate: Grown on variety of soils ranging from poor degraded, eroded, gravelly, saline and alkaline soils. Productivity is higher in red loamy, deep well drained soils. The absolute maximum temperature varies from 36-47.5 ^{0} C and the absolute minimum temperature varies from 0-17.5 ^{0} C. Rainfall requirement – 750-1900 mm. Altitude – up to 100 m above MSL.

Propagation : Seeds / Grafts

Nursery: Fresh seeds are sown in nursery beds in March –April. Soaking of seeds in 10 per cent cow urine or in cow dung solution (500 g in 10 l of water) for 24 hours. Two year old seedlings are transplanted to the main field.

Vegetative propagation:

Softwood grafting: March- April

Air Layering: Shoots treated with IBA 4000 ppm.

Planting Season: June - December.

Spacing: Plant at a spacing of 8-10 m x 8-10 m.

Planting: Take pits of 1 m^3 and fill with FYM (10 kg/pit) and top soil. Add 50 g of Methyl parathion 1.3 % dust in the pit. Immediately after planting, support the graft with stakes.

Irrigation: Regular watering should be given once in seven days.

Fertilizers: Apply 200:150:250 g of NPK per tree per year along with 25 kg of FYM and 2 kg of Neem cake.

After cultivation: Remove the rootstock sprouts. Remove the dried and diseased parts.
Intercrops like leguminous crops, short duration vegetables, annual drumstick, Sesamum and Sorghum may be raised in the alley spaces up to four years.
Training: Early training is necessary to form a high head and uniform scaffold branches in all directions.
Pruning: removal of dried, diseased and criss cross branches.

Plant protection

Pests
Leaf caterpillar (*Achaea janata*): Spray monocrotophos 36 SL 2 ml/lit.

Disease
Powdery mildew: Spray Dinocap 1 g/lit or wettable sulphur 2g/l.

Yield: Grafts start yielding from 4 to 6 years. Pods are harvested in March-April every year. 150 - 200 kg/tree/year.

Market information

Concentrated pockets of growing districts	Dindigul, Theni, Madurai and Trichy
Major markets in Tamil Nadu	Madurai, Trichy
Preferred varieties	**PKM 1, Urigam**

Allspice (*Pimenta dioica* Lindl.); Myrtaceae

Soil and Climate

Deep rich loams with high humus content and lateritic soils are best suited
Altitude : 1000 m above mean sea level.
Annual rainfall : 100-200 cm
Ideal temperature : 27^{o}C

Propagation

Seeds: Seeds are collected from high yielding and regular bearing trees. Seeds are extracted after soaking the fruits overnight in water and rubbing them in a sieve and washing with clean water. The seeds are ready for sowing after drying them in shade.

Nursery beds of 1.2 m width are prepared with light soil incorporated with organic matter or a mixture of sand and coir dust or coir dust alone. After sowing the beds are mulched to hasten germination. Dried leaves, paper and damp sacks are used as mulches. Germination takes place 15 days after sowing.

Vegetative propagation: Air layering in the month of January.

Planting: 9-10 months old seedlings of 25-30 cm height are used for field planting.

Spacing: 6 m x 6 m. Since the plant is dioecious in nature, it is desirable to keep a male: female ratio of 1:10 in plantation.

Fertilizer: FYM (10 Kg) + 20:180:50 g of NPK per tree in the first year.
For grown up trees of 15 years or more, FYM (50 kg) + 300:250:750 g of NPK / tree is applied as two split doses.
Apply manures in shallow trenches dug around the plant 1-1.5 m away from the tree.

Harvesting:
Clonally propagated plants start flowering in three years while the seed propagated plants in 6 years.
Soil application of Paclobutrazol (1.25g/tree) induces flowering, increased number of panicles, flowers and setting of berries which in turn resulted in higher yield.
Fully developed green berries are harvested.

Yield: 20-25 kg dry berries per year/ tree.

Chapter C
Seed Spices

Coriander: *Coriandrum sativum* L.; Apiaceae

Varieties: CO 1, CO 2, CO 3, CO (CR) 4, GAU 1, UD 1, UD 2, UD 20 and UD 21

Soil: Well drained black cotton soil and red loamy soil

Climate: Cool and comparatively dry, frost free climate

Season: June - July and October - November.

Seed rate: 10 - 12 kg/ha (irrigated crop)
20 – 25 kg/ha (rainfed crop)

Seed Treatment: Soak the seeds in water for 12 hours. Treat the seeds with *Azospirillum* @ 1.5 kg /ha for better crop establishment + *Trichoderma viride* @ 50 kg/ha to control wilt disease. Presowing seed hardening treatment with Potassium Dihydrogen Phosphate @ 10 g/lit of water for 16 hours is to be done for rainfed crop.

Field preparation and sowing:
Prepare the main field to a fine tilth.
Add FYM 10 t/ha before last ploughing.
Form beds and channels (for irrigated crop).
Sow the split seeds at a spacing of 20 x 15 cm.
Spray pre-emergence herbicide Fluchloralin 700 ml in 500 lit of water per ha .
The seeds will germinate in about 8-15 days.

Manuring:

Basal: Apply 10: 40: 20 kg of NPK/ ha 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: First irrigation immediately after sowing and the second on the third day. Subsequent irrigations at 7-10 days interval.

Aftercultivation:
Thinning is done 30 days after sowing by keeping 2 plants per hill.
Weeding is done as and when necessary.
Spray CCC @ 250 ppm one month after sowing for inducing drought tolerance in rainfed crops.

Plant protection

Pests

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

Diseases

Powdery mildew: Seed treatment with *Pseudomonas fluorescens* (Pf 1) @ 10 g /kg and foliar spray of Pf1 2 g/lit or Spray Wettable sulphur 1 kg/ha or Dinocap 250 ml/ha at the time of initial appearance of the disease and 2nd spray at 10 days interval. Neem seed kernel extracts 5 % spray thrice (1st spray immediately after the appearance of disease, 2nd and 3rd at 10 days interval).

Wilt: Seed treatment with *Pseudomonas fluorescens* @10g /kg followed by soil application of Pf1 @ 5 kg /ha

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 :

Grain yield	**Kg/ha**
Rainfed Grain yield	300-400
Irrigated	500-600
Leaf yield	6000-7000

Market information

Concentrated pockets of growing districts	Thoothukudi, Virudhunagar, Ramanathapuram and Coimbatore
Major markets in Tamil Nadu	Virudhunagar
Preferred varieties	Co3
Grade specification	Pungent, golden colour, Well dried and matured , without shrivels

Fenugreek: *Trigonella foenum graecum* L.; Leguminosae

Varieties: Co 1, Pusa Early Bunching, Lam selection 1, Rajendra Kranti, Kissar Sonali, RMT1and CO 2.

Soil: A rich well drained loamy soil is best suited.

Climate: Cool and comparatively dry, frost free climate

Season: June - July and October - November.

Seed rate: 12 kg/ha.

Seed treatment: *Azospirillum* 1.5 kg + *Trichoderma viride* @ 50 g/ha for 12 kg of seeds.

Field preparation and sowing:
Prepare the main field to a fine tilth.
Add FYM 20 - 25 t/ha before last ploughing. Form beds and channels of 3.5 x 1.5 m.
Seeds are sown at a spacing of 20 X 15 cm. Spray pre-emergence herbicide Fluchloralin 700 ml in 500 lit of water per ha.

Manuring

Basal: Apply 30:25:40 kg of N, P, K /ha.

Top dressing: Apply 20 kg of N at 30 days after sowing.

Irrigation: Give 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.
Weeding is done as and when necessary.

Plant protection

Diseases
Root rot: Soil application of Neem cake @ 150 kg/ha and Seed treatment with *Trichoderma viride* @ 4 g/kg or drenching with Carbendazim 0.5 g/l or Copper oxychloride 2 g/litre or *Trichoderma viride* @ 5 kg/ha.

Powdery mildew: Dust Sulphur at 25 kg/ha or foliar spray with wettable sulphur 2 g/lit at the time of appearance of disease.

Crop duration and harvest
20 - 25 days for greens.
90 - 100 days for grains.

Yield
Green yield: 4 – 5 t/ha., Grain yield: 500 - 700 kg/ha.

Fennel: *Foeniculum vulgare* Mill.; Apiaceae

Varieties: CO 1, UF 32, PF 35 and Gujarat Fennel 1

Soil: Rich in organic matter with well drained loamy soil or black or sandy soil.

Climate: It comes up well in fairly mild with frost free climate.

Season:
Hills: May - June.
Plains: October - November.

Seed rate:
Direct sowing: 9 - 12 kg/ha.
Transplanting: 3 - 4 kg/ha
Nursery area 100 m^2.

Field preparation
Prepare the main field to a fine tilth.
Add FYM 10 t/ha before last ploughing.
Form beds and channels
Pre-emergence application of Pendimethalin @ 1 kg a.i./ha
5- 6 weeks old seedlings are transplanted at a spacing of 60 x 30 cm

Thinning: In direct sown crop thin 4 – 5 weeks old seedlings to 25 – 30 cm spacing

Manuring

Basal: Apply 25:10 kg N and P/ha.

Top dressing: Apply 25 kg N/ ha at the time of flowering.

Irrigation: First irrigation immediately after sowing, second on the third day and subsequent irrigations at 7 - 10 days intervals.

Aftercultivation:
Two or three weedings are necessary. The plants are earthed up after 3 months.

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 or foliar spray with wettable sulphur 2 g/lit at the time of appearance of disease.

Harvest: The crop matures in 7 - 8 months. The umbels are harvested 4 - 5 times at 10 - 15 days intervals and dried in sun for 4 - 5 days and seeds are thrashed.

Yield: 500 - 750 kg/ha.

Chapter D
Other Spices

VANILLA: *Vanilla planifolia*; Orchidaceae

Varieties: No named varieties

Soil: Lateritic soil rich in humus having good drainage.

Climate: Humid tropical climate with an annual rainfall of 150 – 300 cms (well distributed for a period of 9 months and dry period of 3 months).
Elevation: 700 – 1500 m MSL and with latitude of 10^0 N and 20^0 S
Temperature: 21^0 C – 32^0 C.

Standards: *Glyricidia sp, Erythrina indica, Jatropha curcus, Plumeria alba* and *Casuarina equisetifolia.* Planting during on-set of rain after summer during May and June.

Season for vanilla planting: 6 months after planting standards (i.e.) September – October – November.

Propagation: Stem cuttings of 60 – 120 cm

Spacing:

Plains: 2.0 to 2.5 m X 1.2 – 1.5 m

Hills: 1.5 x 1.5 m

Planting: Pit size 30 cm^3 for standards and for planting of vanilla cuttings.
Place 2 nodes of unrooted cuttings of 60 – 120 cm below the soil surface.

Training:
Train the vines to a height of 1.2 to 1.5 m.
Then trained horizontally or allowed to grow downward towards the ground.
Horizontally trained vines are coiled round the pole connecting the two supporting trees.
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: Mulch the vine with pruned vegetation 2 – 3 times in a year.

Recommended dose of fertilizers:
Apply 40 – 60: 20 – 30: 60 – 100 g of NPK per vine per year. It is given in 2 to 3 splits.
Spray 1 % solution of 17: 17: 17 NPK mixture once in a month for boosting growth and flower production.

Flowering:
Flowering starts in the third year of planting during December – January.
Pinching of top 7.5 – 10 cm of vine 6 – 8 months before flowering seasons encourages flower bud initiation.
Pruning of older fruiting branches also encourages flower production.
Each inflorescence consists of 15 – 20 flowers.

Pollination:

The artificial pollination is useful in vanilla and pollination must be done on the same day as flowers start opening from 4.00 am and extend upto 1.00 pm.
About 10 to 20 inflorescence may be pollinated in a vine.
Normally 5 to 6 flowers in the lower side of inflorescence are pollinated.
Hand pollination is done using a needle or a piece of pointed wood or a tooth pick to lift the hood covering the anther cap so that the anthers are brought into contact with stigma
A skilled worker can pollinate 1000 – 1500 flowers in a day.

Plant Protection

Pest

Leaf eating beetles, Feeding bugs and Caterpillars: Spraying quinolphos 0.05 %.

Diseases

Fusarium wilt: Infection starts in the axil of the leaf and spread to nodal region resulting in rot.

1. Spraying and drenching of 0.1 % Carbendazim.
2. Addition of organics also reduces the intensity of the disease.

Phytophthora rot: It causes rotting of beans, leaves and stems.
Spraying Bordeaux mixture 1 % or soil drenching with Copper oxy chloride 0.2 %

Sclerotium rot:
It occurs in root tips and later extends to whole root system followed by yellowing and wilting of vines. Soil drenching of Carbendazim 0.1 %

Shoot tip rot and Sclerotium rot: Soil drenching of Carbendazim 0.1 %

Harvesting: The pods are ready for harvest in 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 are harvested by cutting with a knife.

Yield: Average cured bean yield is 300 to 600 kg / ha / year.
6 kg of green pods produces 1 kg of cured beans.
The economic life of vine is 12 – 14 years.

Paprika (*Capsicum annum* L.); Solanaceae

Variety: Arka Abir, Kt-Pl-19, Byadagi

Soil: Well drained, light fertile loam soil with moisture holding capacity is ideal. pH 6-7

Climate: Long, warm growing season, frost free for 4-5 months is ideal. In tropical southern India the crop is raised during winter months (August – December) is desirable and hence temperature - 21ºC at night & 27 ºC in day.
Optimum temperature for seed germination 18-24 ºC.

Seed Rate: 600 g / ha

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

Field preparation
Prepare the main field to a fine tilth.
Add FYM 20 to 25 t/ha before last ploughing.

Transplanting: Age: 35 – 40 days old seedlings are ready for transplanting

Hills: 45 x 45 cm

Plains: 60 x 45 cm

Hardening: Seedlings are first hardened by gradually withholding the Water 6-8 days before transplanting and exposing them to direct sunlight. Water the seedling 12-14 hr before transplanting

Fertilizers: (kg /ha)

Time of application	N	P	K
Basal dose	60	100	60
Top dress 3 weeks after transplanting	20	0	20
Top dress 6 weeks after transplanting	40	0	40
Total	120	100	120

Plant Protection

Pest
Mites: Apply wet able sulphur 2 kg / ha
Thrips: Spray with Fenzaquin 10 EC @150 ai /ha
Nematode: Apply carbofuran 3gin soil @ 25 kg /ha

Diseases

Damping off: Drenching the beds with metalaxyl MZ @ 0.1 %

Anthracnose: Seed treatment with Carbendazim (2 g / kg seed) and spray with Mancozeb 2 g/lit.

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

Powdery mildew: Spray Wettable sulphur @ 0.3%

Chilli leaf curl complex: Sorghum leaf extract @5.0% +monocrotophos 2ml/lit + dicofol 2.5 ml /l

Harvesting: The matured fruits are ready for harvest after 70-80 days of planting. Fruits are harvested 3 to 6 times in a crop. The harvesting is spread over a period of 3-4 months.

Yield: 25 – 35 t/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

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. Optimum temperature – 20-27 ^{o} C.

Nursery: The nursery soil should be well drained and deep loam in nature with pH of 4.5 to 4.8.

The rooting medium should be tested for pH and free from 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 m^2 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 bags of 30 – 45 cm length, 10 cm width and 150 or 200 guage thickness 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 and preparation of mother bush: Healthy and vigorously growing high yielding bushes should be selected. For selected bush, application of 0.5 % Al SO_4+ 1 % Mg SO_4 as foliar spray is recommended. One week later, apply 2 % Zn SO_4. After one week apply 1 % Urea. Then 40 g of young tea mixture 60:90 NK mixture per bush may be applied upto 5 years.

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 - 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 Weight
Potassium sulphate	15 parts by Weight

(or) MOP	12 parts by Weight
Magnesium sulphate	15 parts by Weight
Zinc sulphate	3 parts by Weight
Total	**80 parts by Weight**

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: Planted at the spacing of 1.20 x 0.75 m accommodating 10,800 plants/ha.

Double Hedge System: Planted at the spacing of 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 adopted for the first 3 years and a ratio 1: 1 thereafter may be followed.

Year of application	kg/ha/year		No. of applications	g/plant/year	
	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: First tipping at a height of 35 cm and second tipping at 60 cm respectively from ground level.

Pruning: To maintain convenient height and vegetative growth and to remove dead and diseased branches, pruning is done.

Area to be pruned every year = $\frac{\text{Total extent of the garden}}{\text{}}$

Pruning cycle

Pruning interval = (Elevation in feet / 1000) + 1
Pruning should be done in April - May or August – September respectively to S.W or NE monsoon areas.

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. Remove the top 5 - 8 cm new growth 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 before monsoon season.

Plant protection - Pests

Scales: Spray carbaryl 50 WP @ 2 g/lit. or phosalone 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.
Thrips: Spray any one of the following insecticide

Insecticide	Dose
Azadirachtin 5 % Neem extract concentrate	5.0 ml/10 lit.
Azadirachtin 1.0 % EC (neem based)	2.0 ml/lit.
Ethion 50%EC	5.0 ml/10 lit.
Profenofos 50 % EC	2.0 ml/lit.
Quinalphos 25 % EC	7.5 ml/10 lt.

Aphids: Spray phosalone 35 % EC @ 2.0 ml/lit

Red spider mite, Pinkmite, scarlet mite:

Insecticide	Dose
Azadirachtin 5% Neem extract concentrate	5.0 ml/10 lit
Azadirachtin 1.0% EC (neem based)	2.0 ml/lit
Dicofol 18.5 % SC	2.0 ml/lit
Ethion 50 % EC	5.0 ml/10 lit
Fenazaquin 10 % EC	1.6 ml/lit
Fenpyroximate 5 % EC	1.2 ml/lit
Flumite 20%SC/flufenzine 20%SC	5.0 ml/10 lit
Hexythiazox 5.45% EC	1.2 ml/lit.
Phosalone 35 % EC	1.0 ml/lit.
Profenofos 50 % EC	2.0 ml/lit.
Propargite 57 % EC	2.0 ml/lit.
Spiromesifen 22.9 % SC	1.0 ml/lit.

Tea mosquito bug:

- Monitoring the incidence of tea mosquito bugs at regular intervals.
- Removal of alternate hosts like neem, cashew, guava in the surroundings
- When the infestation is lesser: Spraying of any one of the following:
    - Imidacloprid (0.6 ml/l)
    - Thiamethoxan (0.6 g /l)
    - Profenophos (2 ml/l).

Diseases

Blister blight:

1. Spray Hexaconazole 200 ml + Copper oxychloride 210 g/ha at 5 days interval/ha. (or)
2. Spray 210 g of Copper oxychloride and Nickel chloride per ha at 5 days interval from June – September, 11 days intervals in October and November (or)
3. Copper oxychloride 210 g + 200 ml Propiconazole/ha at 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.
Rush period - harvesting of 2 – 3 leaves with a bud at 7 to 10 days interval
Lean period – harvesting of two leaves and a bud at 10 – 15 days interval

Yield: The yield of green leaves is 10 t/ha.

Market information

Growing Districts	Nilgiris, Coimbatore, Dindigul, Theni, Kanyakumari and Tirunelveli districts
Major markets in Tamil Nadu	Coimbatore, Nilgiris
Grade specification	Size of the tea leaves : Whole, large tea – Higher grading Method of production : CTC process (Crush, Tear and Curl) and Orthodox

Coffee: *Coffea arabica* L.;*Coffea canephora* Pierre ex Frechna; Rubiaceae

Varieties

Arabica varieties: Sln 795, Sln 7, Sln 9, Sln 10, Cauvery and its selections HRC (Hawaian Red Cuturra), Chandragiri and sanRoman

Robusta varieties: Sln 274, Sln 270, Sln 3.

Soil: Soil should be deep, friable, open textured rich in plant nutrients with plenty of humus and of slightly acidic nature (pH – 4.5 to 6.5)

Varieties	Elevation (m)	Rainfall (mm)	Distribution
Robusta	500 – 1000	1000 - 2000	Blossom shower – February - March
Arabica	1000 - 1500	1600 - 2500	Blossom shower – March - April
Backing shower during April – May is required for both the varieties.			

Propagation: by seeds.

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 of 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 *Phosphobacteria* 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 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 in the proportion of 6:2:1.
An area of 12 x 8 m can accommodate 5000 seedlings. Seedlings are planted in polythene bags.

Season: June - September.

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^3 are dug. 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.

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.

Planting shade trees: Dadap is commonly used as a lower canopy shade. Stakes of 2 m length are planted for every two coffee plants. Silver Oak and Dadaps are planted during June when South-West monsoon commences. During summer the stem of young Dadaps are painted with diluted lime or wrapped with 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 at 6x6m for permanent shade.

Irrigation: It is generally grown as a rainfed crop. But irrigation with sprinkler during March - April increases blossoming and results in higher yields.

Manuring:

Species	**Pre-blossom March $N:P_2O_5:K_2O$**	**Post – blossom May $N:P_2O_5:K_2O$**	**Mid-monsoon August $N:P_2O_5:K_2O$**	**Post-monsoon October $N:P_2O_5:K_2O$**	**Total**
ARABICA					
Young coffee 1st year After planting	15:10:15	15:10:15	---	15:10:15	45:30:45
2nd and 3rd year	20:10:20	20:10:20	---	20:15:20	60:45:60
4th year	30:20:30	20:20:20	---	30:20:30	80:60:80
Bearing coffee 5 years and and above for less than one tonne/ha crop	40:30:40	40:30:40		40:30:40	140:90:120
For one tonne/ha and above	40:30:40	40:30:40	40:30:40	40:30:40	160:120:160
ROBUSTA					
For less than one tonne/ ha crop	40:30:40	---	---	40:30:40	80:60:80
For 1 tonne /ha and above	40:30:40	40:30:40	---	40:30:40	120:90:120

Pruning: Centering and desuckering should be carried out for 5-6 years after planting.Done immediately after the harvest (June-July and September - october) and till the onset of monsoon. Unproductive wood between all primaries, secondaries and tertiaries should be removed.

Rejuvenation / collar Pruning: Removal of dead, exhausted, dried and worn out branches. Done immediately after the harvest.

Hard pruning: Plants are cut at 5-20 cm above the ground level and one leader shoot is allowed.

Medium Pruning: Removal of lateral shoots to regulate shade.

Light pruning: Removal of Suckers.

Intercropping: Orange, Pepper, Banana, Pine apple, Avocado, Custard apple.

After cultivation: 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.

- Maintain/create optimum shade
- Borer infested plants should be thoroughly trace, uprooted during March and September , burnt to avoid economic loss during the subsequent years.
- Install pheromone traps @ 25 /ha, if the incidence is high.
- Remove the loose scaly bark on the main stem and thick primaries using coir glove or coconut husk.
- Pad with monocrotophos 36 WSC @ 5 ml by making a window in the stem at 5 cm x 5 cm and fill 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.
- 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

Green scales and mealy bugs:

Release coccinellid predator *Cryptolaemus montrouzieri* @ 300 beetles/acre.

Spray *Verticillium lecanii* @ 6 x 10^6 spores/ml or spray any one of the following insecticide

Insecticide	Dose
Monocrotophos 36 % SL	1.5 ml/lit.
Oxydemeton –Methyl 25 % EC	2.5 ml/lit.
Quinalphos 25 % EC	2.5 ml/lit.

For the control of leaf miner spray Oxydemeton –Methyl 25 % EC @ 2.5 ml/lit.

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 October and 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.

Fly picking: small scale picking of ripe berries during October to February

Main picking: well formed and ripened berries are harvested during December. Bulk of the yields are obtained from this picking.

Stripping: picking of all the berries left irrespective of ripening.

Cleanings: This is collection of fruits that have been dropped during harvesting.
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.

Market information

Growing Districts	Dindigul, Nilgiris, Salem and Theni
Major markets in Tamil Nadu	Coonoor, Bodinayakanur , Mettupalayam
Types	Arabica, Robusta
Grade specification	Washed, Unwashed, Monsooned, Instant, Ground, Roasted, Speciality

Cashew: *Anacardium occidentale* L.; Anacardiaceae

Varieties: VRI 1, VRI 2, VRI 3, VRI 4 and VRI (CW) H1

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 for cultivation.
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^3 size are dug and filled up with a mixture of soil + 10 kg FYM + one kg neem cake and 100 g Methyl parathion 1.3 %.

Spacing: 7 m either way.

High Density Planting: Spacing of 5 x 4 m accommodating 500 plants per hectare is recommended prune the interlocking branches during the July-August to maintain the frame.

Manuring (per tree)

Manures and fertilizers	I year	II year	III year	IV year	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 October - November in the East Coast areas. Wherever possible the fertilizer can be applied in 2 equal split doses during June-July and October-November periods under eastcoast area, a fertilizer schedule of 1000:125:250 g NPK/tree is recommended tree.
Irrigation: Noramally grown as a rainfed crop. Irrigation once in a west from flinching to fruit maturity stage is good to increase the yield.

Intercropping: Plough the interspaces after the receipt of rain and raise either groundnut or black gram 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 –

- Collect and destroy 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 or swab the tree trunk with neem oil 5% thrice during January-February, May-June, and September-October

- Root feeding with monocrotophos 36 SL @ 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.
- Remove grubs from early stage infested trees and drench the damage portion with Chlorpyriphos 0.2% @ 10 ml/lit or Neem Oil 5%

Tea mosquito bug:

- Spray application of phosalone 35 EC@ 2.0 ml, followed by carbaryl 50WP @ 2g/l and monocrotophos @ 2ml/l at vegetative flush stage, panicle initiation stage and nut formation stage respectively are recommended for the management of tea mosquito bug.
- Spray schedule involving three rounds of spray *viz.,* first spraying with Profenophos (0.05%) at flushing stage, second spraying with Chlorpyriphos (0.05%) at flowering and third spraying with Carbaryl (0.1%) at fruit set stage is most effective.

Apple borer: Spray dichlorvos 76 % EC @ 6.0 ml/10 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 in May- June and again in October as a prophylactic measure.

Harvest: The plant starts yielding 3rd year onwards. The peak picking months are March to 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.

Market information

Growing Districts	Cuddalore, Tirunelveli
Major markets in Tamil Nadu	Jayankondam, Vridhachalam, Panruti
Grade specification	White/ Pieces, splits, butts

Cocoa: *Theobroma cacao* L.; Sterculiaceae

Varieties: Criollo, Forestero and Trinitario. CCRP – 1, CCRP – 2, CCRP – 3, CCRP – 4, CCRP – 5, CCRP – 6 and CCRP – 7.

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 above MSL with an annual rainfall of 150 cm and a relative humidity of 80 % and annual mean temperature of 24^0C to 25^0C. Cocoa can be grown as intercrop in coconut and arecanut gardens.

Season: June - July and September - October.

Seeds and sowing: Propagated by seeds. Before sowing the seeds the pulp adhering to the seeds has to be removed. Cocoa seeds are individually sown in polybags soon after extraction.

Pot mixture:
The bags are filled with pot mixture containing**.**

- Red soil -2 parts
- Sand -1 part
- FYM- 1 part
- Super phosphate – 5 kg/ton of the above mixture

This can be filled in 320 gauge polythene bag with 30 cm height and 20 cm width provided with two holes in the bottom. 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^3 pits at a spacing of 3 x 3 m either way. Stake the plants to ensure upright growth and early establishment. 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.

Fertilizer	I year after planting(g)	II Year after planting(g)	III Year after planting(g)
Urea	75	145	200
Super phosphate	85	165	250
Muriate of Potash	80	160	240
Time of application	2 split doses / year (Feb – March & July – Aug)	3 split doses / year (Feb – March, May – June & Aug - Sep)	3 split doses / year (Feb – March & May – June & Aug - Sep)

Micro nutrient application: Foliar application of $FeSo_4$ @ 0.5% + Zn So_4 @ 0.5% in 2 split doses/ year.

Pruning:
Formation pruning: Done in young plants of cocoa (1 year after planting). The height of first jorquette is kept at 1-1.5m from the ground.
Structural pruning: done generally 16-24 months after planting. Done to maintain tree at optimum height.
Maintenance Pruning: Starts from second year of planting. Remove low and hanging branches. Remove excess number of chupons regularly. Remove unproductive branches, dead, diseased and badly damaged branches in periodical intervals.

Aftercultivation: Weeding is done as and when necessary. The unproductive shoots, dead, diseased twigs should be removed periodically. Banana is better raised as a primary shade plant in the early years of plantation.

Plant protection

Pests

Tea mosquito bug:

- Monitoring the incidence of tea mosquito bugs at regular intervals.
- Removal of alternate hosts like neem, cashew, guava in the surroundings
- When the infestation is lesser: Spraying of any one of the following:
    - Imidacloprid (0.6 ml/l)
    - Thiamethoxan (0.6 g /l)
    - Profenophos (2 ml/l).

Mealy Bug:

- Monitoring the incidence of mealy bugs at regular intervals.
- Removal of alternate weed hosts like Parthenium.
- Collection and destruction of infested plant parts before spraying.
- When the infestation is lesser: Spraying of neem oil 2 % or fish oil rosin soap 25 g/l.
- On severe incidence, spraying of any one of the following chemicals is recommended.
    - Dimethoate (2 ml/l)
    - Profenophos (2 ml/l)
    - Chlorpyriphos (5 ml/l)
    - Imidacloprid (0.6 ml/l)
    - Thiamethoxam (0.6 g/l).
- Release coccinellid predator *Cryptolaemus montrouzieri* @ 10 nos/tree.

Aphids: Spray dimethoate 35 EC 1 ml/lit at monthly intervals.

Grey Weevil: Spray phosphamidon 40 SL 2 ml/lit.

Hairy caterpillar: Dust Methyl parathion 1.3 D or spray Methyl parathion 20 EC 2ml/lit.

Semilooper: Dust Methyl parathion 1.3 D.

Rodents:

Rats & squirrels: keep 10g of Bromodiolone (0.005%) wax cakes on the branches twice at an interval of 10-12 days.

Diseases

Black pod disease: Spray 1 % Bordeaux mixture or 0.2 % Mancozeb or Copper oxychloride at 20 days interval.

Stem canker: Remove the infected areas and apply Bordeaux paste at 10 %

Dieback disease: Spray 1 % Bordeaux mixture or Copper oxy chloride at 0.25 %.

Charcoal pod rot: Spray with 1 % Bordeaux mixture or Copper oxy chloride at 0.25 %.

Cherelle wilt: Spray carbendazim @ 0.1 % or Dithane M 45 @ 0.2 % or Copper oxy chloride @ 0.25 %.

Pink disease: Prune the affected branches and swab the cut ends regularly with 1 % Bordeaux mixture.

Harvest: Bearing starts from 3rd year but economic yield starts from 6th year onwards. The season of harvest is April – May and November – December.

Yield: 500 - 1000 kg of dry beans/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. Requires tropical temperature 20 – 30^0 C with the well distributed rainfall of 2000 – 5000 mm and an elevation of 300 – 800 m above MSL. is ideal.

Season: June - July.

Propagation: Propagated by green budding and brown budding.

Nursery**: bed size:** 60-120 cm width and of convenient length.
Spacing: Seedling stumps – 23 x 23 cm, 30 x 30 cm and 34 x 20 cm
Budded stumps – 30 x 30 cm
Stump budding – 60 x 60 cm
Bud wood nursery – 60 x 90 cm or 60 x 120 cm.

Seedling Nursery:

Manuring: Basal -2.5 t/ha of FYM and 350kg/ha of Rock Phosphate.
1.5 – 2 months after planting –10:10:4:1.5 NPKMg mixture -2500 kg/ha.
Urea @550 kg /ha -3 to 3.5 months.

Planting: Pit size of 1 m^3 are dug and filled up with top soil and compost.

Planting material	Spacing (m)	Population / ha
Budded plants		
Hilly areas	6.7 X 3.4	445
Plains	4.9 X 4.9	420
Seedlings		
Hilly areas	6.1 X 3.0	539
Plains	4.6 X 4.6	479

***In situ* sowing:** Germinated seeds are sown *in situ* in the pits. Healthy ones are retained and the others removed.

Manuring: Manuring is done 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	NPK and Mg **mixture (10:10:4:1.5)**	
		g/plant	**Kg/ha**
3	September/October	225	100
9	April/May	445	200
15	September/October	450	200
21	April/May	450	250
27	September/October	550	250

33	April/May	550	200
39	September/October	450	200

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. For matured rubber trees under tapping apply NPK 10:10:10 grade mixtures at the rate of 900 g/tree (300 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.

After cultivation: Growing of cover crops, incorporation of cover crops and weeding are important operations for soil conservation. *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.

Tapping system:

S/2 d/2	(half spiral, alternate day for 6 months and rested for 3 months)	100% Intensity
S /2 d/2 6m /9	(half spiral, alternate day for 6 months and rested for 3 months)	67 intensity
S /2d/3	(half spiral, third day)	67 intensity
S/2 d/3 1m/2	(half spiral, daily for one month and rested for next month)	100% intensity
S /1 d/4	Full spiral,fourth day	100% intensity
V /2 d/2 12m/16	Half circumstances and cut alternate day for 12 months and rested for the next 4 months	75% intensity

Rain guarding: Fixing a polythene rain guard to the trunk of the tree above the tapping panel during the raining season is recommended in areas where the annual yield is 700 kg/ha or more.

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.

Tapping panel dryness (Brown bast): Syndrome characterized by prolonged dripping of latex with the gradual decline in volume yield, pre coagulation of latex and partial or complete drying of tapping area (10-25 per cent).

Control: Reduce tapping intensity or give a tapping rest for 3 to 12 months.

Plant protection

Pests

Scale insect:
When severe infestation is noticed, spray 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 dicofol 18.5 EC @ 2.5 ml/lit.

Diseases

Abnormal leaf fall and Secondary 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 oxy chloride using low volume sprayer or through aerial application.
Two rounds of spray using about 17 to 22 lit of fungicide oil mixture per ha per round (1:6 proportion) at 10 to 15 days interval (or)
a single round of spray with about 30 - 37 lit of fungicide oil mixture per ha (1:5 proportion)**.**

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 %.

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 rotting bark and the coagulated rubber and the wound washed well with Dithane M 45 @ 0.75 %.
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.

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.
Drench the base with fungicide Carbendazim (0.1%) solution.
Yield: Rubber yield steeply increases year by year, reaching a peak after 14 years of planting.

Annual yield: 375 kg/ha from seedlings trees
800 - 1000 kg/ha from budded plants.

Coconut (*Cocos nucifera* L.); Palmae

Varieties:

Hybrids: VHC1, VHC2 and VHC3

Tall: VPM3, ALR 1, ALR 2 and West Coast Tall

Dwarf (tender coconut): COD, CYD, CGD and MYD

Soil and climate: Light sandy soils to heavy soils with a pH - 5.2 to 8.0. Proper drainage, good water-holding capacity, presence of water table within 3 m and absence of rock or any hard substratum within 2 m of the surface.
Altitude: 600 to 900 m
Rainfall: 200 cm per year.

Planting seasons: Jun - Jul and Dec - Jan. The planting can also be taken up in other seasons wherever irrigation and drainage facilities are available.

Spacing: For garden: 25' x 25' (Square system - 7.5 x 7.5 m) - 175 plants/ha.
Field border as a single row - 20' spacing between plants

Planting: Pit size of 3 cubic feet.
Sprinkle methyl parathion Dust to prevent white ant damage. Fill the pit to a height of two feet (60 cm) with FYM, red earth and sand mixed in equal proportions. At the center of the pit, remove the soil mixture and plant the seedling after removing all the roots. Press the soil well around the seedling and provide the seedling with shade by using plaited coconut leaves or palmyrah leaves. Keep the pits free from weeds. Remove soil covering the collar region. As the seedlings grow and form stem, fill up the pits gradually by cutting the sides.

Water management: Summer irrigation – production of female flowers and setting percentage increases. Moisture stress – stunted growth, drooping of leaves, immature nut fall

Months	Normal condition (for best yield)	Moderate water scarcity condition	Severe water scarcity condition
A. Drip irrigation			
March – September	80 lit / day	55 lit / day	27 lit/day
October – February	50 lit / day	35 lit/ day	18 lit /day
B. Basin irrigation			
March – September	410 lit / 5 days		
October – February	410 lit /8 days		

Drip irrigation in coconut: Root zone of coconut for moisture absorption is concentrated in a circular area of 200 cm radius around the base of coconut tree up to a depth of 100 cm. Irrigating coconut trees by a set of four drippers set equidistant in a circle 100 cm away from the base of the tree and discharging water at the rate of 30 l/h for 2.5 h with a irrigation frequency of 8 days can maximize the wetting area of soils in the effective root zone of coconut.

Drought management and soil moisture conservation:

a. **Mulching with coconut husks/leaves/coir pith**
   Apply coconut husks with convex surface facing upwards (100 Nos.) or dried coconut leaves (15 Nos) or coir pith up to a height of 10 cm in the basin of 1.8 m radius around the palms during summer season

b. **Burial of coconut husk or coir pith**
   Bury husks @ 100 Nos. with concave surface facing upwards or 25 kg of coir pith /palm in circular trenches, dug 30 cm width and 60 cm depth at 1.5 metres radius - preserves the monsoon rains.

Manuring & Fertilizer application

Age(Years)	FYM(kg/tree)	Urea(kg/tree)	Super Phosphate(kg/tree)	Muriate of Potash(kg/tree)
1	10	0.308 (140 g N)	0.500 (80g P_2O_5)	0.480 (300 g K_2O)
2	20	0.616 (280 g N)	1.000 (160 g P_2O_5)	0.960 (600 g K_2O)
3	30	0.924 (420 g N)	1.500 (240 g P_2O_5)	1.440 (900 g K_2O)
4	40	1.23 (560 g N)	2.000 (320g P_2O_5)	1.920 (1200 g K_2O)
5^{th} year on wards	50	1.23 (560 g N)	2.000 (320g P_2O_5)	1.920 (1200 g K_2O)

Apply manures and fertilizers in circular basins of 1.8 m from the base of the palm, incorporate and irrigate.
The fertilizers may applied in two split doses, in June – July and in December to January.

TNAU Coconut Tonic Nutrition: For nut bearing coconut, root feed TNAU coconut tonic @ 200 ml/palm once in six months.

Bio-fertilizer recommendation : 50 g of *Azospirillum*, 50 g of *Phosphobacteria* (or) 100 g Azophos and 50 g of VAM. Mix all the contents in sufficient quantity of compost or FYM and apply near feeding roots once in 6 months / palm starting from planting. Don't mix with chemical fertilizers and pesticides

Organic recycling: Any one of the green manure crops like sunhemp, wild indigo, calapagonium or daincha may be sown and ploughed *in situ* at the time of flowering as a substitute of compost to be applied. Sow sunhemp @ 50 g/palm in the basin and incorporate before flowering. Coir pith compost or vermicompost made from coir pith/ coconut leaves/ other wastes from coconut grove can be applied.

Intercropping in coconut

a) Below 7 years of age: annual crop
b) 7 – 20 years of age: Green manure crops and fodder crops
c) Above 20 years of age

Annuals		Groundnut, bhendi, turmeric, tapioca, sweet potato, sirukizhangu, elephant foot yam, ginger, pineapple
Biennials		Banana varieties *viz*., Poovan and Monthan are suitable
Perennials		Cocoa, pepper (Panniyur 1 or Panniyur 2 or Panniyur 5 or Karimunda), nutmeg and vanilla

Weed management: The inter-space in the coconut garden has to be ploughed twice in a year in June-July and December - January. Intercultural operation is essential to keep weed population under check, to enhance the utilisation of the applied plant nutrients by the coconut trees, to facilitate proper aeration to the roots of coconut, to induce fresh root growth.

For the broad-leaved weeds, pre-emergence spraying of atrazine @1.0 kg *a.i.* / ha for the control of grasses and sedges. Post emergence spraying of glyphosate @ 10 ml and 20 g ammonium sulphate/litre of water.

Yield and Earlyness:

S.No	Variety	Nut yield (Nos / tree / year)	Earlyness (year)
1.	Hybrid	100	3 – 5
2.	Tall	60 – 80	6 – 7
3.	Dwarf (tender coconut)	70 - 90	4 – 5

Pests and diseases

I) Rhinoceros beetle

i. Remove and burn all dead coconut trees in the garden (which are likely to serve as good breeding ground) to maintain good sanitation.

ii. Collect and destroy the various bio-stages of the beetle from the manure pits (breeding ground of the pest) whenever manure is lifted from the pits.

iii. Incorporate the entomopathogen *i.e*, fugus (*Metarhizium anisopiae*) in manure pits to check the perpetuation of the pest.

iv. Apply Methyl parathion dust in the manure pits once in three months to kill the grubs.

v. Soak castor cake in small mud pots and keep them in the coconut gardens to attract and kill the adults.

vi. Treat the longitudinally split tender coconut stem and green petiole of fronds with fresh toddy and keep them in the garden to attract and trap the beetles.

vii. Examine the crowns of tree at every harvest and hook out and kill the adults.

viii. Fill the crown and the top most three leaf axils with a mixture of Aldrin 5 D and fine sand (1:1 by volume) once in three months, particularly before and after the monsoon months to check the damage by adults. For seedlings, apply 3 nos. of naphthalene balls/palm weighing 3.5 g each at the base of interspace of leaf sheath in the 3 inner most leaves of the crown once in 45 days.

ix. Set up light traps following the first rains in summer and monsoon period to attract and kill the adult beetles.

x. Field release of Baculovirus inoculated adult rhinoceros beetle reduces the leaf and crown damage caused by this beetle.

xi. Mixture of either neem seed powder +sand (1:2 @ 150 g per palm or Neem Seed Kernel powder + Sand (1:2) @ 150 g per palm applied in the base of the 3 inner most leaves in the crown effectively controlled rhinoceros beetle damage.

II Black headed caterpillar

i. The incidence of the pest is noticed from the month of November to May and from August to November after rainfall. The coconut trees of all ages are attacked. Among the larval parasites, the bethylid *Parasierold nephantidis* is the most effective in controlling the pest. The optimum level of release is 1:8 of host parasite ratio. The parasite should be released under the coconut trees then the pest is in the 2nd or 3rd instar larval stage. Parasite release trap may be used to release the parasite at the site of feeding. Parasites should not be released in the crown region since they will be killed by predators like spiders and reduvilds.

ii. Remove and burn all affected leaves/leaflets.

iii. Release the larval (Bethylids, Braconid and Iohneumonid) and pupal (Eulophid) parasites and predators periodically from January, to check the build up of the pest during summer.

iv. Spray Malathion 50 EC 0.05 % to move the undersurface of the leaves thoroughly in case of severe epidemic outbreak of the pest in young palms.

v. Harvest all mature nuts, and drill a downward slanting hole and inject 5.0 ml of Monocrotophos 36 SL into the stem at about 1.5 m above the ground level and plug with clay mixed with Copper oxychloride. Monocrotophos (5 ml) may also be mixed in water (20 ml) and injected into the stem or a cotton wick soaked in Monocrotophos (after absorption of 5 ml) and inserted into the hole and plugged. Plucking tender coconuts or harvesting the nuts should be avoided strictly for forty days after treatment.

vi. Root feeding for the control of coconut Black headed caterpillar: Select a fresh and live root, cut sharply at an angle and insert the root in the insecticidal solution containing Monocrotophos 36 SL 10 ml + water 10 ml in a 7x10 cm polythene bag. Secure the bag tightly to the root with a cotton thread. Twenty four hours later, check whether there is absorption. Select another root. These methods should not be resorted to as a routine practice and it is suggested only for cases of severe epidemic outbreak of the pest and when the survival of the tree is threatened.

III. Red palm weevil

i. Remove and burn all wilting or damaged palms in coconut gardens to prevent further perpetuation of the pest.

ii. Avoid injuries on stems of palms as the wounds may serve as oviposition sites for the weevil. Fill all holes in the stem with cement.

iii. Avoid the cutting of green leaves. If needed, they should be cut about 120 cm away from the stem.

iv. Plug all holes and inject Pyrocone E or Carbaryl at 1% ml or 10 ml of Monocrotophos or 5 ml of Monocrotophos + 5 ml of Dichlorvos into the stem by drilling a hole above the points of attack.

v. Setting up of attractant traps (mud pots) containing sugarcane molasses 2 ½ kg / toddy 2 ½ litres + acetic acid 5 ml + years 5 g + longitudinally split tender coconut stem /logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers.

IV. Termites

i. Locate termite mounds in or near the coconut nursery or garden and destroy.

ii. Incorporate 120 kg of Heptachlor 3 D per ha into the soil twice a year, *i.e*, on receipt of summer and monsoon showers (Heptachlor 3 D per tree). Spray Aldrin 0.15 % or HCH O.25 % or Neem oil 5 % once on the base and upto 2 m height of the trunk for effective control.

iii. Spray Copper sulphate 1 % or Cashew nut shell oil 80 % followed by Copper sulphate 1 % then neem oil 5 % and copper sulphate 1 %, then NSKE 20 % to preserve planted coconut leaves from the termite attack.

V. Scale insect: Pluck mature nuts and spray Monocrotophos 0.036%. Do not harvest nuts for 1 ½ months after spraying.

VI. Mealy bugs: Remove leaflets harbouring these insects and destroy them and spray Malathion at 0.1 % or Dimethoate 0.03 % or Methyldemeton 0.025 % or Phosphomidon 0.05 %