

PACKAGE OF PRACTICES FOR HORTICULTURAL CROPS

Prepared jointly by

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&

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FRUIT CROPS

PINEAPPLE

Ananas comosus L. Merr.

Cultivar : Kew, Queen and Mauritius

Soil : It can be grown on any type of well drained acidic soil.

Propagation : It can be propagated by sucker, slip and crown. These planting materials of 5-6 months age bear flowers after 12 months of planting except crowns which bear flowers after 19-20 months.

Treatment of planting material : Planting materials should be dipped in Mancozeb-75 WP (2 g/lit) before planting to protect the plants against bud rot.

Time of planting : April to October

Planting and population : Planting is done in two-row beds. In each bed, plant at 60 cm from row to row and at 30 cm from plant to plant. Distance between rows of two adjacent beds should be 90 cm. This will accommodate about 44,000 plants/ha.

Manure and Fertilizer : 10 to 15 t/ha of FYM may be applied at last ploughing. N, P₂O₅ and K₂O @ 12g, 2g and 12g, respectively per plant per crop should be applied. Half of N and the whole of P₂O₅ and K₂O are to be applied as basal dose and rest half of N to be applied as foliar spray.

For foliar applications, 450 g urea is dissolved in 10 lit of water and sprayed on 200 plants. It will provide 1 g of N per plant. Thus for giving 6 g of N as foliar application 6 such spraying are required after every 2 months. Soil application of 40 % of fertilizer of main crop i.e. 4.8 g N, 0.8 g, P₂O₅ and 4.8 g, K₂O/plant after harvest of main crop increase production of ratoon crop of pineapple.

Cultural operation : Weeding should be done at least three to four times a year. Hand weeding can be partially eliminated by chemical weedicide. Diuron @ 3 kg/ha as pre-emergence spray can be used economically in the first year to control broad spectrum of weeds in pineapple field. Black polythene (50 micron) can also be used for controlling weeds.

When there is long drought, irrigation may be given fortnightly.

To protect the fruits from sunburn, partial shade may be provided by planting arhar in between the beds. The spacing has to be adjusted accordingly. Covering the matured fruits with leaves adjacent to the fruits will reduce both sunburn and bird damage.

Crop Cycle: One main crop followed by two ratoons

Flowering:

There are two main seasons of flowering- March-April and June-July. Sporadic flowering may take place in other periods also. Fruits usually ripen about 5 months after flowering.

Regulation of flowering and early fruiting :

In general, when no special treatment is given, only 50-60% plants flower in main season.

With some chemical substances it is possible to get uniform flowering (over 80%) in the main season. For this purpose, Ethrel @ 100 ppm (10 ml in 100 lit. of water) solution should be applied to plants one month before flowering. About 30 ml of Ethrel solution should be poured on the core of the plant. Since Ethrel is a costly chemical one tenth of it can be made equally effective (1 ml in 100 lit) by adding 2% urea and 0.04% sodium carbonate or calcium carbonate.

To delay harvest by a few days (10-15 days) spray the fruit (just 60-70 days ahead of normal harvest) with 300 ppm Planofix.

To ripen the fruit earlier by about 10-15 days spray 500 ppm of Ethrel on the fruit about one month before normal harvest.

Harvesting :

Harvesting is done when the fruits become yellow in colour. Over ripening on the mother plant or any injury to fruits at harvesting should be avoided. For distant market, the fruits may be harvested when they just change colour from green to yellow.

Yield :

50-80 t/ha depending upon spacing and cultural practices

Plant Protection :

Leaf spot: This can be controlled by spraying Mancozeb 75 WP (2 g/lit).

Benefit: Cost ratio: Main crop: 3.70; Ratoon crop: 8.50

BANANA

Musa spp. Colla

Cultivar: Dwarf : "Jahaji" (Dwarf Cavendish)
Medium tall : "Chenichampa"
"Malbhog"
"Bar Jahaji"
Tall : "Pura Kal" (Kach Kal)
"Manohar"
"Jati"
"Bhimkal"

Soil: Well drained friable loamy soil with adequate organic matter is ideal.

Propagation : It is propagated by sword suckers. Select healthy sword suckers and uproot with corm. Trim all the roots without damaging the buds. Give a slanting cut to the pseudostem 30cm above the base of the sucker. Weight of such planting materials should be around 1.5 kg to 2.0 kg.

45-60 days old tissue culture hardened plants (Dwarf Cavendish) can also be used as planting materials.

Planting: Planting is generally done in pits. Double planting (2 plants/pit) with a spacing of 1.8 m x 1.8 m for Jahaji gives higher yield.

For High density Planting 3 suckers per pit at 2m x 3m (5001 plants/ha) spacing should be planted. Pits should be filled up with 18 kg FYM along with top soil. Planting should be done 30 cm apart in the pit.

Size of Pit : 45 cm x 45 cm x 45 cm and 1m³ for high density planting.

Spacing : Dwarf cultivars: 1.8m x 1.8 m
Dwarf cultivars: 1.4 x 1.4 m (Without ratooning)
Medium tall cultivars: 2.1m x 2.1m
Tall cultivars : 2.4 m x 2.4m

High density planting:

Jahaji : 1.0m x 1.2m x 2m (6250 plants/ha)

Bar Jahaji: 1.2m x 1.8m (4629 plants/ha)

Malbhog : 1m x 1.2m x 2m (6250 plants/ha)

Time of planting: March – May

Manure and Fertilizer:

1. 12 kg FYM/plant, 110 g N/plant, 33 g P₂O₅/plant and 330 g K₂O/plant
2. For Integrated Nutrient Management of banana 12 kg FYM/plant, 55 g N/plant, 33 g P₂O₅/plant, 330 g K₂O/plant and 25g each of *Azospirillum* and Phosphate Soluble Bacteria (PSB) per plant should be applied.
3. For High Density Planting 18 kg FYM, 165 g N, 50 g P₂O₅, and 495 g K₂O should be applied for 3 plants in each pit.

In case of Jahaji K₂O may be increased upto 550 g/plant. In case of Barjahaji 200 g N/plant in three splits (3rd month, 5th month and shooting stage) should be applied.

FYM should be applied at the time of planting. The whole of P₂O₅, half on N and half of K₂O should be applied in 3rd month of planting. The remaining N and K₂O should be applied in 5th month of planting.

Soil application of different micronutrient mixture of B (6 g), Zn (9 g), Cu (6 g) and Mo (1 g) per plant for Borjahaji is beneficial. Micronutrient mixture of B, Zn, Cu & Mo at the same rate for Chenichampa and B & Zn mixture for Jahaji increase the production.

Irrigation: 3 irrigations per month during dry periods.

Drip cum fertigation:

1. Drip irrigation at 75% EpR during November to March can be applied for banana cultivar ' Barjahaji' with Benefit: Cost ratio 5.72
2. 75% recommended dose of N and K (82.5g N and 247.5g K) can be applied through drip.

Intercultural:

Desuckering : Remove all the suckers till shooting and allow only one sword sucker at shooting to set as ratoon crop.

Weeding :

Remove weeds as and when required. Diuron @ 3 kg/ha or Gramoxone @ 1.5 kg/ha should be applied to check weed growth.

Grow one crop of cowpea and incorporation in soil followed by hand weeding at 30 days interval upto shoot stage.

Bunch Covering : White polythene bunch covering is suitable measure to overcome low temperature effect.

Crop Cycle:

In a banana plantation one main crop followed by 2 ratoons should be allowed. However, in Kachkal 5 ratoons can be taken.

For high density planting, after harvesting of the main crop, new plantation should be done in between the rows. Preparation of the pits for planting should be done before harvesting of the main crop.

Harvesting : The fruit is harvested when the ridges on the surface of the skin change from angular to round, i.e. after the attainment of $\frac{3}{4}$ full stage. The dwarf bananas become ready for harvest within 11 to 14 months after planting, while tall varieties require about 14 to 16 months to harvesting.

Yield : The yield of banana depends on a number of factors such as variety, plant density, management practices etc. Tall varieties usually yield 15-20 t/ha. Dwarf varieties like Dwarf Cavendish yield 30-40 t/ha.

Plant Protection:

1. Corm borer and Nematodes: Healthy corms free from nematodes should be selected as planting materials. In case of infected suckers, the infected portions should be scraped out with a sharp knife. In such corms, carbofuran (Furadan) granules should be applied @ 40 g per corm after dipping in mud slurry.
2. Pseudostem borer: Spray 0.1% malathion 50 EC (1 ml in 1 litre of water). Apply Carbofuran 3 g granules in soil @ 10 g per stool.
3. Leaf & Fruit scarring beetle: Spray 0.1% malathion 50 EC (1 ml in 1 litre of water) on the bunches immediately after emergence or application of 0.05% monocrotophos @ 30 ml/plant. Bagging of bunch with muslin cloth or blue polyethylene before fruit set and remove after 60 days of fruit setting.
4. Bunchy Top: To check the spread of the disease, the aphid vector should be controlled by spraying dimethoate or phosphamidon @ 1 ml/lit. (3 lit/ 25 plants) Uproot and bury the infected plants.
5. Panama disease or Banana wilt: Soil drenching with 1.0% Bordeaux mixture or 0.05% carbendazim (0.5g in 1 litre of water) is effective.
6. Sigatoka leaf spot: Spraying of Carbendazim at first appearance followed by 4 sprays at 30 days interval.

Benefit: Cost ratio : Main crop: 4.1; Ratoon crop: 6.5

ASSAM LEMON

Citrus limon L. Burm. F.

Cultivar: Assam Lemon (Local).

Soil: Loamy soil with uniform texture upto a depth of 3 m is ideal, for cultivation. Avoid waterlogged conditions.

Propagation:

1. Stem cutting
2. Leaf bud cutting
3. Air layering

1. Stem cutting :

The cuttings are usually prepared from fully matured stem. The size of cutting is 18 to 20 cm in length with a thickness of lead pencil. The upper cut is made 1 cm above the node and lower cut close below the node in a slanting manner.

The cuttings are planted with a spacing of 30 cm x 30 cm in a slanting position in the nursery bed measuring 30 cm x 1 m x 10 m. The bed is prepared with a mixture of 1:1:1 decomposed cowdung, soil and sand respectively.

2. Leaf-bud cutting :

Leaf-bud cutting should be taken from the branch having healthy well developed bud and actively growing leaves. The cuttings consist of a leaf blade and short piece of the stem measuring 2 cm.

The nursery bed should be prepared with a mixture of leaf-mould, soil and sand in a ratio of 3:2:1. The cuttings are planted in rows 15 cm x 25 cm spacing and buried upto 2/3rd to their length in a slanting position. Before planting, cutting should be treated with plant growth regulator, viz. IBA (500 ppm) or Seradex B. The sprouted cuttings can be transplanted within 1 year in the field.

3. Air layering :

The first step in air layering is to remove completely a strip of bark 3 cm in width at a point 15cm or more below the tip end. Scraping the exposed surfaces to ensure complete removal of the phloem and cambium is desirable to retard healing. About one to two handful of only slightly moistened sphagnum moss or mud pudding with a mixture of well decomposed cowdung, soil and sand with a ration of 1:1:1, respectively is placed around the stem to cover the cut surface. Then a piece of polyethylene sheet 15 to 20 cm wide is wrapped carefully around the branch so that the sphagnum moss or mud is completely covered. Both the ends of the polyethylene sheet should be tied firmly so that the moss or mud does not dry up.

The best time for Stem cutting, Leaf-bud cuttings and Air layering is March-April. Stem cutting may be raised in polyethylene bags under partial shade as the best nursery techniques.

Planting:

Before monsoon, pits of 0.5m x 0.5m size with a spacing of 3m x 3m are prepared and refilled with soil-manure mixture (1:1) and then allowed to settle. The time of planting is May to August.

Pruning and Training:

In the nursery stage, pruning should begin soon after the seedlings start sprouting from the Stem cutting or Leaf bud cutting or Air layering. After planting in the main field, upto 50-60cm from the ground level all side branches should be removed keeping only single main trunk. Above 50-60cm, pruning is confined to the training to develop.

Mechanically strong trees with well spaced scaffold limbs before the onset of fruit setting. At the bearing stage, during winter when bearing of tree is low, the branches touching the ground should be cut close to the laterals without leaving any stub. All diseased, injured, criss-cross branches and water sprout should be removed.

Manure and Fertilizer :

Year	FYM	N	P ₂ O ₅	K ₂ O	Remarks
<i>A. Plain Zone :</i>					
1st yr.	5kg	150g	100g	145g	Per plant per year
2nd yr.	10 kg	300g	200g	290g	
3rd yr.	15 kg	450g	300g	435g	
4th yr.& above	20 kg	600g	400g	580g	
<i>B. Hill Zone :</i>					
1st yr.	10 kg	100g	100g	100g	Per plant per year
2nd yr.	10 kg	100g	100g	100g	
3rd yr.	10 kg	100g	100g	100g	
4th yr.& above	20 kg	100g	100g	100g	

This mixture is to be applied in two split doses, i.e. during February/March and October/November.

Fertilizer should be applied leaving about 15-45cm space around the tree trunk and well beyond the canopy spread. It should be incorporated into the soil by light hoeing.

Micronutrient:

Spray 0.2 % (2 ml per litre of water) of Polymax or Multiplex during new flushes.

Orchard Management:

Weeding should be done frequently at monthly intervals. Paddy straw or black polyethylene can also be used as mulch for controlling weeds.

To produce off-season crops, 15cm pruning after the harvest of main crop with a single spray of cycocel at 3000 ppm is recommended. Three irrigations at 15 days interval @ 15 lit/plant combined with black polythene (50 micron) mulching 1st week of November is effective in producing off-season crop (1st week of March).

Harvesting:

After 2nd year of planting the plants start bearing. Bearing of Assam Lemon is continuous throughout the year. Harvesting should be done when fruits become fully matured. Peak period of bearing is July to September.

Benefit: Cost ratio: 3.50 after 4 years

7.80 for full bearing plants

KHASI MANDARIN

Citrus reticulata L. Blanco

Cultivar : Khasi Mandarin (Local)

Soil : Mandarin thrives well in deep loose well aerated soil devoid of any hard pan. Ideal pH range for mandarin is 5.5 to 7.5. It is also highly sensitive to moist soil conditions.

Propagation:

- 1) Seed
- 2) Budding

1. Seed:

Since seeds of mandarin are mostly polyembryonic, the nucellar seedlings obtained through the mother plant, thus enable to retain the clonal characters as in vegetable propagation. Seeds should be sown first in (a) primary nursery and then seedlings should be transferred to the (b) secondary nursery.

(a) Primary nursery:

The site for the primary nursery should be selected on high land in light soil with good drainage. Raised seed beds of 20-30cm x 1m x 5m size should be prepared with a mixture of well decomposed cowdung, soil and sand at a ratio of 1:1:1 respectively. Seed from healthy and vigorous mother trees with uniform and good bearing capacity should be collected. The mother plant should preferably be 20-30 years old. Freshly extracted seeds should be washed and dried in shade. Seeds should be dibbled at 2.5cm. between the rows and 1.25cm within rows at a depth of 0.5 to 1.25cm. Adequate watering should be done at regular interval.

(b) Secondary nursery:

Seedlings at 4 to 6 leaf stage should be transplanted from the primary nursery to the secondary nursery bed. The seedlings should be transplanted at 30cm between and within the rows. Side sprouts should be regularly removed. Regular control measures against pests and diseases are essential. Seedling of 3 years is ready for transplanting.

2) Budding:

T or inverted T (L) budding is the best budding method for Khasi Mandarin:

(a) Root Stock :

1. Rough Lemon.

2. Rangpur Lime.
3. Cleopatra Mandarin.
4. Trifoliate orange.

(b) Rootstock Seedlings:

The rootstock seedlings are ready for budding within 1¹/₂ to 2 years.

(c) Scion or bud-wood:

Scion or bud-wood should be collected from known productivity, vigorous, healthy and insect and disease free trees with a regular bearing habit. The best time of budding is September and February.

(d) Budding method:

Budding should preferably be done at a height of about 20-25 cm from the ground level. First a vertical cut (about 2 cm long) is made using a sharp budding knife in the stock plant. Then a horizontal cross cut at the top or bottom of the vertical cut is made as per 'T' or '-' method through the bark about 1/3rd the length around the stock. Then the flap of bark is opened by the knife for insertion of the bud. After making the proper cut in the stock plant, the shield piece is cut out of the bud stick. A shield shaped piece of bark containing the bud from 1 to 2 cm in length is removed from the bud stick including a thin silver of wood on the cut side.

Then the shield is pushed under the two raised flaps of bark of stock until it is well covered by the two flaps of bark keeping the bud exposed. The bud union is wrapped using transparent polyethylene sheet. This can be unwrapped after 6-8 weeks of budding,. After success of the budding, just before new growth begins the root stock is cut off immediately above the bud. The budded plants are ready for transplanting within 6-9 months.

Planting:

Before monsoon, pits of 0.75m x 0.75m x 0.75m size with a spacing of 5m x 5m are prepared and then refilled with soil-manure mixture (1: 1) and then allowed to settle.

The time of planting is May to August.

The plant is set at the centre of the pit and the soil around is compacted. Mulching with dry leaves should be done. Plants should be irrigated regularly at fortnightly intervals during dry periods.

Pruning and Training:

In the nursery stage pruning and training should be done soon after the seedlings starts sprouting from the seed or scion buds have started growing.

After planting at the main field, all side branches should be removed upto 50-60cm from the ground level keeping only single main tree trunk. Above 50-60cm height, pruning is confined to she training to develop mechanically strong trees with well spaced scaffold limbs before the onset of fruiting. The side branches at the main trunk should be allowed to grow in a spiral manner from base of the plant to top. At the bearing stage after harvest of the crop, the branches touching the ground should be cut close to the laterals without leaving any stub. All diseased, injured, criss-cross branches and water sprouts should be removed.

Manure and Fertilizer:

Age	FYM	N	P ₂ O ₅	K ₂ O	Remarks
2 nd yr.	5kg	150g	120g	100g	
3 rd yr.	10kg	300g	240g	200g	Per plant per year
4 th yr.	15kg	450g	360g	300g	
5 th yr.	20kg	600g	480g	400g	
6 th yr. onward	25kg	600g	300g	600g	

In the first year of planting no fertilizer is applied to the plant. For bearing plant, apply Neem cake @ 7.5 kg per plant per year.

Manures and fertilizers should be applied in two split doses, i.e. February/March and September/October.

Fertilizer should be applied leaving about 15-45 cm space around the tree trunk and well beyond the canopy spread. Immediately after application of fertilizer, it should be incorporated into the soil by light or shallow hoeing.

Integrated Nutrient Management (INM):

75% recommended dose of fertilizers i.e. 450 g N, 225 g P₂O₅, 450 g K₂O and 5.625 kg Neem oil cake along with VAM 500g, PSB 100g, Azospirillum 100g and *Trichoderma harzianum* 100 g are to be applied per plant per year in 2 splits i.e. in March/April and September/October. The required amount of biofertilizers is to be mixed together with 10 kg FYM and should be applied 15 days before the application of inorganic NPK.

Micronutrient:

Foliar application of micro nutrient viz. Zn, B and Mo is very much effective, @ 0.02%, 0.05% and 0.05% as ZnSO₄, Borax and Ammonium-molybdate respectively thrice in a year during Feb-March, June-July and Sept-Oct.

Orchard Management:

Weeding should be done from the month of April; first by hoeing followed by spray of Glyphosate a.i. @ 1 kg/ha after 60 days followed by another hand weeding after 60 days of chemical spraying.

Intercropping:

Summer green gram/cowpea followed by toria as intercrop up to bearing stage and alternatively pineapple can be grown successfully as intercrop.

Harvesting:

After 8-10 years, the seedling trees start bearing. Harvesting should be done by using ladder. Fruits should be collected in a bag and gently placed on a gunny carpet. Subsequently, they should be packed in baskets or cartoons for transportation to the market. About 800 to 2000 fruits per plant per year can be obtained from a 30-40 years old orchard.

Plant Protection for Citrus:

(1) **Trunk borer:** It is a very damaging insect pest of mandarin orange in Assam. The grub bores hole into the tree trunk near the base and makes tunnel through the pith upward and the plant eventually dies. Prophylactic smearing of carbaryl or monocrotophos or quinalphos with lime and water (1 : 1 : 25) should be applied upto one metre from the base of the tree during March/April which prevents the adult from laying egg. Once the hole is made, it should be spiked with wire to kill the grub and then the hole should be cleaned and plastered with wet soil. Alternatively to kill the insect the hole should be plugged with cotton/cloths soaked in insecticides like dichlorvos (0.07%) or phosphamidon (0.05%) and then plastered with mud to have an airtight condition. Proper pruning and training are also essential to minimize the infestation.

Prophylactic smearing with lime solution (1kg/10lt. of water) along with 50ml monocrotophos and gum applied upto 1m from the base of the trees during March followed by injection of either 10ml petrol or dichlorvos 0.05% or monocrotophos 0.07% into the holes and sealing with mud and cowdung plastering for effective control of Trunk borer.

(2) **Shoot borer:** The shoot borer damages mostly young and new shoot of the plant. The grubs bore into the tip of the new shoot and make tunnels through the pith of the branch from top to bottom and the shoot dies due to infestation. The insect starts damaging from March to October. The insect can be controlled by pruning and burning the infested branches. Then smear Bordeaux paste with Nuvan in the cut portion. The insect can also be controlled by giving regular spraying with Monocrotophos (0.04%) i.e. 0.4ml in 1 litre of water) or phosphamidon (0.03% i.e. 0.3ml in 1 litre of water) starting from March to October at an interval of 20 days.

(3) **Bark eating caterpillar:** The insect damages the bark of the plant and as a result the flow of nutrients is stopped and ultimately the plant dies. It is a serious pest in neglected and old orchards. Removal of webbing followed by painting or spraying with monocrotophos 0.04% (0.4ml in 1 litre of water) on the infested portion of the bark can control the insect.

(4) **Leaf miner:** The larvae usually mine the undersides of new leaves making serpentine mines which are silver coloured because of entrapped air. Due to mining the leaves become distorted, curled and defoliation occurs during severe attack and the plant becomes stunted in growth. Two sprays with monocrotophos (0.4% i.e. 4ml in 1 litre of water) or phosphamidon (0.03% i.e. 0.3ml in 1 litre of water) during flushes have been found effective in controlling the insect. First spray should be given during initiation of new flush and the second after 20 days of the first spray.

(5) **Lemon butterfly:** The caterpillars feed on the leaves and defoliate the branches. Hand picking of larvae, with spraying with Sevin (0.1% i.e. 1ml in 1 litre of water) may be helpful in controlling the insect.

(6) **Fruit sucking moth:** The insect sucks the juice of the fruit and the fruits drop within few days. Destruction and disposal of fallen fruits and baiting with malathion 50 EC (0.1% i.e. 1 ml in 1 litre of water) with molasses (1%) and fruit juice help in controlling this insect.

(7) **Scales, mealy bugs, aphids and psylla:** These are sap sucking insects; Scales are brown tiny insects and are immobile. While sucking plant sap mealy bugs secrete honey dews on which sooty mould develops. Mealy bugs also cause fruit drop. The aphids infest the lower surface of the tender leaves, shoots and young fruits due to which the infested twigs are curled and the plant becomes sickly. The nymphs of psylla suck the cell sap from tender shoot, leaves and flowers causing curling, defoliation and drying of twigs.

To control these insects spray monocrotophos (0.025% i.e. 0.25ml in 1 litre of water) or phosphamidon (0.035% i.e. 0.35ml in 1 litre of water) or malathion (0.1% i.e. 1ml in 1 litre of water). Repeat the treatment and when necessary.

(8) **Gummosis or phytophthora foot rot:** Phytophthora disease produces symptoms of declining health of citrus trees causing rotting of roots, girdling of the tree trunk and defoliation. The first symptoms are dark staining of the bark followed by olive brown in colour with a water soaked appearance. In advanced stage, the bark cracks, strips off lengthwise as it dries and gum starts exuding particularly in the late spring resulting into yellowing and die back. At the early stage, the affected portion should be scraped with a little extra healthy tissue without injuring the wood and then smear Bordeaux paste or Bordeaux paint (1:2 linseed oil).

(9) **Wither tip:** Wither tip or dry-up twigs from top to the bottom is a serious problem in citrus. Pruning followed by spraying of 1% Bordeaux mixture after harvest of the fruit control this disease. Twig blight or wither tip or dry-up twigs can be effectively managed by pruning in the month of January/February followed by two sprays with Copper oxychloride (COC) @ 3g/litre at 30 days interval or Pruning followed by one spray with COC @ 3g/litre + one spray after 30 days with carbendazim @ 1g/litre.

(10) **Scab:** The scab lesions appear as minute water soaked round spots which enlarge slightly, turn brownish and then corky on fruit, leave and young twigs. Removal of infected leaves, twigs, fruit and spraying of Bordeaux mixture (1%) or copper oxychloride 50WP (0.3% i.e. 3g in 1 litre of water) or Mancozeb 75 WP (2 g/l) have been found effective in controlling the disease.

(11) **Canker:** It is a bacterial disease. The canker lesions appear as minute water soaked round spots, enlarge slightly, turn brownish, corky which can be controlled by 1% Bordeaux mixture or Streptocyclin 100 ppm + copper oxychloride 0.3% (3 g in 1 litre of water) spraying during new flushes.

(12) **Greening:** The infected plant shows chlorosis of leaves, thickening of leaf blade, shortening of twigs internodes, off-season blooming, leaf shedding and die-back. To control this disease, insect vector psylla should be first controlled (see psylla control).

(13) **Twig Blight:** Pruning in the month of January/February followed by 2 sprays of carbendazim 0.1% and thereafter 2 sprays of Copper oxychloride 0.3% (3 g in 1 litre of water) at monthly interval can control.

(14) **Pre harvest stem end rot:** Four sprays of carbendazim 0.1% (1 g in 1 litre of water) at monthly interval from May i.e. after fruit set to control fruit drop due to pre-harvest stem end rot.

Other Maladies:

1. **Zinc deficiency:** Zinc deficiency is considered as the most wide spread and damaging micronutrient deficiency of citrus. Deficiency symptom develops only in the new growth. The leaves are small sized, chlorotic crowded on shoot stems giving a bunched appearance, mottling, twig die-back and ultimately the tree starts declining. It can be controlled effectively by foliar spray of 0.4 to 0.6% (4 to 6 g in 1 litre of water) Zinc sulphate during new flushes.

2. **Moss:** Remove the mosses mechanically by rubbing with gunny bag.

3. **Loranthus:** The group of parasitic plants should not be allowed to develop on branches. It should be controlled by efficient pruning.

4. **Fruit drop.** Spray 10 ppm Planofix (1 ml in 4.5 lit water) or 2,4-D @ 25 g/100 lit of water immediately after flowering and again after one month. 3 sprays of

0.1% Carbendazim along with 30 ppm NAA starting from May onwards i.e. after fruit setting at bimonthly interval also can control fruit drop.

Suggestions for Improvement of Citrus-Decline

- 1) Proper drainage should be provided to drain out the excess water from the root-zone.
- 2) For vegetative propagation the mother plants should be ascertained of their freeness from virus and mycoplasma diseases.
- 3) It is advisable to establish new orchard with budded plants on resistant root stocks.
- 4) Regular manuring of both non-bearing and bearing trees is essential.
- 5) Foliar feeding of micronutrients is essential as a regular practice.
- 6) Cultural practices like regular weeding, intercropping with only short duration, shallow rooted legume crops upto pre-bearing stage are suggested.
- 7) Pruning of dead and dried twigs, removal of plant parasites like Ioranthus etc. are desirable practices.
- 8) Soil working near root zone should confine only upto 10 cm soil depth.
- 9) Application of Bordeaux paste may be practised regularly to a height of about 50 cm of the trunk from the ground level.
- 10) Pest and disease control measures should be followed strictly.

Schedule for rejuvenation of declining Khasi mandarin orchards:

1. Pruning and Training

- Unwanted, diseased and pest infected branches and twigs are to be removed by pruning and training during January/ February.

2. Correction of soil pH

- Applying of 1 kg Agricultural lime per plant for three years during January/ February and then mixed thoroughly with soil by light hoeing.

3. Integrated nutrient management

- Application of nitrogen (N), phosphorous (P_2O_5), and potash (K_2O) @ 600g, 300g and 600g per plant along with 7.5 kg. Mustard oil cake in two splits is to be done during March/April and Sept/Oct. Zn @ 2.5 g, B @ 0.6 g and Mo @ 0.1 g per plant are also to be applied along with NPK. Apply foliar spray using Green Harvest Crop Booster @ 25 g with 50 g Zinc Sulphate and 100 g Urea in 10 lit water.

4. Integrated management of Phytophthora foot rot, twig blight and stem end rot

- For control of Phytophthora foot rot, soil drenching and spraying of tree trunks with Mancozeb + Metalaxyl (Ridomil MZ-72) @ 0.2 % (2g in 1 litre) followed by Bordeaux mixture (1%) during Feb-March and July-August.
- Following pruning and training in January, 2 sprays of Carbendazim (0.1%) *i.e.*, 2g per lit. of water followed by two sprays of COC (0.3%) *i.e.*, 3g per lit. of water at monthly interval for control of Twig blight.
- Four sprays of carbendazim @ 0.1% *i.e.*, 1 g per lit. of water at 60, 80 and 120 days initiating from May onward for control of Pre harvest stem end rot.

5. Integrated management of trunk borer and bark eating caterpillar

- Prophylactic smearing of 50ml endosulfan + 1 kg lime in 10 litres of water along with gum up to 1 meter from the base of the trees during March every year to prevent adult from laying eggs.
- Afterwards 10ml petrol is to be injected into the holes of trunk borer and holes are sealed with mud and cowdung plastering.

6. Integrated weed management

- Light hoeing before application of fertilizers during March followed by glyphosate 41 SL @ 1 lit./ha spray on the resurgent weeds during May followed by hand weeding at bimonthly interval.

Benefit: cost ratio: 3.30 after 7-8 years

5.60 after 10 years

COCONUT

Cocos nucifera L

Varieties : Assam Tall, T x D hybrid (Chandrasankar), Bengal Selected, Bengal Hazari, Kamrupa and Kahikuchi 1.

Selection of Mother Palm :

1. Select palm producing above 100 medium sized nuts /palm/year.
2. Age of mother palm should be above 20-25 years.
3. Mother palm should have well developed crown with maximum number of horizontally oriented leaves.
4. Sept.-Dec. harvested nut should be used.

Soil :

Sandy loam

If the soil is clay, 1 or 2 basket of sand per pit should be applied.

Sowing the nut:

Sowing time is December to February. 1m wide and 30cm raised beds of required length should be prepared. Large size nuts are planted horizontally with the widest of the three segments upwards which helps in the plumule emergence.

Selection of seedlings:

1. One year old seedling should be planted.
2. The seedling with early splitted leaf is preferable. The seedlings having 5-6 leaves or just after splitting of leaves become ready for planting.
3. The seedlings should have stout collar.

Planting Distance : 7.5 m x 7.5 m

Pit size : 1 m x 1 m x 1 m

Time of Planting:

March-April under high land condition

September-October under low land condition

Pit filling:

Pit should be filled up with mixture of top soil, 20 kg compost or dried cowdung and 100g of 5% malathion dust up to 2/3rd of pit.

Fertilizer Dose: (per palm per year for bearing plants)

Fertilizer	Improved varieties	Hybrid varieties
Urea	1.50 kg	1.10 kg
SSP	2.50 kg	3.12 kg
MOP	1.75 kg	3.34 kg
Borax	25 g	25 g

The fertilizer should be applied in two equal split doses, i.e. in April and October. The fertilizer should be applied to a trench of 30 cm width and 10 cm depth at a radius of 1 to 1.75m away from the trunk depending upon the age of plant and covered with green leaves and then by soil. For seedling, the dose should be increased up to 4th year at the following rates:

1st yr. – 1/5th of the full dose

2nd yr. – 2/5th of the full dose

3rd yr. – 3/5th of the full dose

4th yr. – 4/5th of the full dose

From 5th year onwards-full dose of fertilizer for bearing palm

For integrated nutrient management in T x D hybrid (Chandrasankar) 500g vermicompost, 500g P₂O₅ and 2000g K₂O per palm per year should be applied. Benefit: Cost ratio is 2.02.

Irrigation: Irrigation increases total number of female flowers, nut setting, endosperm content, fruit weight and ultimately crop yield and reduces immature nut fall. Palms should be irrigated at 10 days interval during the dry months.

Weeding: Light ploughing or harrowing twice a year in February-March and September-October.

Weed management by mulching in coconut nursery: 50 micron black polyethylene film mulch can be used as mulching material in coconut nursery with a benefit: cost ratio of 2.36.

Intercropping: The crops, like black pepper, betelvine, grasses, turmeric, ginger, pineapple, banana (Chenichampa), Kachkal, Assam Lemon and vegetables like

pumpkin, okra, brinjal etc. have been found to be very profitable as intercrop in coconut orchard. Intercropping with colocasia under half dose of recommended fertilizer and ginger and turmeric with full dose of fertilizer can be grown profitably.

Coconut based cropping system: Coconut + Turmeric + Black pepper as alternate cropping system can be adopted for a benefit: cost ratio 1.70.

Plant Protection:

White Ant: Apply 5% malathion powder @ 200 g per 7.5 sq. m. in nursery and 100 g per pit during planting.

Rhinoceros beetle: Apply 5% malathion dust mixed with equal quantity of sand at the axil of leaves of the crown.

Red palm weevil and Mealy bug: Spray Endosulfan 35 EC @ 1 ml/lit. Pour monocrotophos 2ml/lit. in the trunk cavity and plug with mud.

Terathea and Betrachedra spp: Clean the palm twice a year before and after monsoon and spray dimethoate 30 EC 1 ml/lit.

Crown chocking: Apply 25 g Borax in a trench of 15 cm width and 10cm depth at a distance of 1 to 1.75m away from the trunk. In acute cases repeat the application after one month of first application for three times.

Stem bleeding: Scrape out the infected portion completely and apply Bordeaux paste or coal tar. Chiselling out of the infected portions followed by wound dressing with tridemorph (1 ml/litre) or carbendazim (1 g/litre) and finally application of hot coal tar will manage the stem bleeding disease of coconut.

Spindle rot: Spray 1% Bordeaux mixture immediately after emergence of seedlings.

Ganoderma disease:

1. Drainage should be improved.
2. Recommended dose of fertilizer should be applied.
3. When disease symptoms are observed, isolate the diseased plant by digging a trench 60 cm deep, 30 cm wide and 1 m away from the trunk and drench the trench with 0.2% Captan.
4. Application of 5 kg Neem cake per palm in addition to organic matter.
5. Apply 1.5 to 2 kg Sulphur powder around the palm.
6. Palms showing initial disease symptoms should be treated with 0.3% Captan or 0.2% Carboxin three times at monthly interval with 10 litres of solution per palm.

7. Strict phytosanitary measures should be taken by removing the diseased palm along with roots and burying them completely.
8. Grow one row of banana plant as a disease resistant crop in between two rows of coconut.
9. Soil drenching with 1 g copper sulphate + 1.5 g Auriofungin solution in 100 ml of water.

Bud rot: Clean the affected portion and apply 1% Bordeaux mixture.

Leaf blight: Remove the older affected leaves and spray 1% Bordeaux mixture.

Immature nut shedding:

1. Apply recommended dose of fertilizer per year.
2. Apply pesticides and fungicides against pests and diseases.
3. Irrigate the palms during dry months to prevent formation of abscission flowers at weekly interval for a month after fruit set.

Benefit: cost ratio: 1.60 after 6 years
5.70 after 10-12 years (full bearing plant)

JACK FRUIT

Artocarpus heterophyllus Lam

Cultivar: Singapore Jack, Rudrakshi, Local types.

Soil: It can be grown in a wide range of soil condition. But the crop is successfully grown in rich deep alluvial soil.

Propagation:

By seeds : Seeds from fully ripe fruits of high yielding prolific bearing types should be selected.

Air-layering : For obtaining true to type plant air layering of one year old shoot of bearing plant is the best method when treated with IBA (500 ppm).

Epicotyl grafting : Jack seeds should be sown in poly bags (10cm x 20cm) filled with pot mixture in the 1st week of July. The seedlings when reached 12-14 cm height (10-12 days old) should be used as rootstock for grafting. Scions from the terminal shoot of selected good variety of one season old having well developed buds should be used. Grafting should be performed by decapitating the seedlings at a height of 6 cm from the base and the top of as the stem should be split vertically to about 3.5 cm length forming a V-shape, 2.5 cm above the base. At the base of the individual scion a wedge of 4.0 cm should be prepared and inserted in the split epicotyl region of the stock and tied firmly by polythene strip.

Sowing: Freshly extracted seeds should be sown *in situ* during fruiting season.

Planting distance: 10 to 12 m

Manure and Fertilizer : For a bearing tree

FYM : 20 to 30 kg

N : 200 g.

P₂O₅ : 320 g.

K₂O : 960 g.

Ash : 5 kg.

Cropping: First fruiting takes place 6 to 8 years after planting.

Harvesting: The fruit matures towards the end of summer in June. Harvesting is done by cutting the stalk carrying the fruits.

Yield: 200 to 500 fruits per tree/year.

Plant Protection:

1. **Shoot and trunk borer:** Application of carbaryl 50% @ 4 gm per litre of water by spray in flowering season.
2. **Fruit rot:** Spray Indofil M-45 (Dithane M-45) as prophylactic measure.

Benefit: cost ratio: 4.10 for bearing plants

MANGO

Mangifera indica Linn

Cultivar: Langra, Malda, Gulabkhas, Krishnabhog, Dashehari, Fazli, Mallika and Amrapalli.

Soil :

It can be grown in a wide range of soil condition. But the crop is successfully grown in rich deep alluvial soil.

Propagation: Inarching and veneer grafting during July.

Time of Planting: During monsoon.

Planting Distance: 12 m x 12 m

Propagation:

Air layering : For obtaining true to type plant air layering of one year old shoot of bearing plant is the best method when treated with IBA (500 ppm).

Manure and Fertilizer :

Non bearing stage (upto 3 rd year) per plant/year	Bearing tree per plant/year	Old declined tree per plant/year
10–15 kg FYM	20-25 kg FYM	50–60 kg FYM
73 g N	730 g N	1 kg N
18 g P ₂ O ₅	180 g P ₂ O ₅	0.5 kg P ₂ O ₅
68 g K ₂ O	680 g K ₂ O	1 kg K ₂ O

(In case of old declined tree 3% urea as foliar spray per year after pruning).

Pruning and Training: Pinch off sprouts below the graft union regularly and pluck off panicles upto 3 years. Practise thinning of terminal shoots every year. Prune criss-cross branches once in 5 years.

Harvesting: After 4 years of planting during June to August

Yield: 10 years old plant: 200-250 fruits.

Plant of 20 years and above: 400-600 fruits.

Plant protection:

- 1) **Stem borer:** Plug with kerosene dipped cotton.
- 2) **Mango hopper :** Spray 1 ml/lit. malathion.
- 3) **Red Ants :** Apply 5% malathion dust with sulphur in 2: 1 ratio.
- 4) **Pulp weevil :**
 - (i) Spray 1ml/lit. malathion or deltamethrin @ 1 ml/lit.
 - (ii) Cultural practices like clean cultivation light hoeing and smearing & lime on the base of trunk.
 - (iii) Combined treatment of cultural practices and spraying of deltamethrin @ 0.1%
- 5) **Pink disease and anthracnose:** Spray copper fungicide @ 0.4%.
- 6) **Fruit Fly:** Spray 1 ml/lit. malathion or bait spray of carbaryl (2g/lit) + molasses (1 g/lit) at egg laying stage.
- 7) **Mango malformation:** Deblossom affected panicles and spray 200 ppm NAA.

Fruit drop: Spray 2, 4-D @ 10 ppm twice at full bloom and again after two months of 1st spray.

Benefit: cost ratio: 4.10 for bearing plants

PAPAYA

Carica papaya Linn.

Cultivar :

Dioecious Type: Co.1, Co.2, Washington, Ranchi, Halflong

Hermaphrodite type: Solo papayas, Coorg Honey Dew.

Soil : Well drained high and rich sandy loam.

Propagation: By seeds (500 g seeds to raise seedlings for 1 ha)

Raising Nursery:

Prepare raised beds in sandy loam soil during February-March. Dibble seeds at 1 cm depth at a spacing of 2.5 cm. Water the beds every day. Seeds germinate after 15 days of sowing. Keep seedlings in the nursery for 1 month.

Time of planting: April to June.

Planting Distance : Prepare pits of 45 cm x 45 cm x 45 cm size at a spacing of 1.8m x 1.8m. Plant 4 seedlings per pit in case of dioecious type and 1 seedling per pit in case of hermaphrodite type.

Manure and Fertilizer:

NPK @ 500 g, 500 g and 500 g per plant, in two splits : (i) 2 months after planting, (ii) at first fruit set.

Maintenance of Sex Ratio:

In dioecious type, after flowering, keep 2 male plants for every 10 female plants and remove excess male plants.

Harvesting:

Almost throughout the year, after 1 year

Crop cycle: As yield declines after 3 year, start new plantation after 3rd year.
Yield of the fruit varies according to cultivar.

Plant Protection:

- (1) **Mosaic and leaf curl:** Rogue out affected plants. Control the aphid vector using malathion or dimethoate 0.1% spray.
- (2) **Collar rot and foot rot:** Maintain good drainage and spray 1% Bordeaux mixture in the collar region of plant.
- (3) **Management of papaya mealy bug (*Paracoccus marginatus*)**
 - Legislative: Restricted movement of infested plants/planting materials from endemic areas to prevent spreading of the insect pest

- Survey and Surveillance: Monitoring the crop to detect infestation of the papaya mealy bug early in order to initiate management practices effectively
- Mechanical: Removal and burning of infested parts/plants
- Cultural: Removal of weeds/ alternate hosts like *Hibiscus* sp. and application of sticky bands or alkathene sheet on main stem of the plant to prevent upward movement of crawlers.
- Biocontrol: Prevention of the movement of ants with destruction of already existing ant colonies in the vicinity, conservation of natural enemies like *Coccinella septumpunctata*, *Coccinella transversalis*, *Cheilomenes sexmaculata* and *Spalgis epius*, release of *Acerophagous papaya* (Hymenoptera: Encyrtidae) @ 500 - 1,000 per ha for three times at weekly interval.
- Chemical: Dusting of chlorpyrifos 1.5% dust or malathion 5% dust around the healthy plants to check the movement of crawlers; spot spraying of Neem oil (1 to 2%), NSKE (5%), profenophos 50 EC (2 ml/l), chlorpyrifos 20 EC (2 ml/l), dimethoate 30 EC (2 ml/l), thiomethoxam 25WG (0.6 g/l) and imidacloprid 17.8 SL (0.6 g/l); destruction of ant colonies with drenching of chlorpyrifos 20 EC @ 2 ml/l

Nematode: Apply 0.5g carbofuran 3 G per nursery polybag and 25g per plant in field condition.

Benefit: cost ratio: 4.60 for unripe fruits
12.40 for ripe fruits

LITCHI

Litchi chinensis Sonn.

Cultivar : Muzaffarpur, Dehra Dun, Calcutta, Rose Scented, Khatti, Seedless.

Soil: Loamy Soil

Propagation: Air layering during rainy season.

Planting Material: Layers of 15 months

Time of Planting: August to September.

Planting Distance: Prepare pit of 1m x 1m x 1m size at a spacing of 10m X 10m.

Manure and Fertilizer:

For bearing Tree:

Urea: 110g.

Super Phosphate: 250g

Sulphate of Potash: 125g.

Oil Cake: 2 kg.

Bone Meal: 2 kg.

Wood ash: 4 kg.

Pruning: Remove the dead or diseased branches and damaged shoots or crossed limbs. Skipping of old branches is desirable to promote new growth.

Mulching : Dry leaves or rice straw are used as soil mulch.

Cropping : Litchi bears fruits 5 to 6 years after planting. Flowering time is from February-March and the harvesting time is May-June.

Harvesting: Mature ripe fruits should be harvested with fruit stalks.

Yield: A healthy mature tree can yield a crop of 75 to 100 kg.

Plant Protection:

- (i) To control bats and birds during fruit ripening, the tree should be covered with bird proof nets.
- (ii) Leaf curl or "Erinose" caused by the mite should be controlled by spraying Kelthane 1.5ml or dimethoate 2ml/lit of water.
- (iii) Fruit cracking: Spray 2, 4, 5-T or NAA at 35-100 ppm.

Benefit: cost ratio: 4.60 for bearing plants

GUAVA

Psidium guajava Linn

Cultivar : Hafsi, Lucknow-49. Allahabad Safeda, Chittidar, Seedless.

Soil: Well drained loamy soil.

Propagation: Air layering during rainy reason.

Time of Planting: May to June.

Planting Distance: 4-5 m x 4-5 m

Manure and Fertilizer: 20-30 kg FYM, 260 g N, 320 g P₂O₅ and 260 g K₂O/ plant/year in two split doses in February-March and September-October.

Pruning : Sprouts arising from the base of the trunk should be removed immediately.

Shoot Bending : The straight branches may be bent and tied on the pegs driven to the ground. In bent branches dormant buds are activated and induced to bear flowers and fruits heavily.

Harvesting : Layered plants start bearing at the age of 2 to 3 years. Mature or half-ripe fruits are harvested by hand picking.

Yield: Average yield is 75 to 175 kg/plant/year.

Plant Protection:

1. **Fruit fly**: Spray malathion 0.1% (1 ml per litre of water) and burn the infected fruits.

2. **Wilt**: Drench the soil with Captan 50 WP (0.3% i.e. 3 g in 1 litre) and spray the plant with carbendazim 50WP at an interval of 15 days in the early stage of infection.

Benefit: cost ratio: 4.20 for bearing plants

SAPOTA

Achras zapota Linn.

Cultivar: Cricket Ball, Barmasi, Oval, Co.1.

Soil: Well drained deep sandy loam, laterite and old alluvium

Propagation : Propagation is by inarch grafting during rainy season. In case of inarch grafting the rootstock should be Khirni (*Manilkara hexandra*).

Time of Planting: Early monsoon.

Planting Distance: 7-9 m x 7-9 m

Manure and Fertilizer : For a bearing tree, 40 kg FYM, 200g. N, 80 g P₂O₅ and 300 g K₂O/tree/year

Pruning : Remove all the sprouts appeared on the rootstock below the graft or bud joint. After 3 to 4 years of planting the lower branches upto height of 60-90cm should be removed. Remove the over shaded and crowded branches.

Cropping : Grafted Sapota bears fruits 3 years after planting. Fruit production increases up to 30 years and declines thereafter. Sapota blossoms continuously in several flushes at short interval throughout the year.

Harvesting : Mature fruits should be harvested with fruit-stalks.

Yield : A mature tree bears 1500 to 3000 fruits a year.

Plant Protection:

(1) **Stem borer:** Plug with kerosene dipped cotton.

(2) **Scale insects:** Spray malathion (2 ml per lit. of water)

(3) **Leaf spot:** Monthly spray of 0.2% (2 g in 1litre of water) Dithane Z-78.

(4) **Sooty mould :** Spray starch solution (100 g in 18 litres of water)

ARECANUT

Areca catechu Linn.

Cultivar : Local type

Soil: Well drained soil. Avoid stiff clay and water logged soil.

Seed Selection : Select the healthy round nut of average weight 40 g. Deep the nuts in a bucket containing water. The nuts which are floating on the water vertically are suitable for raising seedling.

Nursery : Remove the perianth from the healthy seed nut and place vertically in the raised nursery bed 15 x 15 cm apart. Provide adequate shade in the nursery bed containing sand, soil and compost. When the seedlings attain 25-30 cm height transfer the seedlings to the 2nd nursery bed at 30 x 30 cm apart. Keep the seedlings in second nursery upto maximum age of 18 months.

Planting Distance: 2.75 m x 2.75 m

Pit Size: 60 cm x 60 cm x 60 cm.

Planting Time: Spring/Autumn

Manure and Fertilizer:

Age	FYM kg/Plant/yr	N g/plant/yr	P ₂ O ₅ g/plant/yr	K ₂ O g/plant/yr
1 st yr	5	30	15	50
2 nd yr	10	60	30	100
3 rd yr & onwards	20	100	40	140

Apply 2 splits, one during March/April and the other during September/October.

Weeding:

Remove weeds by hand hoe twice a year, once after pre monsoon and once after monsoon.

Intercrops:

Turmeric and ginger can be grown profitably as intercrops. Besides, one line of banana or lemon or three rows pineapple can be grown as intercrops.

For both bearing and non-bearing plantation, combination of banana and pineapple with an additional crop like black pepper or betelvine can be grown as intercrops.

Disorder:

Phula Tamul: In Arecanut cultivation, the phenomenon of the soft/leathery kernel, i.e. lack of proper hardening of kernel associated with moisture stress in the endosperm in ripe and mature fruit may be termed as phula tamul. This condition of fruit is generally found in the first bunch of the palm which ripens earlier and gets ready to be harvested in the beginning of the harvesting season (Late March to Early April). The incidence is observed when the palm experiences scanty or irregular rainfall during the fruit development period.

Control: Providing irrigation to the arecanut plants especially during the dry months with proper drainage facilities followed by improved cultural practices are some of the remedial measures to be adopted.

Nut Splitting : It is considered to be a physiological disorder. Improvement of drainage in area of high water table is known to help in minimizing the incidence. Spraying of Borax at the rate of 2g/l per palm during the early stage of the problem also reduces the splitting.

Pencil tip: Apply adequate manures and fertilizers regularly and improve cultural practices. Improvement of drainage is essential in areas of high water table. Plants should not suffer from N deficiency.

Plant Protection:

Bud rot – Same as in coconut

Ganoderma – Same as in coconut

Band disease:

- (i) Improve the soil condition by loosening hard soil strata present and providing good drainage.
- (ii) Apply powder mixture of copper sulphate and lime in equal quantities @ 225g per palm twice a year at the base of the affected palm.

Stem bleeding: Same as coconut.

Benefit: cost ratio: 1.40 after 6 years
12.6 after 8-10 years

BETELVINE

Piper betle Linn.

Introduction:

In Assam three different types of cultivation of betelvines are followed - (1) Around arecanut or any other trees. (2) Baroj type and (3) Khuti type. Of these, the first type is generally followed in most households whereas the later two types are practised for commercial purposes.

Cultivar:

Assamiya pan or Jati pan, Khasi pan, Garo pan, Sanchi pan, Bangla pan, (Kali Bangla, Nua Bangla, Ghanegette and Godi Bangla) Mitha pan and Karbi pan.

Soil:

Well drained fertile clay to sandy loam type of soils are suitable. For a new plantation top soil transplanted from a nearby plot should be used. Soil pH may be increased upto 6.5 by adding lime at least 20 days before planting the cutting of betelvine.

Cultivation with Arecanut Support:

Pits of 60 cm x 60 cm x 30 cm size are dug 60-90 cm away from the base of arecanuts and filled up with well decomposed FYM and top soil. Three to four cuttings are generally planted in each pit for each of the arecanut tree. It is extremely important to press the soil firmly around the cuttings. Generally 60 to 90 cm long cuttings having 6 buds are preferable.

Baroj Type and Khuti Type of Cultivation:

Baroj are prepared out of bamboo and thatch. These are covered from all the sides with thatch and bamboo support and betelvines are supported to climb on bamboo sticks and in Khuti Type. The roof is covered with thatch.

Planting Material:

The vines are propagated by terminal stem cutting obtained from mature mother vines. In Baroj system, the spacing between the cuttings is 15 cm from plant to plant and 50 cm from row to row. Approximately 95,000 to 1, 00,000 cuttings are required per hectare for planting. In Khuti Type, the row to row and plant to plant distance is 90 cm and approximately 10,000 to 12,000 cuttings are required per hectare.

Planting Season and Raising of Seedlings:

Land for planting the betelvine setts should be fully pulverized and soil treatment should be given with Formalin solution (4%) which should be sprinkled at the rate of 3 liters per sq.m. of soil and covered with polythene sheet or moist

gunny bag for 24 hours. Planting should not be done for 15-20 days following formalin treatment.

Before planting, drench the soil with Mancozeb 75 WP 0.2% uniformly by means of a rose can. Lines are made for planting and cuttings obtained from disease free garden and treated with a solution consisting of Bordeaux mixture 0.5% and streptomycin 500 ppm for half an hour before planting. In Assam, the cuttings are planted during May to August.

Manure and Fertilizers:

Age	N : P ₂ O ₅ : K ₂ O (kg/ha)
1 - 5 year	0 : 50 : 100
>5 – 10 year	100 : 50 : 150
>10 year	200 : 50 : 100

For Baroj type cultivation, apply N @ 200 kg/ha/year as mustard oil cake in 4 split doses.

Apply 6(six) foliar sprays of ZnSO₄ (4%) at 60 days intervals to increase the leaf yield. The first spray should start in April.

Trailing the Vines:

Trailing of the vines is done by tying the vines at intervals of 15 to 20cm along bamboo sticks loosely with the help of banana fibre, arecanut leaf sheath or any other locally available material.

Lowering the Vines:

Under normal cultivation, the vines grow to a height of about 3m in a year. When they reach this height, it is needed to be lowered down. This is achieved by lowering the vines down to the ground level at least twice in a year. The top of the young vine is again winded around the stick for the next season's growth.

Plant Protection:

1. **Phytophthora leaf and root rot:** Apply four drenches and eight sprays of Bordeaux mixture @ 1.0% and 0.5% respectively. From June to September Drenching and spraying should be done at monthly and fifteen days interval.
2. **Bacterial leaf spot:** Give four sprays of Streptomycin (1.0%) along with Bordeaux mixture (0.5%) at 20 days interval after initiation of the disease.
3. **Anthraxnose:** Give four spray of Bordeaux mixture @ 0.5% at 20 days interval after initiation of the disease.
4. **Biocontrol of *Phytophthora* and basal rot of betelvine:** Apply 500kg de-oiled mustard oil cake at quarterly interval cultured with *Trichoderma harzianum* at the root region of the vines.

CASHEWNUT

Anacardium occidentale

Climatic requirement

Cashew is restricted to an altitude below 700 M where temperature does not fall below 20°C for prolonged period. The optimum temperature for growth is 17°C to 36°C. Cashew is grown in areas with annual rainfall ranging from 600 to 4500mm. Fruit set in cashew is good if rains are not excessive during flowering (November to February). Dry spell during flowering ensures better harvest.

Soil

Cashew is grown on a wide variety of soils like laterite, red soils and coastal sands of Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra, Tamilnadu and West Bengal. Whatever the nature of top soil, free drainage and absence of brackish water are considered essential.

Planting material

Cashew is a highly cross pollinated crop, hence seed propagation is avoided. The most common and successful method of propagation is the use of softwood graft.

Soft wood grafting

1. About 45-60 days old seedlings raised in polythene bags are utilized as root stocks.
2. From the selected variety, lateral shoots of current seasons' growth (pencil thickness, 3-5 months old) are selected and procured on the mother plant by clipping the leaf blades. After 10-15 days these shoots are collected and used as scions.
3. The terminal growth of the rootstock (soft wood portion) at a height of 15cm from ground level is decapitated and a cleft of 5-6 cm deep is made on the stem.
4. The scion stick is mended into a wedge shape of 5-6cm long by chopping of the bark and a little portion of wood from two opposite sides.
5. The wedge of the scion is inserted carefully into the cleft of the root stock.
6. Then the graft union is secured firmly with a polythene strip.
7. A white polythene cover is inserted on the graft and it is tied at the bottom to maintain humidity.

Planting season

Planting of softwood grafts is usually done during monsoon (June to August).

Land Preparation

Clearing of wild growth, digging of pits for planting should be done during pre monsoon season (May to June).

Variety

So far National Research Centre of Cashew (NRCC) has released about 40 varieties. Out of which NRCC has recommended Jhargram-1, Ullal-3 and BPP-8 for North Eastern Region.

Jhargram-1: It has a medium compact canopy and intensive branching habit. It bears on an average 6 nuts per bunch and yields 8.5 kg/tree with small sized nuts (5g). Shelling percentage is 30 and kernel grade is W 320.

BPP-8: This variety is superior to all other released varieties from Bapatla. It yields about 14 kg/tree with better nut size (8.2 g) with 29% shelling recovery. The kernel grade is W 210.

Ullal-3: It is an early flowering variety with short duration (November to January), fruiting period is also short (50 to 60 days). The fruit occurs from January to March. It is a high yielding variety with average production of 14.7 kg raw nut/tree. The nut size is medium with 7g per nut. Shelling percentage is 30 and kernel grade is W 210. The apples bears red colour.

Spacing

- A spacing of 7.5 m x 7.5 m (175 plants/ha) for 8 m x 8 m (156 plants/ha) is recommended for cashew in sloppy areas.
- In level plains it is advantageous to plant the graft at 10 m x 5 m spacing (hedge row system) which will accommodate about 200 plants/ha and at the same time leaving adequate interspaces for growing intercrops during the initial years.
- Under high density planting system (HDP) a spacing of 4 m x 4 m is recommended (625 plants/ha) in low fertility soils whereas spacing of 6 m x 4 m (416 plants/ha) and 5m x 5m (400 plants/ha) are recommended in medium fertile soils.

Pit size

- The pits should be opened at least 15 to 20 days before planting.
- The pit size of 1m length x 1m breadth should be opened in soils with hard laterite substratum. A pit size 60 cm x 60 cm x 60 cm is sufficient in other soils.

Filling up of pits

- The pits should be filled with mixture of top soil, compost (5 kg/pit) or poultry manure (2 kg/pit) and rock phosphate 200 g/pit).
- A small drainage channel at the elevation side of pit can be made to drain the excess rain water.

Planting

While planting the grafts, the polythene bag has to be removed carefully without disturbing the ball of earth. A portion of soil is scooped out from the

centre of the filled pit and grafted plant is placed in such a way that the graft joint remain above the soil level. The base of the plant should be covered with topsoil and pressed gently and a stack should be placed near the graft plant to prevent wind damage. The polythene sheet used during grafting should be removed at planting time to avoid constricted growth at the grafting point.

Soil and water conservation

Terracing is required in sloppy site where soil erosion and leaching of plant nutrients are generally common. In such case terracing with catch pits followed by mulching is done.

Terracing

- Terracing of 2m radius is prepared during May to June at the second year of planting.
- The terraces are done by removing the soil from the elevated side and spread it in the lower side of the slope.
- Terraces are generally made crescent shape to retain the washed soil from the upper side along with rain water.

Catch pit

- A catch pit of 200cm length x 30cm width x 45cm depth) across the slope at upper side of peripheral end of the terraces is made to conserve rainwater. A channel is made side way to drain out excess rainwater.

Mulching

- Mulching can be done at the basin of cashew plants either with green leaves or dry leaves soon after planting.
- Live mulches are also utilized to conserve moisture.

Manure and fertilizers

- Application of 10 to 15 kg FYM or compost per plant every year is beneficial.
- The recommended dose of fertilizer by National Research Centre for Cashew is 750g N, 125g P₂O₅ and 125g K₂O per year per plant. It is advisable to use straight fertilizer instead of complex fertilizer.

The Year wise fertilizer is as follows

Year (s) after planting	Dose (g/plant)		
	Urea	Rock phosphate	Muriate of potash
1 st	330	125	40
2 nd	660	250	80
3 rd	990	375	120
4 th	1320	500	160
5 th	1650	625	200

- The fertilizer is to be applied in two splits. First split is given during pre monsoon (May/June) and second part is applied in post monsoon (August/September).
- Fertilizers are applied in 50cm circular band in flat land at a distance of 50cm, 70cm, 100cm and 150cm away from the trunk of cashew of plant during 1st, 2nd, 3rd and 4th year after planting and onwards respectively and rake the fertilizer into the soil.
- In sloppy areas the fertilizers are applied in circular trenches of 25cm width and 15cm depth at the distance mentioned earlier.

Canopy management

Training and pruning are essential management practices in cashew.

Training

- Training is done in the initial years.
- During 1st and 2nd years after planting flower panicles are removed to encourage vegetative growth and frame formation.
- Stacking is provided to plants to prevent lodging.
- The lower branches are gradually removed with the help of secateur during the initial 4 to 5 years of planting so that the trunk up to 60 to 75 cm remain single stemmed. This operation assists easy cultural operations like pest control and nut collection.
- Branches are evenly spaced by pruning unwanted criss-cross branches.
- The mature plants are detopped at 3 to 4m height and a semi globular canopy is maintained.

Pruning

- Water sprout, crown suckers, dead branches/twigs are removed.
- About 60 per cent of leader shoots (1 to 2 years old laterals) are to be pruned by pruning back at two third lengths.
- Pruning at least in 2 to 3 years is necessary depending on amount of dead wood and age of the plants.

Intercropping/Mixed cropping

- Intercropping or mixed cropping is recommended in cashew orchard during the initial years of formative stage of cashew.
- Intercrops help to check soil erosion apart from utilizing soil water and solar energy.

Some of the recommended intercrops are:

Pineapple: Pineapple can be grown for 7 years from planting in between cashew plants in trenches of 1m width and 0.5m depth.

Black pepper: Black peppers can be grown by allowing them to trail in the stems and branches of more than 6 years old plants. A net profit of Rs. 14,000/ha can be achieved from black pepper.

Ginger: Ginger can be raised in the initial 3 to 4 years of cashew plantations. A net profit of Rs. 40,000/ha can be obtained from ginger as a mixed crop.

Turmeric: Turmeric can also be easily taken up as intercrop in the initial 7 years.

Vegetables: A wide range of vegetable viz., cucurbits, cowpea annual leafy vegetables etc. can be raised.

Plant Protection

Cashew is most commonly attacked by Tea mosquito bug. (*Helopeltis antonii*), cashew stem and root borer.

Tea mosquito bug (*Helopeltis antonii*): This insect causes maximum damage to the new flushes, flowers and young fruits by sucking cell sap. If extreme infestation occurs, the leaves show scorching effect which drastically reduces the yield of the crop. The occurrence and build up of the insect coincide with the new flushes, flowering and fruit setting after cessation of monsoon.

The insect is controlled by spraying insecticide viz., monocrotophos and carbaryl at different times. The first spray of monocrotophos @ 0.05% (1.5ml/l) is to be given at the time of new vegetative flush, which is followed by carbaryl @ 0.1% (2g/l) at flowering stage. This is followed by another third spray of carbaryl at the same rate at the time of fruit setting.

Cashew stem and root borer: The grub of this insect causes extensive damage to the old plantations. Young plantations are also not spared. The grub makes irregular tunnels inside the trunk and feed on the bark. Infested plants show falling off of fruss near the base of trunk as these are expelled out by the grub. Unattended old plants are mostly attacked. The mature roots are attacked by the grub of the insect. It is a high flier. Grubs are medium to large in size (5cm x 15cm length). Extensive feeding results in death of the plants within a period of 1 to 3 years.

To save the plants from the grub attack, the infested part is carefully chiseled out to find the grub inside the trunk hidden in tunnels and then physical removal is mostly done with prophylactic swabbing of carbaryl 1.0% solution. Examination of exposed roots and collar region is most essential to detect insect infestation.

Harvesting

Harvesting of cashew nut for its kernel starts by March to June. Nut maturity is a varietal character from a short duration to long duration. The nuts are allowed to be matured fully along with the apples. The apple matures slower than the nuts. Mature nuts show brown colour. Ripen apples are yellow, red and yellow reddish in colour. The apples are used or various industrial use as well as

in preparation of pickles and jams. If only nuts are to be used than it is better to allow the nuts to fall naturally. The mature well filled nuts sink in water easily which is used as a selection criterion of mature nuts. As soon as nuts are collected they should be washed and sun dried as a pre-conditioning measure.

Processing of cashew nuts

Processing of raw cashew nuts consists of conditioning of nuts, shelling, drying, humidifying, peeling, grading and packing of kernels.

Conditioning:

Harvested mature cashew nuts are sun dried for two days soon after harvesting to bring the moisture content from 16% or above to 8 to 9%. Then the nuts are packed in gunny bags and stored for further processing.

- Conditioning is required to make the nuts hard and brittle so that the shell can be removed without damaging kernel inside.
- Conditioning is done in three ways. They are drum roasting, oil bath roasting and steam roasting. Among these, the steam roasting is most commonly followed which have the added advantage of utilizing the cashew shell nut liquid (CSNL) for further industrial use.

Steam roasting

The sun dried cashew nuts are roasted in steam under pressure of 25 to 30 lb/inch for 20 to 30 minutes. Then the nuts are allowed to cool 24 hours before shelling.

Shelling

- Shelling requires hand and foot operated mechanical devices in which the roasted nut is held by fingers between two pairs of blades of the shelling machine, in such a way that the kernel never come into contact with blades.
- Then the splitted nuts become easy to scoop out the kernel, 92 to 95% kernel recovery is possible with the hand and foot operated sheller.

Drying of kernel

- Scooped out kernels are then sent to drier in trays to be dried in hot chamber at 78^o to 80^o C for 6 to 8 hours to bring the moisture content in the nuts to 4 to 5%.
- For uniform drying, the trays used for spreading the kernels are changed in position in the chambers.
- Dried kernels in the same trays from the hot chamber are brought to a humidifier room to facilitate easy peeling of seed coat.

Peeling

- Peeling of seed coat (testa) is done with the help of sharp knives or bamboo edges.
- 70% kernels are recovered through peeling operation.

Grading

- Grading of peeled kernels is done manually.
- Kernels are graded according to size of wholesome or bits. There are many commercial grades viz., W180, W210, W240, W320, W450 and W500.
- The large size kernels are graded as W180 (309 to 410/kg) and smallest grades are W500 (1000 to 1100/kg).
- The common grades are WW (White whole), SW (Scorched whole), DW (Dessert whole), SWS (Scorched whole seconds) etc.
- Pieces are also graded as B (Bits), S (Splits), LWP (Large white pieces), BB (Baby bits), SB (Scorched bits), SS (Scorched splits), SSP (Scorched small seconds), SPS (Scorched pieces seconds), DP (Dessert pieces).

Packing:

The export trade required packing of kernels in 11.3 kg tin containers which are

hermetically sealed by infusing CO₂. Moulded vacuum packing (MVP) is gaining popularity where in nitrogen flushing is done to avoid oxidative rancidity.

Important address for planting materials

1. The Director,
National Research Centre for Cashew,
Puttur – 574 202, Dakshina Kannada,
Phone 08251 – 221530 (O), 08251 – 224539 (R)
E-mail: nrccaju@sancharnet.in
2. Cashew Research Station,
Acharyya NG Agricultural University,
BAPATLA – 522101
Guntur District, Andhra Pradesh,
Phone No. (08643) 225304
3. Cashew Research Station,
Department of Horticulture,
Orissa University of Agriculture & Technology
Bhubenewswar – 751003, Orissa
4. Regional Research Station,
Bidhan Chandra Krishi Viswa Vidyalaya
Jhargram Farm, P. O. Jhargram – 721 507,
Midnapore District West Bengal,
Phone No.(03221) 255593,
E-mail : spc@cal.vsnl.net.in

VEGETABLE CROPS

HI-TECH NURSERIES

Nursery is a place where seedling, sapling or any other planting materials are raised and sold out for planting in gardens and orchards. The nursery industry is diverse, comprising such varied operations as the production of potted plants, cut flowers, greens, ornamentals, fruit and tree nursery plants. The initial planting material is the basic requirement on which both the quality and quantity of the final crop depends.

Objectives of nursery production

- To raise healthy and disease free planting materials.
- To distribute plant materials in masses who have little knowledge about the techniques of raising plants.
- To introduce exotic species/cultivars.
- Planting of nursery grown plants is the surest method of artificially regenerating poor and barren sites.
- Replacement of casualties.

Selection of site for the nursery

The selection of site for the nursery should be made after considerable care and thought since location has great impact on overall success of the nursery. The land for nursery should be levelled for most efficient use. Areas that are prone to flooding should be avoided. The soil should have good structure and porosity. Sites with degraded top soil should be avoided.

Propagation structures

Different types of propagation structures like greenhouse, hot bed, cold frame, lath house, net house and mist chambers etc. are being routinely used under different agro-climatic conditions for different crops.

Propagation techniques

It includes all the steps involved in the propagation/multiplication of a particular crop/cultivar, from beginning to the end, i.e. it provides a schedule of activities for propagation. Plant multiplication involves either sexual or asexual propagation.

Containerization

Plastic bag of appropriate size, root trainers, earthen pots or trays can be utilized at various stages of plant multiplication. These containers can be shifted to green house for protecting against rain, cold or high temperature for quick growth.

Rooting media/potting mixture

Field soil can be used in container mixes (10% -30% by volume) but requires the additional step of pasteurization to eliminate disease and weed seeds. Though peat moss can be used as an alternatives but it is a non renewable resource.

Importance of mother plants

Stock or mother plants should receive every care in the way of pruning, manuring and weed control to keep them in good condition over a period of years. The aim should be to keep them as far as possible, in strongly vegetative condition. Both, the rootstock and the scion determine the performance of a compound horticultural tree. Choice of a scion is based on its quality, yield performance, adaptability and other horticulturally desirable traits. Rootstocks exhibit a great effect on the production efficiency, yield, quality, adaptability, tree vigour and resistance to biotic and abiotic stresses of scion cultivar. The primary function of rootstock is to provide anchorage by growing deep in to the soil and also regulate the uptake of moisture and nutrients.

Care of nursery plants

Proper care of nursery plants includes timely application of manures and fertilizers, irrigation and weed control. Regardless of fertilizer type whether the source is synthetic or organic in sustainable nursery production, the emphasis is on zero runoff. Organic or synthetic slow release fertilizers help to cut down levels of nitrates in run off water. Foliar feeding can be used to supplement soil and liquid fertilization. The two most widely used irrigation systems are overhead and drip and each has certain advantages and disadvantages. Weed control is extremely important in container production, since large quantities of media are lost when big weeds are pulled out of containers.

Some marketing tips

Effective marketing is key to profitability and success of a nursery.

1. Ensure reliable and consistent plant availability.
2. Proper labelling & proper displaying.
3. Place plant in clean containers/proper location.
4. Nurseries must be registered.
5. Proper quarantine measures.
6. Adding value to the product.
7. Market research.

PROCEDURE FOR 'NURSERY RAISING' OF TRANSPLANTED VEGETABLE CROPS

VEGETABLE CROPS:

1. Select a sunny area with well drained friable light soil rich in organic matter.
2. Bring the soil into fine tilth and prepare the bed of 1 m width and of convenient length. Raise it to 10-15 cm above ground level.
3. For an area of 10 m² in the bed, mix 20 kg sand or silt and 20 kg compost (well decomposed, dried and sieved) thoroughly.
4. To make the soil free from soil-borne disease causing pathogens (most common disease in the nursery is the 'Damping-off') drench the bed with 0.1% solution of Captan or Fytolan or Formalin 4% solution so as to saturate the soil upto a depth of 10-15 cm.
5. Keep in covered, immediately after treating, with polythene sheet or gunny bag or thick paper for 2 days.
6. Uncover the soil and get it loosened and leave it as such for 3 to 4 days.
7. Treat the dry seeds with Captaf or Thiram @ 3g/kg seeds against seed-borne pathogens.
8. Thoroughly mix malathion 5% dust @ 20g/10m² in order to protect the seedlings from soil-borne insects.
9. Sow the seeds thinly in U-shaped furrows spaced at 2.5 cm and at a depth of 1-2 cm (4 times the diameter of the seed). Cover the seeds immediately with a thin layer of sand mixed with well dried and sieved cow dung. The surface should be levelled and firmed by wooden leveller.
10. Water the sown beds using water can fitted with a fine rose.
11. Cover the beds with a thin layer of straw, banana leaf or dried grass to prevent displacement of seeds. The cover should be removed the first appearance of sprouts.
12. The seedlings get ready for transplanting when they attain 10-15 cm height or become 30-35 days old.
13. Harden the seedlings before lifting by gradual reduction of water for about 7 days.
14. Soak the beds 6 hours before lifting to facilitate the maximum retention of roots and plant turgidity.
15. Avoid shading or protection of seedlings; allow maximum sunlight except in case of expected injury due to heavy rain or frost.
16. Dip the seedlings in plant protection formulations just before transplanting to avoid attack in the initial stage of establishment.

Secondary Nursery:

In case of large scale cultivation, hardening of seedlings of Cabbage, Cauliflower, Knolkhol, Tomato, Brinjal, Chilli etc. can be done by pricking them to a wider spacing

of 5-10 cm either way in a well prepared secondary nursery when their first pair of true leaves develop. Shade should be provided for at least 2 days.

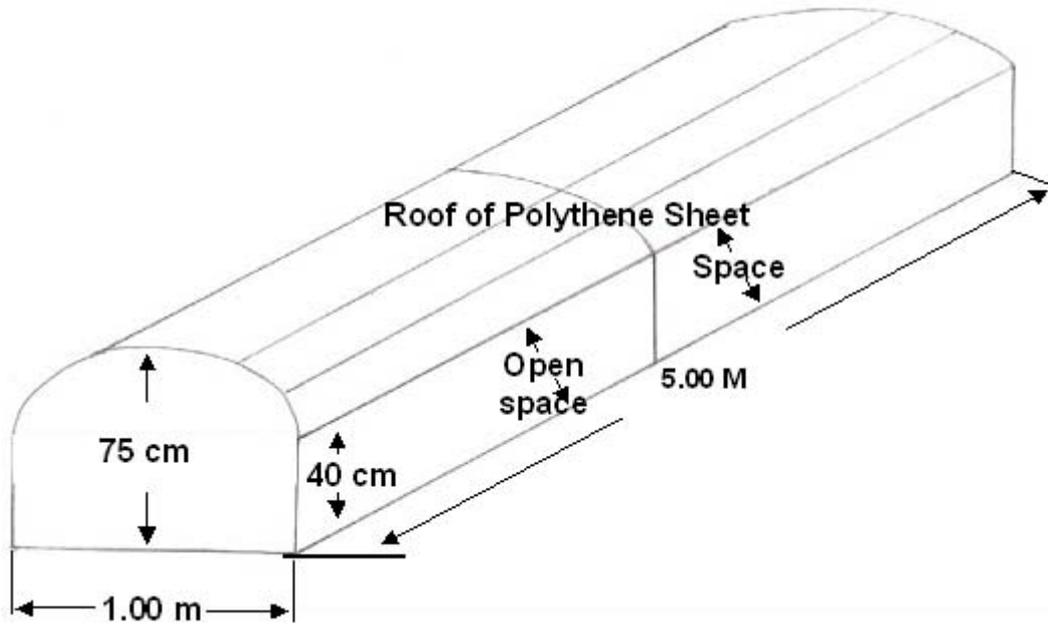
CULTIVATION OF HYBRID VARIETIES OF VEGETABLES:

Hybrid varieties of vegetables are comparatively superior in respect of yield and quality as compared to the traditional varieties. Presently, a number of Govt. organizations and private seed companies have developed some hybrid varieties with high yielding attributes. Moreover, a large amount of hybrid seeds are imported each year by the private companies and sold in the domestic markets. These are widely accepted by the farmers of our country. Every year new hybrid varieties are incorporated into the cultivation stream making the former ones obsolete, and hence, it is not possible to standardize agro-techniques for each and every variety at the University level. It is, therefore, advisable to adopt as such the package of practices of these hybrid varieties recommended by the concerned companies for Assam. However, some hybrid varieties of tomato, cabbage, cauliflower, capsicum and cucumber released by IAHS and HOECHST were tested at AAU and had been found promising for Assam condition.

The comprehensive package of practices for various hybrid varieties of vegetables, as per IAHS Company leaflet, is given below:

Vegetable	Tomato	Cabbage	Cauliflower	Brinjal	Capsicum	Cucumber	Okra
Varieties	Rupali	Ganga	Swati	Suphal	Bharat	Priya	Vijay
	Vaishali	Yamuna	Himani	Round-14			Vishal
	Naveen	Kaveri		Long-13			Varsha
	Mangla	Green Express					
	Avinash-2						
	Namdhari Suraksha Karnataka						
Sowing & transplanting	Throughout the year except the heavy rainy periods	Throughout the year except the heavy rain periods, Kavery can tolerate very high temp.	June-July. These varieties are heat tolerant	September-November. Long-13 can be grown year round	August-October January-February	March-April	Feb-July
Seed rate/ha	150 g	300 g	300 g	200 g	375 g	375 g	3.5 kg
Manure & fertilizer (per hectare)	FYM 360 q N 120 kg P ₂ O ₅ 200 kg K ₂ O 200kg	FYM 250 q N 170 kg P ₂ O ₅ 100 kg K ₂ O 120kg	FYM 300 q N 250 kg P ₂ O ₅ 100 kg K ₂ O 120kg	FYM 250 q N 120 kg P ₂ O ₅ 100 kg K ₂ O 100kg	FYM 360 q N 170 kg P ₂ O ₅ 120 kg K ₂ O 120kg	FYM 250 q N 120 kg P ₂ O ₅ 75 kg K ₂ O 75kg	FYM 150 q N 120 kg P ₂ O ₅ 90 kg K ₂ O 60kg
Spacing	45cm x 75cm 75cm x 75cm 60cm x 90cm	45cm x 30cm 45cm x 60cm	45cm x 30cm 45cm x 60cm	60cm x 90cm 90cm x 90cm	30cm x 60cm 45cm x 60cm	120cmx60cm	30cm x 60cm 45cm x 60cm
Duration from sowing to first harvest	90-120 days	100-130 days	100-130 days	90-110 days	3.5 months	70 days	50-55 days
Average weight of edible part	70-80 g	1750-3000 g	700-1200 g	250-500 g	150-200 g	300-500 g	10-15 g
Yield per ha.	300-400 q	300-350 q	120-150 q	250-350 q	180-240 q	100 q	150 q

Details of structure for raising of seedling in nursery



Breadth : 1 m, Length: 5 m, Height of Post: 40 cm in the side, 75 cm in the middle

LAYOUT OF KITCHEN GARDEN

Objectives of Kitchen Gardening:

1. To meet the daily requirement of balance diet (85g fruits, 75-125g green leafy vegetables, 75g root or tubers and 100g of other vegetables).
2. To produce fresh and quality vegetables.
3. To utilize the labour of the family members profitably.
4. To obtain pleasure, inspiration and a means of recreation.

Principles of Kitchen Gardening:

1. Select well drained sunny area at the backyard near water source.
2. Size and design of the garden depend on availability of land. However, the garden should preferably be rectangular in shape.
3. Selection of crops is governed by choice of the family, size of the garden and time available to devote in the garden.
4. 200 sq.m area is sufficient for a five member family to supply 1.5 kg of vegetable per day.
5. Quick growing plants like banana, papaya, lemons etc. should be planted in the northern side of the garden and climbing type of vegetables like cucurbits, dolichos, etc. can be grown near the fence or boundary wall.
6. To ensure steady and regular supply of vegetables, several sowing of a particular crop at short intervals should be done during the season.
7. Ridges which separate the beds may be utilized for growing root crops like radish, carrot, etc.
8. Early maturing crops should be planted together in continuous beds so that the area can be made available at one for putting late crops.
9. Interspaces of the long duration crops like brinjal, tomato, chillies, etc. may be utilized for quick growing crops like spinach, beet, lettuce, knolkhol, etc.
10. One or two compost pits should be dug in the corner of garden to dispose off the plant residues which will be reutilized as compost material.

Recommended Vegetable Cropping Pattern for the Main plots:

1. Radish + Turnip /Beet (Oct.-Dec.) - Knolkhol (Jan-March) - Bitter gourd (April-July) - Lai + Palak (Aug-Sept.).
2. Kate Cabbage (Nov-Feb) - Okra (March-June) - Early Cauliflower (July-Oct.).
3. Tomato (Sept.-Early Dec.) - Late cauliflower (Late Dec. - March) - Okra (April - July).
4. Mid cauliflower (Oct-Jan) - Amaranth (Feb-May) - Okra (June-Sept).
5. Knolkhol (Sept - Nov.) - Palak + French bean (Dec - April) - Bitter gourd (May-Aug).
6. Potato (Oct - Jan) - Cucumber (Feb - June) - Ridge gourd (July - Oct.).
7. Potato (Oct - Jan.) - Bitter gourd (Feb - May) - Okra (June - Sept.).
8. Brinjal (Sept - Jan.) - Snake gourd (Feb - May) - Cowpea (June - Aug.)
9. Onion (Oct - Feb.) - Cowpea (March - May) - Cucumber (June - Sept.)
10. Garlic + Coriander for leaf (Oct - Jan.) - French bean (Feb - April) - Cowpea (May - Sept.).
11. Carrot (Oct - Feb.) - Capsicum (Feb - June) - Brinjal (July - Oct.).
12. Tomato (Oct - Jan.) - Ridge gourd (Feb - May) - Cucumber (June - Sept.)
13. Okra (March - June) - Radish (July - Sept.) - Brinjal (Oct - Jan.).

Crop Rotation for Fencing or Permanent "Chung"

1. Bitter gourd (Dec - March) - Cucumber (April - June) - Sponge gourd (July - Nov.).
2. Pumpkin (Sept - Feb.) - Ridge gourd (March - June) - Bitter gourd (July - Oct.).
3. Cucumber (Dec - March) - Bitter gourd (April - July) - Dolichos bean (Aug - Dec).
4. Cowpea (Jan - March) - Ash gourd (April - July) - Dolichos bean (Aug - Dec.).

CAULIFLOWER

Brassica oleracea L. var *botrytis*

Variety :

Early : Early Kunwari, Pusa Katki and Pusa Deepali.

Mid : Improved Japanese, Pusa Synthetic, Pusa Snowball and Main Crop Patna.

Late : Snowball-16, Pusa Snowball, K-1 and Hissar 1.

Description:

Early Kunwari: Plant short, bluish green leaf with waxy bloom, small to medium curd, tends to grow loose faster, hemispherical with even surface.

Pusa Katki: Plant medium; bluish green leaf with waxy bloom; curd small to medium.

Pusa Deepali: Plant medium tall, leaf short erect, waxy, green, curd medium compact, white, self blanching uniform, well protected by leaves, riceyness is almost absent, maturity 100-120 days.

Improved Japanese: Plant tall, erect, leaf bluish green, not incurved, curd large, compact, white, maturity 90-95 days.

Pusa Synthetic: Plant erect, leaf nos 24-28, varying in colour, curd medium, somewhat creamy white to white compact, maturity 130 days, yields 225 q/ha.

Pusa Snowball: Curd medium sized, solid and of attractive snow white colour.

Snowball-16: Plant short, 24 to 28 outer leaves, upright greyish green, incurved, curd medium, compact, snow white and self blanched, maturity 90 days.

Pusa Snowball K1: Plant spreading, outer leaf 24-28 nos., self blanched, snow white, maturity 90-95 days, resistant to black rot.

Soil:

Well drained sandy loam for early and well drained loam to clay loam for mid and late varieties. Optimum pH- 6.0-7.0

Seed bed preparation and seedling raising:

Early cauliflower seedlings can be successfully raised under poly tunnel. Refer to "Procedure for Nursery Raising of Transplanted Vegetable Crops":

Field Preparation:

Land should be prepared to a fine tilth and FYM or compost to be applied. It is advisable to apply slaked lime every 3 years according to the soil test result. Lime should be applied at least 30 days before planting.

Seed rate:

600 g/ha for early crop

400 g/ha for mid crop

600 g/ha for late crop

8-10g of seeds should be sown per sq.m.

Time of sowing:

1. Early: From mid July to first week of August (Matures by October).
2. Mid: From first week of September to last week of October (Matures by Dec -January).
3. Late: Up to first week of November (Matures by Feb - March).

For North Bank Plain Zone:

Early – Last week of August

Late Mid – First week of November

Late – Last week of November

Spacing: (Row to Row x Plant to Plant)

Early: 45cm x 45cm

Mid: 60cm x 60cm

Late: 45cm x 45cm

Manures and Fertilizers:

FYM @ 10 t, N 80 kg., P₂O₅ 60 kg and K₂O kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at 30 days after planting (during earthing up). For kitchen garden, half of N and whole of P₂O₅ and K₂O may be applied by ring method around the plant at 15 days after planting and the other half of N at 30 days after planting.

Apply either 8 kg of Borax or 6 kg of Boric acid powder per ha along with basal fertilizers or spray 0.2-0.3% Borax (@ 1.6-2.4 kg/800lit/ha) against browning in boron deficient soils.

To prevent deficiency of molybdenum, apply Na or NH₄-molybdate @ 1-2 kg per ha along with basal fertilizers or irrigation water. Foliar spray of NH₄-molybdate (0.01-0.1% -@ 200-300g/h is also recommended. Foliar spray with commercial micronutrients formulation may be done.

For Hill Zone (i) Apply boron 3000 ppm (3g/lit) as foliar spray 30 days after transplanting @ 650 lit spray solution/ha. (N. B. Boron content in Borax is 11.3% and the Boric acid 17.5%.) (ii) Apply commercial micronutrient formulation in two splits at 32-45 days after transplanting as per recommendation.

Interculture:

1. Irrigation: A light irrigation immediately after transplanting to be given and subsequent irrigations whenever required. In total five irrigations are sufficient.
2. Weeding: First weeding at 20 days and the second at 40 days after transplanting.

Plant Protection: (1) **Caterpillars and other leaf eaters:** Spray Malathion 50EC@1.5 ml/lit of water (0.15%). (2) **Field-cricket, cutworm, red ants and other soil insects:** Apply Malathion 5% dust @ 20 kg/ha. (3) **Black rot:** Drench the soil with 100-200 ppm solution (0.1-0.2g/lit) of Agrimycin or Streptomycin after transplanting.

Harvesting: Cauliflower is harvested when the curds obtain proper size.

Yield: 150-175q for early and mid and 175-200 q/ha for late crop.

Seed yield: 25-40q/ha

N. B. Boron content in Borax is 11.3% and the Boric acid 17.5%.

SEED PRODUCTION OF EARLY CAULIFLOWER

Variety: Pusa Katki

Time of Sowing: Second fortnight of July.

Benefit Cost Ratio: 5.16

SPROUTING BROCCOLI OR BROCCOLI

Brassica oleracea var. italica

Variety:

Early: Early Danish Giant, De Cicco, Green Bud, Sparton Early, Coastal and Atlantic.

Mid: Green sprouting medium.

Late: Waltham 29, Green Mountain, Coastal and Atlantic.

Hybrid: Southern Comet, Premium Crop, Clipper, Laser (extra early and early), Corsair, Cruiser, Emerald, Corona (mid season) and Late corona, Stiff, Kayak and Green Surf (late).

Description:

Early variety : Duration is 45-55 days after transplanting.

Medium variety : Duration 100 days after transplanting.

Late variety : More than 110 days.

Soil:

Light soil with high organic matter either through incorporation of FYM or compost or green manuring crops. Broccoli is slightly tolerant to acidic soils. Optimum pH 6 to 6.8.

Seed bed preparation and seedling raising:

Refer "Procedure for necessary raising of transplanted vegetable crops".

Field preparation: Same as cauliflower

Seed rate:

500-700 g/ha for transplanting

Time of sowing: Same as cauliflower.

Spacing: (Row to Row x Plant to Plant) = 75 cm x 45 cm.

Manures and Fertilizers:

FYM @ 20 t, N 100-200 kg, P₂O₅ 60-80 kg and K₂O 40-60 kg/ha. Nitrogen should be applied in split doses. Molybdenum and Boron should also be applied as in case of cauliflower.

Interculture:

Irrigation: 4.0 cm irrigation at IW/CPE ratio of 1.6 (13-15 days interval).

Weeding:

In early stage hoeing is necessary in order to provide good aeration as well as to make the plot weed-free before irrigation.

Plant Protection: Same as in cauliflower

Harvesting:

Harvesting should be done when the head is compact and green but before the opening of buds. Over matured buds will open and the heads become loose which is unsuitable for marketing. Only the green head should be harvested leaving the whole plant intact to facilitate the growth of axillary head (cull head) which can be harvested as ratoons.

Yield: 5 to 15 t/ha, depending upon the variety, time of planting and length of harvesting period.

Benefit Cost Ratio: 5.26

CABBAGE

Brassica oleracea L. var *capitata*

Variety:

Early maturity : Golden Acre, Pride of India, Pusa Mukta (Sel – 8)

Late maturity : Drum Head and Eclipse Drum Head.

Description:

Golden Acre: Plant small, compact with a few outer leaves, short stemmed with small cup shaped leaves, head very uniform, solid and round weighing 1.0 to 2.5 kg, interior clear white, excellent in quality, early maturity (60-70 days), yield 280 q/ha.

Pride of India: Characterized by small solid round head weighing 1.0 to 1.5 kg, outer leaves few and slightly cup shaped, early maturity (60-70 days), yield 220 q/ha.

Pusa Mukta: Plant short stalked, medium sized, leaf light green, margin wavy, leaf blade slightly puckered, head slightly flat, maturity 65 days. Average yield is 250 q/ha, resistant to black rot, suitable for salad purpose.

Drum Head: Head large, drum shaped, loose, late maturity (80-100 days), yield 450q/ha.

Soil :

Well drained sandy loam with pH 5.5-6.5.

Seed bed preparation and seedling raising: Refer "Procedure for nursery raising of transplanted vegetable crop".

Field Preparation: Same as in cauliflower

Seed Rate: 800 g/ha for early

450 g/ha for late

10 g of seeds should be sown per sq.m.

Time of Sowing: First week of September to last week of November.

Spacing: (Row to Row x plant to plant) –

Early maturity: 60 cm x 30 cm

Late maturity: 60 cm x 60 cm.

Manure and Fertilizer:

FYM @ 10 t, N 120 kg, P₂O₅ 60 kg, K₂O 60 kg per ha and Borax 8 kg/ha. Application method same as in Cauliflower.

Interculture:

- 1. Irrigation:** Immediately after transplanting a light watering should be given and continued till the seedlings are established and subsequent irrigation should be given whenever required. Availability of water in soil should be as far as practicable uniform, otherwise splitting may occur.
- 2. Weeding:** Give two weeding, the first at 20 days and 2nd at 40 days after transplanting.

Plant Protection: Same as for Cauliflower.

Yield: 200-250 q/ha.

Benefit Cost Ratio: 3.08

KNOLKHOL

Brassica caulorapa L var. *gongyloides*

Variety: Early maturity: White Vienna.

Late maturity: Purple Vienna.

Description:

White Vienna: Plant dwarf with short stem and leaf, knob globular, light green smooth; flesh creamy white and tender with delicate flavour; maturity 60 days.

Purple Vienna: Flesh purplish; other character almost similar to white Vienna; maturity 70 days.

Soil: Well drained sandy loam with pH 5.5-6.5.

Seed bed preparation and seedling raising:

Refer "Procedure for nursery raising of transplanted vegetable crops".

Field Preparation: Same as in cauliflower.

Seed Rate: 1.25 kg/ha 10 g of seed should be sown per sq.m.

Time of sowing: First week of September to last week of November.

Spacing: 30 cm x 25 cm (Row to Row x plant to plant).

Manure and Fertilizer:

FYM @ 10 t, N 80 kg, P₂O₅ 60 kg and K₂O 60 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top-dressed at 20 days after transplanting.

Intercultural: Same as in Cauliflower.

Plant protection: Same as for Cauliflower.

Harvesting:

Harvesting should be done when knobs are fully matured before they become tuff, spongy and stringy.

Yield:

Early maturing variety : 80 q/ha

Late maturing variety : 100 q/ha.

Benefit Cost ratio: 7.71

TOMATO

Lycopersicon esculentum Mill

Variety: Punjab Chhuhara, S-12, Punjab Kesri, Pusa Early Dwarf, Sioux, Pusa Ruby, Arka Abha (BWR-1), Arka Alok (BWR-5) and BT-1.

Punjab Chhuhara: Determinate, dwarf with good foliage cover; Prolific bearer, high yielder, fruit medium, pearshaped, pericarp thick; maturity 120 days; suitable for distant transport and processing.

S-12: Plant dwarf, bushy, early bearing, fruit medium sized, round, juicy, highly acidic; av. yield 175-280 q/ha; suitable for growing in the plains for fresh marketing (table purpose).

Punjab Kesri: Determinate, dwarf, bushy, fruit small, pear shaped, less pulpy; early maturity; yield about 268 q/ha, no fruit cracking, moderate incidence of late blight and fruit borer, susceptible to root-knot nematode, less suitable for processing.

Pusa Early Dwarf: Determinate, typical dwarf with compact fruiting, fruit slightly flattish in shape, medium large, uniformly red ribbed, maturity in 55-60 days after transplanting, yield 200-500 q/ha.

Sioux: Indeterminate, spreading; fruit round, smooth, medium to large, less seeded, sub-acid in taste, medium late maturity (70-80 days) av. Yield about 250 q/ha, good for short distance market and suitable for hilly region.

Pusa Ruby: Indeterminate, spreading, less branched and hardy; fruit flattish round, small to medium, slightly acidic, early maturity (60-65 days), yield about 330 q/ha, withstands hot and humid climate, good for fresh market and for marking ketchup; tolerant to excess rain.

Arka Abha (BWR-1): Semi determinate : fruits oblate, light green shouldered, average fruit weight 75 g, duration 135 days, yield 250 q/ha, resistant to bacterial wilt.

Arka Alok (BWR-5): Determinate; fruits square round, thick fleshed with light green shouldered, average fruit weight 100 g, duration 125 days, yield 350 q/ha, resistant to bacterial wilt.

BT-1: High yielder, tolerant to bacterial wilt.

Soil: Well drained sandy loam rich in organic matter with pH 5.0-7.0.

Nursery bed preparation and seedling raising:

Refer "Procedure for nursery raising of transplanted vegetable crops".

Field preparation:

The land should be prepared to a fine tilth and FYM to be applied at least 15 days ahead of transplanting. Liming should be done earlier to transplanting, liming should be done to raise the soil pH to optimum level. It is advisable to apply lime @ 10 q/ha in every three years depending upon soil testing.

Time of Sowing: October – November.

Spacing : (Row to row x plant to plant)

50 cm x 30 cm (for both the determinate and semi determinate variety)

75 cm x 30 cm (for indeterminate variety)

Time of planting for hill zone: To escape the leaf curl virus planting should be done in October.

Manure and Fertilizer:

- i) FYM @ 10 t, N 75 kg, P₂O₅ 60 kg and K₂O 60 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed in one or two splits.
- ii) Foliar application of Nitrogen in tomato is very much affective. In that case, 40 kg/ha N should be applied as basal and 20 kg/ha N as foliar spray. The schedule for foliar spray to be followed is given below :
 - i. Spray on the 30th days after transplanting by dissolving 9.71 kg. urea in 1000L of water for one hectare of land
 - ii. Spray on the 40th days after transplanting by dissolving 14.1 kg. urea in 1500L of water for one hectare of land
 - iii. Spray on the 50th days after transplanting by dissolving 19.3 kg urea in 2000L of water for one hectare of land.

Interculture:

1. Irrigation: application of 4 cm irrigation at 18-20 days interval by surface flooding.
2. Weeding: Pre-emergence application of Metolachlor@1kg ai/ha followed by application of Grubber at 40 DAP is recommended. Alternatively, garden hoeing is to be done at 20 and 40 DAP.
3. Growth regulator: Spray 20 ppm of Gibberellic acid at 30 days after planting.
4. Intercropping: Knolkhol can be successfully grown with tomato as intercrop (1 row of tomato: 2 rows of Knolkhol).

Plant Protection:

1. Late blight: Against late blight 0.25% solution of Mancozeb 75WP (2g/l), Mancozeb (72% a.i.) should be used at the following rates

Early stage (1st month) 600 lit of water/ha.

Mid stage (2nd month) 800 lit of water/ha.

Late stage (3rd month) 1000 lit of water/ha.

Depending upon weather conditions particularly on cloudy weather Mancozeb 75 WP (2 g/l) should be sprayed as prophylactic measure. Alternatively, Dithane Z-78 @ 0.25% (25 g in 10 lit of water) can be used. If disease appears, spraying should be done at an interval of 7 to 10 days depending upon weather condition. While spraying care should be taken to cover the lower sides of the leaves.

(ii) Metalaxyl 8% (2.5 g/lit) followed by Mancozeb 75 WP (2 g/l) in alternate application [3 sprays with Metalaxyl 8% (2.5 g/lit) and 3 sprays with Mancozeb 75 WP (2 g/l)] at an interval of 12 days. The first spray should be given between 10-15th December. Use sticker Tricon (0.5 ml/l.) in spray solution during rainy weather.

(iii) 1% Bordeaux mixture (10 g CuSO_4 + 10 g lime + 1 l water) is also effective in controlling blight in tomato.

2. Wilt:

(i) Bacterial wilt:

- a. Drench soil with 200 ppm Streptomycin.
- b. Grow resistant varieties.
- c. Apply oil cake.
- d. Apply : "Asafoetida – Turmeric powder mixture (1 g Asafoetida + 5 g turmeric powder in 10 l of water) to drench the soil 3 times i.e. at 15 , 30 and 45 days after transplanting.

(ii) Fungal wilt: Drench soil with Captan 50 WP 0.3%.

Yield: 350 – 400 q/ha.

Benefit Cost ratio: 6.41

BRINJAL

Solanum melongena L.

Variety :

Long: Pusa Purple Cluster, Borbengena, JC-1, Kuchia and BWR-34. Pusa Kranti, Pusa Purple Long,

Round: Pusa Purple Round, Pusa Vairab, BWR-12.

Oblong: BB-7, Pant Samrat, JC-2.

Description:

Pusa Kranti: Dwarf and spreading growth habit, leaf long, narrow and highly lobbed, green coloured, non-spiny, fruit are 15-20 cm long, attractive dark purple in colour, less seeded, yield about 270 q/ha.

Pusa Purple Long: Plant semi-erect and dwarf, in habit; fruit glossy, light purple in colour, 25-30 cm long, smooth and tender; av. yield 275 (q/ha), maturity 100-110 days.

Pusa Purple Cluster: Plant tall erect, compact, sturdy with purple pigmentation on stem; leaf purple, non-spiny; fruits born in cluster of 4-8, 10-12 cm long, deep purple colour, Av. yield 175 q/ha, maturity 75 days, relatively resistant to bacterial wilt and little leaf disease.

Pusa Purple Round: Plant very tall with thick stem of greenish purple colour; leaf highly lobbed with deep green colour; av. weight 137 g with only 6 fruits per plant, resistant to shoot borer and little leaf disease.

Pusa Vairab: Resistant to phomopsis blight.

Kuchia: Fruit thin, elongated, perennial, yield about 200q/ha, tolerant to fruit and shoot borer.

BB-7: Fruit oblong, borne in cluster, purple, yield about 200q/ha, tolerant to bacterial wilt.

BWR-34: Fruit elongated, borne in cluster, purple; yield about 100q/ha, tolerant to bacterial wilt.

Pant Samrat: Resistant to fruit and shoot borer and bacterial wilt. (Recommended for bacterial wilt endemic areas)

JC-1: Plant tall: Pedicel non-spiny, fruit elongated, medium sized, purple with pointed apex, maturity 130 days, av. yield 336q/ha, no incidence of phomopsis blight and little leaf virus, wilt and borer infestation moderate.

JC-2: Plant tall, pedicel spiny, fruit large, oblong, purple with blunt apex; maturity 120 days, av. yield 350 q/ha, no incidence of little leaf and wilt, phomopsis and fruit borer infestation moderate.

JC-1 and JC-2 perform well in Hill zone also.

Soil:

Well drained rich sandy loam for early and silt loam to clay loam for late crop. pH 5.5 – 7.0 is ideal.

Seed bed preparation and seedling raising:

Refer "Procedure for nursery raising of transplanted vegetable crops".

Field Preparation:

The land should be prepared to a fine tilth and FYM to be applied. Malathion 5% dust @ 25 kg/ha should be incorporated. It is advisable to apply lime in every three years @ 20 q/ha depending upon soil test result. Liming should be done at least 30 days before planting.

Seed rate: 700 – 800 g/ha.

Time of sowing:

First week of September to October for winter crop and January to February for spring crop.

Spacing: 75 cm x 60 cm (Row to Row and Plant to Plant).

Manure and fertilizer:

FYM @ 10 t, N 50 kg, P₂O₅ 50 kg/ha and K₂O 50 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed in one or two instalments. For second season crop of Kuchia cultivar, NPK @ 80:80:80 kg/ha is recommended.

Interculture:

1. Irrigation: Application of 4 cm irrigation at 15-18 days interval by surface flooding.
2. Weeding: For weed management, application of pre-emergence herbicide (0-3 days after planting) Pendimethalin @ 1.5 kg/ha followed by hand weeding at 35 days after planting..

Brinjal-Okra Cropping Sequence: FYM 10 t/ha and NPK @ 10:30:15 kg/ha is recommended for 1st crop of brinjal followed by 2nd crop of okra without FYM and with recommended dose of NPK.

Plant protection:

1. Fruit and shoot borer: (a) Apply phorate or carbofuran granule @ 2.5 g/plant at 20 days after transplanting. (b) Apply deltamethrin (Decis 2.8 EC) @ 1 ml/l or malathion50EC @ 1.5 ml/l (c) Growing of garlic as intercrop or boarder crop reduces the infestation.

2. Bacterial wilt: Soil drenching with 100 ppm of Streptomycin should be done.
3. Fungal wilt: Soil drenching with Captaf 0.3% should be done.
4. White blight (white mould): Spray Carbendazim 0.05% (0.5 g/l.)
5. Nematodes:
 - i) Sebuphos @ 0.6 g a.i. /m² against root knot nematode.
 - ii) Seedling root-dip treatment in monocrotophos or Carbosulfan @ 0.05% for 6 hours.
 - iii) Carbofuran or phorate 500 ppm for 30 minutes root dip treatment.

Yield : 200 q/ha.

PEA

Pisum sativum L.

Variety:

T-163: Selection from local pea of Bulandshaire (UP). Plant type is medium tall of 100 to 120cm in height and double podded variety. Maturity: 100-120 days. Yield: 10-11 q/ha. Other characters: Pods are 7-8 cm long and light green in colour, bear 5-6 seeds per pod. 1000 seed weight 150-200 g. It is susceptible to powdery mildew and Fusarium root rot.

Boneville: Plant type: Medium tall and double podded variety (used as vegetables) 100 to 120 cm in height. Maturity: 110-120 days Yield: 10-12 t/ha. Other characters: Seeds are wrinkled and light greenish to white in colour, pods are light green, straight and 8-9cm in length with 5-6 seeds per pod. It is susceptible to powdery mildew and fusarium root rot.

HUP – 2: T-163 x EC 33866. Plant type: Plants are tall, semi spreading and semi leafless, 130-140cm in height. Maturity: 115-125 days. Yield: 13-15 q/ha. Other Characters: Bears 4-5 seeds per pod. Seeds are white, 1000 seeds weight 200-250g. It is resistant to powdery and downy mildew.

KFPD 1: Selection from material received from U.S.S.R. Plant type: Plants are dwarf, 50-60cm in height. Maturity: 100-105 Days. Yield: 18-20 q/ha. Other characters: Bears 5-6 seeds per pod. Seeds are white and bold. 1000 seeds weight 250-300g. It is susceptible to powdery but escapes the disease because of earliness.

Soil type: Peas can be grown on variety of soils; well drained light soil is suitable.

Liming: After soil test to bring pH around 6.0, requisite quantity of lime is to be applied at least 21 days before sowing.

Time of Sowing: The optimum time of sowing is mid October.

Field Preparation:

Peas generally require reasonably deeply worked soils. The field is to be ploughed 3 to 4 time to obtain a good tilth.

Seed rate:

1. T-163: 50 kg/ha or 7 kg/bight.
2. Boneville: 60 kg/ha or 8 kg/bigha.
3. HUP – 2: 65 kg/ha or 8.5 kg/bigha
4. KFPD- 1: 77 kg/ha or 10 kg/bigha

In reverine tracts recommended seed rate 4-6 kg/bigha.

Relay cropping of pea:

Pea seeds at 25-50% higher seed rate are to be broadcast in the standing crop of rice about 15-20 days before harvest, provided that the soil is in moist condition.

Seed treatment:

Seed treatment with Carbendazim 50 WP or Benomyl 50WP @ 2 g/kg of seed of Captan or Thiram @ 3g/kg of seed is recommended.

Spacing: The seeds are to be sown in lines at spacing of 30 cm between rows and 10cm between plants.

Fertility Management: Compost or FYM @ 4-5 t/ha or 6 q/ bigha should be applied.

Nutrient requirement (kg/ha)	Name of fertilizer	Nutrient requirement	
		(kg/ha)	(kg/bigha)
A. Without Rhizobium Culture:			
N	Urea	45	6
P ₂ O ₅	SSP	285	40
K ₂ O	MOP	0	0
B With Rhizobium Culture:			
N	Urea	22	3
P ₂ O ₅	SSP	285	40
K ₂ O	MOP	0	0

For Upper Brahmaputra Valley, Lower Brahmaputra Valley and North Bank Plain Zones, 10 kg K₂O/ha is recommended in addition to normal dose of NPK. In North Bank Plains Zone 10 kg Borax/ha is also recommended.

Diammonium phosphate (DAP) @ 100 kg/ha or 13 kg/bigha should be applied in lieu of urea and SSP in non inoculated crop. NPK may also be supplied in the form of mixed fertilizers like.

Weed control:

Fluchloralin (Basalin 45EC) @ 2.5 kg a.i./ha as pre emergence spray one day before sowing be incorporated in the soil with light hoeing.

Suitable Rhizobium Culture: *Rhizobium leguminosarum* can be used.

Irrigation:

If required and available, 1 irrigation at 40-50 days of sowing may be given.

Plant Protection:

A. Insect Pests:

Insecticide Common Name	Concentration (%)	Insect pest
Dichlorovos (Nuvan 100EC)	0.5	Pod borer
Malathion 50EC	2.0	Leaf Miner, Aphid

B. Disease :

Disease	Fungicides	Dose/ha	Concentration	Mode of application
1. Wilt	(i) Carbendazim (Bavistin), Benomyl (Bentate) 50WP or	2 g/kg of seeds	-	Seed treatment
	Captan or Thiram 50 WP	3 g/kg of seeds	-	-do-
	(ii) Carbendazim /Bentate 50 WP	-	0.1%	Drenching the soil in localized patches
2. Rust	Tridemorph (Calixin) or	500-700 ml in 500-700 litre of water	0.1%	As soon as disease appeared
	Mancozeb 75 WP (Dithane M-45)	1.0-1.4 kg in 500-700 litre of water	0.2%	-do-
3. Powdery mildew	Wet Sulphur (Thiovit)/ (Hexasul) or	2.5 to 3.5 kg in 500-700 litre of water	0.5%	-do-
	Storsul or Tridemorph (Calixin) or	500-700 ml in 500-700 litre of water	0.1%	-do-
	Wet Sulphur (Karathane) or	500-700 g in 500-700 litre of water	0.1%	-do-
	(Sulfex)	1.0-1.4 kg in 500-700 litre of water	0.2%	-do-

Harvesting: Harvesting should be done when 75-80% of the pods turn yellow.

Seed storage:

For seed storage, seeds should be treated with 3% black pepper powder to protect the seeds from storage pest such as *Callosobruchus spp.* Before treatment the seeds are to be dried to 10-12% moisture content level by sundrying for 10-12 days.

FRENCH BEAN

Phaseolus vulgaris L.

Variety : Pusa Parvaty, Contender, UPF-203, UPF-191 and Premier.

Description:

Contender: Bush variety , ready for picking in 50 days, pod round, green, very long, curved at the tip, thick, meaty and stringless; very prolific bearer; suitable for most areas except very hot and dry localities; yield 160q green pods/ha.

Pusa Parvaty: Bush variety; pod attractive, light green in colour, round and meaty; early variety, pods available 5 days earlier than contender; yield 170q green pod/ha.

Soil: Well drained sandy loam with pH 5.5-6.0

Field preparation: Land should be prepared to fine tilth.

Seed rate: 50 kg/ha.

Time of sowing: October-March.

Seed treatment: Seeds should be treated with Captan 50 WP @ 3 g/kg seeds.

Spacing: 45 cm x 30 cm (Row to Row x plant to plant).

Manure and fertilizer: FYM @ 20t, N 30 kg, P₂O₅ 40 kg and K₂O 20 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at flowering.

Interculture: 1. Irrigation: Irrigation should be given regularly. There should not be moisture stress especially in the early phases of crop growth, during blooming and pod development. 2. Weeding: First weeding at 20 days after emergence and subsequent weedings as per necessity.

Plant protection:

Aphid, Jassid and Beetles: Spray Malathion 50EC 0.2% @ 2.0 ml/l of water.

Anthracnose, Root rot and Wilt: Treat the seeds with Captan @ 2-3 g/kg before sowing, Spray carbendazim or Benlate on the crop.

Leaf spot: Spray the crop with Mancozeb 75 WP (2g/l) twice at 15 days intervals starting at one month after sowing.

Bacterial Blight: Treat the seeds with Streptomycin sulphate @ 2.5 g/kg.

Mosaic: Prophylactic measure should be taken against aphid vector by spraying dimethoate or monocrotophos.

Harvesting: The pods become ready for harvest in 2-3 weeks after first bloom. Pods should be harvested while they are young and tender.

Yield: 80-120 q of green pod/ha.

Seed storage: Seeds should be treated with 3% black pepper powder to protect the seeds from storage pest such as *Callosobruchus spp.* Before treatment the seeds are to be dried to 10-12% moisture content level by sundrying for 10-12 days.

DOLICHOS BEAN

Dolichos lablab L.

Variety:

Pusa Early Prolific, HD-18 and local cultivars. Besides these; DC-4 and DC-5 are recommended for Hill Zone.

Description:

Pusa Early prolific: Pole type; pod long, dark green curved, thin in bunches, 4-5 seeded; suitable for early crop, maturity 70-80 days, yield 50-60 q of green pods/ha, less susceptible to Cercospora leaf spot and mosaic, aphid tolerant.

HD-18: Pole type, pod dark green, curved, 4-5 seeded, maturity 110-120 days; yield 40-60 q of green pods/ha, tolerant to aphid and mosaic.

DC-4: Pod medium broad, flat purplish green in colour, slightly curved. av. yield 39-44 q/ha.

DC-5: Pod broad, flat of medium length, green in colour and curved. av. yield 38 q/ha.

Soil: Well drained sandy loam rich in organic matter with pH 5.5-6.0.

Field preparation: Land should be prepared thoroughly to a fine tilth.

Seed rate: 20-30 kg/ha.

Sowing time: July-August

Seed treatment: Seeds should be treated with Captan 50 WP @ 3 g/kg seeds.

Spacing: 1.25 m x 75 cm (Row to Row x Plant to Plant).

Manure and Fertilizer:

FYM @ 20t, N 30kg, P₂O₅ 40kg and K₂O 20kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at flowering.

Interculture:

1. Irrigation: As in French bean.
1. Weeding: Inter cultivation should be done to control weeds until vines spread between rows.

Plant protection:

1. Aphids, Jassids and Beetles: Spray malathion 50 EC @ 0.2% or 2.0 ml/lit. of water.
2. Yellow mosaic: Prophylactic measures should be taken against insect vector.

Harvesting:

Pods should be harvested while they are tender, succulent and have not become fibrous.

Yield : 40-50 q of green pods/ha.

SPINACH BEET

Beta vulgaris Roxb. var. *bengalensis*

Variety: Jobner Green, All Green, S-23 and Pusa Jyoti

Description:

All Green: Foliage uniformly green, tender without pigmentation, main stem and inflorescence stalk pigmented purple, maturity 40 days, green leaf yield about 125 q/ha; gives about 6-7 cuttings at 15 to 18 days interval, suitable for sowing round the year.

Pusa Jyoti: Foliage uniformly green, succulent, thick, broad, tender with higher contents of potash, calcium, sodium, iron and ascorbic acid than Pusa Jyoti, has good regeneration capacity, late bolting habit and gives 6 to 8 cuttings.

Soil: Well drained sandy loam, rich in organic matter with pH 6.0-7.0.

Field preparation: Land should be prepared to fine tilth and FYM to be applied.

Seed rate: 20-25 kg/ha

Time of sowing: Second week of September to December.

Seed treatment: Seeds should be treated with Captan50 WP @ 3g/kg of seed.

Spacing:

Seeds should be directly sown in lines spaced at 20cm and seedlings are thinned out to 5-7cm within rows of 10-12 days after emergence.

Manure and Fertilizer:

FYM @ 20 t, N 80 kg and P₂O₅ 60 kg/ha as basal application.

Interculture:

1. Irrigation: First irrigation should be given soon after sowing and subsequently at 10-12 days interval.
2. Weeding: One weeding at 20 days after emergence.

Plant protection:

Leaf spot: Prophylactic measure through seed treatment.

Yield : 70-100 q green leaf/ha.

RADISH

Raphanus sativus L.

Variety:

Early: Pusa Deshi, Pusa Chetki and Pusa Himani.

Late: Japanese White, Jaunpuri and Bombay Red.

Description:

Japanese White: Top medium large, leaf deeply cut, root about 20 to 30cm long cylindrical, skin uniformly white, smooth flesh snow white, crisp, solid, mildly pungent; maturity 50-55 days.

Pusa Deshi: Root pure white, 30-35cm long tapering with green end, pungent; maturity 50-55 days; heavy yielder.

Pusa Chetki: Root medium large, stumpy, smooth, skin pure white, flesh tender, mildly pungent, weight 300-400g each, maturity 50-60 days, yield 200-250 g/ha, suitable for early sowing.

Pusa Himani: Semi-stump to tapering with short tops, root 30-35cm in length and 10-12cm in girth with green stem end skin pure white, flesh crisp and sweet flavoured with mid pungency; maturity in 55 days.

Soil: Well drained sandy loam rich inorganic matter with pH 5.5-6.8.

Field preparation:

Land should be prepared to a fine tilth and FYM to be applied.

Seed rate: 6-11.5 kg/ha.

Time of sowing:

August-September (Early varieties)

October-November (Late varieties)

Seed treatment: Seeds should be treated with captan 50 WP @ 3 g/kg seed.

Spacing:

Directly sown either on ridges spaced at 45cm or in flat beds with 20cm row spacing and seedlings are thinned out to 10cm within rows 10-15 days after emergence.

Manure and fertilizer:

FYM @ 20t, N 50 kg, P₂O₅ 50kg and K₂O 100 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at 30 days after sowing.

Interculture:

1. Irrigation: Field should be properly irrigated before ploughing and subsequent irrigations to be given once in every week depending upon soil condition.
2. Weeding: One weeding at 20 days after emergence.

Plant protection:

Aphid: Spray malathion 50 EC @ 2ml/l of water.

Yield: 140-180 q/ha.

CARROT

Daucus carota L

Variety:

Nantes, Pusa Kesar and Chautney

Description:

Nantes: Medium long, slim, well shape orange, cylindrical, stump root; good flavour five grained , tender, sweet, self colour core, small thin tail, flesh orange scarlet; maturity 110-120 days; does not keep well due to thin skin and fine texture; not suitable for seed production in the plains.

Pusa Kesar: Foliage reduced, root red, long, tapering, self coloured narrow central core, maturity 95-110 days, stays longer in field without bolting, seeds freely in the plains, has higher carotene content.

Chautney: Root 11.5-15 cm long, 3-5 cm in diameter with tapering to blunt end; deep orange cortex and core, excellent cultivar for canning and storage.

Soil:

Well drained sandy loam rich in organic matter with pH 6.5.22 q lime/ha to be applied to raise the pH from 4.5 to 6.2

Field preparation:

The land should be prepared to a fine tilth and FYM to be applied. Liming is necessary in acid soil.

Seed rate: 5.5 – 7.0 kg/ha.

Time of sowing: Beginning of October to November.

Seed treatment:

Prior to sowing, the seed should be well rubbed to remove the fine hairs. The seeds should be soaked in water for 24 hrs dried under shade and to be treated with Captan 75 WP @ 3 g/kg seeds. Seed treatment with 0.1% Boron in the form of Sodium -borate for 24 hours improves the yield.

Spacing:

Seeds should be sown at a depth of 1.5 cm in lines spaced at 30 cm on flat bed and seedlings are to be thinned out to 10 cm within row at 10-15 days after emergence.

Manure and fertilizer:

FYM @ 10 t, N 60 kg, P₂O₅ 30 kg and K₂O 120 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at 30 days after sowing.

Interculture:

1. Irrigation: Field should be properly irrigated before ploughing and subsequent irrigations may be given periodically at 10-15 days interval depending upon soil condition.

2. Weeding: First weeding at 20 days and second at 40 days after sowing.

Plant protection:

1. Cut worm and leaf blight: Apply a mixture of 10 ml of malathion 50 EC and 25 g of Mancozeb 75 WP in 10 lit of water.

2. Nematode: Apply oil cake @ 300-400 kg/ha.

Yield: 200-250 q/ha.

Benefit Cost ratio: 4.93

A FEW GUIDELINES FOR GROWING CUCURBITS

1. Cucurbits should be preferably sown in raised beds.
2. All cucurbits can be planted in pits of size 60 cm x 60 cm x 45 cm filled with soil, FYM and basal dose of fertilizer @ 40-50 g Urea, 40-50 g SSP, 80-100 g MOP.
3. These crops should be provided with suitable climbing support.
4. In monoecious cucurbits such as cucumber, ridge gourd, sponge gourd, pumpkin, bottle gourd etc. where percentage of male flower is higher than the female flower; the femaleness, fruit-set, fruit size and total yield can be increased by spraying NAA (100 ppm) and Ethrel (25 ppm) at 2 to 4 leaf stage.
5. In dioecious cucurbits, like pointed gourd and spine gourd where male and female flowers are borne in separate plants, fertilization is a problem. In such cucurbits, a male-female ratio of 1:10 should be maintained in the field for proper fruit setting.

CUCUMBER

Cucumis sativus L

Variety : Chinese Green, Pusa Sanyog, Poinsette, AAUC-1 and AAUC-2,

Description:

Chinese Green: Medium late, straight variety, very hardy, prolific, fruit very long (50 cm), slender, deep green skin, white spined, flesh white, firm and crisp.

Pusa Sanyog: Early and high yielding hybrid; fruit 28 to 30 cm long, cylindrical, dark green with yellow stripes, crisp flesh, maturity 50 days.

Poinsette: Fruits dark green, 20 to 25 cm long; carries resistance to downy mildew, powdery mildew, anthracnose and angular leaf spot.

AAUC-1: Early variety, prolific bearer, fruit slightly yellow is brown in colour at maturity, light green in colour at harvesting stage, medium spyness upon the fruit, 10 strips on the fruit. Average weight of the fruit is 355 gm. On an average it yields 73 q/ha if planted early.

AAUC-2 : Prolific bearer with fruits of average 362 g weight, green in colour at harvesting stage and yellowish brown in colour at maturity, medium spyness on the surface with 10 prominent stripes on it. Average yield 73 q/ha if planted in mid season.

Soil: Sandy loam to clay loam with pH 5.5-6.5.

Seed rate: 2.5 kg/ha.

Sowing time: March – April (Climbing summer crop)

November – December (Ground trailing spring crop).

(March sowing reduces fruit fly infestation in hill zone of Assam).

Spacing:

(Row to Row x Plant to Plant)

1.5 m x 1.2 m (for ground trailing)

1.2 m x 75 cm (for summer crop).

Manure and fertilizer:

FYM @ 25 t, N 50 kg, P₂O₅ 45 kg and K₂O 80 kg/ha. Half of N with full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at 30 days after emergence.

Irrigation: Occasionally in case of summer season crop when there is no rain.

Harvesting: Fruits should be picked while green and tender.

Yield: 50-60 q/ha.

RIDGE GOURD

Luffa acutangula (Roxb.) L.

Variety : Pusa Nasdar, selected local varieties, viz. AAJJ-1.

Description:

Pusa Nasdar: Bears 15-20 fruits/vine, fruit ridged, club shaped, light green; flesh yellow with firm texture, good flavour; flowers in about 60 days; maturity 70-75 days.

AAJJ-1: Bears 15 to 20 fruits/vine, fruit long ridged, green in colour. Days for fruit setting are 60 days and for first picking of 68 days, good as early variety. Average yield is 110 q/ha.

Soil: Well drained loamy soils rich in organic matter with pH 6.0-7.0.

Seed rate: 3.5 – 4.5 kg/ha.

Sowing time: January-May

Spacing: (Row to Row x Plant to Plant)

1.5-2.5m x 60cm – 1.2m

Manure and fertilizer:

FYM @ 10t, N 20 kg, P₂O₅ 30kg and K₂O 30 kg/ha. Half of N with full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at vining.

Irrigation: At 8-10 days interval during dry spell.

Harvesting: Fruits should be picked while green soft and tender.

Yield: 90-130 q/ha

Elimination of bitterness in fruits:

Seed treatment with 80 ppm succinic acid followed by 2 sprays one at five-leaf stage and another at first pistillate flowering stage completely eliminate the bitterness of fruit.

SPONGE GOURD

Luffa cylindrica Roem

Variety : Pusa Chikni and selected local varieties.

Description:

Pusa Chikni : Bears 15-20 fruits/vine, fruit smooth, dark green, more or less cylindrical; flowers in about 45 days; maturity 50-60 days; suitable for both spring summer and rainy season.

(Other Agro-techniques are same as in ridge gourd).

SNAKE GOURD

Trichosanthes cucumerina L.

Variety : Long Green, Long White and Extra Long.

Soil: Well drained medium to rich loamy soil with pH 6.0-7.0.

Seed rate: 4.5-5.0 kg/ha.

Sowing time: April-June.

Spacing: 2.0-2.5 m x 0.75-0.90 m (Row to Row x Plant to Plant).

Manure and fertilizer:

FYM @ 25 t, N 45 kg, P₂O₅ 30 kg and K₂O 30 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed when the plants start bearing.

Irrigation: At 8-10 days interval during dry spell.

Harvesting: Fruits should be plucked while tender and half grown.

Yield: 100 q/ha.

BITTER GOURD

Momordica charantia L.

Variety:

For spring season-Earliest of All, Long Green, Extra Long and Pusa Do Mausami.

For summer season-Monsoon Monarch and Long Green Monsoon, Coimbatore Long.

Description:

Pusa Do Mausami: Stem green, hairy, leaf broad, deeply lobed, fruit dark green, long (18 cm at edible stage), medium thick, club-shaped with 7-8 continuous ridges; maturity 55 days; suitable for both spring-summer and rainy season.

Coimbatore Long: Vines prolific spreading fruits long, whitish green in colour tender, heavy bearing; suitable for rainy season.

Soil: Well drained sandy loam soil rich in organic matter with pH 6.0-7.0.

Seed rate: 4.5-6.0 kg/ha.

Sowing time:

Early : October-November (Ground trailing)

Mid : February-March

Late : June-July.

Spacing: 1.5 – 2.5 m x 60 cm – 1.2 m (Row to Row x Plant to Plant).

Manure and fertilizer:

FYM @ 10 t, N 40 kg, P₂O₅ 30 kg and K₂O 30 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed during flowering and fruiting stages.

Irrigation: At 8-10 days interval during dry spell.

Harvesting: Fruits to be harvested while tender and green

Yield: 100-120 q/ha.

ASH GOURD

Benincasa hispida (Thumb) Cogn.

Variety: Selected local varieties.

Soil: Well drained soils with pH 6.0-6.5

Seed rate: 3 kg/ha.

Sowing time: February-April

Spacing: 2.0m x 1.0 m (Row to Row x Plant to Plant).

Manure and fertilizer:

FYM @ 20-25 t, N 70 kg, P₂O₅ 80 kg and K₂O 80 kg/ha, Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N be top dressed during flowering and fruiting stages.

Irrigation: At 8-10 days interval during dry spell.

Harvesting: Fruits to be harvested when they are fully ripe, smooth, light and covered with whitish wax.

Yield: 185-325 q/ha.

BOTTLE GOURD

Lagenaria siseraria (Mol.) Standl.

Variety : Pusa Summer Prolific Long, Pusa Summer Prolific Round, Pusa Meghdoot and Pusa Manjiri. "Keyari Lao" is grown well in the hill zone of Assam.

Description :

Pusa Summer Prolific Long : Bears 10-15 fruits/plant, fruits are long (40-50 cm), girth medium (20-25 cm), narrow at stalk end and thicken at distal end, skin pale green, yield about 120 q/ha, suitable for spring and summer planting.

Pusa Summer Prolific Round: Prolific fruiting, fruit round (15-18 cm in girth), green, suitable for spring and summer planting.

Pusa Meghdoot: Hybrid, fruit long, light green, yield about 253 q/ha.

Soil: Well drained sandy loam soil rich in organic matter with pH 6.0-7.0.

Seed rate:

Spring : 4.5-5.5 kg/ha.

Summer : 2.2-3.2 kg/ha.

Sowing time:

Spring : February – March

Summer : June – July

Winter : October – November

Keyarilao : September.

Spacing: (Row to Row x Plant to Plant)

1.5.-2.0 m x 1.0-1.5 m (spring)

2.0-3.0 m x 1.0-1.5 m (summer)

Manure and fertilizer:

FYM @ 20-25 t, N 56 kg, P₂O₅ 56 kg and K₂O 112 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at fruit-set.

Irrigation: At 8-10 days interval during dry spell

Harvesting: Fruits to be harvested while tender

Yield: 120 – 250 q/ha.

PUMPKIN

Cucurbita moschata Duch ex poir

Variety : Arka Suryamukhi, Arka Chandan and selected Local cultivar.

Description:

Arka Suryamukhi: Bears 8-10 fruits/plant, fruit small (1.0 kg), round with flat ends, skin deep orange, flesh firm, orange-flavoured, maturity 100 days, yield about 335 q/ha, highly resistant to fruit fly and rich in vit. C, keeping and transport qualities are good.

Arka Chandan: Bears 2-3 fruits/plant, fruit medium sized (2-3 kg), flat with depressed polar ends, rind light brown with creamy patches at maturity, flesh thick, firm, sweet, (TSS 8-10%), bright orange with pleasant aroma, maturity 120 days, yield about 335 q/ha, rich in vit. A, cooking and keeping qualities are good.

Soil: Well drained sandy to moderately heavy soil rich in organic matter with pH 6.0-6.5.

Seed rate: 6.0-8.0 kg/ha.

Sowing time:

January – April (For summer harvest)

Sept. – October (For spring harvest).

Spacing:

(Row to Row x Plant to Plant)

2.5-3.0 m x 0.9-1.0 m (Spring)

2.5-3.0 m x 1.0-1.5 m (Summer).

Manure and Fertilizer: FYM @ 20-25 t, N 75 kg, P₂O₅ 80 kg, K₂O 80 kg, CaO 30 kg/ha basal application.

Irrigation: At 8-10 days interval during dry spell.

Harvesting: Fruits to be harvested at full maturity, when colour changes to yellow or orange to yellow or orange yellow.

Yield: 65-75 q/ha (Small varieties)

120-200 q/ha (Large varieties).

WATER MELON

Citrullus lanatus (Thumb.) Matsumura and Nekai

Variety : New Hampshire Midget, Asahi Yamoto, Pusa Bedana, Sugar Baby and Faizabadi

Description:

New Hampshire Midget: Fruits small (1.5-2.0 kg), oval, skin bright, green with dark green lacerations, flesh red takes 28-30 days from pollination to ripening.

Asahi Yamoto: Fruit medium sized (30-35 cm in dia.) weighing 5-6 kg, rind light green, flesh deep pink (TSS 11-13%), seed small, brown, maturity 95-100 days, quite adaptive to various regions.

Sugar Baby: Leaf with deeply cut lobes, fruit slightly oblong, small to medium (20-25 cm in dia.) weighing 3-5 kg, round, skin dark green with faint dark stripes, flesh deep red, very sweet (TSS 11-12%), fine textured, seed small, pale brown with black tip, maturity 85 days.

Pusa Bedana: Hybrid, credited for seedlessness.

Soil: Well drained, sunny, sandy loam soil, rich in organic matter with pH 6.5-7.0.

Seed rate: 5-7 kg/ha.

Sowing time:

Early : January – February

Late : June – July.

Spacing: 2.5m x 2.0 m (Row to Row x Plant to Plant).

Manure and fertilizer: FYM @ 25 t, N 60kg, P₂O₅ 40kg, K₂O 60kg/ha basal application.

Irrigation: At 7-10 days interval during dry spell.

Harvesting:

Fruits are to be harvested when fully ripe and show signs of maturity.

- (1) Withering of tendrils.
- (2) Muffled sound when stumped with finger.
- (3) Colour of ground spot turns yellow.
- (4) Cracking noise when pressed hard with thumb.

Yield: 280-465 q/ha.

MUSK MELON

Cucumis melo L.

Variety: Pusa Sharbati, Hara Madhu, Punjab Sunehri, Durgapur Madhu, Arka Rajhans and Arka Jeet.

Description:

Pusa Sharbati: Vine moderately spreading, leaf 5 lobed, green with light pubescence, petiole medium long, fruit medium in size, round to oval, netted with green stripes on outer skin, bears 3-4 fruits/vine, weight 800 q, flesh firm, thick deep orange with small seed cavity, moderately sweet (TSS 11-12%), yield 100-130 q/ha.

Hara Madhu: Vine 3-4m long, vigorous, fruit large globose, slightly tapering at stalk end, weights 1 kg, does not slip from vines at maturity, skin light yellow with ten prominent green strips, flesh crisp light green, juicy, very sweet (TSS 12-15%), seed cavity small, maturity 100-110 days.

Punjab Sunehri: Fruit with thick pale skin, flesh salmon-orange, thick with moderate sweetness (TSS 11-12%), early maturing.

Durgapur Madhu: Plant spread medium, fruit oblong, medium sized, weighing 500 to 600 g, rind yellowish green with green stripes smooth, flesh light green with dry texture, very sweet (TSS 13-14%), seed cavity big.

Arka Rajhans: Fruit medium large, round to slightly oval weighing 1 to 1.5 kg, rind creamy white with fine netting, flesh thick, white with more sweetness (TSS 12-14%), yield 320 q/ha, highly resistant to powdery mildew and has good transportable quality.

Arka Jeet: Fruit flat, small weighing 300-500 gm, skin orange to orange-brown, flesh white very sweet (TSS 15-17%) with high vit. C content (41.6 mg/100g) and big seed cavity.

Soil: Well drained sandy loam to silty loam rich in organic matter with pH 6.0-6.5.

Seed rate: 5-7 kg/ha.

Sowing time: January – mid March

Spacing: 1.5-2.0 m x 0.6-1.2 m (Row to Row x Plant to Plant)

Manure and fertilizer:

FYM @ 25t, N 68 kg, P₂O₅ 68 kg, K₂O 130 kg/ha basal application

Irrigation: At 10-15 days interval during dry spell.

Harvesting: Fruits to be harvested when fully ripe and show signs of maturity as in watermelon

Yield: 280-450 q/ha.

CHOW-CHOW/CHAYOTE

(Popularly know as squash among the people of Assam)

Sechium edule (Jack) Swartz.

Cultivated Types:

White types – Round White, Long White

Green types – Pointed Green, Broad Green, and Oval Green.

Soil: Well drained deep, moist, sandy loam rich in organic matter.

Planting method:

The crop can be raised by planting whole fruits or tuberous roots directly in field or first it is planted in nursery and then transplanted in the main field.

Raising of nursery:

The fruits and tuberous roots are to be planted in polyethylene bag filled with soil and cowdung mixture (3: 1 ratio). The fruit should be buried horizontally in the soil exposing the sprout end. When the sprouts attain a height of 30 cm the plants can be transplanted in the main field.

Pit size: 45 cm x 45 cm x 45 cm.

Spacing: 2-3 m x 1-2 m.

Planting time:

September – November (for irrigated crop)

January – February (for rained crop).

Manure and fertilizer:

FYM @ 10-15 kg, Neem Cake 1.5 kg, N 50 g, P2O5 20 g, K2O 30 g are to be applied to each vine each year. An additional application of 50 g N may be required during rainy season when the vine show poor growth.

Interculture:

Control the weeds during the initial growth of the vines. Weeding may be followed twice or thrice in a year when the vines are allowed to trail over pandal or trellis.

Harvesting:

The fruits are not allowed to become too old, and must be picked prior to seed development. Usually the marketable size of fruits is obtained in about 30 days from flowering.

Yield: 200-250 q/ha.

SPINE GOURD

Momordica dioica Roxb.

Variety: Selected local varieties.

Soil: Well drained, sandy loam to loamy soil rich in organic matter, with pH 6.0-7.0.

Land Preparation:

Deep ploughing is essential as it is a perennial crop. The land should be properly relevelled and at the time of final preparation 20-25 kg of Malathion 5% dust should be incorporated in the soil to protect the tubers from termite and cut worm.

Planting Material:

Spine gourd should be propagated by vegetative method. For propagation, well developed tubers should be selected from female plants when the crops are at bearing stage.

Planting Time: February – March

Planting Method:

Tubers are planted in the field in trench method. 30-35 deep trenches are made and filled with FYM. Large size tubers (80-100 g) should be placed in furrows at a depth of 8-10 cm maintaining a spacing of 1 m x 1 m.

Manure and Fertilizer:

FYM @ 20-25 t, N 50 kg, P₂O₅ 40 kg, K₂O 50 kg/ha. Whole of FYM, P₂O₅ and K₂O should be applied at vining and the remaining half after 30 days of 1st application.

Trailing: Trail the vines by fixing bamboo or other suitable supports within 15 days after sprouting.

Irrigation: As and when necessary in dry season.

Harvesting: Harvest the fruit while tender and slightly green in colour.

Yield: 90-100 q/ha.

Benefit Cost ratio: 4.15

POINTED GOURD

Trichosanthes dioica Roxb.

Variety: Selected local varieties.

Soil: Well drained sandy loam to loamy soil rich in organic matter with pH 6.0-7.0.

Land Preparation: Same as in Spine gourd

Planting Materials:

Female and male plants are to be identified first in the previous season and then skin and root cutting from female plant should be taken. The cuttings should be dipped in 0.2% Indofil M-45 solution for 10 mins.

Planting Time: January – February

Seed Rate: 100 cm cuttings @ 2500 nos. /ha

Spacing: 2.0 m x 2.0 m (Row to Row x Plant to Plant).

80 cm mid portion of cutting should be buried in soil and 10 cm to be kept exposed on either ends.

Manure and Fertilizer:

FYM @ 22-25 t, N 80 kg, P₂O₅ 50 kg, K₂O 50 kg/ha as basal application and 2% Urea and 2% MOP at 60 days interval as foliar spray.

Irrigation: As per necessary during dry spell.

Interculture:

The crop should be kept weed free particularly in the early stages and light earthing up should be done. For getting a good second crop weeding, top dressing of fertilizer and thinning of overcrowded population should be done. The crop has to be provided with bedding materials like paddy, straw/paddy husk to protect the fruits from decay and to reduce weed infestation. In light soils and river banks, the crop should be trailed on ground whereas trailing on bamboo tops or tree branches is recommended in heavy soils.

Harvesting:

Fruits should be picked while green and tender.

Yield:

1st yr. Crop : 56-72 q/ha.

2nd yr. Crop : 93-130 q/ha.

N.B. Propagation of pointed gourd can also be done by leaf bud cutting. Single leaf from the mature vine along with 2-3 cm stem should be taken and put into nursery bed or polyethylene bag containing 1 part sand and 1 part loamy soil under shade. Regular light watering should be done. Initiation of new shoots and subsequent rooting take place after 12-15 days. New plantlet gets ready for transplanting after 30-40 days.

PLANT PROTECTION FOR CUCURBITS

1. Fruit fly, epilachna beetle, aphid, red pumpkin beetle and black pumpkin beetle: Spray malathion 50 EC 0.2% (2 ml/lit.) with 1% molasses.
2. Cutworm: Incorporate malathion 5% dust in the soil around the plant.
3. Mite: Spray Karathane WP 0.5% (0.5 g/lit.) or Kelthane 0.1% (1 ml/lit.) of malathion 50 EC 0.2% or monocrotophos 40 EC 0.1%.
4. Powdery mildew: Spray Karathane WP 0.5% or carbendazim 0.1%.
5. Downy mildew: Spray 1% Bordeaux mixture or Zinc 0.3%.
6. Fusarium root rot: Pre-sowing seed treatment with Captan 50 WP @ 5 g/kg of seeds.
7. Anthracnose: Spray Zinc 0.2% or Difolatan 0.15%.

OKRA

Abelmoschus esculentus (L.) Moench.

Variety:

Pusa Sawani, Arka Anamika, Parbhani Kranti and Selected local cultivars. Red Wonder (Hills zone): Panchasira (North Brahmaputra Valley zone).

Description:

Pusa Sawani: Stem and leaf moderately hairy, top leaves deeply lobed (3-5 lobes) purple, top leaves deeply lobed (3-5 lobes) purple patch at base of yellow petal on both sides, slight purple pigmentation on stem, petiole and leaf base; first fruit is at 8th node, fruit dark green smooth, 5-ridged, about 10-12 cm long at marketable stage; maturity 50 days; suitable for both spring-summer and rainy seasons, was tolerant to YMV at the time of release but its tolerance has since broken down.

Arka Anamika: Plant tall (180 cm). Erect, well branched; fruit long (200cm). Spineless lush green and tender, borne in two flushes, duration 120-135 days, Yield 175-250 q/ha; resistant to yellow vein mosaic virus.

Parbhani Kranti: High yielder: resistant to yellow vein mosaic virus.

Red wonder: Av. Yield 125.1 q/ha.

Panchasira: Plant tall (158 cm.) well branched, (6), fruits long (19 cm) and average yield is 150 q/ha.

Soil: Well drained sandy loam to clay loam rich in organic matter

Land Preparation:

Land should be prepared thoroughly and FYM should be applied.

Seed Rate:

21 kg for spring summer crop (Jan-March)

7 kg for rainy season crop (May-July)

Sowing Time: Mid January – July

Spacing: (Row to Row x Plant to Plant) 30 cm x 15 cm (spring/summer crop)

45 cm x 30 cm (Rainy season crop)

Seed Treatment and Method of Sowing:

Pre sowing soaking of seeds in water for 24 hrs, enhance germination. Seeds should be directly sown in the pit and to be covered with sand and/or FYM.

For organic cultivation, treatment of seeds with biofertilizers AZB and PSB @ 7.5g each per 100 g of seeds and application of Rock Phosphate @ 313 kg/ha, FYM @ 5 t/ha and Vermicompost @ 1 t/ha during final land preparation has been recommended.

Manure and Fertilizer:

FYM @ 10t, N 50 kg, P₂O₅ 50kg and K₂O 50kg/ha, Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at 35-40 days after sowing.

Interculture:

Weeding: Pre-planting incorporation of Basalin @ 1.0 kg. a.i./ha supplemented with one hand weeding at 25-30 days after sowing is recommended for adequate control of weeds.

Plant Protection:

1. Fruit and shoot borers and Jassids: Apply deltamethrin 2.8 EC @ 0.5 ml/lit or dichlorvos 100 EC @ 0.5 ml/lit or malathion 50 EC @ 2 ml/lit. Waiting period after the treatment is 3 days.
2. Cut Worm: Apply malathion 58 Dust @ 20 kg/ha.
3. Yellow Vein Mosaic: (a) Prophylactic measure should be taken against the insect-vector by spraying systematic insecticide like dimethoate or oxydemeton methyl. The first spray should be given within 20 days after emergence of seedlings and altogether 5-6 sprays are required to get a disease free crop. (b) Grow the crop early in the season so as to escape the incidence of YVM which generally intensifies with the increases of the vector (White Fly) population beyond April (c). To get highest yield and low incidence of YVM February and March sowing is the best.
4. Root knot nematode: Carbofuran 3g @ 1 kg @ 1 kg a.i./ha as spot application.

Harvesting: It takes 45-50 days for first picking. Fruits should be picked at an interval of 4-5 days. Picking should be done before spraying of insecticides.

Storage of seeds: First borne 8-10 fruits from the base of the plant should be retained for quality seed production. The upper fruits may be harvested for consumption purpose.

Yield: 150-200 g/ha.

Benefit Cost ratio: 3.56

COWPEA

Vigna unguiculata (L) Walp

Variety: Pusa Barsati

Description:

Pusa Barsati: Plant dwarf, height 60-80 cm; flowers in 35 days pod becomes ready in 45 days; produces 2-3 flushes in about 90 days; pod light green, pendent, 20-25 cm long seed striped, bold; yield 70-75 q/ha; suitable for growing under long day condition.

Soil: Well drained sandy loam with pH 5.5-6.0

Land Preparation: The land should be ploughed 2-3 times followed by levelling.

Seed Rate: 20-25 kg/ha.

Sowing Time: March-April

Seed Treatment: Dry seed treatment should be done with Captaf @ 2.0 g/kg seed.

Spacing: 70 cm x 30 cm (Row to Row x Plant to Plant).

Manure and Fertilizer: FYM @ 9t, N 15 kg, P₂O₅ 35kg and K₂O 10 kg/ha basal application.

Interculture : One weeding at 20-25 days after sowing.

Plant Protection: Caterpillar and Aphid: Spray malathion 0.1-0.15 % (@ 1-1.5 ml/lit. of water with a spray volume of 500-700 lit. for 1 ha.)

Harvesting: Pods are to be picked while green and tender.

Yield: 50-60q of green pods/ha.

POTATO

Solanum tuberosum

Varieties:

Name	Duration (days)	Yield (q/ha)		Plant Characters	Tuber Characters	Tolerance to disease
		Rainfed	Irrigated			
Kufri Chandramukhi	80-100	85-100	150-160	Medium tall erect	Oval shaped, Slightly curved, Skin colour white eyes flat.	Leaf roll and virusy Late blight.
Kufri Jyoti	100-120	85-100	150-160	Tall erect	Oval Shaped, Flat skin White, Eyes Flat, flesh Dull White	
Kufri Sindhuri	110-120	85-100	100-160	Tall erect	Round Shaped skin light red eyes flesh pale yellow sticky	Moderately Tolerant

Soil type:

Well drained sandy loam and loam soils, rich in organic matters are suitable. Preferably a pulse crop should be included in the rotation to improve the soil condition.

Field preparation:

Field should be thoroughly ploughed to obtain a good tilth. It should be levelled for uniform distribution of irrigation water or to maintain soil moisture uniformly under rainfed situation. The furrows should be prepared at 50 cm apart.

Time of planting:

The optimum time for planting is mid October to mid November. In case of Kufri Sindhuri planting may be extended up to first week of December.

Methods of planting:

The sprouted tubers should be planted in furrows with sprouts facing upward. In handling the tubers, care should be taken to avoid sprout damage.

Seed selection:

Virus free, healthy, medium or small sized sprouted tubers are to be selected for planting. Ideal size is about 2.5 cm in diameter (25-40 g) Bigger sized tubers may be cut into pieces longitudinally with 2-3 eyes in each piece.

Seed sources:

Certified seeds of the recommended varieties are to be procured from Govt. or such other recognized agencies.

Seed treatment:

In case of cut seeds, the pieces are to be dipped in Mancozeb (Indofil M-45) @ 5g in 1 lit of water for about 10 minutes. Benomyl (Benlate) 0.1% solution may be used if other chemicals are not readily available. After treatment seeds are to be spread thinly and dried under shade for 48 hours, or should be covered with moist gunny bags for 2-3 days for suberization.

Seed rate:

The seed requirement is 22.5-23 q/ha when size of the tubers are about 2.5 cm in diameter (about 25 g) and planted with an intra row spacing of 15 cm. Intra row spacing is increased with bigger size tuber.

Fertility management:

The tones or 5 truck loads or 20 cart loads of well decomposed FYM/ha should be applied in the furrows before planting.

Nutrient	Requirement (kg/ha)	Form of fertilizer	Requirement	
			(kg/ha)	(kg/bigha)
A. Rained :				
N	60	Urea	133	19
P ₂ O ₅	50	SSP	312	45
K ₂ O	50	MOP	83	12
B. Irrigated :				
N	60	Urea	133	19
P ₂ O ₅	100	SSP	624	90
K ₂ O	100	MOP	168	24

Entire quantity of mixed fertilizers should be applied in furrows as basal application and be covered with a thin layer of soils so that tubers do not come into direct contact with the fertilizers.

Mulching:

Adoption of mulching under rain-fed situations increases tuber yield. Water hyacinth plant materials are applied to cover the entire field after planting of tubers under flat method. Of course, skin of the tubers may turn green due to exposure to sunlight or shrinkage of mulching materials on drying. Tubers become unsuitable for consumption on greening, however, quantities may be reduced by applying mulching materials in furrows just after planting of tubers, materials in furrows just after planting of tubers, immediately followed by light soil cover. Such practice also reduces rodent damage of tubers considerably.

Irrigation:

The furrow method of irrigation has to be adopted. Three irrigations has to be adopted. Three irrigations should be applied, first at 25 days (stolen formation

stage), second at 60 days (tuber formation stage) and third at 80 days (tuber formation stage) after emergence or sprouts. In case of application of mulching materials in furrows, only two irrigations are to be applied at 25 and 60 days after emergence of sprouts. At the time of application of irrigation care should be taken not to submerge the ridges completely.

Weeding and Interculture:

Earthing up is to be done just before first and second irrigation. Under rainfed condition, this should be done at stem and tuber formation stage. One or two inter-cultural operations may be necessary when weed infestation is high.

Plant Protection:

A. Pests:

In areas where infestation of red ants and other soil insects are common, application of phorate 10% granules @ 15 kg/ha or malathion 5% dust @ 40 kg/ha in the soil at the time of earthing up should be done to control insects efficiently. Local potato variety Lalpahari: is relatively tolerant to red and cutworm.

Application of mustard oil cake @ 150 kg/ha at the time of earthing up reduces red and white ant infestation to a greater degree.

Soil application of quinalphos 25EC @ 400 g a.i./ha (1.5 lit./ha or 2 ml/lit of water) against white grub and other soil insects in potato.

B. Disease:

Late blight

One spraying of Mancozeb 75% (Indofil M 45 / Dithane M 45) @ 0.25% (2.5 g/Lit) at canopy closure (35-40 days after planting) and second spraying of Cymoxanil 8% + Mancozeb 64% (Curzet M / Moximate) @ 0.25% (2.5 g/Lit) at first appearance of the disease (if disease appear) and third spraying of Mancozeb 75% (Indofil M 45 / Dithane M 45) @ 0.25% (2.5 g/Lit) after 10 days of second spraying and fourth spraying of Cymoxanil 8% + Mancozeb 64% (Curzet M / Moximate) @ 0.25% (2.5 g/Lit) after 10 days of third spraying against late blight of potato.

Against late blight, six sprayings with Mancozeb 75%. (Dithane M-45) @ 0.25 % (2.5g/l) at an interval of 12 days.

OR

Ridomil MZ-27 (64% mancozeb +8% metalaxyl (2 g/l) followed by Dithane M-45 (2.5g/l) in alternate application (3 sprayers with Ridomil MZ-27 and 3 with Dithane M-45) at an interval of 12 days give very good control if used at the following

rates with high volume sprayers.

Early stage: (1st month) 600 l of water/ha.

Mid stage: (2nd month) 800 l of water/ha.

Late stage: (3rd month) 100 l of water/ha.

The first spray should be give during 10-15th December. Use of sticker Triton (0.5ml/l) will be essential in the spray solution for spraying during rainy weather.

Depending upon weather conditions particularly on cloudy weather Dithane M-45 should be sprayed as prophylactic measure. Alternatively, Zineb (Dithane Z-78) @ 0.25% (25 g in 10 l of water) can be used. If disease appears spraying should be done at an interval of 7 to 10 days depending upon weather conditions. While spraying, care should be taken to cover the lower sides of the leaves.

N.B:

(i) In flood prone areas under low land situation of North Bank Plains Zone cropping system of Rice-Fallow-Potato is recommended.

(ii) Under medium land, medium rainfall, flood free situation, inter cropping of potato and pea is recommended for Sonitpur district.

(iii) Inter cropping pea in between every two rows of potato grown with, mulches with usual doses of fertilizer in recommended for potato.

SWEET POTATO

Ipomoea batatas L.

Variety:

- Pusa Red-average yield 24 t/ha
- Kalmegh-average yield 30 t/ha
- Dergaon White-average yield 22 t/ha
- Dergaon Red-average yield 20 t/ha

Soil and climate:

Sweet Potato can be grown on a variety of soil having good drainage except clay but it is best suited to fertile sandy loam and deep loam. It requires a warm humid climate with a mean temperature of about 22°C. It is sensitive to frost but can withstand drought to certain extent. Under rain-fed condition, it requires a fairly well/distributed rainfall of 175 to 150 annually.

Preparation of land:

The land should be ploughed or dug to a depth of 15 to 25 cm and brought to fine tilth ridges of 25-30 cm. Height are made 60 to 75 cm apart and vines are planted on these ridges.

Planting season:

The rain-fed crop of sweet potato is generally planted in May-June and a second crop is raised in September-October (to be harvested ion 105 days after planting). As an irrigated crop it can also be grown in October-November or even later.

Planting materials planting:

- a) Propagation of this crop is done by means of vine cuttings. In the main field, cutting of 20 to 25 cm length are planted on ridges at a distance of 20 to 30 cm between vines. While planting, the central part of the cuttings is buried deep in the soil exposing the two cut ends. About 50,000 to 62,000 cuttings are required to cover a hectare. Care should be taken so that there is sufficient moisture in the soil at the time of planting for the early establishment of the cutting. Since sweet potato is susceptible to water logging, proper drainage facilities should be provided.
- b) Adopt 2 tiers planting of deep bulking type (X-5) in between two rows of shallow bulking type (X-4) at 30 cm x 15 cm spacing.

Manure and Fertilizer:

Sweet Potato is a soil exhausting crop. Therefore, proper manuring should be done for better yield. Cattle manure or compost @ 10t/ha or 1.5t/bigha may be applied at the time of preparation of main field. Application of 75 kg N, 50 kg P₂O₅ and 75 kg K₂O per ha or 10 kg N, 6.5 kg P₂O₅ and 10 kg K₂O/bigha may be done in two split doses as tabulated below :

Name of Fertilizer	Time of application	
	At the time of planting	3 weeks after planting
1. Urea	80 kg/ha (10.5 kg/bigha)	80 kg/ha
2. Super Phosphate	310 kg/ha (40 kg/bigha)	
3. Muriate of Potash	135 kg/ha (16 kg/bigha)	

Interculture:

The crop should be given a weeding and earthing up at about 4 to 5 weeks after planting. The second split dose of fertilizer can also be applied at this time. Disturbing the vines occasionally during their active growth period will help to prevent the development of small, slender undesirable tubers at the nodes.

Spray 1000 ppm CCC at 30 and 45 days after planting. This gives an additional yield of 25% over control.

Rotation and Mixed Cropping:

When the crop is raised under rain-fed condition, leguminous green manure crop like *Crotalaria juncea* (sunhemp) can be grown after the harvesting of the crop and later on incorporated in soil at the time of preparation of land for the next crop of sweet potato. In such cases, use of compost or cattle manure can be eliminated. As a mixed crop, it can be taken along with Colocasia, Amorphophallus, etc.

Plant Protection:

Weevil- Sweet potato weevil is the most serious pest. It damages vines and tubers by tunneling through them. Dip the vine cuttings in sumithion (1ml/lit.) solution for 10 minutes before planting to reduce the infestation. In case severe infestation, spray malathion (2ml/lit.) or phosphamidon (0.5 ml/lit.) 3-4 times at 25 days interval commencing after one month of planting depending upon intensity at attack.

Red ant- Malathion 5% dust @ 20 kg/ha should be incorporated in the soil at the time of soil preparation.

Harvesting:

The duration of the crop depends upon the variety grown but generally it gets ready for harvest within 3.5 to 4 months after planting when leaves begin to turn yellow.

Yield: 20 to 30 t/ha

Cost benefit ratio: 1:3.03, Cost of cultivation is Rs.31, 018.00.

TAPIOCA

Manihot esculenta Crantz

Cassava, popularly known as Tapioca in India, is the important tuber crop cultivated in Kerala, part of Tamilnadu, Andhra Pradesh, Karnataka and Assam. It is consumed both as freshly cooked tubers and as processed food products like chips, sago and vermicelli. It forms a component of animal and poultry feeds too. Industries use tapioca for producing starch and glucose.

Variety: H-97, H-165, Sree Prakash, Sree Sahya, Sree Harsha, Sree Jaya and Sree Vijaya

Sri Jaya: Early maturing variety (6-7 months); Average yield-26 to 30 t/ha; Starch- 24-27 (%); Cooking quality- excellent.

Sri Vijaya: Early maturing variety (6-7 months); Average yield-25 to 28 t/ha; Starch- 27-30 (%); Cooking quality- excellent.

Soil and climate:

It can be grown on all types of soils except saline, alkaline and ill-drained soils. It grows best in warm and humid climate with well distributed rainfall (1500 to 2000 mm annually).

Site selection and preparation of land:

Tapioca can be cultivated profitably on hill slopes, waste land and lands where normal cultivation is difficult. The land should be ploughed two or three times or dug to a depth of 25 to 30 cm.

Planting material:

Tapioca is propagated from cuttings obtained from mature healthy stems having 2-3 cm diameter. Discard the basal 10 cm and the top one third and use the remaining portion. Prepare the cuttings of about 15-20 cm length giving a slanting cut towards lower end or cutting using hacksaw or knife.

Spacing:

Planting is done in a square alignment with spacing of 90 cm x 90 cm, 1646 setts/bigha are required for planting.

Time and method of planting:

April-May is the best planting time for Assam. Cuttings are planted vertically (after smoothening the lower portion) and basal 4 to 6 cm is buried inside the

soil. Flat, ridge or mound method of planting can be adopted considering the soil type, topography and water table.

Manure and Fertilizer:

Cattle manure or compost may be applied @ 12.5 t/ha (1.5t/bigha) during the preparation of the land. Application of organic is better than spreading the manure in the whole area. Tapioca responds well to 75 kg N, 75 kg P₂O₅ and 100 kg K₂O per ha., when applied in two split doses as tabulated below :

Name of Fertilizer	Time of application	
	At the time of planting	Two months after planting
1. Urea	81 kg/ha (10 kg/bigha)	81 kg/ha (10 kg/bigha)
2. Super Phosphate	235 kg/ha (30 kg/bigha)	235 kg/ha (30 kg/bigha)
3. Muriate of Potash	83 kg/ha (10 kg/bigha)	83 kg/ha (10 kg/bigha)

Interculture:

Removing the weeds and loosening the soil by light digging or hoeing may be done two to three times upto third month followed by a light earthing up. Excess shoots should be removed retaining only two shoots per plant at 45 days after planting.

Irrigation:

Irrigation is not necessary for tapioca when the rainfall is well distributed. Irrigation may be done at the time of planting if there is a long dry period. Depending upon the soil moisture, 3 to 5 irrigations may be provided to overcome the drought period.

Rotation and mixed cropping:

Tapioca can be rotated with maize, banana, yams etc. with proper fertilization once in two years.

Intercropping with short duration leguminous crops like ground nut or cowpea has been found to be advantageous and economical.

Plant protection:

Tapioca is not affected by any serious pest and disease. The important ones attacking the crop are mentioned below:

Spider, mites and scale insect occur during dry season which feed on leaf sap causing blotching, curling and leaf shedding and can be controlled by spraying kelthane (2ml/lit.). The two important diseases of tapioca are "Cassava mosaic" and "Cercospora leaf spot". The mosaic disease is apparently transmitted by the insect vector *Bemisia* sp. (white fly). As a rule only stem cutting from healthy

plants should be used for planting to minimize the spread. The diseased plants should be uprooted and destroyed when the symptoms are visible. Spraying 0.03% dimethoate 3 to 4 times at monthly intervals in the first 4 months of the crop controls the vector and thereby checks the spread of the disease. Leaf spot disease can be controlled by spraying carbendazim 0.1% or Mancozeb 75 WP (2g/lit.).

Harvesting:

Tapioca becomes ready for harvest at 8 to 10 months after planting. Harvesting for table purpose is to be done after 8 months and for starch manufacturing, after 10 months of planting. Harvesting is done by removing the soil from the base of the plants and pulling out the tubers by holding the basal portion of the stem.

Storage of Tapioca:

Freshly harvested least damaged roots are packed with 50% moist sawdust in wooden boxes. Dry or very moist sawdust should not be used as it results in deterioration. Once packed, the boxes can be stored in a thatch-roof shed or in an open covered by a water proof tarpaulin. By following the above method, cassava roots can be stored up to eight weeks without any deterioration. However, the normal method for overcoming the damage is to leave the plants in the ground until needed and once harvested these are to be dried for longer storage life.

Yield: 25 to 35 t/ha.

Cost benefit ratio: 1: 2.53, Cost of cultivation Rs.21,236.00.

Value addition of tubers:

1. Plain white chips: The harvested tapioca tubers are peeled and the rind is removed completely. Sliced them into thin slices of 2 mm thickness. Dried in the sun over a clean surface for 6-7 days to bring down the moisture content upto 15%. The converted arrowroot biscuit like chips can be broken easily.

2. Parboiled dried chips: The plain chips are parboiled for 4 minutes, cooled immediately by pouring cold water over them and then dried over clean surface under open sun preferably in single layer, for 5 to 7 days to bring the moisture level below 15%. Dried parboiled chips are consumed after grinding as semolina or suji or these can be deep oil fried and seasoned with spices /salt. Such oil fried chips can be consumed fresh or preserved in air tight polybags.

3. Tapioca flour: Flour can be made from both plain and parboiled chips, by grinding in a hammer type mill. Flour made from plain white chips will have colour and texture just like wheat flour and it can be used for making 'roti' and other snacks. Flour made from parboiled chips has texture and colour similar to suji and it can be used just like Halwa, Ladoo etc.

Primarily processed tapioca products (dried chips and flour) should be packed airtight in food grade plastic containers, stored upto six months at room temperature.

COLOCASIA

Colocasia esculenta Schott

Variety: Kaka Kachu, White Gaurya, Panchamukhia, Bidhan Chattanya, Ahinia Kachu and Bidhan Jaydeb

Soil:

The best soil is sandy loam or alluvial with abundant organic matter. The land should be ploughed 2-3 times after applying adequate quantities of organic manure and wood ash.

Planting material:

- (a) Small corms or setts cut from large corms
- (b) Cormels or setts cut from large cormels.

Spacing: 60 cm from row to row and 45 cm from plant to plant.

Time and method of planting:

April-June is the best planting time for Assam, Planting is done on well prepared land in pits filled up with burnt earth, ashes and rubbish. When plants grow to about 30 cm height, the soil around is lessened and earthing up is done.

Manure and Fertilizer:

FYM or compost should be applied @ 12 t/ha. In addition 80 kg N, 60 kg P₂O₅ and 120 kg K₂O should be applied per ha.

Interculture:

Weeding and earthing up should be done at 35-40 days after planting, i.e. when plants attain a height of about 30 cm. All dead leaves should be plucked off.

Intercropping: Okra and green gram can be grown profitably as intercrops.

Plant Protection:

Colocasia blight is a serious disease which can be controlled by using Mancozeb 75 WP (2g/lit.) at an interval of 14 days. The spraying should be started 1-2 months after planting.

In the endemic areas of red and other soil insects apply malathion 5% dust @ 20 kg/ha in the soil at the time of preparation.

Harvesting:

Colocasia gets ready for harvest when most of the leaves begin to turn yellow. Generally, it takes 6-7 months after planting depending upon the variety.

Yield: 12 to 16t/ha.

Cost benefit ratio: 1:2.32 Cost of cultivation Rs.30, 097.

SMALLER YAM

Dioscorea esculenta Burk

Smaller yam is cultivated for its tubers and utilized as vegetables. Yams are considered to be more nutritious than potato and are used as wholesome food during periods of scarcity. The tubers of smaller yam are small and born in cluster on each plant unlike other yams which usually produce only one or two large tubers per plant.

Variety : Sree Latha, Lotani, Local Moa Aloo

Soil and climate:

It requires a loose, deep and well drained fertile soil. It is essentially a tropical plant and needs a tropical climate. It requires a fairly distributed rainfall.

Preparation of land:

Plough or dig the land up to a depth of 15-20 cm. Prepare mounds at a spacing of 75 cm x 75 cm.

Planting material: Select good, healthy and medium sized tubers of 100-150 g.

Method of planting:

Tubers are planted at the centre of the mound (one tuber/mound) in an upright position keeping the proximal end of tuber 5-7 cm below the soil surface.

Manure and Fertilizer:

Broadcast 10 t of FYM/ha and incorporated into the soil during land preparation. In addition, 30 kg N, 60 kg P₂O₅ and 60 kg K₂O should be applied per ha. The fertilizers should be applied in two split doses, the first dose one week after sprouting and the second a month later.

Interculture:

Weeding and earthing up of soil are done along with fertilizer applications. The plants are either staked or the vines are trailed on coir ropes attached to supports. Training of the vine is essential for the economic yield of tuber.

Plant protection:

Yam Scale: It usually infests the corms both the field and under storage condition. Avoid planting the tubers infested with scales.

As a prophylactic measure, dip the planting material in monocrotophos solution (1.25 ml in 1 lit of water) for 10 minutes before planting.

Harvesting: Harvesting of the crop is done within 78 months when the leaves dry up

Yield: 9 to 14 t/ha.

Cost benefit ratio: 1:2.31 Cost of cultivation Rs. 20,120.

GREATER YAM

(Dioscorea alata L.)

Greater yam is cultivated for its tuber which can be utilized as vegetable.

Variety : Kowari Aloo, DA – 48, Sree Roopa

Soil and climate:

It requires a loose, deep and well drained fertile soil. It requires a fairly distributed rainfall.

Preparation of land:

Plough or dig the land up to a depth of 15-20 cm. The pits (45cm x 45cm x 90cm) are dug out at a spacing of 1m x 1m. Fill up $\frac{3}{4}$ th of the pits with 1-1.5 kg of cattle manure or compost and mix up with top soil and form a mound over it.

Planting season: Planting is done from March to May.

Planting material:

Divide the whole tuber into pieces weighing 250-300 g each. Dip the cut pieces in cowdung slurry and allow drying under shade before planting.

Method of Planting:

Plant the cut pieces in the prepared pits with mounds keeping buds facing upward and cover these with soil.

Manure and Fertilizer: 80 kg N, 60 kg P₂O₅ and 80 kg K₂O per ha.

Interculture:

Weeding and earthing up are done along with fertilizer application. The plants are either staked or the vines are trailed on coir rope attached to supports within 15 days after planting.

Plant protection: Same as in smaller yam.

Harvesting:

Harvest the crop at 8-9 months after planting.

Yield: 16 to 24 t/ha.

Cost benefit ratio: 1: 2.39 Cost of cultivation Rs.27,926.

WHITE YAM

(*Dioscorea rotundata* Poir.)

White yam is an introduction from West Africa and is cultivated for its tuber which is utilized as vegetables.

Variety: I-212

Description: Plant medium height, ranges 5-8 meters, the vine twine to the right and roughly circular spines as well as a whitish bloom are present on the stem. The leaves are simple, cordate and usually pointed at the tip. The leaves are opposite in their arrangement. The tubers more or less is cylindrical in shape. The skin of the tuber is smooth and light brown, while flesh is usually white, sometimes creamy and firm.

Soil: Well drained sandy loam soils.

Land preparation: The land should be ploughed to 15-20 cm. Depth followed by levelling. Pits of 45 cm x 45 cm x 90 cm are dug out at a spacing of 1m x 1m. Fill up the pit with 1:1:1 cowdung or compost, straw or dried leaves and top soil and form a mound over it.

Planting materials: Divide the whole tuber into pieces weighting 250-300g each. Preferably use the head and/or tail or tips and dip them in cowdung slurry or smear in wood ash and dry under shade before planting.

Planting season: Planting is done from March to May.

Method of planting: Plant the cut pieces in the prepared pits with mounds keeping buds facing upwards and cover them with soil, put 3-5 cm mulch over the mounds.

Trailing: Put 2-3m bamboo split poles on each pit and tie 3-4 such poles into one at top construct a pandel for climbing of the vines.

Manure and Fertilizer: Cowdung or compost @ 1-1.5 kg/pit should be incorporated at the time of mound preparation. NPK @ 80:60:80 kg/ha should be incorporated in to the soil at the time of first earthing up of soil (1-1.5 months after their culture).

Weeding and earthing up are done along with fertilizer application. The plants are allowed to trail on bamboo poles or pandels within 15-20 days after planting.

Plant protection: Same as in smaller yam.

Harvesting: Harvest the crop at 9-10 months after planting.

Yield: 25 to 50t/ha.

Cost benefit ratio: 1:3.16. Cost of cultivation Rs.25, 173.

ELEPHANT FOOT YAM

(*Amorphophallus paeonifolius* (Dennst) Nicholson.)

Elephant foot yam is cultivated for its under ground stem which is used for making vegetable dishes.

Variety: Gajendra and local selected varieties

Soil and climate: It needs well drained sandy loam soil. It is both a tropical and sub-tropical crop. It requires a well distributed rainfall with humid and warm weather during vegetative phase and cool and dry weather during vegetative phase and cool and dry weather during the development of the corms.

Preparation of land: Plough or dig the land to fine tilth. Make pits of size 60 cm x 60 cm. Collect the top soil to a depth of 15-20 cm. Mix the top soil with cowdung or compost (2-2.5 kg per pit) and fill the pit with it.

Planting season and method of planting: Start the cultivation in the month of March to April. It can also be planted up to August bud planting later than the middle of August will affect the size and yield of corm.

Planting Material and Planting: Select good corms free from mealy bug infestation. Cut the corms into pieces of 1kg size each with a central bud. Dip the pieces in cowdung slurry. Dry it in shade for 2-3 days.

Plant the corm vertically in the prepared pit and cover it with soil.

Manure and Fertilizer:

A high fertility in the soil is essential as the crop is a heavy feeder. Potash in the form of wood ash, farm refuse etc. is suitable for it.

Paddy husk, dried leaves, etc. are also applied in the absence of cattle manure. It responds well to 80 kg N, 60 kg P₂O₅ and 100 kg K₂O per ha.

Interculture: Weeding and earthing up should be done at 30 and 60 days after planting. Retain only one healthy shoot.

Plant protection: Corms are usually attacked by mealy bugs in field and storage condition. Avoid planting corms infested with mealy bugs.

As a prophylactic measure, dip the planting material in monocrotophos solution (1.25ml in 1 lit of water) for 10 minutes.

Harvesting: Harvest the crop at 9 months after planting when all leaves turn yellow and dry off.

Yield: 25 to 40 t/ha.

SPICES & CONDIMENTS

ONION

Allium cepa L.

Variety : Pusa Red, Pusa Ratnar, Pusa White (Round), Pusa white (Flat), N-53, Agrifound Light Red, Punjab Red Round, Pusa Madhuri, Arka Niketan.

Description:

Pusa Red: Plant height 30 cm; bulb medium sized (70-90 g each,) flatish round; purplish red, less pungent, maturity 125-140 days after transplanting; 12 bulbs weight about 1 kg; characteristically free from bolting tendency; keeps well in storage; short to intermediate day length type.

Pusa Ratnar: Plant height 30 cm; leaf dark green with waxy bloom; bulb large, obovate to flat globular, attractive bronze deep red coloured, less pungent, neck dropping; maturity about 125 days after transplanting; heavy yielder (500 q/ha); less bolting tendency, keeps better in storage.

Pusa White (Round): Bulb white, roundish flat in shape; av. Yield 300 q/ha suitable for dehydration.

Pusa White (Flat): Bulb medium to large in size, flatish round in shape, attractively white coloured; maturity 130-150 days; high yielder; good in storage and suitable for dehydration.

N-53: Bulb has bright scarlet red colour; maturity 121-140 days; bulb yield 197 q/ha.

Agrifound Light Red: Bulb globose, skin light red; duration about 110 days from transplanting to harvesting; yield 200 q/ha.

Punjab Red Round: Bulb round, neck thin, skin shining red; duration about 120 days from transplanting to harvesting; yield about 200 q/ha.

Pusa Madhavi: Bulb round, neck thin, skin light red; duration about 125 days from transplanting to harvesting; yield about 220 q/ha.

Arka Niketan: High yielding short duration and low bolting variety.

Soil: Well drained sandy loam to silty loam rich in organic matter with pH 5.5-6.5.

Seed bed preparation and seedling raising:

Refer "procedures for nursery raising of transplanted vegetable crops".

Field preparation:

The field should be prepared to a fine tilth. Apply FYM or compost during field preparation.

Seed rate:

10-12 kg /ha (for transplanting).

20-25kg/ha (for direct sowing).

Sowing time : Last week of September – mid October.

For Hills Zone : Transplanting of seedlings should be done in the last week of October (25th October).

Method of sowing/planting:

1. Direct sowing: Seeds are sown in lines in a well prepared field and seedlings are thinned out to proper spacing after 6-8 weeks. Direct sowing is preferable in river bed or "CHAR" areas.
2. Transplanting: 6-8 weeks old seedlings are planted either in dry or puddled beds. In dry planting, irrigation is provided immediately after transplanting. Shallow planting should be done at 2-3 cm depth.

Spacing: 20cm x 10 cm (Row to Row x Plant to Plant).

Manure and fertilizer:

FYM @ 20 t, N 60 kg, P₂O₅ 50 kg and K₂O 50 kg/ha, 40kg N and full doses of FYM, P₂O₅ and K₂O as basal and of the remaining N 10 kg to be top dressed at 30-40 days after planting followed by foliar spraying of remaining 10 kg N at 60-70 days. For hills zone; N @ 120kg, P₂O₅ 80 kg and K₂O 80 kg/ha is recommended.

Interculture:

1. Irrigation: At 7 days interval and a total of 10-15 irrigations required from transplanting to harvesting. Irrigation at bulb development is a great importance; however, it should be stopped at least 15 days before harvest.
2. Weeding: Preplanting application of Basalin @ 0.5 kg. a.i./ha followed by one hand weeding at 40 days after transplanting should be done to control the weeds.

Plant protection:

1. **Thrips:** Spray malathion 50 ec. 0.2 % (@ 2.0 ml./lit. of water with a spray volume of 370 lit./ha)

Harvesting and Curing:

The crop matures in 3-4 months after planting of when 70% of plant starts drying. Harvesting should be avoided during rainy period. At least 10-15 days ahead of harvesting denecking (breaking of stem) should be done for proper drying of the bulb. After lifting the bulbs, they may either be left in the field for curing or removed to provide shade for curing. After curing sort out the injured, damaged and thick necked bulbs from healthy stock and the thoroughly ripened and well cured ones with thin necks. For storage of onion, bulbs are suspended in bundles on bamboos or ropes. Besides, bulb can be stored for a considerable period of time on dry sand (5cm thick) spread over pacca floor and room temperature.

Yield: 150 – 200 q/ha.

Benefit Cost ratio: 7.92

GARLIC

Allium sativum L

Variety: Selected local varieties, Eknalia, 56-4 and G-1.

Soil: Well drained sandy loam rich in organic matter with pH 5.5-7.0

Field preparation: As in onion.

Seed rate: About 350-500 kg cloves/ha.

Sowing time: September – October

Spacing: 15cm x 5-7 cm (Row to Row x Plant to Plant).

Manure & Fertilizer :

FYM @ 20 t, N 100 kg, P₂O₅ 80 kg. and K₂O 60 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be supplied as basal and the remaining half of N to be top dress at 30 days after sowing.

Interculture:

1. Irrigation: Irrigation through drip of 2-3 mm (100% evaporation replenishment) after every 2 days from 10 days after emergence during rainless period.
2. Weeding: First weeding at 30 days and the second at 60 days after planting.

Harvesting and curing:

Garlic is a crop of about 4 – 5 month duration. Harvesting of bulbs should be done when the leaves start drying, yellowing or browning and show the signs of drying. The bulb should be cured for 7-10 days.

Plant protection: Same as in onion.

Yield: 60-90q/ha.

Benefit Cost ratio : 4.24

CHILLI

Capsicum annuum L. var. *acuminatum*

Variety : NP 46 A, Pusa Jwala and selected local varieties like Suryamukhi, Krishna and Balijuri.

Description:

NP 46 A: Plant dwarf, dense, spreading fruit long (about 10.7 cm), thin, green when unripe and bright red when ripe, less seeded, pungent, prolific bearer; medium early; tolerant to thrips; contains 0.5 mg capsaicin per gram of fruit.

Pusa Jwala: Plant dwarf, spreading fruit long, thin, usually, curved, red coloured; more suited as green chilli; tolerant to thrips, leaf curl and mosaic viruses; contains 0.43 mg capsaicin per gram of fruit.

Soil:

Well drained sandy loam rich in organic matter with pH 6.0-6.5

Field Preparation:

The field should be prepared to fine tilth and FYM to be applied.

Seed Bed Preparation and Seedling raising:

Refer Procedure for "Nursery raising of transplanted vegetable crops".

Time to Sowing: December-January.

Seed Rate: 600-700 g/ha 3-4 g of seeds should be sown per 10 sq.m.

Method of Sowing or Planting:

1. Direct Sowing: Seeds should be sown thinly in lines spaced at 40-45 cm and seedlings are thinned out to proper spacing later on.
2. Transplanting: 4-5 weeks old seedlings are to be transplanting in the field.

Spacing: (Row to Row x Plant to Plant)

45 cm x 45 cm.

Manure and Fertilizer:

FYM @ 10t, N 120 kg, P₂O₅ 60 kg and K₂O 60 kg/ha. Half of N and full doses of FYM, P₂O₅ and K₂O should be applied as basal and the remaining half of N to be top dressed at 30-35 days after transplanting.

For direct seeded chilli, N: P₂O₅: K₂O @ 150: 75: 75 kg/ha should be applied as basal dose.

Interculture :

Irrigation : 4 cm irrigation water at 18-20 days interval by surface flooding method

Plant Protection:

1. Fruit rot or Anthracnose disease: Spray Captan 50 WP 0.2% (@ 2 g/lit. of water) or Dofolatan 0.2%.
2. Root knot Nematode: Neem oil cake: Mustard oil cakes and cattle manure application reduces infestation.

Yield: 70-80 q of green chilli/ha.

Benefit Cost ratio: 4.24

BHUT JALAKIA

Capsicum chinense

Varieties

<u>Types</u>	<u>Description</u>
Borbhut	Fruits are bigger in size with average fruit weight 7g, fruits with dark green colour should be selected
Ranibhut	Fruits are of medium size with average fruit weight 5g
Lotabhut	Fruits are slender with average fruit weight 5g. Plants have a tendency to climb.

Soil

Well drained sandy loam rich in organic matter having good water holding capacity with pH 6.0-6.5

Field Preparation

The field should be prepared well with ploughing and harrowing. Cross ploughing is advocated to avoid the possibility of unploughed strip remained.

Seed Bed Preparation and Seedling Raising

Seed collection

- * Collect mature red ripe fruits from authentic source. The mother plants should be free of diseases and in bearing of healthy fruits.
- * Extract the seeds manually using blades and forceps.
- * Always use hand gloves and spectacles for such work.
- * Wash the freshly extracted seeds in clean water and dry under shade.
- * Before sowing, treat the seeds with 1% potassium nitrate or potassium iodide solution for 3 ha. Alternately, the seeds should be soaked overnight in 0.1% solution of potassium nitrate or potassium iodide. In place of the chemicals, seeds can also be soaked overnight in fresh cow urine diluted 10 times.
- * The treated seeds should be dried under shade for 12 hours after treatments.

Seed Bed Preparation

- * The nursery bed should be prepared in well drained sunny area.

- * 20 kg sand or silt and 20 kg well decomposed sieved cattle manure or compost per 10 m² area should be mixed thoroughly.
- * The bed should be drenched with 0.1% Bavistin + 0.2% Captan @ 3 lit per m².
- * The bed should be covered with a polyethylene sheet for 2 days.
- * The bed should be uncovered and exposed for 1 more day.

Sowing

- * Sow the germinated seeds thinly in furrows spaced at 2.5 cm.
- * Cover the seeds with a thin layer of treated mixture of sand and sieved cattle manure.
- * Water the bed lightly.
- * Place an overhead insect-proof net (40 mesh), 1m high, covering all sides.
- * Keep another transparent polyethylene sheet ready for placing on the overhead structure to serve as a rain-shelter at necessity.
- * The seedlings get ready for transplanting in 30-45 days after sowing when they attain 10-15 cm height.
- * Harden the seedlings before lifting by gradual reduction of water for about a week.
- * Copiously water the bed 6 h prior to lifting for minimizing root damage during removal of seedling and maintaining plant turgidity.

Sowing Time

- * Sept-Nov in the plains for irrigated crops
- * Jan/Feb for rainfed crops
- * Jan-March for hills region

Seed Rate

- * 15g seeds/bigha
- * 115g seeds/ha

Spacing

- * 1.0 m row to row
- * 0.75-1.0 m plant to plant

Land Preparation

- * Raised bed (15 cm) of 2.40 m width and convenient length should be prepared keeping 40 cm wide inter-bed channels. The channels should be connected to drainage ditch of deeper level.
- * Pits measuring 45 cm × 45 cm × 45 cm at the recommended spacing should be prepared leaving 20 cm longitudinally on both sides of the beds.

Transplanting

- * 30-45 days old seedlings should be transplanted.

Manures and Fertilizers

- * FYM @ 1 kg/pit to be applied at final land preparation and mixed well.
- * NPK @12-6-6 g/pit should be applied. Half of nitrogen and full doses of phosphorus and potash should be applied as basal and the remaining half of nitrogen to be top dressed in 2 splits at 30 and 60 days after transplanting.
- * Each seedling should be dipped in a slurry made from 5g Azospirillum and 5g PSB for 1 h before transplanting in a pit.
- * Foliar application of Multiplex 0.2% should be done during active growth stage.
- * Application of growth promoter like 0.2% Tricentanol is also recommended for boosting up growth and yield.

Intercultural Operations

- * Pre-planting application of Pendimethalin @ 1.25 kg per ha followed by 3 manual weeding at 30, 60 and 90 days after transplanting.
- * Mulching with organic materials or LDPE film can also be practised for suppression of weeds.
- * The crop cannot tolerate very intense sunlight. Therefore, appropriate measures should be taken to raise non-competitive shade plants.
- * Staking with bamboo sticks may be required to provide mechanical support to the plants.

Insect management

- * For controlling insects like aphids, thrips, white fly, leaf and plant hoppers, apply Imidachloropid or Thioamethoxam 20-25 g a.i./ha.
- * Apply Profenofos 50 EC (1 ml/lit) against mites and lepidopteran insects.

- * For controlling fruit borer, spray Lambdacyhalophrin @ 0.1 ml/lit at the time of fruit setting followed by another spray after 15-20 days.
- * In organic culture, spray Beauveria basiana @ 3 ml/lit against sucking pests. Neem seed kernel extract (NSKE) 5% may also be sprayed @ 3 ml/lit for repelling insect pests.

Yield: 120-150 q/ha

B:C ratio: 8.7

CAPSICUM

Capsicum annuum L.var. *grossum*

Variety: California Wonder, Elephant Trunk, Arka Mohini, Arka Gaurav and Selection-16.

(The other cultivation practices are same as for chilli).

GINGER

Zingiber officinale L.

Variety : Rio-de-Geneiro, Nadia, Karkai, Bardwan, Moran, Jorhat and China.

Soil : Well drained medium loam.

Seed Rate: Seed rhizome with one or two good buds weighing about 5g @ 10-15 q/ha.

Planting Time: March-April

Spacing: 25 cm x 15x 10 cm (Row to Row x Plant to Plant) to be planted in shallow pit.

Manure and Fertilizer:

FYM @ 10 t, N 20 kg, P₂O₅ 60 kg and K₂O 20 kg/ha, Half of N and full doses of FYM, P₂O₅ and K₂O to be applied as basal and the remaining half of N to be top dressed at 60 days after planting.

Interculture:

1. **Mulching**: First mulching should be done after planting and to be repeated at 40 days after planting with suitable mulching material like paddy husk and saw dust.
2. **Irrigation**: At 15 days interval during dry spell.
3. **Weeding**: First weeding at 40 days after planting (before second mulching) and to be repeated depending upon intensity of weed growth.
4. **Earthing up**: To be done along with weeding.

Plant Protection:

1. Shoot borer and leaf roller: Spray dimethoate 0.05%.
2. Rhizome (soft) rot: (a) Drainage system should be improved. (b) Prophylactic measure should be taken through treatment of seed rhizome with Mancozeb 75 WP (2g/l) or Metalaxyl & Mancozeb 75 WP formulation 0.3% before storage or planting. (c) The affected areas should be drenched with 0.3% Mancozeb 75 WP (2g/l) or Captaf.

Rhizome treatment with Copper oxychloride (COC) @ 3g/Lit + streptomycin (0.2g/Lit) for 45 minutes followed by shade drying and planting and two soil drenching with COC @ 3g/Lit at 60 and 90 days after planting against rhizome rot of ginger and alternatively rhizome treatment with Biofor-pf + 2 soil drenching with Copper oxychloride (3g/Lit) at 60 and 90 days after planting and also for organic management, rhizome treatment with Biofor- pf followed by spraying with Biozine @100ml /clump at 60, 90 and 120 days after planting against rhizome rot of ginger.

3. Leaf spot: Apply 1% Bordeaux mixture or 0.2% Thiram.

Harvesting and Curing:

The crop should be harvested when leaves start yellowing and gradually dry up. Rhizomes should be thoroughly washed in water 2-3 times to remove soil and dirt and then dried in sun for a day.

Yield: 150-200 q/ha.

Benefit Cost ratio: 5.29

TURMERIC

Curcuma longa Linn.

Variety : Shillong Type, Tall clone, CL-24, PTS-38, PCT-13, and VK-145

Description:

Shillong Type : Plant height 140-180 cm; tiller 2-3/clone; leaf 6-9/tiller leaf shiny green; finger rhizome stout, reddish; mother rhizome smaller and constitutes about 24% of the total crop; maturity 255 days; percentage of dry turmeric to green turmeric is 16; highly resistant to *Collectotrichum* leaf spot and *Taphrina* leaf spot.

Tall Clone : Plant height 160-190 cm; tiller 2-3/clump; leaf 5-8/tiller; finger rhizome stout, reddish-yellow; maturity 210-280 days, percentage of dry turmeric to green turmeric is 17; susceptible to *Taphrina* leaf spot in the later stage.

CL-24: Medium duration variety with av. curing % 26.35, av. Yield of cured produce of 11.60 t/ha and curcumin content 8.55% av. fresh rhizome yield is 54 t/ha with good tolerance capacity towards common disease and pests.

PTC-38: Medium duration variety with almost 24% curing, av. cured produce of 12.15 t/ha and curcumin content 5.75%. Average fresh rhizome yield is almost 54 t/ha with good field tolerance to common pests and disease.

PCT-13: Medium duration variety with 17.15% av. curing and 11.25 t/ha cured produce. Average fresh rhizome yield is 66t/ha and curcumin content is 4.8%. This variety is also tolerant to common pests and diseases.

Soil :

Well drained sandy loam to clay loam rich in organic matter.

Seed Rate: Mother or finger rhizome @ 25 q/ha.

Planting time: April

Spacing: 45 cm x 25 cm (Row to Row x Plant to Plant).

Rhizomes are to be planted in furrows at 10 cm depth.

Manure and Fertilizer:

FYM @ 20t, N 30 kg, P₂O₅ 50 kg and K₂O 60 kg/ha, half of K₂O and full doses or FYM and P₂O₅ should be applied as basal. Half of N and the remaining half of K₂O should be side dressed at first earthing up (3 months after planting) and the remaining half of N to be side dressed at second earthing up (4 months after planting). For hills zone; N @ 90 kg, P₂O₅ 50 kg and K₂O 60 kg/ha is recommended.

Interculture: As in Ginger

Plant Protection:

1. **Mites, Leaf roller and shoot borer:** Spray phosphamidon 0.06% (0.6 ml/lit. of water)
2. **Taphrina and Collectotrichum leaf spot:** Apply 1% Bordeaux mixture or Zincs or Mancozeb75 WP (2g/l). Spraying should be done at 15 days interval starting at the first appearance of the disease
3. **Rhizome rot:** Same measure as in Ginger.

Harvesting and Curing:

The crop should be harvested when leaves after yellowing and gradually dry up. Fingers are separated from rhizome, cleaned and dried for one day.

Processing:

The clean rhizomes are boiled to make them soft in water containing alkaline substances like, lime, sodium bicarbonate or sodium carbonate at 0.05% - 0.1% concentration. Alkalinity of boiling water helps for developing orange yellow tinge to the core of the turmeric. The boiled turmeric is dried in the sun until they produce metallic sound. The dried rhizomes are polished by putting the rhizome in a gunny bag and struck against floor to remove the scales and roots.

The next stage in processing is giving yellow colour externally to the turmeric tubers to make them attractive in the eyes of the buyers. The polished fingers are taken in a vicker basket which is shaken continuously while a prepared emulsion is poured in. After the fingers are uniformly coated with the emulsion they are again dried in the sun.

The composition of the emulsion required for coating 100 kg of polished turmeric is –

Alum	0.04 kg
Turmeric Powder	2.00 kg
Castor seed	0.14 kg.
Sodium bisulphate	0.30 kg
Hydrochloric acid	0.30 ml (Developed by CFTRI, Mysore)
Curing Percentage	14-16%
Curcumin Content	2.5-3.5 %

Yield: 300-350q rhizome/ha.

Benefit Cost ratio: 7.77

CORIANDER

Coriandrum sativum L.

Variety :

Bold seeded: UD 21, GAUI, CSI and CIMPO 33 (Normally cultivated under irrigated condition).

Small seeded: UP 41, Pusa 360 and Local selection (suitable for cultivation under rained condition).

Soil:

Well drained medium to heavy soil rich in organic matter with PH 6.0-7.0.

Field preparation:

Field should be thoroughly ploughed and harrowed to obtain a fine seeding bed and FYM to be applied.

Seed rate: 8-10 kg/ha.

Sowing time: Mid October-November

Seed treatment:

For ensuring good germination, seed should be soaked in water for 12-24 hours. Floated seeds should be discarded. Seeds should be treated with Captan 50 WP @ 2 g/kg seed before sowing and rubbed or crushed between palms until the pericarps separate.

Spacing: Directly sown in lines spaced at 30 cm and later on thinned to 20 cm within rows at 35-40 days after sowing.

Manure and Fertilizer: FYM @10-15 t, N 50 kg, P₂O₅ 50 kg and K₂O 50 kg/ha basal application

Interculture:

1. Irrigation: Application of 4 cm irrigation at 18-20 days interval by surface flooding
2. Weeding: Sufficient weeding as per necessary.

Plant protection:

1. **Wilt:** Take prophylactic measure through seed treatment.
2. **Powdery mildew:** Apply wettable sulphur @ 2 kg/ha.
3. **Stem gall:** Take prophylactic measure by sun drying the seed thoroughly.

Harvesting:

The crop matures in 4 months. Stage of harvesting influences seed yield and oil content. Seed should be harvested at fully ripe stage. Unripe seeds lack the pleasant odour.

Yield: 45 q of seed/ha

BLACK CUMIN

Nigella sativa L.

Variety: Local cultivars.

Soil: Well drained high sandy loam soil rich in organic matter with pH 6.0-7.0.

Field Preparation: Land should be thoroughly prepared by 5-6 ploughing and laddering. FYM should be applied.

Seed Rate: 7.5-8.0 kg/ha.

Sowing Time: Mid October- November

Seed Treatment:

Seeds should be soaked in water for 24-36 hours followed by drying in shade. Dry seed treatment should be done with Captan50 WP @ 3 g/kg seed.

Spacing:

Seed should be directly sown in lines spaced at 30 cm and seedlings are thinned out to 10 cm within row at 35-40 days after sowing.

Manure and Fertilizer:

FYM @ 20 t, N 30 kg, P₂O₅ 40 kg and K₂O 40 kg/ha, half of N and full doses of FYM P₂O₅ and K₂O to be applied as basal and the remaining half of N should be applied in two equal splits, first at 6-8 weeks after sowing and the second just prior to flowering.

Interculture:

1. Irrigation: First irrigation at 35-40 days, second at 60 days and the third at 80-85 days after sowing.
2. Weeding: First weeding should be done at 35-40 days after sowing followed by another at 60 days after sowing.

Plant Protection:

1. **Cut worm and Fruit borer:** Apply oxydemeton methyl or dimethoate 0.1% (1 ml/lit of water) or phosphamidon 0.05% (0.05 ml/lit. of water).
2. **Stem rot:** Apply copper oxychloride 50WP or Mancozeb 75WP (2g/lit) at an interval of 15-20 days.

Harvesting:

Transition of plant and fruit colour to yellow indicates the right stage of harvest. The plants should be uprooted or cut at ground level, stacked for 7 days and threshed.

Yield: 8-15 q of seed/ha.

CUMIN

Cuminum cyminum L.

Variety : RS- 1, S-404, MC-43, NP (6)-1, NP (J)-140 and NP (J)-126

Soil: Well drained sandy loam rich in organic matter with pH 6.0-7.0.

Field preparation:

Land should be prepared thoroughly and FYM should be applied.

Seed rate: 10-15 kg/ha.

Sowing time: February-March

Seed treatment: As in Black cumin.

Method of sowing and spacing:

Seed are sown on rows spaced at 50 cm, in finally prepared and irrigated beds. Thinning should be done afterwards to maintain a plant spacing of 10 cm within row.

Manure and Fertilizer : As in Black cumin

Interculture:

1. **Irrigation:** A light irrigation before sowing, another at 7-8 days after sowing (at germination) and at 15-20 days interval thereafter.

2. **Weeding:** Same as in Black cumin.

Harvesting: As in Black cumin

Yield : 8-10 q/ha.

FENNEL

Foeniculum vulgare Mill

Variety:

Selected local varieties and PF-35

Soil: Well drained sandy loam rich in organic matter with pH 6.0-7.0.

Field Preparation: Land should be prepared thoroughly and FYM should be applied.

Seed Rate: 10-12 kg/ha.

Sowing Time: October-November

Seed Treatment: Seed should be treated with Captaf @ 2 g/kg seed.

Spacing: Same as in Black cumin.

Manure and Fertilizer :

FYM @ 20 t, N 50 kg and P₂O₅ 25 kg/ha. Half of N and full doses of FYM and P₂O₅ should be applied as basal and the remaining half of N to be top dressed at 40 days after sowing. All total 5-6 irrigation are required depending upon soil and climatic conditions.

Weeding: As in Black cumin

Harvesting:

The crop is ready for harvesting in 4-5 months.

Yield: 10 q of seed/ha.

FENUGREEK

Trigonella foenum graceum L.

Variety:

Pusa Early Bunching, Kasuri and Methi No.47

Soil: Well drained sandy loam to clay loam rich in organic matter with PH6.0-7.0.

Field preparation:

The land should be prepared to a fine tilth and FYM to be applied.

Seed rate: 20-25 kg/ha.

Sowing time: Mid October-November

Spacing:

Directly sown in rows spaced at 30 cm and seedlings are thinned out to 10 cm within the rows at 35-40 days after sowing.

Seed treatment: Seed should be treated with Captaf @ 2 g/kg seed.

Manure and Fertilizer: N:P₂O₅:K₂O::25:25:30 kg/ha.

Interculture:

1. Irrigation: A light irrigation should be done just after sowing and frequently thereafter; generally, each cutting should be followed by a light irrigation.
2. Weeding: Weeds must be controlled within 20-25 days after sowing.

Harvesting:

The young shoots are nipped off about 3 weeks after sowing. Later on the whole plant is pulled out, bunched and marketed. Sometimes the plants are left in situ to produce seeds after taking 2-3 cuttings.

Yield: Leaf yield 70-100 q/ha.

Seed yield 6-15 q/ha (Provided no leaf cutting is made.)

MINT

Mentha arvensis L.

Variety: Japanese Mint and Local varieties.

Soil: Well drained organic or loamy to loamy clay with pH 6.5-7.0.

Planting Material: Propagated by runners or rooted cuttings of parent plant.

Seed Rate:

2.5-3.5 q suckers are required to plant a hectare of land. Suckers are planted in furrows 12-15 cm apart.

Treatment:

The Stolen should be treated with 0.1% solution of Dithane M-45 for 5-10 minutes before planting against root rot.

Manure and Fertilizer:

30 to FYM per ha should be applied before planting. Also, application of 150 kg N, 80 kg P and 60 kg K per ha is necessary. Nitrogen should be applied in split doses.

Interculture:

1. Irrigation: It required occasional irrigation be provided alternate days.
2. Weeding: Two hoeing operations for each flush of crops.

Harvesting:

It requires special care during harvesting otherwise yield is affected. Harvesting should be done in the morning on a bright sunny day.

Yield: Japanese mint yields 248 kg green leaves per ha.

Plant protection: (Cumin, Fennel, Fenugreek and Mint).

1. **Powdery mildew:** Can be controlled be spraying wettable sulphur @ 1 kg/ha or Karathane @ 500 ml/ha in 625 lit. of water. The spray should be repeated after 10-15 days. Dusting the crop with 20-25 kg sulphur dust/ha would also control the disease.
2. **Blight:** At the time of flowering the crop should be treated with Indofil Z-78 or Fytolan of Difolaton @ 600-1000 g/ha, Indofil Z-78 can be mixed with Karathane to control both blight and powdery mildew.
3. **Wilt:** Runner or sucker treatment with carbendazim @ 2 g/kg of planting materials.
4. **Termite:** Soil application of malathion 5% dust @ 25 kg/ha at the time of field preparation.
5. **Aphid:** Spraying 625 ml Malathion in 625 lit, of water/ha is recommended. Spray should be repeated at 10-15 days interval according to need.
6. Other pests like stink bug and leaf eating caterpillar are seen feeding on the crop but not that seriously which need control.

BLACK PEPPER

Piper nigrum L.

Variety:

Only hermaphrodite varieties should be cultivated.

The following varieties are common.

1. Panniyur-1 (hybrid variety).
2. Kalluvalli.
3. Balankotta.
4. Karimunda.
5. Kottandan.
6. Arkulam Munda.

Soil:

Well drained alluvium with a high organic matter content.

Propagation:

Black pepper is propagated from cuttings rather than from seeds. Runners used for cuttings should be of 3 nodes length and can be planted directly near the standard (support) or in polythene sleeves in the nursery filled with 1:3 part well rotten cowdung or compost and virgin soil.

Time of taking cutting: March.

Time required for rooting and new shooting: 2 to 3 months.

Time of planting in the main field: May/June.

Method of planting:

Planting in virgin land can be done by providing some kind of standard like some fast growing trees, e.g., fast growing trees, e.g., Modar (*Erythrina indica*) or wooden posts. Coconut or arecanut can also be used as standard. The cuttings should be planted 30 cm away from the support.

Spacing: 3 m x 3 m.

Pit Size: 50 cm x 50 cm x 50 cm.

Manure and Fertilizer: Compost @ 9 kg, Urea 225g, SSP 1kg, MOP 100g and lime 500-1000 g per plant at the following rates.

1st year: ½ of the full dose.

2nd year: ½ of the full dose.

3rd year: ¾ of the full dose.

4th year onward: Full dose.

April is the best time for application.

Interculture operation:

Pepper Plant makes rapid growth and the vine should be tied to the support at 30 cm interval. The lower portion up to 90 cm of the vine is to be kept clean and unranked. Encourage the vine to produce lateral fruiting branches and do not allow growing to a height beyond 4m. Mulching near the collar of the vine conserves moisture during the drought period.

Looping of the branches of the standard trees is essential in monsoon to ensure proper fruit-setting.

Plant Protection:

1. **Pollu beetle:** The grubs feed on tender berries and make them hollow. endosulfan 35 EC or quinalphos 25 EC or dimethoate 30 EC @ 1 ml/lit of water should be sprayed in July and October.
2. **Marginal gall forming thrips:** It attacks the leaves and makes crinkles. Malathion 50 EC @ 1 ml/lit of water should be sprayed.
3. **Quick wilt:** In monsoon, infection appears 25-30 cm above ground level and the vine dies within 10-12 days. Spray 1% Bordeaux mixture before onset of monsoon on the ground up to 1 m of the vine,.

OYSTER MUSHROOM CULTIVATION

Advantage of oyster mushroom over button mushroom (*Agaricus* spp.) or paddy straw mushroom (*Volvariella* spp).

- i) Cultivation technology is easier to take up.
- ii) Most suitable for the climate of Assam.
- iii) Can be grown for a longer period in a year-7 months.
- iv) Not exigent in its temperature requirement-20 to 33°C.
- v) Possesses the highest biconversion ability-60%
- vi) Can be easily sundried and preserved.

Season:

It is grown in a temperature range of 20° to 33°C. The best temperature is around 25°C.

The best months in a year for growing this mushroom at Jorhat are September to March. The remaining five months, viz. April to August are not favourable. It may take a month longer to bear mushroom after opening of beds. Besides, the yield is poor, June is the last favourable month for this mushroom.

Species of oyster mushroom:

Seven species, viz. *Pleurotus sajorcaju*, *P. citrinopoleatus*, *P. florida*, *P. cornucopie*, *P. sapidus*, *P. ostreatus* and *P. flabellatus* were successfully grown at Jorhat. For winter, i.e. during December, January and February, *P. florida* is more suitable than others.

Substrate:

Rice straw is the best substrate among all the materials. Rice stubbles and mustard husk are also good substrates. Rice straw from Ahu crop (harvested in July) causes contamination of bed.

Soaking:

Straw is soaked in clear water for 12 hrs. If soaking is done during night, all the steps in preparing Mushroom beds can be completed in the following day time. About 12 kg of straw can be soaked in an empty oil; drum. Place a boulder to check floating of straw.

Pasteurization on straw:

It means partial sterilization of straw. The purpose is to eliminate unwanted micro organisms from the straw. Without this treatment, performance of mushroom beds will be erratic. The yield is more consistent with pasteurization. It can be done by the following method.

With boiling water:

Water is boiled to 85°C in aluminium vessel or in a cauldron. Wet straw is immersed in this for 30 min. Treated straw is spread on a cement floor for 15 min. to drain excess water. This method is not fully efficient.

There is however a plus point with hot water treatment since the yield is better than in steam pasteurization. The fungus breaks down straw quickly and established itself faster in boiled straw compared to steamed straw.

Spawn: Spawn, i.e. seed of mushroom consists of mycelium of the fungus grown on grains.

Spawn, i.e. seed of mushroom consists of mycelium of the fungus grown on grains. It is produced in saline bottle or polypropylene bags. If there is no immediate use, the spawn can be stored at room temperature up to two months from the date of inoculation.

Spawning: It means seedling of substrate with spawn.

Polythene bag method:

- Get polythene bag of 40 x 60 cm. This can hold 3 kg of wet straw.
- Punch holes at a distance of 10 cm.
- Remove spawn from bottle or bag, squeeze it to separate grains.

How much spawn to use :

- Add @ 3% the weight of wet substrate. 90 g of spawn is required to seed 3 kg of wet straw.
- Put 10 cm. Layer of the straw in the polythene bag and press it.
- Fill the bags to 3/4th capacity with alternate layers of straw and spawn.
- Tie the bag and place in spawn-running room.

Spawn running: Filled bags or cubes are arranged on rack in a dark room for 12 to 15 days. 20° to 30°C is good for spawn run. A cottony growth proliferates through straw. The bed is taken out by inverting the bag. The opened bed is transferred to cropping room.

Cropping:

Direct sunlight should not fall in to the cropping room. Ventillation and diffused light is required for fruiting. Small pinheads surface of mushrooms can be harvested at weekly interval. Water should be sprayed three times a day. One kg of dry straw will produce 600 to 800g of mushroom in three flushes. Mushrooms

are plucked before their edges curl upwards. Overmatured mushrooms shed spores forming a white coating on the ground. To get optimum yield and better nutritive quality paddy straw mushroom should be harvested when the volva are still intact.

String:

Use paper bags for packing. They can be kept for a maximum of 7 days in a refrigerator.

MICROPROPAGATION IN HORTICULTURAL CROPS

A number of plants are vegetatively propagated using rhizomes, bulbs, stem cutting or through conventional techniques, such as grafting, layering, budding etc. These include majority of fruit crops, ornamental plants etc. However, because of low multiplication rate and progressive build up of pest and pathogens, there is often scarcity, of healthy planting material in these crops. Alternatively, an economical method is available for rapid control multiplication, average yield of several important crops and forage tree can be tremendously increased by selecting propagation of already existing elite genotypes. Development of tissue culture techniques has revolutionized the clonal propagation for past 2-3 decades and plant regeneration in vitro has been reported for over 100 species. The following are some of the highlights of micropropagation of some of the horticultural crops which have been undertaken during last few years.

- 1) The technique of regeneration from internodes segment of *Citrus reticulata* cv. Khasi mandarin and *Citrus limon* cv. Assam lemon was standardized by culturing them on modified M.S. medium supplemented with 0.25 mg/l BAP + 0.5 mg /l NAA +0.5 mg/l IBA.
- 2) The techniques for regeneration of kashi mandarin was standardized by culturing the nucellar tissue on (Murashige and Tucker (MT), (1969) medium supplemented with 500 mg malt extract. Nucellar calli are the ideal for protoplast culture.
- 3) The technique for shoot tip and nodal segment culture was standardized for citron (*C. medica*) on modified MS medium supplemented with 1 mg/l BAP + 0.5 mg /l kinetin + 0.5mg/l NAA.
- 4) The technique for in-vitro propagation of *Poncirus trifoliata* from shoot tip of mature plant (8-9 years old) was standardized by culturing on modified MS media with 1 mg /l NAA-1 + 1 mg/l kinetin.
- 5) Modified Mutative and Scourged (1962 (MS) media + 0.25 mg/l IAA+2mg/l BAP for shoot proliferation and MS basal + 1.5 mg/l IAA for rooting was standardized for Heliconia by taking auxiliary and terminal bud.
- 6) Notch media (1969) media (1969) supplemented with 0.1 mg/l IAA +0.5 mg/l IBA exhibited the immature embryo of cymbidium in to protector and protocol in to shoot and root proliferation. In in-vivo condition the survival percentage was 76.67%.

USES OF PLASTICS IN HORTICULTURE

The use of plastics in Horticulture is one of the new technologies, which had made rapid development in the agricultural sector and made a direct contribution to improve crop production in many ways. Plastics are now a days extensively used as roofing materials in the greenhouse, polyhouse or low tunnel, as mulching materials in the crop field and as lining materials in a surface irrigation channels. The major thrust area of plasticulture is in drip and sprinkler irrigation.

The following technologies for the use of plastics in horticultural sector are recommended for Assam.

Off season Production of vegetable under Plastic Greenhouse:

Forcing of vegetables for early as well as off-season market has been found to be possible under UV-stabilized transplant LDPE-polyhouse cum rainsheiter in Assam. The gable Even design polyhouse can be easily built with locally available framing materials like bamboo or wood. The UV stabilized plastic materials of 200-micron thickness should be used as the cladding materials. The durability of this plastic material is 5-6 years. The details of erection cost for 20m x 5m i.e., 100 sq.m. floor area polyhouse of bamboo frame is given below.

ESTIMATE FOR CONSTRUCTION OF BAMBOO STRUCTURE LOW COST PLASTIC GREENHOUSE

Floor Area = 5.00m x 20.00m = 100 sqm.

Item No. 1: Earthwork in excavation for foundation, In ordinary soil.

- a) Length 21.00 m
 b) Breadth 6.00 m
 c) Height 0.30 m

$$21 \text{ m} \times 6.0 \text{ m} \times 0.30 \text{ m} = 37.80\text{m}^3$$

@ Rs.29.00/ m³ Rs. 1,096.20

Item No. 2 : Larger diameter bamboo works (Bhaluka Bamboo) for making,
 a. Central post b. Tie beam c. Side post.

	<u>Nos.</u>	<u>Length(m)</u>	<u>Total length(m)</u>
a.	7	3.50	24.50
b.	7	6.50	45.50
c.	14	2.50	35.00
			105.00 m

@ Rs. 7.00/m Rs. 735.00

Item No. 3 : Smaller diameter bamboo works (Jati Bamboo) for making,
 a. Purlin b. Ruffer c. Roof making (Kami) d. Supporting kami.

	<u>Nos.</u>	<u>Length(m)</u>	<u>Total length(m)</u>	
a.	7	21.60	151.20	
b.	28	0.80	22.40	
c.	84	6.80 (5 No of Kami)	114.00	
	28	21.00(5 No of Kami)	118.00	
d.	31	6.8 (4 No of Kami)	<u>52.70</u>	
			458.30m	
	@ Rs.5.00/m			Rs. 2,291.50

Item No. 4 : Others

a.	Coal tar – 2 lits		Rs. 200.00
b.	G. I. Wire. 3 kg		Rs. 150.00
c.	Coconut rope. 1 kg.		Rs. 50.00
d.	Nails 0.5kg. (1 inch long)		Rs.40.00
e.	Kami/Bet		Rs.50.00

Item No. 5 : U. V. Stabilized film (200 micron thick)

a.	For roof making	29kg	
b.	For wall making	<u>22 kg</u>	
		51 kg	
	@ Rs.200.00/kg (Approx.)		Rs. 10,200.00
	AGST (Tax) 8.8%		Rs. 898.00

Item No. 6 : Labour charges for roof making and plinths filling etc.

40 Mandays @ Rs. 80.00/day		Rs. 3,200.00
		Rs. 18,910.70

Say Total Rs. 18,911.00

(Rupees eighteen thousand nine hundred eleven) only

ESTIMATE FOR CONSTRUCTION OF BAMBOO STRUCTURE LOW COST AGRO SHADE NET HOUSE

Floor Area = 5.00m x 20.00m = 100 sqm.

Item No. 1 : Earthwork in excavation for foundation, in ordinary soil.

a)	Length	21.00 m	
b)	Breadth	6.00 m	
c)	Height	0.30 m	
		$21\text{ m} \times 6.0\text{ m} \times 0.30\text{ m} = 37.80\text{m}^3$	
	@ Rs.29.00/ m ³		Rs. 1,096.20

Item No. 2 : Larger diameter bamboo works (Bhaluka Bamboo) for making,

	a. Central post	b. Tie beam	c. Side post.
	<u>Nos.</u>	<u>Length(m)</u>	<u>Total length(m)</u>
a.	7	3.50	24.50
b.	7	6.50	45.50
c.	14	2.50	<u>35.00</u>
			105.00 m
	@ Rs. 7.00/m		Rs. 735.00

Item No. 3 : Smaller diameter bamboo works (Jati Bamboo) for making,
a. Purlin b. Rafter c. Roof making (Kami) d. Supporting kami.

	<u>Nos.</u>	<u>Length(m)</u>	<u>Total length(m)</u>
a.	7	21.60	151.20
b.	28	0.80	22.40
c.	84	6.80(5 No of Kami)	114.00
	28	21.00(5 No of Kami)	118.00
d.	31	6.8 (4 No of Kami)	<u>52.70</u>
			458.30m
	@ Rs. 5.00/m		Rs. 2,292.00

Item No. 4 : Others,

a.	Coal tar – 2 lits	Rs. 200.00
b.	G. I. Wire. 3 kg	Rs. 150.00
c.	Coconut rope. 1 kg.	Rs. 50.00
d.	Nails 0.5 kg. (1 inch long)	Rs. 40.00
e.	Kami/Bet	Rs. 50.00

Item No. 5 : Shade net (50-70%) shading

For roof cover = 6.70m x 21.50m = 144.05 sq.m.

@ Rs. 35.00/sq.m. Rs. 5,042.00

Item No. 6 : Labour charges for roof making and plinths filling etc.

40 Mandays @ Rs. 80.00/day Rs. 3,200.00

Total Rs. 12,855.20
Say Rs. 12,855.00
(Rupees twelve thousand eight hundred and fifty five) only

During summer, all side of polyhouse can be kept open or nylon nets may be provided in place of it for free passage of air. During winter, all the sides are replaced with plastic film, which caused an increase in temperature rise of at

least 4 -5°C than the ambient. In fact this polyhouse acts as a greenhouse during winter and a rain shelter during rainy season.

The following crop sequence can be adopted for raising as off-season vegetables under polyhouse by the farmers of Assam:

March to June : Tomato/Capsicum
June to August : Palak
August to November : Tomato/Capsicum
December to February : Cucumber

Recommended Varieties:

Recommended Varieties for growing under net house:

Tomato: Arka Alok, Arka Abha, Arka Saurabh, Namdhari Suraksha, Yash, BT10, BT1, LE-79, Rocky, All Rounder & Amlik.

Capsicum: California Wonder, Arka Gaurav, Bharat, Bull Nose, Selection – 16, Elephant Trunk, Swarna F1, Natasa & Mahabharata.

Palak: All Green, Pusa Jyoti and Pusa Harit

Cucumber: Pusa Sanyog, Long Green, Poinsette, AAUC-1 And AAUC-2.

Growing Ornamentals under plastic house:

Chrysanthemum

Variety : Purple Decorative, Gulmohar, Proff. Harris, Red Gold, Red Anemone, Ravi Kiran, Yellow Gold, Sadbhavana, Flirt and AAUCC-2 (Spray); Snow Ball, Diamond Jubilee, Sonar Bangla, White Spider, Houston, Stanly Glossing, and Dignity (Standard).

- Rooted cutting of spray variety of chrysanthemum should be planted in middle of April to get early and profuse flowering.
- Rooted cutting of chrysanthemum should be planted in September to get flower in December.

Gladiolus

- July is the best time for planting gladiolus

Plastic Mulch

Black LDPE-film of 20-micron thickness can suitably be used as mulch for suppression of weeds and promoting growth and development of crops like okra, tomato and banana. Mulching with 25-micron black poly films can be practiced by farmers for higher economic return in pineapple.

COCONUT-BASED MULTIPLE CROPPING

(An Ideal Household Garden for Assam Conditions)

In a state like Assam, where individual land holding is marginal, multiple cropping is the only option for increasing the production and productivity of either field or horticultural crops. Secondly, in Assam unlike field crops, horticulture is confined to household or 'bari' level. As such, for development of horticulture in the state, it is the first and foremost need to develop the household gardens which apart from increasing the production per unit area gives some other advantages such as maximum use of available land, economic use of nutrients from the soil and sunlight from the air. Multiple cropping is also a way to avoid any lean period of production as well as income.

A model household garden with multiple cropping system required systematic planning with regard to selection of crops, planting, manuring and other management practices,. The following points are to be considered while raising a model household garden.

1. **Base Crop:**

In multiple cropping system, one crop is taken as base crop. Coconut can be selected as a base crop because of its tall growing unranked natured. It is particularly suitable for Assam condition because of its wide adaptability. Wider spacing of the base crop provides more opportunity for raising other crops.

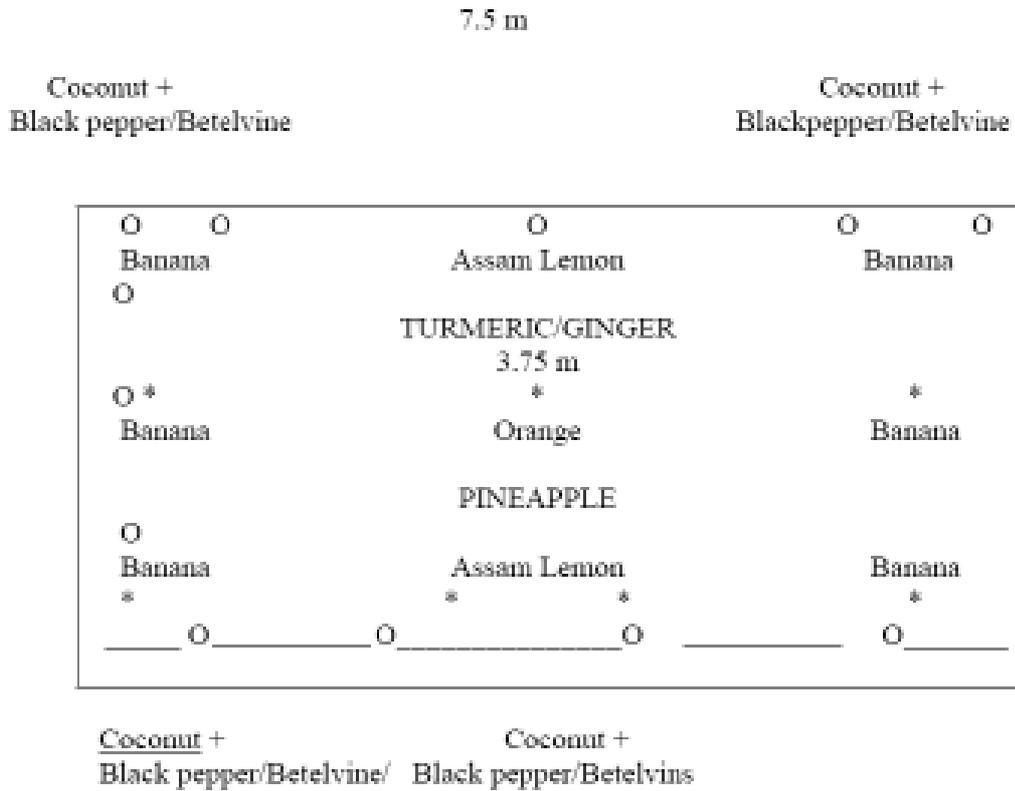
2. **Other Crops:**

Locally adapted crops should be selected for growing in between the rows of the base crop. The root system of these crops should be of different depth so that they can draw nutrients from different depth of soil. These crops should have differential height so that each crop can get their required light. These crops form their canopy at different height, for which the system is also termed as "Multistoried cropping should be able to withstand partial shade or shade to some extent. Banana (var. Chenichampa), pineapple (Var. Kew), lemon (var. Assam Lemon), Ginger (var. Nadia) are found to be suitable for growing in coconut based garden in Assam condition. Black pepper (var. Panniyur-I) can suitably be allowed to grow along the stem of the coconut tree.

3. **Planting Method :**

The taller plants should be planted nearer to the base crop and shorter ones should be grown gradually away from the base crop. This system of planting gives more effective.

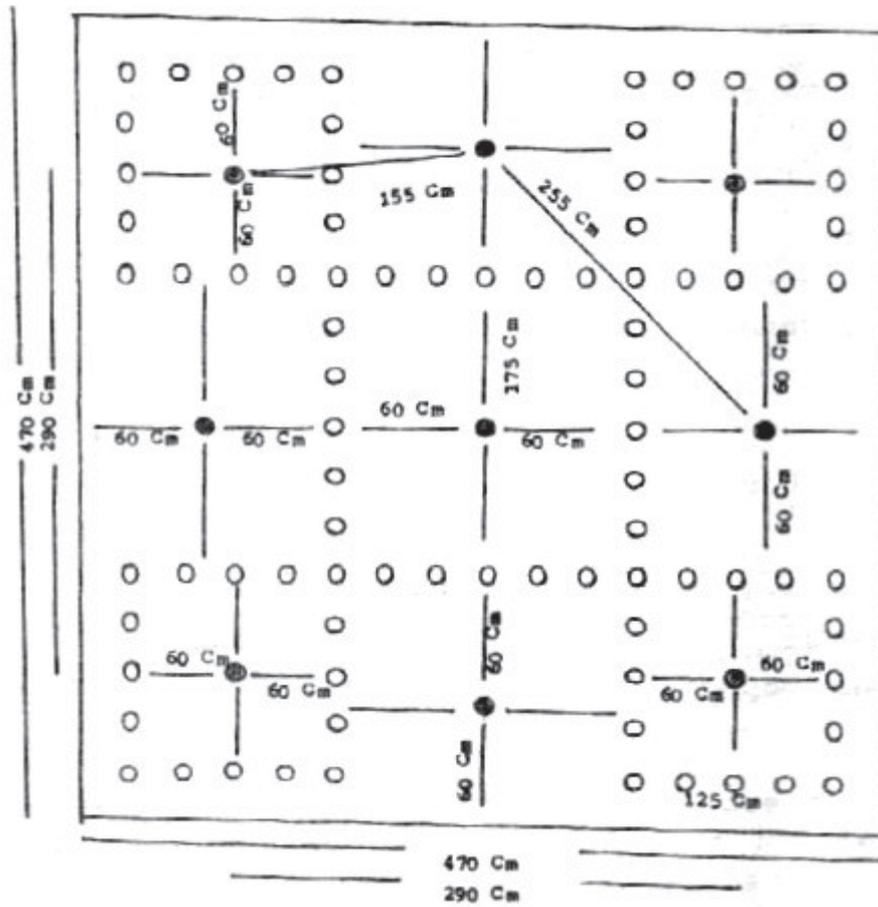
Model of Coconut-Based Multistoreyed cropping



Model – I

Use of sunlight 3 to 5 different crops can be raised in the coconut based garden depending upon the adaptability of crops.

ARECANUT - BASED MULTIPLE CROPPING



Banana	4 Nos.	2.9 m × 2.9 m
recanut	5 Nos.	2.55 m × 1.75 m
Pineapple	84 Nos.	1.20 m × 0.3 m

(Model -II)

FLOWERS

ROSE

Rosa spp.

Variety: Hybrid Tea:

Super Star, Arjun, Happiness, Rakta Gandha, Avil's Spakra, Avon, Blue Moon, C, Christian Dior, Crimson Glory, First Prize, Friendship, Illona, Kiss of fire, Priyadarshini and Jawahar. **Floribunda:** Queen Elizabeth, Arunima Banjaran, Chandrama, Mohini, Suryakiran, Navsadabahar and Sindoor. **Ployantha:** Anjali, Nartaki, Pink Showers, Echo, Cameo, Baby Fanreach.

Rambler: Amercan Pillar, Albertine.

Miniature: Cri Cri, Mimi, Babi Masquerade, Bonny, Cindrella, Coralin, Pixie, Rosmarin, Starina, Chandrika, DarkBeauty.

Green house variety: First Red, Confetti, Nobless, Grand Gala.

Propagating Material:

Commercially rose is propagated by T- or Shield budding but for root stock preparation one year old cuttings having pencil thickness are used..

Planting:

The pit should be dug 75 to 90 cm deep, thoroughly dried and filled with, well rotten FYM at the bottom and good garden soil at the top. New plants may be planted at the beginning or during the rainy season at a distance of 75 to 90 cm from each other depending on type of variety. Soil around the plants should be firmly pressed and watering is done immediately after planting

Soil Type: Any well-drained garden soil.

Aftercare:

In budded roses, the suckers arising from the rootstock should be removed as soon as they emerge, Dead, weak, criss crossing, diseased or insect-infested branches should be removed or pruned.

Manure and Fertilizer:

Immediately after pruning, during the months of October-November, the top soil around the base of the plant is dug out up to a depth of 10 to 15 cm and kept exposed for 2-3 days, then filled with half a basket of well decomposed FYM and then covered with the excavated soil. The soil compacted around the base and flooded with water. Urea @ 10 g per plant is to be applied 20 cm away from trunk and mixed carefully before watering. Super phosphate at the same rate may be applied after the flower buds have just begun emerge since it promotes flower production.

A foliar feeding with 2 parts Urea, 1 part dihydrogen ammonium phosphate, 1 part potassium nitrate and 1 part Potassium phosphate @ 3 g per lit. of water is an excellent supplement to root feeding. This solution is thoroughly sprayed on both sides of the leaves and stems periodically, insecticides can also be added to the solution if required. Foliar feeding should start 5 weeks after pruning and given at 10 days interval. Foliar feeding should not be done when the plant is in bloom.

Irrigation:

A periodical soaking of soil is done to keep the soil moist but not rootwet.

Plant Protection:

Red scales, which cover the branches and suck cell sap from the plant, are the most serious pests of rose. Spraying of malathion or dimethoate 0.1% during April and again in October will control this insect.

Rose chafer beetle which eats away the leaves may be controlled by spraying 0.2% malathion and light traps may also be used.

Die back, powdery mildew and Black spot are the common diseases of rose. Dieback appears after pruning; therefore fungicidal paint should be applied on the pruned surfaces. Sulphur dusting is an effective remedy for mildew. Black spots of leaves can be controlled by spraying with 0.2% Captan 50WP as soon as these are noticed

Harvesting and post harvest handling:

Rose flowers are harvested at tight bud stage when the bud show full colour but the petals have not yet started unfolding. Grading is based on length of stem and size of bud. Roses are packed in corrugated cardboard boxes (100 cm × 32.5 cm × 6.5 cm) in bundles, each bundle containing 20 blooms. Boxes are inner lined with thin polythene and very fine moist tissue paper.

Roses are graded according to the length of the stem as follows:

<u>Length of stem (cm)</u>	<u>Grade</u>
Above 70	White
60-70	Blue
50-60	Yellow
40-50	Red
30-40	Brown
Below 30	Working grade only for local market

BOUGAINVILLEA

Bougainvillea spp.

Variety:

Mary Palmer, Dr. Homi Bhaba, Crimson, Orange King, Golden Glow, Scarlet Queen, Alok, Million Dollar, Thimma, Dr. Rao, Dr. R.R. Pal, Mahara, Chery Bloosm, Double White, Double pink and L.N. Birla.

Propagating Material:

Bougainvillea is propagated by hardwood or semi hardwood cuttings from a matured branch of the past seasons growth taken during early or late monsoon. Difficult to root varieties are propagated by layering.

Planting:

The cuttings are planted in the nursery under shade and care is taken to keep the soil moist by regular sprinkling of water. New shoots emerge from the nodes. About 2-3 basket of FYM or compost is applied/pit. The rooted cuttings are planted 3 weeks after preparation of the pit. Extra soil is added to the base of the plant to avoid water logging.

Site and soil:

Light, well-drained soils are considered ideal for growing bougainvillea. The plant flowers profusely when growing in full sun. Shady, damp waterlogged areas are to be avoided.

Plant Protection:

Bougainvillea is usually not affected by any serious insect-pest and disease.

MUSSAENDA

Mussaenda philipica

Mussaenda is a beautiful flowering shrub cultivated for their attractive flowers of which the most colourful part is the bracts. The shrub has double, showy leafy sepals and the colour of the sepals may be greenish white, pink and red.

Cultivation:

The decorative plant should be grown in pots containing well drained mixture consisting of equal parts of loam, peat and leaf mould with sand added to ensure good drainage. Deep well-drained loamy soil is ideal for its cultivation.

Propagation:

Mussaenda is propagated by cuttings of some hard wood shoots taken during February to March and inserted in sandy soil. For pink and white mussaenda, cutting area treated with 2000 ppm IBA for better rooting. It can also be propagated by air layering.

TUBEROSE

Polianthes tuberosa L.

Variety:

Single type: Calcutta Single, Mexican Single, Shingar (Hyb) Prajwal (Hyb), Rajat Rekha, Arka Nirantara, GK-TC-4, Phule Rajani.

Double type: Calcutta Double, Mexican Double, Suvasini (Hyb) Vybhav (Hyb), Suvarna Rekha.

Planting:

Bulbs more than 2.5 cm diameter of tuberose are generally planted 5 cm. deep at a spacing of 30 x 20 cm or 25 x 25 cm. However, for high density planting spacing is maintained as 20 x 20 cm or 20 x 10 cm. from February to March.

Soil and Site:

It is grown in a wide range of soils. Well-drained sandy and sandy loam soil rich in organic matter with a pH of 6.0–7.5 and having ample sunlight is suitable.

Mulching:

Mulching of Tuberose with 50 micron black polyethylene sheet for quality cut flower and year-round production including the lean period (December to February).

Manure and Fertilizer:

Application of NPK @ 30:20:20 g/m² with half of N and full doses of P₂O₅ and K₂O to be applied at the time of land preparation and the remaining N to be top-dressed in 2 split doses at 35 and 55 days after planting of cutting

Interculture :

Irrigation : Watering should be done at weekly interval during dry spells in the growing season.

Weeding : For weed management in tuberose, application of Metribuzin @ 500 g/ha or Oxadiargyl @ 150 g/ha as pre-emergence followed by garden hoeing 3 times at 60, 90 and 120 days after planting.

Plant Protection:

There are no serious insect pests and diseases of tuberose. However, as a prophylactic measure, it is necessary to spray Carbendazim 50WP @ 1.5 g/lit. in

the advanced stage of plant growth to control the incidence of collar rot disease caused by *Sclerotium rolfsii*. It is also necessary to spray malathion 50 EC @ 1 g/lit. to control the aphids which suck cell sap from the tender spikes.

For management of Sclerotial wilt, dipping of bulbs in captan (0.3%) for 30 minutes before planting followed by drenching soil also with captan (0.3%)@ 10 lit/ sq. m at monthly interval for three months is recommended. Alternatively before planting bulbs are dipped in *Trichoderma viride* (10 g/lit) followed by soil application of *T. viride* 100 g / Sq.m mixed with 1 kg FYM at the time of planting.

For management of leaf blight, spraying of Chlorothalonil or Iprodione+ carbendazim (Quintal) @ 0.2 % (2ml in 1 litre) or carbendazim 0.1% (1 g in 1 litre) at 10 days interval is recommended.

Intercropping:

In commercial cultivation of tuberose, certain vegetable crops like-pea, spinach beet, French bean and carrot can be taken up as intercrops. However, maximum return can be attained with tuberose- pea combination.

Ratooning:

Fresh planting should be done after every 3 years but for quality flower production replanting is done every year. Regular and frequent weeding should be done. Half dose of the recommended fertilizer should be applied during the second year and third year of the ratoon crop.

Vase- life:

A preservative solution containing potassium permanganate (25ppm) is suitable for extending the vase life of cut tuberose spike.

Cost of cultivation: Rs. 47,100

Cost: Benefit ratio: 1:5.96

CHRYSANTHEMUM

Dendronthema graindiflora Tzvelev

Chrysanthemum morifolium Ramat.

Variety:

A. Cultivars suitable for pot culture:

i. Spray: Ravi Kiran, Charming, Prof. Harris, Anupam, PC-21, AAUCC-2, Nirod, Yellow Decorative, Basanti, Sadbhavana, Yellow Gold, Aparajita and Yellow Bangla.

ii. Standard: Snow Ball, Silk Brocade, Sonali Tara, Houston, Alfred Simpson, Kiku Biori, Stanley Gosling, White Spider, Pink Cosa Grande, White Cosa Grande and Gloria Deo.

B. Cultivars suitable for open field :

i. Spray: Purple Decorative, Purple Anemone, Ravi Kiran, Gulmohar, Yellow Decorative, Flirt, Sadbhavana, Yellow Bangla, AAUCC-2 and Basanti.

ii. Standard: Snow Ball, Diamond Jubilee, Sonar Bangla, White Spider, Houston, Stanly Gosling, Dr. Erabe Cross, Dignity, Heather Gem and Golden Giant.

C. Cultivars suitable for poly house:

i. Spray: Ravi Kiran, Charming, AAUCC-2, Nirod, Basanti, Prof. Harris.

ii. Standard: Snow Ball, Stanly Gosling, Diamond Jubilee, Dignity, Sonar Bangla, White Spider, Dr. Erabe Cross, Heather Gem, Golden Giant.

Propagation material:

Annual chrysanthemums are propagated from seeds and perennial chrysanthemums are propagated by the separation of suckers and terminal stem cutting. Planting of suckers are done in the month of February. Terminal stem cuttings of 5-7 cm long are taken during June to September. Lower leaves of the cuttings are removed and the cuttings are treated with rooting hormone (Rootex) before planting in sand or sand+peat moss/vermiculite/soil to promote rooting.

Planting of rooted cuttings:

The planting of rooted cuttings for better yield and quality of flower is done from July to September

Potting and Repotting:

The planting materials prepared from suckers in the month of February and from stem cuttings in the month of June to August are potted and repotted 3 to 4 times, each time into bigger sized pots and richer potting media. Newly potted plant should be kept in shade for 3 to 4 days till they are established

Aftercare:

Growing shoots should be pinched off in between second and third week in order to make the plants bushy. Plants should be watered daily preferably during morning hours. It is necessary to stake the plants to keep them erect.

Feeding to chrysanthemums:

Occasional top dressing of SSP @ 3 g per pot especially at final potting, helps in growth and flowering of chrysanthemum.

A supplementary feeding with-liquid manure is done at 10 days intervals just after light watering. Liquid manure is made in the following way:

Liquid manure is prepared by dissolving 1 kg of fresh cowdung manure and 100 g of mustard oil cake in 10 lits of water. Occasional string is necessary. After 10 days the supernatant liquid is taken out and diluted to attain a straw colour by mixing 1 mug of this liquid with 10 mug of plain water. Feeding with liquid manure should start with the establishment of the plant and to continue up to the appearance of first flower bud.

Use of Plant growth Regulators:

Spraying of plants 30 days after final transplanting with GA₃ at 40 ppm improve growth and increase the number and size of flowers. However, to induce early flowering, 10 ppm GA₃ is recommended which also increase self-life in spray cultivars.

Spraying of 5000 ppm CCC increases the flower size in standard cultivars and branch and flower number in spray cultivars, spraying of 10,000 ppm B-9 is better than normal pinching method.

Plant Protection:

Aphids attack the tender growing points and cause curling of leaves. These can be controlled by spraying malathion 50 EC @ 1.5 ml/lit. Caterpillars eat up buds and young shoots and these should be controlled by spraying dimethoate @ 1 ml/lit. at 10 days interval. Leaf miners, which burrow into the leaf, can be controlled by spraying dimethoate @ 1.2 ml/lit.

Leaf spot can be controlled by spraying carbendazim @ 1.5 g/lit. virus infected plants are uprooted and destroyed. Aphids and Thrips are the vectors of viral diseases and must be effectively controlled.

Harvesting and post harvest handling:

The correct stage of harvesting depends on the cultivar, marketing and other facilities available to the grower. The decorative type is harvested when petals at center of the top-most flower are fully developed. Standard type is harvested when outer ray florets ceased to elongate. Flowers are cut about 10 cm above the soil and 1/3 of stems are stripped of leaves and placed immediately in water. Cut flowers are graded into several grades depending on stem length, colour and diameter of the flower. The standard chrysanthemums are packed in display boxes measuring 91 cm x 43 cm x 15 cm size. For spray chrysanthemum, a bundle of 20 stems are packed in cardboard boxes measuring 80cmx 50cm x23 cm.

For local markets, packaging of spray chrysanthemum in PP-100 gauge polythene to increase shelf- life and maximum floret opening in vase.

Cost: benefit:

- 1) For spray (a) Open field, bed 1:5.15 Cost of cultivation Rs. 67,480.
(b) Pot each 1:2.13 Cost of cultivation Rs. 16.00
- 2) For standard (a) Open field 1:8.88 Cost of cultivation Rs. 67,480.
(b) Pot (each) 1:3.71 Cost of cultivation Rs. 17.00
- 3) Planting; material generation 1:7.93 Cost of cultivation Rs. 22,680.

DAHLIA

Dahlia variabilis Desf.

Variety :

Swami Madhavanadam, Swami Lokeshwarananda, Lord Buddha, Ketu, Avalenche, Blood Red, Black Out, Nearest Blue, Bholu Baba, Bhiku's Vivek, Prime Minister, Sri Ramkrishna, Dandapani, Queen Elizabeth, Swami Brahmananda, Bhikku's Mother, Bhikku's Raktajaba, Sarada Devi, Dr. B.P. Pal, Jyotsna, Clarissia, Potgainter.

Propagating Material:

Dahlia can be propagated through seeds, tubers and stem cuttings.

Sowing/Planting:

Generally, the single and dwarf bedding dahlias are propagated by seeds. Seeds are sown in well-prepared nursery beds or seeds boxes during October-November and the seedlings are transplanted into the permanent beds or pots when they reach the 4 to 6 leaves stage. Cuttings are taken from plants raised from tubers in nursery beds from August onwards and planted out in their permanent places in October-November, In case of bedding dahlias, a spacing of 90 cm from row to row and 50-75 cm from plant to plant is given. 60 cm x 60 cm spacing is kept in case of dwarf dahlias.

Soil and Site:

Dahlias grow best in a sunny location although they are remarkably tolerant to semi-shade. They do not like much rain and extreme cold or heat.

A good, well-drained sandy loam soil is best suited for dahlia.

Aftercare:

When the plants reach 10 to 15 cm height, they are staked by tying 2 or 3 places to bamboo or wooden sticks with a soft-rope. Staking is done to prevent the plant from toppling or lodging over. Earthing up is necessary to give support to its weak and succulent stems.

Manure and Fertilizer:

When dahlia is grown on rich soils, additional feeding is not required; but in poor soils a top dressing of 35 g to 50 g/m² of any complete chemical fertilizer is beneficial. Care should be taken to see that the chemical fertilizer should not come into contact with the base of the plant. Liquid feeding should be done.

Irrigation:

Adequate watering with a watering cane should be done throughout the growing season.

Plant Protection:

Aphids, wire worms and caterpillars generally suck cell sap or eat up tender portions of stem and leaf. Spraying malathion or fenitrothion @ 1.5 ml./l. of water control these insects-pests.

Leaf spot, mildew and mosaic virus are common diseases of dahlia. Control measures are the same as in chrysanthemum.

Storage of Tuber:

Bulk quantity of dahlia tubers are to be stored in cold storage at a temperature of 7.7°C to 10°C. Small quantity of tubers should be stored in pots covered with sand. Tubers are not allowed to shrivel in any case.

GLADIOLUS

Gladiolus grandiflorus L.

Variety:

Red Candiman, White Prosperity, Priscilla, Novalux, Palamtard, American Beauty, Eight Wonder, Friendship, Red Sea, Suryakiran, Gold Beauty, Dhannawanty, Tiger Flame, Marallow, Poppy Tears, Her Majesty, Thunder Horn, Sunayana.

George Mazure, Mayur, Vink's Glory, Show Princess, Apple Blossom, Sunny Boy, Lady Killer, Gold Dust, Friendship, Psittacinus Hybrid, Happy End, Melody, Bis Bis, Sylvia, Oscar, Copper King, Rose Spire, Green Woodpecker, Spic and Span, Tropic Seas, Agnirekha, Suchitra, Manmohan, Mukta, Manisha, Manhar, Mohini, Apsara, Shobha, Meera, Nazrana and Poonam.

Propagating Materials:

Large sized corms having 3-5 cm diameter is used when gladioli are grown for cut flowers. Large corms can be vertically cut into two or three pieces which are then used for propagation. Small and medium size cormels are grown for further corm production in the next season.

Soil and Site:

Gladiolus can be grown in a wide range of soils but deep, rich, well pulverized and well drained loam is considered the best soil which should be moisture retentive having medium acid to neutral pH.

Aftercare:

After the corms sprout, the rows should be hilled up about 10-15 cm. Staking is necessary when flower spikes start swelling. The soil around the plants should be lightly dug up with a khurpi but this should be discontinued when flower spikes start swelling.

Manure and Fertilizer:

N: P: K should be applied in the ratio 1: 2:2 @ 56 g/sq.m. in two equal split doses. One split dose should be thoroughly mixed with the soil before planting of corms and the other at 4 to 6 leaf stage.

Plant Growth Regulators:

Soaking corms with GA₃ (2500 ppm) has shown the best performance on growth, flowering and corm production of gladiolus. However, Ethrel (2000 ppm) increases the number of cormels at harvest.

For quality spike production of gladiolus, treatment of corms with 100 ppm GA₃.

For healthy cormel production, treatment of gladiolus corms with Ethrel @ 250 ppm.

Application of Atrazine @1.5 kg a.i./ha before planting for controlling weeds and quality gladiolus spikes and corms.

Irrigation:

Watering should be done at 10-12 days interval to keep the soil moist.

Plant Protection:

Fusarium corm rot is the most common and serious disease in the field. Bacterial scab also causes corm rot. Pre-sowing treatment against fungal disease included dipping the corms in carbendazim or Benomyl 0.3% (3 g in 1 litre water) for 20 minutes.

Thrips and cutworms are serious pests of gladiolus. Dusting of malathion 5% dust at the base of the plants is effective against thrips, while spraying of malathion 50 EC 1% at 15 days interval effectively controls cutworms.

Harvesting and Post harvest handling of spikes:

For local market, gladiolus spikes are harvested when the 1st pair of florets fully opened. For distant market flowers are harvested at tight bud stage when 1-5 florets show colour with atleast two numbers of clasping leaves. Gladiolus spikes are usually graded based on spike length and number of florets per spike according to the following groups:

<u>Grade</u>	<u>Spike length (cm)</u> (Minimum)	<u>No. of florets</u>
Fancy (A)	107 & above	16
Special (B)	96-107	14
Standard (C)	81-96	12
Utility (D)	81 & below	10

The graded spikes are made into bundles of 50-100 spikes and packed in perforated and light proof cardboard boxes.

Harvesting and Storage of Corms:

When leaves turn yellow, the corms along with cormels are lifted in the last week of April to second week of May. Corms and cormels are soaked in 0.2% Captan or carbendazim or 0.1% Benlate solution for 15-30 minutes and stored in airy room on wooden trays in a single layer. The best way to store is in a refrigerator or cold storage at 4.4^o C to 10^o C. During storage, the brown scales covering the corms should not be removed.

Vase-life:

Use of holding solution containing Sodium hypochlorite (50 ppm) and Potassium permanganate (25 ppm) along with Sucrose (4%) extends vase life.

Cost of cultivation: Rs. 66,300.

Cost: benefit: 1:3.21.

HELICONIA

Heliconia psittacorum L.

Variety :

Local Type: Plant height varies from 90 cm to 120 cm. Inflorescence colour orange yellow with a boat shaped bract and size is 10-19 cm across. Flower yield is 35 number of inflorescence/m² and rhizome yield is 6145 g/m².

Propagating material:

Rhizome with average weight of 40 g

Soil:

Heliconia can be grown in a wide range of soils but deep rich well pulverized and well drained loam is considered the best.

Time of Planting: January.

Spacing: 40 cm x 40 cm.

Manure and Fertilizer:

4 kg of FYM/m² and 40:20:20 g NPK/m² is given in 2 split doses for better growth, yield and quality of flower. The first dose is given at the time of planting and 2nd dose at 45 days after planting.

Irrigation:

Watering should be done at weekly interval during dry weather in the growing season.

Plant Protection:

There are no serious insect pests and diseases of Heliconia.

ORCHIDS

Orchids are the most beautiful among all the flowering plants in the world. There are consist of about 22,000 to 35,000 species and 700-800 genera and thus include innumerable varieties.

From the floricultural point of view orchids are classified into two broad categories, viz. epiphytes and terrestrials. The epiphytes live an independent life as far as their food requirement is concerned and they perch themselves on trees and rocks. On the other hand, the terrestrial types grown on earth, like ordinary plant.

Some Important Genera:

Epiphytic: Dendrobium, Vanda, Rhynchostylis, Coelogyne, Areodes etc.

Terrestrial: Cymbidium, Paphiopedilum, Thunia, Phaius, Spathoglottis, Arundina etc.

Hybrid variety: Sonia, Makara, Oncidium.

Propagating Material:

Monopodial epiphytes like Vanda, Rhynchostylis, etc. are propagated by stem cutting or layering. Sympodial orchids, both epiphytes and terrestrials, are propagated by division of pseudobulbs or offsets.

Potting of Orchids:

i) Potting material : For epiphytic orchids side-perforated earthen pots and for terrestrial orchids, ordinary earthen pot should be used.

Pot mixture : For epiphytic species, coconut fiber, sawdust, charcoal and brick pieces in equal proportion with moss as covering material should be used.

For terrestrial species, a mixture of loam soils, river sand and coconut fiber (size 3 cm x 3 cm) and peatmoss or leaf mould in equal proportion with moss as covering materials should be used.

ii) Growing media for pseudobulb production:

Epiphytic orchid: Coconut fibre + charcoal in equal proportion is the best growing media for higher pseudobulb production.

Terrestrial orchid: Loamy soil + sand + coconut fibre + shredded wood in equal proportion is the best growing media for higher pseudobulb production.

Growing condition: Orchids are grown commercially in low cost (bamboo frame) or medium cost (angle iron) agrosHADENET house with 30-50% shade.

Harvesting and post harvest handling: Orchid flowers are harvested 3-4 days after opening of flowers. Grading is done based on length of flower spike, flower number, size and arrangement of flower on the spike. Packaging method is different for different species of orchids. Dendrobium is packed in 4 dozen sprays per box. The cut ends of the flower stems are to be covered with wet cotton and wrapped with polythene to maintain humidity. Cymbidium spikes are generally packed 100 flowers per box.

Aftercare:

The pots of epiphytic orchids should be watered regularly and those of terrestrials at longer intervals. Occasionally emerged weeds should be removed from time to time.

The epiphytic orchids should be held in position by using stakes. Newly potted plants should be kept in semi shade for few days until new roots starts growing.

If the basal portion of monopodial orchids become leafless. It is suggested to cut off the portion so that healthy roots are formed.

Application of bio-fertilizers - Azospirillum and Phosphobacterium each @ 2 g per plant in two months interval along with a regular spraying of NPK (20: 10: 10) @ 0.2% twice a week for better growth and flower production in the orchid - *Dendrobium* Var. Sonia.

Plant Protection:

Disease: Fungi, viruses and bacteria attack orchids; growing of healthy plant under good hygienic condition is the best way to prevent diseases.

- i) Pythium black rot which infects roots and spread into the rhizome and pseudobulbs can be checked by spraying 10 ppm copper sulphate solution at weekly intervals.
- ii) Anthracnose, which causes leaf spots and soft leaves, can be controlled by copper fungicide spray.
- iii) Rust causes reddish brown spots and quickly spreads from plant to plant. This can be controlled by dusting with sulphur or spraying with Mancozeb 75 WP (2g/l).
- iv) Bacterial soft rot causes slimy rot of pseudobulbs and stembases. The affected plants should be destroyed and other plants sprayed with 10 ppm mercuric chloride.
- v) For viral diseases, affected plants should be destroyed.

vi) Cercospora leaf spot can be controlled by spraying captan 50WP @ 2 g/lit water.

Insect-Pest: The following are the chief pests of orchids. The control measures are given against each of them.

Pests	Control measures
Ants	Chlordane dust or nicotine sprays
Snails, slugs	Mataldehyde baits containing arsenic
Earthworms	Watering with Derris solution
Thrips	Liquid malathion
Mites	Parathion, Kelthane etc.
Mealy bugs, Leaf hopper & Beetle	Malathion spray
Aphid	Rogor @ 1.5 ml/lit of water
Caterpillar	5% Malathion dust

Blooming time : Most of the orchids bloom either between February to June or between October to November.

Potting : For potting, the selected plants should be carefully examined and decayed roots and dead membrane should be removed. The used need to be soaked in water and broken crocks, a 2 cm thick layer of decayed moss should be placed,. Then the pots should be half filled with the mixture in the form of hillock in the centre of the pot. The plant should be held with one hand and placed over the hillock and with the other hand the pot should be filled up by spreading the roots upward and downward. The mixture should be carefully pressed and 3 cm layer of moss should be spread over the pot.

Irrigation : In potted orchids, watering should be done in the evening hour when the soil becomes dry. Beds may be watered at 3-4 days interval during dry spells.

ANTHURIUM

Anthurium andrea Land.

Varieties:

Red: Tropical, Red Dragon, Ozaki, Mickey Mouse, Hawaii Red, Cherry Red, Sweet Heart, Temptation, Fla Red, Sikkim Red, Tina Red, Fire.

Pink: Agnihotri, Abe Pink, Paradise Pink, Lady Jane, Passion, Magic Pink, Nunzia.

Obake : Red Dragon (red obake), Madonna (cream obake), President (pink obake), Lambada (white obake), Farao (deep orange obake).

White: Trinidad, Lima White, Manoa Mist, Meringue White, Mauritius White, Hidden Treasure, Fla Exotic, Accropolis, Carnival.

Cream: Fantasia.

Green: Midori – Green, Pistache.

Orange: IASH-2, IASH-1, Sante, Sundet Orange, Nitta, Mauritius Orange, Orangeeth, Fla Orange, Sunburst, Diamond Jubilee.

Varieties like Fire, Calore and Tropical for red colour; Acropolis, Moment for white and Evita Pink for pink colour are recommended for growing in soil less culture under shade net house.

Climate:

Anthurium needs conditions of high relative humidity well above 70%. It is grown commercially in low cost (bamboo frame) or medium cost (angle iron) net houses with 75-80% agro shade net roofs. To protect the plants from heavy rains, UV stabilized 200 micron plastic film can be used in combination with agro shade net cloth. The sides of the net house should also be covered with shade net (50% or lower) to improve the microclimate inside it. These nets can be raised for proper ventilation when the temperature rises.

Planting season: Anthuriums can be planted almost round the year except in winter and during heavy rains.

Planting material/Propagation:

Anthurium is commercially propagated by separation of suckers produced at the base of the plant. When these suckers grow to 5-6 leaf stages with 2-3 good roots, they can be separated and planted. Suckers should be removed by pulling them out by hand and not by knife or scissors. Tissue cultured plantlets, which are true to type and disease free, can be procured.

To grow anthurium plants from seeds is a lengthy process. Seedlings may take 2¹/₂ – 3 years to come from seed to bloom. Mature seeds may be scattered in the growing media. The seeds germinate immediately and can be transplanted within 4 to 6 months.

Growing media:

The growing media for anthurium should be rich in organic matter, slightly acidic, porous, well aerated and well drained. According to the availability, different materials like coir pith, sand, gravel, decomposed organic materials like rice husk, coconut husk, sugarcane bagasse, wood shaving, tree bark, water hyacinth, leaf mould, saw dust etc. can be mixed and used as a growing media. Growing media consisting of 2 parts rice husk/pine bark + 1 part soil + 1 part sand + 1 part cowdung + ½ part charcoal produced the best vegetative growth and good flower characters under Jorhat conditions.

Growing media for sucker production:

FYM + soil + coconut fibre in equal proportion is the best growing media for sucker production.

Pot culture of anthurium:

In small scale planting, anthuriums are generally planted in earthen pots of 25 to 30 cm with two or more holes. Crock pieces are placed at the bottom of the pot above which a 2 cm layer of coarse sand is spread. Over this, brick or charcoal pieces are arranged so that the root ball can be placed easily. The sides of the root ball are covered with pieces of coconut husk and a filler mixture of sand and cowdung is spread over it to fill up the gaps. Initially the pot is filled to about 1/4th to 1/3rd and subsequently with increasing growth, fresh medium is added once in about three months. Besides providing good anchorage, this encourages growth of the plant and gives an earthing up effect.

Planting in beds:

Large scale commercial cultivation of anthurium is done in beds.

1. The bed should be 1.2 to 1.4 m wide depending on the length and breadth of the greenhouse and distance between posts.
2. The sides of the bed can consist of a wood/bricks.
3. There should be a path at least 0.80 m wide between two beds.
4. Plastic foil (0.1 cm) thick should be placed on the bed to separate the media from the ground.
5. A drainage hose should be placed on the bottom of the bed to drain out the excess water located at the lowest point.

6. The bottom of the bed should slope from the side to the centre of the bed (2-3 cm), so that water flows to the drainage hose. The gradient of the slope should not be more than 0.03% (3 cm per 100 m).
7. A sprinkler system, which provides adequate distribution of water, can be installed in the middle of the bed.
8. The height of the growing medium should be minimum 20 cm. It can be refilled within 2-3 years to a maximum of 30 cm.
9. A wire should be tied along the bed (fastened to posts placed 4 m apart) to keep the flowers out of the path.
10. Spacing in beds: 40 – 45 cm x 40 – 45 cm depending on the cultivar.

Aftercare:

Application of growth regulators:

Plant growth regulators play an important role in increasing growth, sucker production, flower yield and quality and in reduction of juvenile phase of anthuriums. Plants sprayed with Maleic hydrazide 1000 ppm at one and three months after planting produced shorter plants with more number of suckers. Plants sprayed with GA₃ (500 and 300 ppm) and BA (200 ppm) showed better vegetative growth and flower characters.

Pruning of leaves: About 4 to 5 leaves are sufficient on a plant. The older leaves should be periodically removed.

Removal of suckers: Suckers produced at the base of the parent plants should be removed at an early stage.

Manure and fertilizers:

Fertilizers should be applied in smaller doses at frequent interval rather than larger doses at longer intervals. For pot cultivation, 5 g of complex fertilizer (NPK 17:17:17) in 500 ml of water (1%) is sprayed on the foliage once in a month. Foliar application of 0.1% urea at monthly interval is found to be beneficial. In case of Ca deficiency, lime @ 5 g/plant/month is recommended. Soil drenching of liquid manure consisting of cowdung/urea once in every month is beneficial. A handful of dried sieved cowdung is applied at the base of the plant at monthly interval. It is advisable to reduce the quantity of nitrogen in flowering plants, to increase the post harvest life.

Irrigation:

For Assam condition, anthuriums require one irrigation/day, either in the morning or evening hours.

Plant protection:

Anthurium blight (*Xanthomonas campestris* pv. *Dieffenbachia*) : Controlled by spraying plants streptomycin-sulphate or oxytetracyclin (200 mg/l) at weekly interval.

Root rot (*Phytophthora* sp, *Rhizoctonia* sp, *Fusarium* sp, *Pythium* sp) : Controlled by soil drenching with 0.25% Mancozeb and 0.25% Thiram or 0.2% Captan.

Nematodes (*Meloidgyne*, *Radopholus similes* and *Aphelenchoides*) : (1) use disease free plant material. (2) Adequate phytosanitary measures. (3) removal of infested plants and growing media.

Aphids and mealy bugs: Controlled by (i) destroying the infested portions (ii) drenching the growing media with malathion @ 2 ml/l.

Snails: Controlled by (i) hand picking and destruction and using baits like Metaldehyde pellets.

Harvesting and post harvest handling: When the spathe is fully opened or when 1/3rd to 2/3rd of the true flowers on the spadix are open. The flower stalk should be cut with a sharp knife, leaving about 3 cm of the stalk on the plant and the basal portion of the flower stalk should be immersed in water as soon as possible to prevent drying out. Cut ends of flowers can also be immersed in 100 ppm BA or 4% sucrose for 30 minutes and then kept in water, to extend the vase life.

Application of 50 ppm Sodium hypochlorite + 5% sucrose or 300 ppm of Aluminium Sulphate + 5% sucrose as holding solution for increased vase life of the spathe.

GERBERA

Gerbera jamesonii Bolus

Varieties:

General gerbera: Red Gem, Orange Green, Yellow queen, Classic Beauty Popular, Dr. Zakir Hussain, Double Super Giant, Pride of Sikim, Indukumari, Red Monarch, Avol, Pride of India, Pink Melody Avon

Black centered gerbera: Miracola, Piton

Black centered gerbera varieties like Antibes (red), Batavia (orange), Shimmer (white with pink trans floret), Faith (yellow), Prianha (purplish pink), Winter Queen (white), Cross Road (yellow with red trans floret) and Dream (pink) are recommended for growing under Green House cultivation in Assam.

Propagating material: Gerberas are propagated by suckers separated from the mother clumps.

Growing condition: Black centered gerberas are suitable for growing under polyhouse. However, for higher production of flowers and their maintenance and also to obtain quality flowers gerbera can be grown under low cost polyhouse.

Time of planting: Suckers are planted in the month of Sep-Oct.

Spacing: Gerbera are planted at a spacing of 30cm between plants and 30 cm between rows, suckers are separated **every year** when the plant become over crowded and are planted in a separate bed.

Soil land Site:

A well drained, sandy loam type of soils best for gerbera.

Aftercare:

Regular weeding and stirring of the soil with a khurpi is necessary. Dried leaves should be removed to improve the vigour of the plant.

Manure and Fertilizer:

FYM 5 kg/m² to be applied 15 days before planting gerbera

The levels of NPK @ @ 30 g N, 10 g P₂O₅ and 20g K₂O per square meter is the best economic level for the agro climatic conditions of Assam. However, half dose of nitrogen and full doses of phosphorus and potassium are to be applied at the time of planting and the remaining half dose of nitrogen is to be applied after 30 days of planting the suckers of gerbera.

For organic cultivation of gerbera, application of enriched compost @ 10 t/ha at the time of land preparation

Irrigation:

In potted gerbera, watering should be done in the evening hours when the soil becomes dry. Beds may be watered at 3-4 days interval during dry spells.

Plant Protection:

Aphid and mites can be controlled by spraying. dimethoate 30 EC @ 1.5ml per lit. of water. Caterpillars can be checked by dusting with 5% malathion dust. In the monsoon, gerbera is affected by Cercospora leafspot which can be controlled by spraying Benlate or Captan @ 2g/lit of water.

Vase-life: A preservative solution of Sucrose (2%) along with Tartaric acid (300ppm) is suitable for extending vase life.

Harvesting and post harvest handling: Gerbera flowers are harvested when second row of disc florets show pollen development. Flowers are graded according to the size of flowers and length of stem. Individual flowers are packed by polythene or netted covers to protect the flower heads. Flower heads are packed in insulated boxes & transported.

SEASONAL FLOWERS

ANTIRRHINUM

Antirrhinum majus L

Variety :

Candle Light, Sunset, Sky scraper, Magic Carpet.

Propagating Material: Seed.

Sowing Time: September-October

Method of Sowing:

Seeds sown in seed pans and watered very carefully as heavy watering will wash away the seeds.

Stage of Transplanting:

Transplanted at 4-leaf stage

Spacing:

15, 30 and 45 cm for dwarf, medium and tall varieties respectively.

Blooming Time :

3 ½ to 4 months after sowing.

Manure and Fertilizer:

In light soils, a top dressing of complete fertilizer or well decayed FYM should be applied when plants are about 2 months old.

Aftercare:

When the plants are 15 cm tall they are pinched off to encourage side growth.

Insect Pest: Aphids.

Disease:

Rust, anthracnose, mold, root rot, crown rot and stem rot.

ASTER

Callistemphus chinensis Esenback

Variety:

Kirkwell, Sunshine, Triumph (dwarf), Giant Comet, Princes, Early Giant, Queen of the Market, Ostrichd Plume (tall), Poornima, Kamini, Shashank

Propagating: Seed.

Soil:

Rich loamy soil is best but heavy clay soil can be conditioned with FYM and river soil.

Sowing Time: September-October.

Method of sowing: Seeds sown in pans, boxes or raised beds and covered with sifted sand or leaf mould.

Stage of Transplanting:

Transplanting at 4-leaf stage

Spacing:

15 cm, 30 and 40 cm respectively for dwarf, medium and late branching types.

Blooming Time:

Early varieties bloom within 3 ½ to 4 months after sowing and late varieties 5 months after sowing.

Manure and Fertilizer:

A light dose of liquid manure or a top dressing of complete fertilizers about 10 g per m.sq. as area

Aftercare:

Regular weeding, watering and occasional exposure of the soil with a khurpi

Insect Pest:

Beetles, aphids and a variety of bugs.

Disease:

Damping off and Aster Yellow

BALSAM

Impatiens balsamina L.

Variety: There are single and double varieties.

Propagating Material: Seed.

Soil:

All types of well drained soils in sunny locations.

Sowing Time:

Last part of April to second week of May.

Method of Sowing:

Seeds are directly sown in permanent beds :

Spacing: Thinned to 25 cm all around.

Blooming Time: 2 to 2 ½ months after sowing.

Manure and Fertilizer:

A light dose of complete fertilizer and little FYM.

Aftercare:

- i) Pinching of shoots at 15 cm height to make the plants bushy.
- ii) Lower leaves should be removed when buds appear to increase flower size.

Insect Pest: There are no serious insect pests of balsam.

Disease: There is no serious disease of balsam.

CALENDULA

Calendula officinalis L.

Variety:

Ball Chrysantha, Sunshine, Apricot, Orange King, Cream Beauty, Shaggy etc.

Propagating Material: Seed.

Soil:

Sandy soil incorporated with organic manure and a small dose of complete fertilizer.

Sowing Time: September-October

Method of Sowing: Seeds sown in seed pans.

Stage of Transplanting: Transplanted at 4 to 6 leaf stage.

Spacing: 20-25 cm between plants and rows.

Blooming Time: 2 ½ to 3 months after sowing.

Manure and Fertilizer:

Liquid manure prepared from fresh cowdung should be applied at flower bud formation upto flower opening and then discontinued.

Aftercare:

Regular weeding, watering and stirring of the plant with a khurpi

Insect Pest:

White fly at the early growth stage sucks cell sap and acts as a vector for many viral diseases.

Disease: Leaf smut, leaf mottling and bud blast.

CARNATION

Dianthus caryophyllus L

Variety:

Marguerite, Chhabaud, Riviera Giant, Margaret, Malaga, Empire, Lipstick, etc.

Propagating Material: Seed (For annuals) and commercially carnation is propagated by cuttings.

Soil:

Light Soil incorporated with well-decayed Leaf mould.

Sowing Time: October

Method of sowing:

Seeds sown in seed pans and covered with sieved leaf mould.

Stage of Transplanting: Transplanted at 4-leaf stage.

Spacing:

In 20 cm pots: 3 seedlings per pot.

In beds: 30 cm between plants and 45 cm between rows, 15cm x 10 cm for cutting production.

Blooming Time: 3-4 months after transplanting.

Manure and Fertilizer :

Complete chemical fertilizer a 38 g per sq.m after pinching the tops of shoots and fertilizer should be mixed well at the base of the plants. Alternatively, liquid manure may be applied just before emergence of flower bud.

After care:

- i) In open beds, the top should be pinched off above the second and third node atleast twice before the buds appear to induce side shoots.
- ii) Bamboo or wire stakes about 60 cm. high should be fixed to the soil in the pot to form the triangle.
- iii) Calyx splitting can be prevented by tying the calyx with strings or rubber bands just before flower buds open.

Harvesting and post harvest handling: For distance market, standards are harvested when outer petals are just unfolding and spray when buds show colour (at Paint brush stage). Harvesting is done by snapping the stem off at a node. Flowers are grouped into bundle of 20 flowers and kept in corrugated cardboard boxes for transportation.

Insect pest: There are no serious insect pests of carnation.

Disease: Wilting, stem rot and rust.

Mass multiplication of carnation by tissue culture (Cv. Malaga, Empire, Lipstick):

Suitable media for shoot proliferation of carnation is MS media supplemented with NAA 0.5 mg L⁻¹ + Kinetin 0.5 mg L⁻¹ + GA₃ 0.5 mg L⁻¹.

Suitable media for rooting is MS media supplemented with 0.5 mg L⁻¹ IBA.

AFRICAN MARIGOLD

Tagetes erecta L.

Variety:

Pusa Narangi Gaiindha, Gaint Double African, Orange, Hajo Local, Golden Glow, Cupid, Pot of Gold, Glitters, Burpee Gold, Guinea Gold, etc.

Propagating Material: Seed

Soil: Almost any type of soil.

Sowing Time: October – November

Planting of summer marigold (var. Seracole) during May to July for flower production and generation of planting materials.

Method of sowing: Seeds sown in seed pans or seed boxes.

Stage of Transplanting: Transplanting when seedlings are 5-7 cm in height

Spacing: A spacing of 45 cm x 40 cm has been recommended for seed production of marigold.

Blooming Time: 1 ½ to 2 ½ months after sowing.

Manure and Fertilizer: A little organic manure is beneficial.

Aftercare:

- i) Staking in tall varieties.
- ii) Regular watering during dry weather.
- iii) Drainage of excess water during rainy season.

Weeding : Pre-emergence application of herbicide (0-3 days after planting) Butachlor @ 1.0 kg/ha followed by grubber at 35 days after planting and alternatively, garden hoeing at 20 and 40 days after planting.

Insect pest: There are no serious insect pests in marigold.

Harvesting and post harvest handling: Flowers are plucked when they have attained full size. Field should be irrigated before plucking. Flowers are mainly used for making garlands. Plucked flowers are loosely packed in bamboo baskets for carrying to the market.

For long distant market, packing of marigold loose flowers in plastic crates and bamboo baskets for better shelf life and lower loss in fresh weight.

Disease:

Leaf and flower blight:

1. Low temperature coupled with cloudy weather and continuous drizzling for more than 2 days have a significant role in the epidemiology of leaf and flower blight of both African and French marigold caused by *Alternaria dianthi*. Necessary prophylactic measures should be adopted in anticipation of such weather conditions. Three spraying with Mancozeb @ 2.5g/litre at 10 days interval will manage the disease.

2. Routine spraying of Mancozeb @ 2.5g/litre at 30, 40 and 50 days after transplanting will effectively protect the African and French marigold crops from the disease.

FRENCH MARI GOLD

Tagetes patula L.

Variety: Harmony, Rusty Red, Sun Old, Red Brocade etc.

Propagating Material: Seed

Soil: Almost any type of soil.

Sowing Time: October – November

Method of sowing : Seeds sown in seed pens or seed boxes.

Stage of Transplanting: Transplanted when seedlings are 5-7 cm in height.

Spacing: 30 cm x 30 cm apart and 60 cm for tall varieties.

Blooming Time: 1 ½ to 2 ½ months after sowing.

Manure and Fertilizer: A little organic manure is beneficial.

Aftercare:

- i) Staking in all varieties.
- ii) Regular watering during dry weather.
- iii) Drainage or excess water during rainy season.

Intercropping:

Growing of spinach as intercrop increases yield and benefit cost ratio followed by coriander.

Weeding : Pre-emergence application of herbicide (0-3 days after planting) Butachlor @ 1.0 kg/ha followed by grubber at 35 days after planting and alternatively, garden hoeing at 20 and 40 days after planting.

Insect Pest:

There is no serious insect pests in marigold.

Disease:

Leaf and flower blight:

1. Low temperature coupled with cloudy weather and continuous drizzling for more than 2 days have a significant role in the occurrence of leaf and flower blight of both African and French marigold caused by *Alternaria dianthi*. Necessary prophylactic measures should be adopted in anticipation of such weather conditions. Three spraying with Mancozeb @ 2.5g/litre at 10 days interval will manage the disease.
2. Routine spraying of Mancozeb @ 2.5g/litre at 30, 40 and 50 days after transplanting will effectively protect the African and French marigold crops from the disease.

PETUNIA

Petunia hybrida Hortorum

Variety :

There are 2 strains, viz., tall and dwarf under the sp. Hybrids. The species grandiflora and Nana compacta have double flowers in a great variety of colour.

Propagating Material: Seed

Soil:

Moist and rich sandy loam and also well drained heavy soil

Sowing Time:

October-November for winter blooming and March-April for summer blooming

Method of sowing:

Seeds sown in seed boxes or in well prepared nursery beds

Stage of Transplanting:

Transplanted at 4-leaf stage.

Spacing: 20 cm all around in beds.

Blooming:

November to January for winter crops and March to May for the summer season.

Manure and Fertilizer:

A small dose of complete fertilizer and a little well rotten cowdung or compost is beneficial.

Aftercare:

- i) Timely pinching of terminal shoots will encourage side shoots.
- ii) Faded flowers should be removed immediately to keep the plants in continuous bloom.

Insect-Pest:

There are no serious insect-pests in petunia.

Diseases:

There are no serious diseases in petunia.

PHLOX

Phlox drummondii Hooker

Variety:

The species *P. drummondii* var. *grandiflora* has *alba*, *coccinea*, *violacea* and *nana* compact strains. The sp. *pilza* has many strains for star phlox.

Propagating Materials: Seed

Soil: Well manured fibrous loam with good supply of water in the bed.

Sowing Time: August-October

Method of Sowing: Seeds sown in seed pans of flat boxes.

Stage of Transplanting: Transplanted when seedlings are 2 cm in height.

Spacing: 25 cm all round.

Blooming Time: 3 months after transplanting.

Manure and Fertilizer: A small dose of any complete fertilizer.

Aftercare:

- i) Pinching of central shoots will induce bushy growth.
- ii) The entire bunch should be plucked off after the first blooms start fading in order to encourage side branching and continuous blooming.

Insect-Pest:

There are no serious insect-pests in phlox.

Disease: Powdery mildew.

PORTULACA

Portulaca grandiflora Hooker.

Variety:

Single and Double varieties with orange, white, purple red or pink flowers

Propagating Materials: Seed

Soil:

All types of soils but perform best in poor sandy soil.

Sowing Time: March to April

Method of Sowing: Seeds sown in seed pans or see boxes.

Stage of Transplanting: Transplanted at 4-leaf stage.

Spacing:

15 to 25 cm between plants and 25 cm between rows

Blooming Time: 3 months after transplanting, i.e. June and July.

Manure and Fertilizer: Fertilizers are not necessary.

Aftercare: Portulacas are very small and succulent and therefore, careful and regular weeding should be done.

Insect-Pest: There are no serious pests in portulaca except scale insect.

Disease: There is no serious disease of portulaca.

SALVIA

Salvia splendens John Bellenden Ker

Variety:

The species splendens includes red, white and purple flowered salvia white the sp. farinacea and leucantha produce blue and deep violet Purple flowers.

Propagating Material: Seeds and cuttings.

Soil: All types of well drained soil.

Sowing Time: Seeds are sown from May onwards, while cuttings are made from April onwards from the new shoots of old plants.

Method of Sowing: Seeds are sown thinly in seed boxes.

Stage of Transplanting: Transplanting is done at 4-leaf stage.

Spacing: 20-60 cm apart depending upon the variety.

Blooming Time: Salvia blooms continuously for a long duration after about 2 to 2 ½ months of planting.

Manure and Fertilizer:

A light dose of organic manure for rich garden soil and a medium dose of complete fertilizer for poorer soils

Aftercare:

- i) In rich soils, staking is necessary to prevent the blooms from lodging.
- ii) Withered spikes should be removed in time.
- iii) Liquid feeding or top dressing with FYM is necessary when plants are seen exhausted.

Insect pest:

Aphid and scale insects

Disease: There are no serious diseases in salvia.

SWEET PEA

Lathyrus odoratus L.

Variety:

The early flowering varieties are Mrs. Herbert Hoover, Princess Blue, Harmony, white Giant, etc.

Propagating Material: Seed

Soil: Any good garden soil.

Sowing Time: October-November

Method of Sowing:

Seeds are directly sown in a prepared trench.

Spacing: 15-25 cm all around.

Blooming Time: 2 ½ to 3 months after sowing.

Manure and Fertilizer: About 450 g of complete fertilizer mixture containing a greater proportion of sulphate should be incorporated into the soil to cover an area of 1.11 to 1.48 sq.m.

Aftercare

- i) Furrows should be irrigated every second or third day from sowing to keep the soil moist but not too wet.
- ii) When vines are about 30 cm high they should be trained over a good support.

Insect-Pest: Aphids.

Disease: Powdery mildew.

ZINNIA

Zinnia elegans Nicholar Joseph Jacquin

Variety:

Primrose, Scarlet, Candy Cane, Yellow, Orange, Crimson, Lilipur Mixed, Giant double strain etc.

Propagating Material: Seed

Sowing Time: October-November for winter blooming and March-April for summer blooming

Method of Sowing:

Seeds are sown in nursery beds and seed boxes.

Stage of Transplanting:

Spacing: 25-30 cm all round.

Stage of Transplanting: Transplanting at 4 leaf stage.

Blooming Time: 1 ½ to 2 ½ months after transplanting.

Manure and Fertilizer: A light dose of complete fertilizer and a fair amount of organic manure are beneficial.

Aftercare:

- i) The first flower bud should be pinched off as soon as it is produced to induce side branches.
- ii) In tall varieties, plants should be staked with bamboo sticks.

Insect-Pest: Leaf eating caterpillars and aphids.

Disease: There are no serious diseases of zinnia.

PLANT PROTECTION MEASURES FOR SEASONAL FLOWERS

1. Aphid, beetles, thrips, leaf hoppers, whitefly, caterpillars and scale insects : Spray malathion @ 0.1% (@ 1 ml/lit of water)
2. Leaf minors: Spray Rogor @ 0.1-0.2% (1-2 ml/lit of water).
3. Cut worms and red ants: Dusting with malathion 5% dust.
4. Mites: Spray Kelthane 0.1% (@ 1 ml/lit. of water.)
5. Powdery mildew and Rust: Spray Karathane W.P. 0.05% (@ 0.5 ml/lit of water.)
6. Anthracnose and Downy mildew: Spray Dithane Z-78 @ 0.2% or any copper fungicide, e.g. Bordeaux mixture, Captan, @ 0.4%.
7. Wilt: Seed treatment with Agrosan GN @ 2g/kg of seeds.
8. Damping-off: Soil treatment with Formal-dehyde 4% @ 40 ml/lit of water.
9. Leaf Spot: Spray Bordeaux mixture or carbendazim 0.2% or Captaf 0.2%. (2g in 1 litre of water)
10. Viral diseases like aster yellow leaf curl, little leaf, stunting etc.
 - i) Uproot and destroy affected plants.
 - ii) Control the insect vector with insecticides.

GROWING OF POTTED PLANTS:

Now a days, the growing of house plants for indoor decoration is gaining much popularity because for rapid urbanization, lack of space around the house as well as their cost of maintenance and transportability. It is possible to grow a variety of attractive decorative and interesting plants within the condoned of the house with the help of which the entire indoor environment can be altered completely to give the home a fresh look.

KINDS OF HOUSE PLANTS:

- (a) Annuals: Various seasonal or annual flowering plants can be grown in pots. Annuals are raised from seeds, either sown directly or first in nursery beds, wooden trays or containers and then transplanted into pots when seedlings are at the 3 to 4-leaves stage or one month old. Annuals include Ageratum, Amaranthus, African daisy, Aster, Carnation, Cornflower, Cosmos, Clarkia, Cuphea, Heliotrope, Lupin, Ladys Lace, Marigold, Nasturtium, Nicotiana, Phlox,

Pink Dianthus, Poppy, Petunia, Pansy, Sweet William, Snapdragon, Stock, Zinnia, etc.

- (b) Perennials: Perennial houseplants are either raised by division, cuttings or simply from plantlets that are produced naturally from the mother plant. These include Begonias, Geranium, Cyclamen, Bromeliads, Succulents, Cactus, Coleus, Chrysanthemum, Ferns, Palms, Orchids, Foliage plants and many flowering shrubs and climbers. Perennial plants can be grown in combination in dish gardens and bottle gardens.

Soil for Potting

Soil for potted plants should be light, well drained and rich in organic matter. A potting mixture containing equal parts of rich garden loam soil and coarse sand is suitable for succulents and cacti. In the absence of rich loamy soil, another part of well rotten organic manure may be added get better results. A potting mixture containing 2 parts loam+ 1 part each of sand and well rotten manure of leaf mould is best suited for fibrous roots plants like Ferns, Geranium, Begonia, Seasonal flower, etc., For flowering shrubs and foliage plants like palms, Crotons, Hydrangea and Bougainvillea which have deep root systems, a potting mixture containing 3 parts loam + 1 part well rotten organic manure+ 1 part sand is suitable.

Fertilizer:

A complete fertilizer mixture of N:P:K: (10: 10: 10) is beneficial for house plants. This should be applied in liquid form (one tablespoonful in 1 litre of water) at monthly interval during the rapidly growing phase of the plants.

Container:

House plants can be grown in different kinds of containers such as earthen pots wooden boxes etc. The size of the pot should be proportionate to the size of the plants. To facilitate better drainage, there should be one or more holes at the bottom of the container. The pot should be glazed or painted because this will block the exchange of gases through the pores of the container.

Aftercare:

All indoor plants require care and attention. The plants must be watered often to prevent the plants from wilting. Some plants for example ferns, shed most of their leaves during a dry spell while in others the lower leaves turn yellow and drop off. On the other hand, watering causes the roots to decompose and the soil becomes very acidic and ultimately the plant withers up and dies. The frequency of watering should depend on the weather and season and nature of the soil. Watering should be done either in the morning or evening hours but never during mid day.

From time to time, leaves should be wiped with a soft sponge or wet cloth to remove the dust particles gathering on their surface, which block the pores and prevent respiration and transpiration. Fungicides and insecticides can be added to the water at proper concentration to control diseases and insects.

Repotting, i.e. changing the potting mixture is essential for perennial house plants. Repotting is done every alternate year with a new pot mixture. However, if old soil is to be reused, organic manure and lime (10 g per pot) should be incorporated in order to reduce the acidity.

POSTHARVEST & VALUE ADDITION

PREPARATION AND PROCESSING OF JAM

Jam is prepared by boiling the whole fruit pulp with sugar to a moderately thick consistency. Pectin present in the fruit or added, helps to develop the jelly fibre with a good gelatinous set. Acid (0.5-1.0 per cent) is added to invert a part of sugar (40 per cent) to prevent crystallization of sucrose in the finished product in addition to hardening the jelly fibre system. Banana, Guava, Mango, Apple, Pineapple, Apricot, Peach, Berry fruits, Rosellies, etc. are widely used for making jam. Jam can be made from practically all varieties of fruits and some varieties of vegetables Blended jam from various fruits can also be made.

The procedure and the amount of ingredients required for the preparation of jam generally have a slight variation according to the fruits. A general procedure for jam preparation is outlined below:

Fruit preparation:

Mature fruits are used. Under or over-ripe fruits should be discarded. Handling of fruits depends upon the kinds of fruit and the type of produce required. In general, the following steps are involved.

1. Removal of unwanted fruits and parts (under ripe and over ripe fruits, stems, stalks, calyces, strings, leaves, foreign matter and mouldy, blemished and defective fruits).
2. Washing and Preparation which may involve quartering, snubbing, cutting, mincing, destining, precooking, sieving, etc.

Precooking and pulping:

Prepared fruits (e.g. cut pieces of pineapple, guava) are boiled with a little amount of water to a soft consistency. The fruit is macerated with a ladle and in case of guava, seeds are separated by passing through a sieve. Fruit pulp can be prepared by a household mixer cum grinder after blanching the fruits for 2-3 minutes.

Jam boiling:

Fruit pulp, water, pectin (1%), sugar (67.5%) and acidity (0.5%) are boiled to ensure sugar penetration into fruit particles. Partial inversion of sucrose to dextrose and laevulose, destruction of enzyme and yeasts and other physical and chemical changes required to set the jelly fibre and to give the product its recognized characteristics. Excess quantity of water can be removed by

evaporation.

A short boiling time is important to preserve the colour and natural flavour. Artificial colour can be added with artificial flavour at the last stage of the boiling. Acid (citric acid or lemon juice) should be added at the last stage of jelly fibre formation in liquid form.

End point:

In open-pan boiling, the temperature is measured with a thermometer and the end point is usually at 105-108°C. A shallow metal spoon is also used to ascertain the end point. The spoon is dipped from time to time in the boiling pan and taken out and held in open for some time. When the syrup adhering to it forms flakes on cooling, it is presumed that the end point is near. Reading of 65 to 68 per cent total soluble solids (TSS) is also an indication of the end point of jam or jelly.

Filling and filling temperature:

The prepared jam should be filled to containers (glass jars) previously cleaned and sterilized in boiling water and dried at 82-85°C. The filled jars are capped, the head space is sterilized near a flame and the packed containers are then air cooled.

Recipe for jam preparation:

Generally, 45 parts by weight of fruit pulp requires 55 parts by weight of sugar and the substrate should be concentrated to 65 to 68 percent total soluble solid (TSS). Depending on the pectin content of fruit, external pectin should be added making the total pectin content about 1.0% Likewise, according to the PH of the fruit, the total pH level should be maintained at 3.2 by adding citric acid or lemon juice (a pinch). Optimum sugar concentration added should be 67.5 per cent which may vary slightly with the kind of fruit, their sweetness or internal sugar concentration, or acidity levels. Flavouring and colouring agents may be added according to necessity.

PREPARATION OF FRUIT JUICES AND SQUASHES

Fruit juice is a natural juice pressed out of a fruit which remains almost unaltered in its composition during its preparation and preservations. The procedure for the extraction of juice varies according to fruit. In industry, various kinds of machinaries like screw press, hydraulic press, basket press, fruit pulper, roller presses, belt presses and centrifugal machines are used. When the fruit contains seeds, it should be separated by cutting and slicing the fruit (Mango, Sapota, Plums, Jackfruit) and small seeded fruit like tomato requires special pressing cum seed separation device (Tomato processing machine). However, citrus fruit which contain bitter principle requires a particular approach where juice are normally extracted in special equipments in order to prevent the extraction of bitter components from their peel and consequent mixing into the juice obtained from their interior pulp. Thus, crushing and pressing are not employed in case of citrus fruits. Generally, citrus fruits are cut into halves and the juice is extracted by holding the cut halves against a revolving rose of burr (reamer) which is conical in shape and ribbed, and is made of stainless steel, monel, aluminium or nickel. The reamer tears the juice cells of the fruit.

For the extraction of juice in home scale level or home made commercial juices, the fruit can be pulped in a mixer cum grinder after peeling, cutting and removing the seeds. The pulp can be pressed with folded muslin cloth by application of pressure. For higher yield of juice in some fruits like banana jackfruit, green mango; ou-tenga, etc. the pulp should be briefly boiled and pressed. Application of a small quantity of citric acid and fungal enzymes helps in the higher recovery of juice from the fruits. For extraction of citrus juice, small glass reamers of aluminium and nickel are available with a minimal cost.

The extracted juice should be filtered with a filter press or ordinary thick type muslin cloth. Some juices which do not settle satisfactorily during storage and are difficult to filter can be clarified by the addition of fining agents. A fining agent is a kind of coagulating agent which settles and carries with in the finely divided particles responsible for the cloudy appearance. The fining materials most commonly used for fruit juices are egg albumen, casein, bentonite clay and infusorial earth, etc.

Preservation:

After extraction and filtration of the juice, it should be processed for preservation. To retain the natural taste and aroma of a juice, it is necessary to preserve it immediately after extraction. Various methods of preservation are employed with their own merit. The methods generally used are:

- 1) Pasteurization: It is done in fruit juices to kill all microorganisms capable of growing in the juice and causing spoilage. It does not kill the thermophillic

bacteria which cannot grow in the acid fruit juices. Heavily carbonated juices can be pasteurized safely at 56°C for 20 minutes. Most uncarbonated juices must be pasteurized at 80°C for 15 to 20 minutes. Juices of high acidity may be pasteurized at a lower temperature of 70-72°C for 20 minutes.

- 2) Addition of preservatives : It is usually necessary to add preservatives to fruit juices except for canned juices which are consumed immediately after opening the can. The use of preservatives is essential in concentrated drinks or squashes which after opening the bottle are consumed over a period of several weeks. Two important fruit juice preservatives are : (a) Benzoic acid (benzoates) and (b) Sulphur dioxide (sulphites).

Sodium benzoate: The quantity required would depend upon the extent and type of infection to be overcome and the nature of juice, particularly the acidity. For juice of pH 3.5 to 4.0, which is the range of most fruit juices, 0.06 to 0.10 percent should be added in a solution. In less acid juices like ripe grapes, banana, jackfruit, sapota, etc. at least 0.3% is necessary.

Potassium metabisulphite: It is used as a source of SO₂. Fruit juices can be preserved for more than a year by the addition of 0.1 percent metabisulphite provided the juice is made from a sound fruit and stored in clean containers at a temperature not above 15°C. For preserving raw citrus juice for a few months for the manufacture of squashes in the off season, generally 700 ppm of SO₂ is added for its strong effect in retarding oxidation preventing discolouration and loss of flavour of products. It should not be used in case of naturally coloured juices on account of its bleaching action. It also cannot be used in case of Juice which are stored in tin containers.

Chemical preservatives should never be added in solid form to fruit juices and squashes. They should first be dissolved in a small amount of juice or water and then incorporated.

Preservation by freezing:

When stored at 0°C, the temperature ordinarily used in cold storage the fruit juices either become moldy or undergo fermentation. In order to prevent the growth of microorganisms, it is necessary to store them at temperatures below -40°C. Grape, apple and pineapple juices can be held for at least 2 years at temperatures of about 5° to 8°C without noticeable loss of flavour, aroma or colour when the juices are stored in sealed containers such as lacquered tins or bottles. A juice can be kept in good conditions for a long time at 1°F to 10°F in frozen form while avoiding contact with air. The juice is defrosted before consumption.

Preservation by sugar:

All fruit juices may be preserved by the addition of sugar or by increasing the natural sugar content of the juice by concentration. Fruit juices containing

66 per cent or more sugar do not ordinarily ferment. Sugar acts as a preservative by osmosis and not as a true poison for microorganisms.

Preparation of pineapple juice

For pineapple juice, varieties Kew and Giant, Kew are employed in the industry. For home preparation, any variety can be considered. Fully ripe fruits are selected, peeled and cut into pieces. The cut pieces should be homogenized or pulped with a mixer cum grinder and the juice is pressed out with folded muslin cloth. Basket press may be used, screw presses are also available at lower price.

Processing of pineapple juice

Processing of pineapple juice (pH 3.5 to 4.0) in glass bottles, 30 minutes heating at 85°C is adequate to provide complete safety against yeast and mould spoilage and other mesophilic spoilage organism. In aluminium foiled pouches heating 25 min. at 85°C is adequate.

Juices from fruits can also be prepared in the same way with a light variation in preparation of the fruit and the mode of extraction of juice.

Preparation of squash

Squashes are sweetened fruit juices containing some pulp. Fruit squashes contain a minimum of 25 percent by volume of fruit juice and are intended to be drunk after dilution. Squashes also invariably contain added flavour.

A. Mango Squash Recipe:

Ingredients	To obtain the concentration of			
	25% juice 45° Brix 0.8% acidity	33.5% juice 45° Brix 0.8% acidity	25% juice 50° Brix 1.0% acidity	33.5% juice 50° Brix 1.0% acidity
1. Mango pulp	45 kg	45 kg	45 kg	45 kg
2. Sugar	62.60 kg	45 kg	80.2 kg	57.2 kg
3. Citric acid	1.2 kg	650 gm	1.575 kg	1.25 kg
4. Water	71.8 lit	44.1 lit	53.1 lit	30.6 lit.
5. Preservative (KMS or Benzoic acid)	110 g	85 g	110 g	85 g

B. Pineapple Squash Recipe :

Ingredients	To obtain the concentration of			
	25% Juice 45° Brix 1.5% acidity	33 ¹ / ₃ % Juice 45° Brix 1.5% acidity	25% Juice 56° Brix 2.0% acidity	33 ¹ / ₃ % Juice 65° Brix 2.0% acidity
1. Pineapple juice, 80° Brix, 0.5% Acidity	45 kg.	45 kg.	45 kg.	45 kg.
2. Sugar	74.8 kg.	55.25 kg.	110 kg.	81.6 kg.
3. Citric acid	2.475 kg.	1.8 kg	3.375 kg.	2.475 lit.
4. Water	56.5 lit.	32.0 lit.	20.1 lit.	4.7 lit.
5. Flavour	1.125 kg.	844 q	1.5 kg.	1.15 kg.
6. Preservative	110 q	85 q	110 q	85 q

C. Lime Squash Recipe :

Ingredients	To obtain the concentration of			
	25% Juice 45° Brix 1.5% acidity	33 ¹ / ₃ Juice 45° Brix 2.0% acidity	25% Juice 65° Brix 2.0% acidity	33 ¹ / ₃ Juice 65° Brix 2.0% acidity
1. Lime Juice 10° Brix, 6% acidity	45 kg.	45 kg.	45 kg.	45 kg.
2. Sugar	76.5 kg.	56 kg.	112 kg.	83.2 kg.
3. Water	58.5 lit	33.75 lit.	22.5 lit.	6.75 lit.
4. Préservative	110 q	85 q	110 q	85 q

D. Carambola squashes:

Preparation of carambola squash:

The following is a recipe for preparation of carambola squash.

Ingredients :

Carambola Juice	= 1 lit.
Sugar	= 1500 g
Water	= 1 lit
Citric acid	= 40 g (for sweet type), 20 g (for sour type)
Potassium metabisulphite (KMS)	= ½ tea spoonful

Preparation: Extraction of juice is done by the help of a juicer then strained and weighed. Sugar and water should be heated by constant stirring to make the syrup. The syrup should then be strained through a muslin cloth and cooled. Fruit juice should be added to the syrup. Measured quantity of KMS & citric acid

should be added separately to the prepared squash dissolving in a little quantity of water. Pour in sterilized bottles and seal airtight.

E. Some Other Preparations:

1. "Outenga" (*Dillenia indica*) ripe fruit can be used for the preparation of a pleasant ready to serve (RTS) beverage.

The best recipe for it is :

Recipe	Amount of ingredients
Dillenia fruits (segments)	1 kg.
Water	3.5 litres
Sugar	350 g.
Benzoic acid	½ teaspoonful
Pineapple flavour	2 drops

Procedure:

1 kg small washed segments are cooked with 1 litre of water under pressure in a pressure cooker for about 10 minutes and thrown away the excess water. Then the segments are again cooled with 2.5 litres water for about 30 minutes and allowed to cool for 5 minutes after removing the lid. The pieces were then blended in a waring blender and strained through a straining cloth.

Measure the liquid which come to about 3 litres. Then the other ingredients are added mixed, bottled and sealed. This product contains 3.20 mg/100ml ascorbic acid with fairly high amount of TSS, reducing, Sugar colour, flavour and other organoleptic properties. It store well for two months without any appreciable change in colour and taste.

2. Recipe for Bhimkal Squash:

Recipe	Amount of ingredients
1. Bhimkal juice	1 litre
2. Sugar	1000 g.
3. Citric acid	45 g.
4. Potassium metabisulphite	0.1%
5. Orange colour	2 drops.

Procedure:

The pulp, separated from the seeds is mixed with 45 g citric acid and kept overnight. Next day the juice is pressed out which gives 65% recovery of the juice. The juice (1 litre) is mixed with boiling syrup containing 100 g sugar. KMS and colour are added to the squash, filled in sterile glass bottles and sealed.

3. Preparation of tomato squash:

A fine quality squash can be prepared from tomato the best being from the variety Pusa Ruby at optimum harvest maturity when 100% colour of the fruit was developed.

The recipe being: (1) Juice extracted from 1 kg of tomato (2) Sugar-500 g (3) Citric acid-1 g. (4) Potassium metabsulphite-1 g. (5) Red colour-0.5 ml.

It can be stored for long time in glass bottles with minimum loss in the nutritional quality and organoleptic quality.

4. Preparation of Bhimkal powder:

A simple dehydrated "Bhimkal" powder can be prepared by the following method.

Pulp of ripe 'Bhimkal' fruit is separated from the seeds, supplemented with 20% arrowroot powder and dehydrated in a simple dehydrator at 65°C for 6 hours. The material is powdered. It has moisture content less than 5% and can be preserved by bagging in polyethylene bages. The powder so prepared has excellent energy value with optimum concentration of minerals, protein and fat. It has got excellent organoleptic quality in respect to test, colour, flavour, texture and eating quality and can be used as baby food.

5. Preservation and processing of banana.

- I) Banana fruits of cultivar Kachkol, Manohor, Chenichampa can successfully be dehydrated for preparation of commercial chips using simple dehydrator.

Method of preparation:

Mature green banana fruits at $\frac{3}{4}$ full finger were cleaned, peeled, sliced to a thickness of 3mm by a slicer and blanched for 2 min. in boiling water (1% NaCl and 0.17 KMS were added to blanching water) and dehydrated at 65°C for 7 hours to a final moisture content of 5 to 6 percent.

Kachkol variety was found to be the best in regards of chip quality, colour and nutrient retention points.

- II) A weaning food can be prepared from Bhimkol using filler material tapioca starch and enrichment of protein by adding green gram powder. Sixty percent banana powder was mixed 40% green gram powder. The formulation developed contains highest protein (14.14%), energy (371.12 K cal) with lowest carbohydrate (76.3%) and fibre content (1.35%). It contains all 18 essential amino acids. It has protein efficiency ratio (3.03) and food effectively ratio x FER) of 0.30.

Organoleptically, colour, flavour, taste and general acceptability was found to be excellent.

It can be stored upto 120 days in metal tin or aluminium foiled pouch at room temperature with maximum retention of nutritional quality.

5. Preparation of carambola chutney: The preservation of fruits and vegetables in the form of chutney is similar to that involved in the making of pickles and involves the use of sugar, salt, spice or vinegar as preservatives. The method of preparation usually includes a cooking process to hasten the action of the preservatives and develops an agreeable flavour and pleasing odour. Unlike pickle which take several days or weeks for seasoning, chutneys can be used for table purpose soon after preparation.

Ingredients :

Fruit pieces	-	1 kg.
Sugar	-	800 g.
Salt	-	50 g.
Ginger	-	50 g.
Onion	-	60 g.
Garlic	-	15 g.
Chilli powder	-	20 g.
Coriander powder	-	15 g.
Cardamom, Cina mon	-	5 g.
Cumin powder	-	25 g.
Vinegar	-	180 ml.

Preparation : The fruit should be cut into small pieces and cooked in a pan with salt and sugar. After proper dissolving of salt and sugar, the pan should be removed from heat and cooled for 30 min. The mixture should then be recooked till it becomes thick and sticky. Grinded spices should be put inside the spice bag and allowed to boil along with fruit pieces. Finally, 2-3 fine thread formation by chutney when stretched between the index finger and thumb will indicate the end point. The spice bag should be removed and vinegar added. The chutney should be allowed to be cooled and then be put into open mouthed sterilized bottles and sealed properly.

This excellent chutney can be stored at least for 6 months at room temperature without much deterioration in nutritional and organoleptic quality.

PREPARATION OF JELLY

Preparation of jelly is similar to that of jam, except for the use of juice instead of fruit pulp. It is prepared by boiling the fruit with water, expressing the juice and concentrating it to such a consistency that gelatinization takes place on cooling. A perfect jelly is clear, sparkling, transparent and of attractive colour. When removed from the glass, it should retain its form and should quiver, not flow.

The raw materials used for jelly making are similar to those used for jam. Pectin, sugar and acid in the mentioned quantity for jam are important ingredients for jelly making. Pectin and acid are added to those fruit juices which are deficient in these ingredients. The fruit rich in pectin and acid are the acid varieties of Apples, Lemon, Logan berries, Limes, Grape fruits, Sour Oranges, Damson plums and other Sour plums. Ripe melon, Carrots, Unripe bananas, etc. are low in acid but rich in pectin. Apricots and Strawberries etc. are rich in acid but low in pectin.

Procedure

The fruits are first washed. Since, jellies are made from juice, ordinarily peeling is not required for fruit like guavas and apples. In case of orange and lemons, the yellow portion of the peel should be removed to get jellies free from excessive bitterness. Fruits are cut into slices so that pectin and acid may be extracted easily. Only a minimum quantity of water should be added to the fruit for a simple extraction of pectin. If necessary, a second or even a third extraction may also be taken and mixed with the first extract. If large quantities of water are used, the jelly will be weak and if too little water is used, the extract will be difficult to clarify. The length of boiling will vary according to the variety and the texture of the fruit. The fruit should be heated only long enough to soften sufficiently to permit thorough extraction of juice by pressing and to render it mushy.

The juice extracted, filtered and boiled with sugar (67.5 percent optimum, which may vary according to fruit and its sweetness or sordidness), pectin (0.1 percent) and acid (pH 3.2). Colour, acid and pectin are incorporated just before the end point. Prolonged boiling results in loss of flavour, injury to colour and hydrolysis of pectin, consequently, it is a frequent cause of jelly failure.

The boiling is continued until on cooling the product forms a jelly of the desired consistency. The end point is determined by allowing the liquid to form sheet on a wooden ladle or spoon in sheets, or forms jelly like sheets on its side, the boiling is considered to be completed. If the juice contains the proportions of sugar, acid and pectin, the boiling point of the liquid at the jelling point will normally be about 110°C.

Packing:

Jelly is usually packed at the boiling point or at about 95°C and sealed hot. Sterilization of jars and lid and hermetical sealing can keep the product free from mould or fermentation.

PREPARATION OF PICKLES

There are several kinds of pickles which can be prepared. They are sour, sweet, special and mustard pickles. Picking is done in two stage, viz., (a) Curing or fermentation (which can be done with dry salting, fermentation in brine, or salting without fermentation) and (b) finishing and packing.

Oil pickles:

In India, oil pickles which contain some edible oil particularly rapeseed or mustard oil are highly popular. Cauliflower, lime and mango pickles are of high demand.

Cauliflower pickle:

Outer leaves and central stalks of cauliflower are removed. The cauliflower is then cut into pieces, washed, drained and placed in sun for 2-3 hours to remove some moisture. All the following spices except mustard are taken and ground into fine powder. These are fried in oil. When they turn brown, cauliflower pieces are also added and mixed thoroughly. When the pieces become soft, they are allowed to cool. Ground or broken mustard is then added and mixed. The mixture is placed in the sun for 5-7 days. Then 2.2 kg of vinegar is added and the mixture is again placed in the sun for 3 more days.

Recipe:

<u>Ingredients</u>	<u>Amount</u>
Prepared cauliflower	18.0 kg.
Salt	1.125 kg.
Chilli powder	560 g
Mustard seeds	560 g
Rape or Mustard seed oil	2.250 kg.
Onion (chopped)	560 g
Green ginger	560 g
Cumin, cloves and Cinnamon (Equal quantities)	168

For a sweet pickle 4.5 kg, of sugar should be added along with vinegar. Sugar may be replaced with equal quantity of gur (molasses). The pickle is put in a jar and covered with oil. It will be ready in about weeks time.

Mango pickle:

Unripe, fully developed, tart variety mangoes should be taken. Slice them longitudinally and varically with a knife, Discard the stones. Keep the slices in 2-3 percent brine and blanch to prevent blackening. Mix the mango slices with the salt of the following recipe. Place the mixturd in a glazed jar and keep it in sun for 4-5 days still the slices turn pale yellow. Mix with other ingredients and smear with a little mustard oil. Then pack the pickle in glass of glazed jars and cover with a thin layer of mustard oil. The pickle will be ready in 2-3 weeks.

Recipe

<u>Ingredient</u>	<u>Amount</u>
Mango slices	10.0 kg.
Slat, powdered	2.5 kg
Turmeric powder	300 g
Red chilli powder	300 g
Black pepper	250 g
Mustard oil	1.5 lit
Pasfuran	250 g
Zira	250 g
White mustard seeds	300 g

Lime pickle:

Fully ripe limes are washed thoroughly and given 2 to 4 slits each. Salt of good quality ($1/4^{\text{th}}$ the quantity of limes) and $3/4^{\text{th}}$ of the limes are squeezed to release as much juice as possible into the jar. The juice should cover the contents of the jar. If necessary, a few more limes may be resqueezed and their juice poured into the jar. The jars are placed in the sun for a week. When the limes get softened and their skins turn light brown, the curing is completed. For preparing lime and green chilli pickle, these may be taken in proportions ranging from 8:1 to 4:1 in weight. The rest of the process is similar to that of lime pickle.

Preparation of carambola jelly

Ingredients:

Carambola juice	1 litre
Citric acid	5 g
Pectin	5 g

Sugar	500 g
KMS	0.5 g/kg jelly.

Preparation:

Matured just ripe carambola fruits are cut into small pieces. Citric acid is added and cooked with little quantity of water for half an hour just to soften the fruit pieces. The fruit juice extract is strained through a muslin bag kept for 6-7 hours in a hanging position. Juice is kept for setting and supernatant juice is tested for pectin. As carambola has lower pectin content, so pectin is added at the rate of 5g per litre of the juice. Sugar is added to the juice and put to heat. The fruit juice along with sugar, pectin is boiled briskly and steadily. The end point of boiling is determined by following the drop test in which a drop of concentrated mass is poured into a glass of water. Settling down of the drop without disintegration denotes the end point. The foam gathered on the top of the jelly should be discarded with the help of a ladle. Then the jelly is poured into sterilized open mouthed bottle and kept for 3-4 hours undisturbed. The bottle are sealed with wax and stored.

Carambola pickle

Ingredients:

Carambola	1 kg
Salt	250 g
Turmeric powder	30 g
Fenugreek	25 g
Coriander powder	30 g
White mustard	50 g
Cumin powder	10 g
Acetic acid	5 ml
Oil (mustard)	500 ml.

Preparation:

Mutured unripe carambola fruits are thoroughly washed and cut length wise. Then they are made into smaller pieces. Turmeric powder is mixed with the fruit pieces. The carambola pieces are then placed over banana leaves and sun dried for 2-3 days. The mustard oil is heated and cooled and rest of the spices mixture is added to it. Then the sun dried carambola pieces are put into above mixture and the whole mass is thoroughly mixed. The pickles are then packed in polyethylene bags or glass bottles and stored at room temperature.

POST HARVEST HANDLING OF FRUITS AND VEGETABLES

A. Fruits

1. Banana cv. Jahaji, Chenichampa and Monohar can be ripened successfully in 46-49 hrs. by applying 1500 ppm of ethrel at room temperature in gas chamber which give improved eating quality, development of attractive colour and pleasant flavour. However, at higher temperature, no development to pale yellow colour can be obtained in case of cv. Jahaji.
2. For post harvest storage of pineapple fruits, saw dust storage system should be used to increase shelf life of the fruits by 9 days. Fruit rotting can be controlled by this system significantly. Storing the fruits in polyethylene bags reduces the loss of fruits weight. Application of 6% wax emulsion can increase the self-life of Kew pineapple upto 21 days with minimum weight loss and retention of optimum freshness.
3. Both the perforated and non-perforated polyethylene bags, transparent or non transparent, can be used for packaging Assam lemon fruits to prolong storage life.
4. The Assam lemon fruits should be harvested when the fruits are 120 days old, the skin of the fruits becomes soft and the change of colour of the fruits from dark green to light yellow.
5. Khasi mandarin fruits should be packed in Corrugated Fiber Boxes (CFB) of 420mm x 300mm x 329mm size (with CFB partitions inside) having 18 numbers of 3 cm (diameter) circular holes (equally distributed on all sides). The shelf life of the fruits can be increased by 12-15 days. The cost per box is Rs 55-60.
6. Two pre harvest sprays during August and September with Carbendazim (0.1%) and *Trichoderma viridi* @ concentration of 1×10^7 cfu (Colony Forming Unit) can maintain the quality of Khasi mandarin fruits like TSS, Sugar content and Ascorbic acid. and increased the shelf life of the fruits upto 15 days.

7. For increasing the shelf life of banana fruits, cut ends of the fruits after harvest should be dipped in Carbendazim 0.1%.
8. Improved Corrugated Fiber Boxes (CFB) of 685cm length, 380 cm wide and 258cm height can be used for long distant transportation of pineapple fruits. Cost of the boxes is Rs.70.00 per box. The cost per box is Rs 65-70
9. Fruits and vegetables can be stored in a low cost cooling structure. The structure should be prepared in an open area with facility of water supply. The length should be 1.5 – 1.6m, 1.0 – 1.2m wide and 0.6 – 0.7m height. Half of the total height should be under the soil and rest half above the ground. The floor and side walls (2 layered) of the structure should be prepared with bricks. The gap between the two layers should be 0.75cm and it should be filled up with sand. The sand should always remain wet. Arrangement should be made to cover the structure.

B. Tomato:

10. Mature tomato can be stored successful by applying 9% wax emulsion + 2 ppm 2,4-D + O. 2% Captan up to 24 days in marketable condition at room temperature. It controls physiological loss in weight, fruit rot and retains maximum organoleptic qualities such as colour, texture and flavour. It retains a fairly amount of ascorbic acid also.

C. Leafy vegetables:

Shelf-life of leafy vegetables like spinach coriander, lettuce and laisak can be extended up to 2 days in perforated transparent polyethylene bag (200 gauge), under room temperature and for 6-9 days under refrigerated condition ($4 \pm 1^{\circ}\text{C}$) with maximum retention of ascorbic acid, colour and freshness of the vegetables.

D. Colocasia:

Storage in perforated (0-3%) polyethylene (300 gauge) bag can prolong the storage life of colocasia with marketable quality up to 75 days for Ahina Kachu, 60 days for Kaka Kachu and 45 days for Neel Kachu.

E. Cabbage:

Matured Cabbage (Hybrid) may be stored under cold storage condition (Temperature 5°C to 7°C) bagging under Gunny bag upto 50 days.

F. Storage of Betel vine: Harvested leaves should be packed in fresh banana leaves in rolling fashion keeping both ends open.

PLANTATION CROPS

BAMBOO

The bamboo is very important plant species and is put to varied uses like fodder, fuel wood in the villages besides its industrial importance.

Soil and climate :

Bamboo can be cultivated on wide ranges of soils but well drained sandy loam to clay loam soils is most suitable. Hot and humid climate with even distribution of rainfall (2000 mm to 3000 mm) per annum) throughout the year is ideal for bamboo cultivation.

Altitude: Upto 3000m from sea level.

Recommended species: The species recommended for cultivation are : Bhaluka (*Bambusa balcooa*), Jati (*Bambusa tulda*), Kako (*Dendrocalamus hamiltonii*), Kotoha (*Bambusa bamboos*), Muli (*Melocanns bambusoides*).and Mokal (*Bambusa nutana*).

Medhod of Propagation: Seeds, offshoots, culm cutting, branch cutting, layering and marcotting.

A. Propagation from seeds:

Seeds are collected from fruiting branches by shaking the culms, in a sheet on four bamboo poles put under the tree. The ripe seeds are mixed with Mancozeb WP 75 (2gm/kg of seeds) and dried before sowing. In no case seeds should be collected from the ground as it is certainly be infected by insects and fungi.

Seeds should be sown immediately after harvesting. Sowing time varied with the time varies with the time of seed seeting in different species.

Seed Nursery: Seeds should be sown into well hoed moist beds on rich soils. Spacings given are 30 cm x 10 cm. Shade of 1-1.5 m high may be provided to provide shade for the nursery. Beds should be 1 m wide and convenient length and 10 cm raised from the ground.

Transplantation: Seeds germinate 2 to 6 weeks after sowing, Transplantation is normally varies according to species but generally done between 12-18 months after sowing the seeds. Normally for 'Muli' and 'Kako' spacing is around 5-6 m and for other is around 6 to 8 m.

Manuring: After transplanting, a liberal application of manure/FYM should be made. In subsequent years 100g urea, 25g SSP and 25g MOP should be applied in a ring around each plant. Such treatments increases the number of tillers/ culms and also height of the tillers.

B. Propagation from offshoots:

Age of the planting material :

The stem which 1 – 1½ years old, bear brown sheaths on the lower nodes indicate the offshoot is selected. Offshoot should be selected from the outer ring and cut 2.5-3m from the ground just above a node. Soils should be removed from the main root and rhizome should be cut away from the parent stalk leaving as much as root as possible with the offshoot.

Time of planting: April to August.

Spacing: Pits should be dug of 60cm x 60cm x 60cm dimension at a distance of 5-8m depending upon the species.

Method of planting: The off shoots should be planted immediately in the pits. The roots should be buried so that one node of the stem is just below the ground. To avoid drying of the stem, the top is covered with a cake of cattle manure. The stem should be point at an angle of 40° to the ground.

Manuring: After planting the offshoots, equal amount of soil and FYM should be mixed to fill up the pits. In the first year of planting 300mg urea, 150g SSP and 50g of MOP should be applied per plant. In subsequent years the application of fertilizer should be increased proportionately.

C. Propagation from culm cuttings:

Selection of culm: Two internodal cutting of varying length having 10-15cm culm length on either side can be used.

Age of the culm: 1 – 1½ years old.

Preparation of the culm for treatment: 1-2 years old culms should be collected and cut into two nodal segments. Lateral shoots should be trimmed. Care should be taken not to injure the nodal segments while trimming. Using a sharp knife/ chisel a small rectangular or round hole can be made in the internodal region of each cuttings.

Use of Chemicals: Boric acid 200g/liter of water. Best results can be obtained by adding 20mg/liter of water of IAA to the above chemical.

Preparation of chemical: All the chemicals are prepared by dissolving the appropriate quantity of chemicals in distilled or deionised water. IAA should be dissolved initially in a small amount of ethanol.

Procedure for treatment: The hollow internodal cavity should be filled with 100 to 150ml of the chemical solution preferably with the help of an injection syringe. The amount of chemical varies depending upon the size of the culm cuttings. Sufficient amount of chemical should be applied so that the two sides or nodes are touched by the chemicals. The holes should be sealed with cellophane tape.

Time of chemical treatment of nursery plantation: April to September.

Plantation of the treated culms in nursery bed: The treated cuttings should then be planted horizontally in the nursery bed so that sealed hole should face

upward. Spacing between cuttings should be around 25cm. Cuttings should be covered with soil 5-6cm deep. The nursery bed should be mulched with straw till the cuttings are sprouted. If there is no rain, watering should be done regularly.

Transplanting : Generally after 2¹/₂ – 3 months time sufficient rooting and sprouting occurs and then the sprouted cuttings should be transplanted into the main field. The two sprouted nodes are separated by cutting in the internodal region and planted separately.

Preparation of nursery beds : Nursery beds should be prepared by hoeing the soil thoroughly. Beds should be raised to 10cm above ground. The beds should be manured with cowdung and/or compost adequately. The bed size should be 5 m x 1.2 m.

Propagation by branch cutting : Applicable in thick walled bamboo species like Bholuka, Kako, and Kotoha. Select good culms of thick walled bamboos. Extract basal lateral branches with root primordia. Cut into 2-3 noded segments and dip in hormone solution. Plant in sand bed in mist chamber and seal the exposed cut ends. Transplant rooted sprouted branch segments in poly bags. Keep in shade and after 6 months will be ready for planting.

Layering and Marcotting : Select 1 year old culm. Prune the branches. Half bury under soil media. For Marcotting, place mixture of garden soil, lead MOULD AND rooting hormone at each node. Wrap with coconut fibre and polythene. Rooted nodes should be separated and new plants planted in the field.

Site should be selected considering the water and nutrient availability, easy accessibility. Soil should be sandy loam and well drained. Provision of shade is important for seed beds and sprouted seedlings.

Cultural care: Earthing up of rhizomes with top soil should be done during February – March every year. Ordinarily young culms are not cut while twisted one and remnants of dead portion are carefully removed. The culms are thinned every year. Protection against stray cattle, goats etc. should be made to the new suckers developed during the month of May-June of the year. For that fencing around the plant area should be given.

Harvesting: Culms should be harvested at 506 years age 1 feet above the ground.

Plant protection:

Rat: Rat damages the shoots of bamboo while sprouting. To control, rats should be destroyed along with the nests.

Weevils, white ants and termites: Plants should be protected by spraying Aldrine 30 EC at 6-10 ml per liter.

Fusarium wilt: Controlled by spraying 2% carbendazim at regular intervals.

AGROFORESTRY SYSTEMS

Agroforestry is a multiple land use system and symbiosis of tree growing, crop production and livestock. Such systems provide livelihood security for rural people along with their basic needs of food, fuel, fodder, fiber and fertilizer. Agroforestry systems are practiced by two ways by integrating the farm crops with the forestry or by integrating forest trees in to farming system.

The different types of Agroforestry systems along with their components being practiced are:

1. AGRISILVICULTURWE (Trees + Crops/trees + Trees)
2. SILVIPASTORL SYSTEM (Trees + Pasture + Animals)
3. AGRI-HORTICULTURAL SYSTEM (Crops + Fruit trees)
4. HORTISILVIPASTORAL SYSTEM (Fruit trees + Trees + Pasture + Animals)
5. AGRI-HORTI-SILVICULTURE (Crops + Fruit trees + Multipurpose trees)
6. AGRISILVIPASTORAL SYSTEM (Crops + Trees + Pasture + Animals)
7. HOMESTEAD AGROFORESTRY (Multiple combination of various components)
8. AGRI-PISCI-SILVICULTURAL SYSTEM (Crops + Fish + Trees)
9. SILVI-APICULTURE (trees + honeybees)
10. PISCI-SILVICULTURE (Fish + Trees).

Different components of agroforestry systems

1. Tree species Subabul (*Leucaena leucocephala*), Bamboo (*Dendrocalamus strictus*), Siris (*Albizia lebbek*), Neem (*Melia azedarach*), Sissoo (*Dalbergia sissoo*), Modar (*Erythrina spp.*), Kanchan (*Bauhinia variegata*), Khoir (*Acacia catechu*), Kadam (*Anthocephalus Cadamba*).
2. Fruits and Vegetables: Anola (*Terminalia officinalis*), Ber (*Zizyphus spp.*), Citrus (*Citrus spp.*), Mango (*Mangifera indica*), Guava (*Psidium guajava*), Jack fruit (*Artocarpus heterophyllus*), Mulberry (*Morus alba*).
3. Crops: Wheat, paddy, mustard, lentil, pea, soyabean, gram, ground nut, ginger, turmeric, chillies, tomato, coriander, methi, French bean, greengram.

Management practices:

Trees and crop system may be modified up to extend to adjust better like pruning of trees, changes in sowing time of crop etc. Need proper management of irrigation and drainage. However layer of soil should not be hard and should have good water holding capacity. Preventive measures against the infestation of pests and diseases should be taken in advance.

TEA

Soil & Climatic Requirement

Soil

- Soil : Deep & friable, high land
- Depth : 90 cm or more
- Texture : Sandy loam to silty loam
- pH : 4.5-5.5

Climate

- Hot and humid
- Temperature: 21-30°C, lower threshold : 13°C
- Rainfall : 1200 mm or more, well distributed

Planting Material

- Planting materials selected are judged on their locality wise performance.
- Clones and seeds ratio of planting materials 60: 40
- Single planting material should not be more than 10 per cent of area
- Minimum 5 to 6 clones should be selected
- Some recommended planting materials

Clone: TV₁, TV₁₇, TV₂₀, TV₂₁, TV₂₂, TV₂₃, TV₂₅, TV₂₆, TV₂₇, TV₂₈, TV₂₉, S₃A₃, P₁₂₆ A, Teen Ali 17/1/54

Seed stocks: TS 462, TS 463, TS 464, TS 506, TS 520

Nursery

Selection of site

- High & well drained land, free from surrounding jungle, bamboo bari
- Avoid Southern and South – Western aspects in hills/ *tillahs*
- Sandy Loam soil with pH 4.5-5.0
- Nematode count < 6/10 g of soil
- Nearby water source for irrigation
- Nearer to residence for better supervision
- Negotiable road

Vegetative propagation

Layout of beds

- Orientation: East – West direction in plain area and as per contours in the hilly areas.
- Bed size 1.2 m width of convenient length
- Drain size 30 cm width and 45 cm depth between two beds

- North – open over – head shade for polysleeves nursery
- Low level shade for callusing nursery
- Low height bamboo lathe frame in bed edges to hold polysleeves

Sleeve preparation

- Sleeve of size 15-17.5 cm lay flat width and 25 cm long of 150 gauge thick polythene.
- Soil mixture : Virgin top soil with SSP @ 500 g/m³ and thimet 10 g
- Prepare sleeves at least six months ahead of planting cuttings

Preparation and planting of cuttings

- Vegetative period – mid April – early June and mid September – mid October.
- Collect unbranched 5-6 months old banjhi shoots from mother bushes preferably in morning hours
- Discard top succulent and basal hard woody portion of shoots
- Prepare single leaf cutting of 3 cm length
- Plant cuttings in the callusing beds at a spacing of 5 cm×5 cm in fish – scale method
- Transfer the callused cuttings to polythene sleeves after callusing and root initiation
- Irrigate the beds as and when necessary. Follow hand weeding and recommended practices against pests and diseases
- Segregate plants into various size groups
- Nursery plants are ready for transplanting to the main field within 9-12 months after hardening.

Seed propagation

- Procure seeds from TRA approved seed growers during November – December.
- Carry out sinker floater test; floaters to be rejected
- Place the sinker seeds in germination pit (2m x 2m x 1m size) for cracking.
- Selection of site and type of soil are same as of vegetative nursery
- Bed size : 120 cm width and of convenient length
- Grow *Crotalaria anagyroides* in between every two beds in raised *bheti* for shade.
- No overhead shade required
- Plant cracked seeds with eye downward at 20cm x 20cm by covering the seed only
- Mulch the beds with leaves of green crops, grass or thatch, hay etc.

- Remove the mulch after sprouting
- Water the beds as and when necessary
- Follow hand weeding and recommended practices against pests and diseases

Drainage

- Dig drain prior to planting
- Dig field drains of 30 cm width and 105 cm depth at 30-40m spacing in sandy soil and 15-20 m spacing in heavy soil.
- Collector and main drains should be 120 cm and 150 depth respectively
- Drains should be of trapezoidal shape
- In sloppy land, graded contour drains with proper vertical interval are constructed
- Dig half the depth of field drains in the first year and then deepened it gradually within three years
- Ensure better fall in outfalls

Planting

- Ideal plant for planting

Age	9-12 month
Leaf number	12-16 numbers
Height	40-45 cm
Collar thickness	0.5-0.8 cm
- Spacing minimum of 60 cm in between plants and 100 cm in between rows
- Plant in single hedge in plains and along the contour in hilly areas
- Planting time : October – November in non-droughty area
 April – June in droughty area
- Pit size : 30 cm diameter and 45 cm deep circular pits
- Mix 1-2 kg compost, 30g SSP, 30g Rock Phosphate and 2.5 g thimet with the top excavated soil and fill the pits.
- Plant tea in pits by keeping soil level of sleeve in same level of ground
- Ram the soil properly without breaking the *bheti*
- Apply Oxyfluorfen @ 500 ml/200 l water as pre- emergent weedicide.
- Plant shade trees and sow green manuring crops (*Crotolaria anagyroides*) at recommended spacing

Shade

- Plant temporary shade trees at 5-6 m apart e.g. *Indigofera teysmanii*, *Melia azedarach*, *Leucaena lucocephala*

- Plant permanent shade trees at 10-12 m apart e.g. *Albizzia lucida*, *Albizzia odoratissima*, *Derris robusta*, *Albizzia lebbek* etc.
- Shade tree pit : 90 cm deep and 60 cm wide
- Mix 5-6 kg well decomposed cattle manure 0.5 kg SSP, 1 kg slaked lime / Dolomite and 0.5 kg wood ash in pit mixture.
- Protect the seedlings by bamboo basket

Bringing up of Young Tea

- Debudding in nursery one week before planting
- Centering at 15-22 cm from ground level leaving below atleast 3 laterals.
- Thumb break the single stemmers/ plants with less than three lateral below 22 cm from ground level
- Centering below 10cm from ground level affects frame formation.
- Centre/Thumb break at least after one flush in April for autumn planted bushes
- Centre/Thumb break in July – Aug in spring planted bushes during the banjhi phase
- Tip at 55-60 from ground level and continue plucking
- Leave UP for the next year and pluck to janam
- First Frame Formation Prune after 22-26 months of planting at 35-40 from ground level
- Recentre wherever necessary
- Remove criss – cross branches, weak shoots, *banjhi* shoots only
- Tip at 60 cm ground level for the next year and continue plucking
- Leave UP for next year
- Final Formation prune at 40-45cm from ground level
- Follow judicious KCO
- Frame Formation should be done either after starch – test or at the end of January

Pruning

- Time : Light pruning – 1st to 15th December
Skiffing – 15th December to 15th January
- Pruning cycle : 3 or 4 year pruning cycle

i) 3 year pruning cycle : Light prune (LP) – Level-off skiff (LOS) - Deep skiff (DS) – Light prune (LP) **(LP-LOS-DS-LP) or**
Light prune – Unprune - Unprune - Light prune (LP-UP-UP-LP)

ii) 4 year pruning cycle: Light prune (LP) – Medium skiff (MS) - Deep skiff (DS) – Light skiff (LS) - Light Prune (LP) **(LP-MS-DS-LS-LP) or**

Light prune – Unprune - Deep skiff – Unprune - Light prune **(LP-UP-DS-UP-LP)**

- Height of pruning
 - i) LP - Prune at 4-5 cm above the previous pruning mark
 - ii) DS - Skiff at 10-14 cm above the last LP mark
 - iii) MS – Skiff at 15-17 cm above the last LP mark
 - iv) LS – Skiff at 20-22 cm above the last tipping mark
 - v) LOS – Level off skiff
 - vi) UP – Level the plucking table by hand

Pest Management in Tea

Mite pests

- Maintain proper shade and check weed growth
- Improve drainage condition, maintain soil pH and supply manures in time.
- Check entry of animals into the tea sections
- Pluck first in uninfested area and then move to infested area
- Spray Propargite 57 EC @ 500 ml/ 200 l water, Profenofos 50 EC @ 200 ml/ 200 l water, Spiromecifen (Oberon) @ 200 ml/ 200 l water, Fenpyroximate 5 SC (Mitigate/Sedna) @ 200 ml/ 200 l water , Micronized sulphur formulations (Sulfex @ 1: 100 & Microsul @ 1:200), Neem formulations (Azadirachtin 5 %) etc. with high volume sprayer etc.

Chewing pests (Looper, Red slug and Bunch caterpillar)

- Soil stirring and collection of chrysalids.
- Hand collection of bunch and looper caterpillar
- Light trapping of moths
- Spray Neem formulations (Azadirachtin 5%), quinalphos @ 500ml ml/ 200 l water, endosulfan @ 500ml ml/ 200 l water (restricted use only), deltamethrin 2.8 EC @ 100 ml/ 200 l water, deltamethrin 10 EC @ 30 ml/ 200 l etc.
- Allow birds to visit the plantation

Sucking pests (Tea mosquito bug, Tea thrips, Tea jassids)

- Thin out shade trees in heavy shaded areas
- Follow hard plucking
- Prune or deep skiff the infested section at the end of the year
- Spray deltamethrin 2.8 EC @ 100 ml/ 200 l water, deltamethrin 10 EC @ 30 ml/ 200 l, thiomethoxam @ 40 g/ 200 l with high volume sprayer etc.
- Spray at 7-15 days interval depending on severity and period of attack after planting
- Spraying is to be done 3 days after plucking
- Follow barrier spraying
- Follow trapping by leaving a few bushes unplucked and then spray these bushes with pesticide.

Termites

- Destroy termite hills and queens and drench the hill with chlorpyrifos @ 1:300 solution
- Remove earth runs and fork the soil around collar region before application of pesticides
- Prepare a solution of chlorpyrifos @ 1:300 and drench the stems and branches using 250-400 ml for mature tea and 60-120 ml spray fluid for young tea.
- Avoid mulching with rice-straw.

Cockchafer grub

- Remove the mulch material or *jabra* from the collar of the plants
- Loosen the surface soil around the collar of the damaged plants
- Never allow entry of fresh cowdung in the field
- Apply 250 ml of chlorpyrifos/ endosulfan @ 1:300 dilution around the collar of the plants. A second application is essential after 2-3 weeks.

Manuring in Young Tea (0-5 year plants)

- Apply YTD mixture, 10:5:10 or 10:5:15 NPK
- Apply at proper dose, proper time and in proper way
- Manuring near the collar of plants should be avoided

- The schedule is as follows

Age	Qty of YTD in g/plant	No of splits	Interval between application	Method of application
0	10	2	8	Ring
+1	15	4	8	Ring
+2	20	4	8	Ring
+3	30	3	10	Ring
+4	525	3	10	Broadcast
+5	550	3	10	Broadcast

Manuring in Mature Tea

- Apply NPK depending on the yielding ability of the sections
- Dose N – 90 – 135 kg/ha, P₂O₅ – 20-50 kg/ha and K₂O – 90-130 kg/ha
- For the plants producing Made Tea above average production of 2000 KMTH, application of N (Nitrogen) is to be increased @ 5 kg N/100 kg of made tea.
- Dose of K (Potash) is increased in soils having low K content.
- Apply on weed free moist soil beginning with March – April
- Apply in 2-3 splits depending yielding ability
- Nitrogen and Potash is to be splitted, Phosphorus in single dose
- The proportion of ratio should be fixed depending on pruning or yielding ability
- Collar of plants should be unmanured.
- Avoid rainy and hot days for application.
- Apply fertilizers in broadcast method ensuring uniform spread in the area

Tipping and Plucking

- Keep allowance of new growth depending on prune or skiff
 - LP : 20 cm
 - DS : 10 cm or 2 leaf
 - MS : 5 cm or 1 leaf
 - LS/LOS/UP : At the same level
- Pluck at the tipping level

- Pluck to 'janam'
- Type of plucking
 - Standard : Leave smaller 1 + b, bud
 - Black : Leave only bud
- Plucking round : 6-9 days depending on the growth of shoots.
- Step – up plucking : Raise plucking by leaving a leaf over the plucking table in end August
- Follow step-up plucking in denuded plants

Green Leaf Handling

- Pluckers should not be allowed to keep the leaves in hand for longer time
- Unload the plucking basket/ bag whenever it is full
- Don't allow to press the leaves in the basket
- Keep the leaves in carrying baskets/ bags loosely in shade
- Don't store leaves in garden for longer period
- Don't allow worker to sit on the plucked leaves while transporting to factory

Intercropping in Tea

- Existing arecanut plantation can be used
- Plant tea leaving a circle of 120 cm around palm
- Arecanut can be used as standard for Black pepper/ Betelvine
- Young tea sections can be interplanted with chilli, tomato, french bean, brinjal, cowpea, etc. in between open rows.
- Possible intercrop: Orange, Chachi plants, Indian Goose berry (Var. Baranasi and Francis) etc.
- Arahar for initial years for new plantation
- Plants Kagji Nemu near the fencing surrounding the plantation

MEDICINAL PLANTS

Ashwagandha (*Withania somnifera*)

Ashwagandha is an alternative plant for medicinal uses. Its roots, leaves and seeds have some medicinal values. The plants have wide adaptability and grown up to an altitude of 1200 m from M.S.L.

Land situation: Well-drained upland having mild acidic to mild alkaline soil is most suited for cultivation. It thrives well in loamy or clay loam soil. A friable loam rich in humus is ideal.

Field preparation: The preparation of land should start with the onset of monsoon. The land should be ploughed 3-4 times followed by several times harrowing and laddering in order to bring the soil to better tilth. At the time of final land preparation, sufficient amount of cow dung or compost or FYM may apply in the soil.

Manures and Fertilizers: Depending upon the availability, well decomposed FYM or compost up to 20t/ ha may be applied either by broadcast over the beds or in the soil prior to sowing. No inorganic fertilizers are generally used for this crop.

Sowing method: Seeds are either broadcasted or sown in lines 50-60 cm apart.

Sowing time: June and July. Generally germination starts with the beginning of summer to mid monsoon season.

Plant population: The plant stand should be maintained at 30-40 plants per sq. meter i.e. 3 to 4 lakhs per ha. Transplanting of 25 to 35 days old seedlings may be done to maintain the optimum plant stand. If transplanting of seedlings in the well-prepared field is to be done, spacing between the lines and plant should be 50 to 60 cm.

Weeding, thinning and interculture operation: Weeding is done at the early stage of the crop depending on the weed infestation. To maintain the optimum population thinning should be done 25-35 days after sowing. A light hoeing and earthing-up may be done during the time of weeding after thinning operation.

Harvesting and post harvesting operation: At 150 to 180 days after sowing (in the month of December when sown in June-July), the crop is harvested.

At maturity, the leaves of the crop turn yellow and the fruits turn red. Leaf shading may also occur.

Crops are uprooted and the entire roots are to be separated by cutting at base or 1 to 2 cm above the ground. Fruits are also collected separately.

Ripe fruits are sun dried for several days and after drying seeds are preserved in polythene bags. Roots are beaten to clean from the soil particles and hairy roots. Cleaned roots are cut into 7-10 cm long pieces, sun dried and preserved in gunny bags.

Medicinal uses: It is medicinal in sexual and general weakness and rheumatism. Also used as diuretic. Root powder is used in ulcers and inflammations as well as antibiotic, more particularly antibacterial.

Yield:

Dry roots : 350 to 500 kg/ha
 Seeds : 50 to 75 kg/ha

Economics :

<i>Expenditure</i>	(Rs./ hectare)
Land preparation	5000.00
Manure & Fertilizer	9000.00
Seed @Rs. 60.00	40.00
Chemicals	500.00
Total operational cost	10000.00
Total expenditure	24540.00
<i>Income:</i>	
From dry root (400 kg x Rs. 120/-)	48000.00
From seed (60 kg x Rs.60/-)	3600 kg
Gross return	51600.00
Net return	27060.00
B-C ratio	1.1 to 1.6 : 1.0

Safed Musli (*Chlorophytum borivilliam*)

It is an annual herb with sub-erect slightly yellowish lanceolate leaves and plant height is about 1.5 ft (45 cm). The root system is tuberous, which is the economic part of the plants. The tuber is of 0.9cmx8.0cm in size and number varies from 5-30 per plant and white in colour.

Soil: The crop needs high land having light to medium textured soil i.e. sandy loam to loam. Water logged soils are not suitable. During the rainy days drainage system should be maintained to drain out the excess rainwater from the field. The crop requires warm and humid climate. For better growth soil pH should be around neutral.

Propagation and planting material: The crop can be propagated by seeds and root-tubers with some portion of crown attached to each tuber. Root-tuber takes lesser crop duration in comparison to crop grown from the seeds. In general, previous year root-tubers are used for cultivation. The sprouted root-tubers with crowns are the best to use as planting material. Root tubers with crown disc having the weight of 15-20g may be used for commercial scale production.

Land preparation: It requires systematic land preparation. Deep ploughing followed by several times harrowing should be done to attain a good tilth. Sufficient amount of well decomposed FYM/compost should also be applied at the time of final land preparation.

After land preparation, raised beds of 90 cm to 200 cm width may be prepared and these may be done easily by making 15 cm deep furrows between the beds to drain out the excess rain water.

Planting time: Last week of May to June.

Seed treatment: Planting materials may be treated with Mancozeb WP 75 or Captaf @ 2.5 to 3 gm/kg of seed or root-tuber.

Seed rate: 1200 kg/ ha or 165 kg / bigha.

Spacing: 20-24 cm between plants.

30 cm between rows.

Manures and fertilizers: 10-t FYM/ha or sufficient quantity of well-decomposed (FYM or) cow dung should be applied at the time of final land preparation. Nitrogen fertilizer is to be applied in the form of urea @ 100 kg/ha in two equal splits at 15 and 30 days after planting. As a basal dose of DAP @ 120 kg/ha and MOP @ 100 kg/ha are to be broadcasted before final land preparation.

Irrigation: Crop is grown generally in rainfed condition. Sufficient soil moisture in the bed should be maintained throughout the growing period and till the harvesting of crops. Sprinkler irrigation system may be employed for better growth and results.

Weeding: Two to three times manual weeding is necessary to maximize tuber yield.

Deflowering: All the flowers should be removed from plants for healthy growth of the tubers, more particularly during the early growth phases.

Harvesting: The crop is ready for harvest in eight months after planting. Root tubers turn into brown or brownish-red from white. Harvesting of tubers may be delayed up to April, if tubers are used for planting materials. The small tubers with crown are stored for planting in the next season, while the biggest size tubers are processed for marketing.

Yield: The average yield of fresh Musli is 5-6 t/ ha or dry Musli 1.0 to 1.2 t/ ha.

Post harvest management:

Drying: After uprooting the tubers, it should be spread in shade for about 4 to 7 days and then peeled to remove the skin.

Processing: Large tubers are washed and outer skin is peeled off with the help of knife and then dried for 2 to 3 days. The dried tubers (18 to 20 % of fresh weight) are stored in airtight poly bags.

Grading: The dried tubers/fingers are graded on the basis of colour and size.

Medicinal uses: It is a principal ingredient in Ayurveda, Unani and Allopathic medicine, as a vitalize and health tonic and as a curative for pre-natal and post-natal problems. It acts as a natural aphrodisiac, alternative to Viagra, restorative for immunity improvement and as a remedy for diabetes and arthritis, used against rheumatism and joint pains. It is also useful for brain development in children and to cure physical weakness.

Chemical constituents:

Alkaloids	25%
Protein	8.9%
Carbohydrate	42%
Steroid saponins	0.1-1.7%
Fiber	34%

Glycosides, vitamins and polysaccharides are also present. The alkaloids and saponins are responsible for medicinal properties of the plant.

Sarpagandha (*Rouvolfia serpentina*)

Sarpagandha is cultivated for its alkaloids. Ajmaline, Deserpidine, Rescinamine, Reserpine, Serpentine are some of the important alkaloids from this plant. Nearly 90% of the total alkaloids are found in its underground portion of stem and roots. And, therefore, "roots" (underground stem, rhizome and root) are the important organs of the plant which are harvested for commercial purposes.

Plant description:

- Habit : Erect herb, 50-70 cm high
Root : Tap root system, deep-rooted
Stem : Cylindrical
Leaves : Ovate elliptic, glabrous, 8-20 cm long, in whorls of 3-4.
Flowers : Tubular, 1-5 cm long, 5-merous, white or pink, in cymose inflorescence; peduncle deep red.
Fruits : Small, round, 1-seeded, sometimes two fruits united, turning dark purple to black when ripe.

Variety: RS-1 (Released from JNKVV, Indore) or local.

Soil: Sandy loam, clayey loam or clay soil, with pH 4 to 7.5.

Climate: Humid and hot to moderately hot climate

Propagation: Sarpagandha can be propagated by seeds, branches and root cuttings.

a. Seed Propagation:

- Nursery beds: 1m x 8m size x 12 beds (for 1 hectare of main field)
- Seed requirement: 500 g per bed (6 kg for 12 beds)
(seed viability: 5 to 30 % in one year old seeds)
- Sowing time: April-May.
- Seed treatment: Before sowing, seeds are treated with Captaf or Thiram @ 2g/kg
- Irrigation: After sowing, light irrigation should be given to keep the beds moist.
- Seedling emergence: 5 to 8 weeks after sowing. At 4-6 leaf stage seedlings are transplanted in the main field.

b. Stem cutting/root cutting:

- Mature stem cutting (12-15 cm long) and root / rhizome cutting (5-8 cm long) are planted in the nursery beds.
- Saplings for transplantation: 3 months after nursery planting.
(This method records 40 to 80 % more success in comparison to propagation through seeds.)
- 100-120 kg rhizome/stem/root will be required to develop saplings for the one hectare main field (13 to 16 kg per bigha).

Land preparation: Land should be deeply ploughed and beds of 1.0-1.5 m breadth, 15 cm high and convenient length may be prepared ensuring proper drainage.

Transplanting: Transplanting of seedlings/saplings is done at 4-6 leaf stage. Planting time: July-August.

Spacing: Seedlings should be transplanted with a spacing of 45 cm between rows and 30 cm between plants.

Manures & fertilizers: FYM @ 2.5 to 3 t/ha (3 to 4 q/bigha) should be applied at the time of final land preparation.

Alternatively, NPK @ 40: 60: 40 kg /ha (12 kg urea, 50 kg SSP and 9 kg MOP per bigha) can be applied with about 1 t of FYM. One third of N along with full doses of P and K should be applied as basal dose. Rest of the N should be top-dressed at 3 months interval.

Interculture: At least two weedings are required before flowering. A light hoeing between the rows followed by application of FYM is required at 30-45 DAP.

Harvesting:

- Harvest time: From 16 to 24 months after planting.
- Harvested roots/rhizomes/stems (0.5 to 2.0 cm in diameter) should be washed in water and sun dried.
- At nearly 8% moisture content, these are stored in air tight poly bags.
- Fruits get matured in July to October. Black fruits are collected during July to October, crushed with sand in hard surface giving gentle pressure, sun dried seeds are stored. Seeds remain viable for about 8 months.

Yield: 15 to 25 q dry root/rhizome/stem per hectare.

B-C ratio (at the end of 2 years) : 3.3: 1

Patchouli or Panchput (*Pogostemon cablin*)

Patchouli is an introduced aromatic crop and adopted very well in Assam. The essential oil extracted from leaves of the plant has various uses in perfumery and drug industries. The best quality of patchouli oil contains 30-33% Patchouli Alcohol, 2-3% Caryophyllene, 2-4% β -selinene, 2.0-2.5% Pogostol and 0.8 to 1.0% other Alcohol. Because of having high demand of patchouli oil, in the national and international markets, it has an assured market.

Plant description:

- Habit : Erect or semi-erect herb, 1 to 2 m high.
Root : Adventitious, shallow rooted.
Stem : Quadrangular, semi woody below.
Leaves : Opposite broadly ovate, acute, 5 to 15 cm long, with serrated margins and long petiole.
Flower : Small, pink, in clusters arranged in racemes.
Fruit : Capsular.

Variety: Indonesian variety is suitable for Assam.

Soil: Clay-loam to sandy-loam soil with good amount of humus and devoid of water stagnation. The ideal soil pH is 5.5 to 6.5.

Climate: Moderately warm and humid climate. The basic requirement is partial shade (30 to 40%) and frequent irrigation.

Propagation: Branch-tips with 3-4 nodes are good propagating organ.

Nursery: Bed size: 1m breadth and convenient length (with sand rich medium + sufficient amount of FYM or compost). Fresh cuttings are to be planted at 3-5 cm gap. Poly bags filled with well prepared sand medium with single cutting can also be used for nursery raising. Light irrigation should be given to keep the beds moist.

Land preparation: Land should be well ploughed and beds of 130 to 150 cm breadth and length of convenient size are to be prepared with 50 cm gap between the beds.

Manure and Fertilizer:

- Sufficient amount of FYM/compost/well rotten cowdung/poultry litter (10 to 15 t/ha) (1.5 to 2 t/bigha) are to be applied at the time of final land preparation.

- Alternatively, Chemical fertilizers can be applied @ 100:50:60 kg/ha N, P₂O₅ and K₂O (30 kg urea, 42 kg SSP and 13 kg MOP per bigha). SSP and MOP should be applied as basal dose, at least four days before planting and urea should be applied in four equal splits.

Plantation: \

- Planting time: March-April and October- November.
- Planting material: Rooted cuttings
- Spacing: 45 cm x 45 cm.

Intercropping: Tall shrubby crops like Arhar, Jatropha, Papaya etc. can be cultivated at a spacing of 1-2 m x 1-2 m. Patchouli can also be cultivated as intercrop in arecanut or ornato-tree plantation or homestead woodlands.

Interculture: Weeding at early growth stage and one light hoeing between the lines at 25-35 days after planting is very essential.

Plant protection:

- Against Mite: Ethion @ one tea spoon mixed with two litre of water to be sprayed.
- Against Nematode: Crop should be harvested and rooted stems should be uprooted and burnt. Furadon/ Carbofuron @ 4.5 kg/bigha should be applied. Application of neem-cake or mustard-oil cake can also control nematodes.
- Against Root rotting: Soil should be sprayed near the stem base with Carbendazim 50 WP @ 2g/ litre of water. (The disease may also occur if there is water stagnation).

In case of severe infections by pests and diseases (if any): The plants should be harvested for leaves immediately and the stems should be uprooted. Uprooted stems should be dried and burnt, and soil should be treated with appropriate medicine. Crop rotation is also a good solution as non-chemical management of these problems.

Crop cycles: Following crop cycle can be maintained:

- March-April to July-September.
- October-November to March-April.
- One to two year crop stand (depending on crop health & situation).

Harvesting:

- Crop is ready for harvest 4-5 months after planting
- In seasonal crop cycle: Plants are cut at base.

- In annual or biennial crop cycle: Less than 50% leaves with young branches of each plant are cut in intermittent harvestings. The crop will be ready for second harvest within 30-45 days after the 1st harvest during summer season. Urea or vermicompost or FYM or well rotten cowdung should be top dressed after harvest.

Drying: Harvested leaves are dried in shade for 1 to 2 weeks. Mature and thick stalks should be removed. Dried leaves are then packed in cotton or jute bags and hanged from the roof of the store house. Ageing of leaves in storage improves oil quality. Market fluctuation, if any, can also be avoided by storing the leaves. Bamboo hut can be constructed with few bamboo "chang" on walls. Leaves should be kept on the mats in thin layers for drying. Storage bags can be hanged from the roof of the house.

Yield : 5 to 7 q dry leaves per bigha (i.e. 37 to 52 q dry leaves / ha).

B-C ratio: 1st Year = 2: 1; 2nd Year= 3: 1.

APICULTURE

Honeybees are essential for pollination of many cross-pollinated crops, and also for production of honey which generates income to the farmers. There are four major honeybee species viz., Rock bee (*Apis dorsata*), little bee (*Apis florea*), Indian bee (*Apis cerana*) and Western bee (*Apis mellifera*). Out of them, former two are wild and the latter two are domesticated species. Indian bee is a brownish black, locally available domesticated Asiatic species. The beekeeping practice of North-East India is mainly based on this species. This is indigenous to India with average honey yield of 12 kg per hive per annum and the foraging range is 0.8-1 km. Western bee is an exotic golden yellow species most widely and commercially reared in the world. This is larger in size than Indian bee having average honey yield of 35-40 kg per annum with the foraging range of 2 km. The species is successfully introduced in Northern India and effort is being made to introduce in Assam including North East India.

Apiar site:

An apiary is a place where honeybee colonies are reared. Site with proper sunlight, air circulation and shade should be selected for apiary. Good apiary location is one with abundance of nectar and pollen producing plants. Commercial beekeepers generally migrate their colonies from one place to another for flora and produce more than one api crop of several types. Some of the important bee foraging crop-plants are rapeseed-mustard, niger, buckwheat, sunflower, safflower, sesamum, bottle gourd, pointed gourd, pumpkin, ridge gourd, sponge gourd, maize, soyabean, *jamun*, *litchi*, mango, drumstick, guava, citrus, coconut, areca nut, date palm, pummelo, ironwood, tamarind, mayflower, pomegranate etc..

Beehive and other equipments:

Honeybees are reared in the modern beehive based on principle of bee space. Beehive is composed of brood chamber and honey chamber. The brood chamber is meant for rearing progeny and the super or honey chamber is used for secreting honey. The following beekeeping equipments are required for honeybee rearing.

- i) Beehive:
 - (a) ISI A type 8 frame for Indian bee, ISI B type 10 frame for Indian bee.
 - (b) Langstroth 10 frame for Western bee.
- ii) Smoker to produce smoke for effective handling of the colony
- iii) Bee veil to prevent bee stinging during handling of the colony
- iv) Hand gloves for effective handling of the colony
- v) Swarm-catcher for collection of colony from natural source
- vi) Honey extractor for extraction of honey
- vii) Uncapping knife

Rearing Season:

Seeds or colonies are normally available during spring i.e. February to March as this is a peak-breeding season of the honeybees. Colonies can be collected from the natural sources or may be procured from the beekeepers. Rearing can be started with three or four frame worker bee having one year mated queen. During winter (December to January) and in spring (February to March) are the best seasons to start beekeeping.

Seasonal Management:

There are generally three seasons for bee management.

Spring Management:

Beekeepers calendar starts with the activity of honeybee colonies after prolonged rain and winter cold. As this is a major flowering season, worker bees become busy for collecting nectar and pollen from flowers and thereby help in building the colonies. This is known as honey-flow season and in this season mostly extraction operation is done. However, there is a problem with swarming, which is acute in Indian species but less in western species. Swarm prevention can be done by frequent inspection of the colony, removing the queen cell, dividing the strong colony and helping the weak one.

Summer and Rainy season management:

In the summer management, honeybee colonies should be kept under shade just to protect from scorching sun. As there is continuous rainfall in Assam during the rainy season, honeybee colony should be provided with artificial diet, composed of carbohydrate, protein and water. Effective artificial diet comprises of sugar (as carbohydrate); black gram or green gram or soybean powder (as protein source) and water @ 1 kg of sugar and 100 gm protein powder mixed in 1 lit of water. It should be administered as per requirement of the colony.

Winter management:

The honeybee colonies should be taken out from the shade and exposed to the sunlight.

Migration of the colony:

During winter, honeybee colonies should be migrated to the oilseed crop fields (mainly rapeseed-mustard crop) and then to spring blooms of fruit, forage crops and forest plantations. In this practice both the beekeepers and farmers will be mutually benefited in terms of honey and crop production. Migration is essential for getting substantial yield of crops as well as honey.

Disease and Enemy Management

Several diseases, viz., and fungal, bacterial, viral and protozoan diseases infect honeybees. Out of these, viral and protozoan diseases are most serious ones in Assam.

Sac-brood disease:

This is a viral disease caused by Thai-sac strain. The symptoms of this disease are

1. The larvae become pale; then turn brownish-black and gradually dry up.
2. The punctured capping with dead pupa within the cell.
3. The infection is usually in worker, seldom in drone and spread by drifting nurse bees.

Control:

Dequeening and Requeening:

Create broodlessness for some time by dequeening and requeening through production of new queen cell. Infected colony should be treated with antibiotics like Teramycin, 250 mg @ one tablet per 4 lit of sugar syrup.

Nosema disease:

Nosema disease is found in adult Western bee colony. The infected bees show the symptom of crawling, disjointed wings and the mid-intestine becomes swollen with pale colour.

The treatment with hydroxy quinoline mixed with sugar @ 250 mg/4 litre of sugar syrup will give effective control. Against fungal disease, proper aeration and exposure to the sunlight prove to be effective.

Natural Enemy:

Almost half a dozen natural enemies such as lizard, wasp, waxmoth, cockroach, birds, ants and mites infest honeybee colonies. Out of them, waxmoth and predatory wasp are most serious enemies.

Waxmoth, *Galleria mellonella*:

Waxmoth lays eggs on the stored combs or on the spare combs in the colony. Larvae develop by feeding on wax and pollen in comb cells. Wax moths are most active in summer and rainy seasons. To manage this pest; store combs by removing extra combs from the colony. Fumigate stored combs in air-tight space (in hive chambers, sealed between with mud or dung) and treated with acetic acid or formalin. But fumigation with sulphur smouldering is most effective. Removal and destruction of infected portion of the comb is also recommended. The biocontrol practice of treatment with *Bt* formulation var. *kurstaki* @ 0.5 gm/100 ml. of water per hive gives effective control of the pest.

Predatory wasp:

Among the wasps, the burrowing (*Vespa magnifica*.) and aerial wasps (*Vespa cincta*) are two common species in Assam, which predate on honeybees. To protect the colonies from the wasp, practices such as destruction of wasp

nest in the vicinity of the apiary and artificial net covering (with nylon net of 1 cm mesh size) over the bee hive colonies are found to be effective.

For controlling bee mites, honey bee colonies should be exposed to the sunlight and in acute cases chlorbenzilate fumigation gives effective control. Sulphur dusting @ 200 mg/hive on top bars of frames is also effective.

Honey bees in crop production

Honey bees are essential for pollination of all the cross pollinated crops. It has been clearly demonstrated through experimentation at AICRP on Honeybee scheme AAU, Jorhat that honey bee colonies enhance crop yield to the tune of 1.5 to 2 times as shown below:

Crop	Colony requirement	Yield (q/ha)	Per cent yield increase over open pollination
Mustard	5	12.2	157.65
Niger	6	6.1	146.98
Buckwheat	5-6	14.2	152.68
Litchi	5-6	66.7	142.75
Assam lemon	4	50.80	57.14

Hence honeybee colonies are considered as essential input for increasing productivity of cross pollinated crops. Migration of honeybee colonies is necessary for both crop and honey yield.

Pesticidal Poisoning to Honey Bees:

In order to protect the honeybees from pesticide poisoning eco-friendly pesticides, which are less toxic to honeybees should be recommended. Moreover, the application of pesticide on flowering crops should be done in the afternoon when the bee activity stops in the field. Some of the bee friendly pesticides with inorganic and organic compositions are oxydemeton methyl, endosulfan and deltamethrin and botanicals. Biopesticides such as *Bt.* formulation, NPV etc. which are having less or no residual toxicity should be incorporated in the Integrated Pest Management Packages.

Recommendation of Bt. Formulation against Wax moth

Wax moth, *Galleria mellonella* is one of the most serious pests of honeybee causing severe damage to the colonies. Various remedial measures such as cultural, chemical were adopted without having any full proof effect. In order to have effective management of this pest, biocontrol experiments with *Bt.* Formulation, var. kurstaki @ 0.5 per cent controlled the waxmoth effectively. Hence, *Bt.* var. kurstaki 0.5 gm/hive/litre of water has been recommended against wax moth.

APPENDICES

APPENDIX I

Pesticides banned for manufacture, import and use in India (25 nos.)

Source: Central Insecticides Board & Registration Committee, Directorate of Plant Protection, Quarantine & Storage, Ministry of Agriculture, Faridabad
(Web site: http://www.cibrc.nic.in/list_pest_bann.htm)

1. Aldicarb
2. Aldrin
3. Benzene Hexachloride
4. Calcium Cyanide
5. Chlorobenzilate
6. Chlordane
7. Copper Acetoarsenite
8. Dibromochloropropane (DBCP)
9. Dieldrin
10. Endrin
11. Ethylene Dibromide (EDB)
12. Ethyl Mercury Chloride
13. Ethyl Parathion
14. Heptachlor
15. Maleic Hydrazide
16. Menazon
17. Nitrofon
18. Paraquat Dimethyl Sulphate
19. Pentachloro nitrobenzene (PCNB)
20. Pentachloro phenol (PCP)
21. Phenyl Mercury Acetate (PMA)
22. Sodium Methane Arsonate (MSMA)
23. Tetradifon
24. Toxaphene
25. Trichloro Acetic Acid (TCA)

APPENDIX II
**Pesticides/Pesticide formulations banned for use but their
manufacture is allowed for export (2 nos.)**

1. Nicotene sulfate
2. Captafol 80% powder

APPENDIX III
Pesticides withdrawn (8 nos.)

1. Dalapon
2. Ferbam
3. Formothion
4. Nickel Chloride
5. Paradichlorobenzene (PDCB)
6. Simazine
7. Warfarin
8. Metoxuron

APPENDIX IV
Pesticides restricted for use in India (12 nos.)

1. Aluminium Phosphide
2. DDT
3. Lindane
4. Methyl Bromide
5. Methyl Parathion
6. Sodium Cyanide
7. Methoxy Ethyl Mercuric Chloride (MEMC)

8. Monocrotophos (banned for use on vegetables)
9. Endosulfan (banned in the state of Kerala)
10. Fenitrothion
11. Diazinon (banned for use in agriculture)
12. Fenthion (banned for use in agriculture)

APPENDIX V

Technical and Trades Names of Insecticides & Acaricides

**Technical name
and formulation**

Trade name

INSECTICIDES

Organochlorine group :

Endosulfan 35 EC	Thiodan, Devisulfan, Endosulfan, Asafan, Hexasulfan, Speed, Endoveer, Thionel, Endocel, Endosaan, Agcel 35, Dawn 35, Endocin, Endomaal 350, Endoset, Endostar, Endotaf, Endovip, Parasulfan, Parrysulfan, Alfasulfan, Spicsulfan
Lindane 20 EC	Agrolindane, Devidayal Lindane 20EC, Dhanuka Lindane, Kilzex 6.5WP, Gamma-001

Organophosphorus group :

Dichlorvos 76% w/w EC	Nuvan, Divap-100, Fast 76 EC, Grovan, Marvex Super, Vepomin, Suchlor, Vapona, Alphavip
Dimethoate 30 EC	Rogor, Tara 909, Daragor 30EC, Demacin, Dimesaan, Dimoken 30, Diveer, Hexagor, Methovip, Parry Dimate, Romal 300, Ultragor, Agromat
Fenitrothion 50 EC	Sumithion, Acothion, Folthion 50, Agrothion, Hexafen, Rentokil, Sandothion, Utkal Fenitrothion

Malathion 5% dust, 50EC	Cythion, Devimalt, Agracide, Malaphos, Malataf, Lakshya 50EC, Hilthion, Agromal 50, Agrithion 50, Rickthion, Kropmal 5D, Alphathion
Monocrotophos 36 WSC	Monocil, Monocin, Monocrown, Monofos, Monokil, Monomol 360, Monosaan, Monostar 36SL, Monoveer, Monovol SL, Monovip, Parryfos, Phoskil, Sufos, Nuvacron, Macrofos, Milphos 36 SL, Monocrotophos, Kadett, Kacil-phos, Atom, Balwan, Bilphos 36SL, Cobra 36SL, Gyphos, Hilcron 36SL
Phosphamidon 100 EC	Dimecron, Cildon, Daracron, D-Don, Deecron, Hydon, Har- Agrophosphamidon, Parrydon, Phosmin, Polycron 850, Rickdon, School, Sumidon, Alphadon
Quinalphos 5% G, 25EC	Bayrusil, Ekalux, Flash, Krush, Nag 25 EC, Quinalmol 250, Quinaltaf, Quinalveer, Quinalvip 25EC, Quinasaan, Quinocin, Spicquinal 25EC, Starlux 25EC, Suquin, GrowLux
Chlorpyriphos 20 EC	Blaze, Chlorosan, Chlorvip, Classic 20, Dursban, Fantom 20EC, Gayachlor, Gold 25EC, Growban, K-BAN, Lethal, Mig 20TC, Pyrivol, Radar 20, Strike 20EC, Suban 20EC, Tricel 20EC, Trishul 20EC, Durmet, Coroban, Pestaban, Kargroban, Agrofos, Ruban
Phorate 10G	Forcin, Parry-tox, Phoromol 505, Phoril, Sandartox, Srifort, Thimet, Tuskar, Volphor, Granutox, Phoratox
Parathion methyl 20% dust, 50 EC	Folidol, Metacid 50, Agrogold, Agrothion, Daracid 50EC, Devithion, Growcid, Kemidol, Missile 50, Rickmethyl, Alphamethyl, Sutacid
Oxydemeton-methyl 25 EC Fenthion 100 EC Diazinon 10G	Metasystox, Hymax, Kemptox 25EC, Metamol 250, Sritox 25, Superkiller 25EC Lebaycid-1000 Basudin 10G, Deviginon, Ditaf, Suzon, Vinash

Formothion 25EC	Anthio, Sandothion
Phosalone 35EC	Zolone 35EC
Carbamate group	
Carbaryl 5% dust, 10% dust, 50% WDP	Sevin 50WP, Sevin Flo 42% , Taffin5DP, Taffin 50WDP, Sevidol 4: 4G (Carbaryl + Lindane)
Carbofuran 3G	Furadan, Carbogran, Difuron 3G, Furin, Hexafuron
Biopesticide	
<i>Bacillus thuriangiensis</i> var. <i>kurstaki</i>	Delfin, Halt
Acaricides	
Organochlorine	
Dicofol 10% 5% EC	Kelthane, Colonel-S, Dicomol 185, Diumite, Flush 18.5EC, Hexakel, Hondakel, Hycofol
Organophosphorus	
Ethion	Ethion 50EC, Acaron, Dhanumit, Force 50EC, Fosmite, Gromit, MIT 505, Rickmit, Alphamit, Srimite 50, Tafethion, Veer

APPENDIX VI

Technical and Trade Names of Fungicides/Antibiotics/Plant Products/Antagonists

**Technical name
and formulation**

Trade name

A. Inorganic copper compounds

Copper oxychloride Akomin, Blitox-50, Fytolan, Kilex, Fycop, Nagcoper, Dhanucop, Fycop, Blue Copper 50, COC 50WP, Copsaan, Coprex, Copsin, Cupravit, Hondacop

B. Elemental inorganic sulphur compounds

Wettable sulphur Hexasul, Thiovit, Sulfex, Akrisulf, Appu, Cosavet-DF, Microsulf, Mitex S, Pesto Sulfur 80WP, Sulfasaan, Sulphur 85WP

C. Organic sulphur (carbamates)

Mancozeb Dithane M-45, Indofil M-45, Uthane M-45, Abis M-45, Amicozeb, DARA m-45, Dhanuka M-45, Hilthane M-45, Hondazeb M-45, Kamyab 75WP, Kohinoor M-45, Kosib, Manocin, Mancokil 75, Manzate 75, Parry M-45, Pradhan 75WP, Rasayan M-45, Raze M-45, Sandozeb, Savior M-45, Shaktiman, Shield 75, Sparsh, Veer M-45, Zeb 75, Zebra, Zebtane

Ziram Cuman L, Dhanuka Z-27, Fuksalin

Thiram Thiram-75, Agrorum, Furam

Zineb Dithane Z-78

D. Heterocyclic nitrogenous compound

Captan Captan 75 WP, Captaf 75 WP, Hexacap, Kohicap, Phytocap, Topas

E. Miscellaneous fungicide

Dinocap Karathane

F. Systemic fungicide

Carbendazim	Bavistin 50WP, Bavistin 5G, Derosal, Dhanustin, Agni, Akozim, Bensaar, Carsin, Polystin 500, Shark 50WP, Sten, Volzim
Carboxin	Vitavax, Hiltavax
Edifenphos	Hinosan
Pyroquilon	Fongoren
Thiophanate methyl	Topsin- M 70 WP, Roko 70 WP, Alert, Baynet, Maxim, Milduvip
Tridemorph	Calixin
Tricyclazole	Beam, Trooper
Propiconazol	Tilt, Radar
IBP	Kitazin 50 EC
Hexaconazole	Sitara, Hexazole, Montaf, Contaf
Propineb	Antracol

G. Combo fungicide (Mixture)

Metalaxyl 8% + Mancozeb 64%	Ridomil MZ 72, Krilaxyl MZ 72, Unilax, Matco
Carbendazim 12% + Mancozeb 63%	Saaf, Companion

H. Antibiotics

Streptomycin sulphate + Tetracycline	Streptocyclin
Hydroxy quinoline	Entakon-M

I. Fungal antibiotics

Validamycin	Sheathmar
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K. Plant derived products

Neem products	Achook, Neemazal, Neem Gold, Nimin (neem oil)
Cymbopogon product	Wanis

L. Antagonists

<i>Pseudomonas fluorescens</i>	Biofor-PF (Jaiva Kiran),
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based product	Pseudocon
<i>Trichoderma</i> spp. based products	Bicure F, Trich-X-P, Viricon-L, Bioderma, Trichostar

APPENDIX VII

Technical and Trade Names of Herbicides

<u>Technical name and formulation</u>	<u>Trade name</u>
2,4-D	Fernoxone, 2,4-D/28L, Agrodone 48, Agrodone 18WP, Agroweed 34EC, Allout 34 EC, Champion 78SL, Cut-out, Herbonil 34EC, Knockweed 38, Weedburn 38EC, Weedkil 38EC
Butachlor	Punch, Delchlor, Agrochlor 50EC, Alachlor Terr, Butakil 50, blchlor, Buchlor, Bumper 50, Butacin, Butaveer, Butamol 500, Darachlor 50EC, Hiltachlor 50EC, Trapp 50, Widkil
Fluchloralin	Basalin
Diuron	Karmex, Diuron, Agromex-Diuron WP, Klass, True 80WP
Atrazine	Atrataf, atramol 500, Mebazine, Solano 50WP, Srizon
Dalapon	Dowpon, Dalapon
Isoproturon	Graminon, Arelon, Taurus, Delron, Agrolon, Avonil, Bilron 75WP, Dararon 75WP, Dhar,

Simazine	Gold Medal, Haragron 75, Hilproturon 75WP, Iso 50, Isocin, Isof\guard 75WP, Isokil 75, Isomol 750, Isopar, Isoveer, Isovip, Nocilon 75 Tefazine, Aquazine, Salute 50WP, Weedex
Methabenzthiazuron	Tribunil
Pretilachlor	Rifit
Anilofos	Arozin, Aninoguard, Anilokil 30, Anilotaf, Anilveer, Avail 30EC, Dhanumon, Sardar Guard, Strong 30EC, Surya, Weedonil

APPENDIX VIII

Technical and Trades Names of Rodenticides, Nematicide and Micronutrient formulation

<u>Technical Name and formulation</u>	<u>Trade name</u>
RODENTICIDES	
1. Aluminium Phosphide	Celphos, Phostoxin, Quickphos
2. Zinc Phosphide	Ratox, Zinc Phosphide, Ratol, Commande
3. Warfarin	Ratafrin, Rodafarin Warfarin
NEMATOCIDE:	
Carbofuran	(Please see Appendix V)
Micronutrient formulation	Tracel, Agromin, Borax Sulphate, Zinc Sulphate

APPENDIX IX

Plant food contents in manures and fertilizers

Manures/fertilizers	N(%)	P ₂ O ₅ (%)	K ₂ O(%)
1. Farm Yard Manure	0.4	0.3	0.2
2. Compost	0.5	0.25	0.5
3. Cowdung	0.5	0.2	0.4
4. Poultry	1.6	1.5	0.9
5. Sheep Manure	0.8	0.6	0.3
6. Cotton Seed Cake	3.9	1.8	1.6
7. Groundnut Cake	4-5	2.0	1.5
8. Castor Cake	4-5	2.0	1.9
9. Neem Cake	5-6	1.8	2.0
10. Mustard Cake	4-5	1.8	2.0
11. Fish Meal	4-10	4-8	0.3-1.5
12. Bone Meal	3-4	20-22	-
13. Ammonium sulphate	20	-	-
14. Ammonium chloride	24-26	-	-
15. Ammonium Phosphate	16	20	-
16. Urea	46	-	-
17. Calcium ammonium nitrate	20	-	-
18. Potassium nitrate	14	-	44.4
19. Potassium ammonium nitrate	16	-	28
20. Super phosphate (single)	-	16	-
21. Super phosphate (double)	-	16	-
22. Super phosphate (triple)	-	32	-
23. Rock Phosphate	-	48	-
24. Muriate of potash	-	-	60

APPENDIX X

Conversion table for various fertilizers (in respect of N, P & K)

Conversion factors:

1 kg. N = 2.2 kg urea = 5 kg Ammonium Sulphate

1 kg. P = 6.25 kg. SSP,

1 kg. K = 1.67 kg MOP,

1 kg. ADP = 2.87 kg. SSP and 0.400 kg Urea

1 kg. N

+

1 kg. P = 6.66 kg. Suphala (15:15:15)

+

1 kg. K

Rate of Application of Nutrients	Urea (46% N) kg/ha	Ammonium sulphate (20% N) (kg/ha)	SSP 16% P ₂ O ₅ (kg/ha)	MOP (60% K ₂ O) (kg/ha)
10	22	20	62.5	17
20	44	40	125.0	34
30	66	60	187.5	51
40	88	80	250.0	68
50	110	100	312.5	85
60	132	120	375.0	102
70	154	140	437.5	119
80	176	160	500.0	136
90	198	180	562.5	153
100	220	200	625.0	170
110	242	220	687.5	187
120	264	240	750.0	204
130	286	260	812.5	221
140	308	280	875.0	238
150	330	300	937.5	255
160	352	320	1000.0	272
170	374	340	1062.5	289
180	396	360	1125.0	306
190	418	380	1187.5	323
200	440	400	1250.0	340

APPENDIX XI

Some unconventional organic pesticidal preparations

A) TOBACCO DECOCTION:

This can be effectively used against aphids and other similar soft bodied insect pests of vegetable crops. The decoction is prepared in the following way:

1. Steeping 500 g of tobacco wastes in 4.5 litres of water for 24 hours.
2. Dissolving 120 g of sliced ordinary bar soap in another container and adding it to the decoction under violent agitation.

The final solution should be diluted 6-7 times before spraying.

B) NEEM KERNEL SUSPENSION

This preparation acts as repellent against locusts, grasshoppers and other chewing insects particularly belonging to Lepidoptera. The following are the steps to be followed for preparing this suspension.

1. Kernels should be ground into a coarse powder form.
2. This suspension is effective only with a concentration of 0.1 to 0.3% (for preparing 0.1% suspension 1 g of powdered neem seeds required per litre of water).
3. The required quantity of neem powder should be put in a bag of muslin cloth and dipped in the corresponding volume of water contained in a bucket for about 12 hours.
4. Thereafter, the bag is to be squeezed repeatedly after dipping in the fluid until the out-flowing liquid turns light brownish.

The suspension is now ready for use.

C) KEROSENE EMULSION:

This contact insecticide is very effective against a wide range of sucking insects. The procedure for its preparation is outlined below :

1. 500 g of ordinary bar soap is to be sliced finely and dissolved in 4.5 liters of hot water.
2. The solution is to be allowed to cool down.
3. 9 liter of kerosene should be added to it under violent agitation till the oil is fully emulsified. This stock solution should be sprayed after it is diluted 15-20 times.

D) ASAFOETIDA – TURMERIC MIXTURE

This preparation can be used for controlling bacterial wilt of solanaceous vegetables like to tomato. This should be applied as soil drench for three times after 15,30 and 45 days of transplanting the vegetables. This mixture can be prepared in the following way:

1. Both asafoetida and turmeric should be ground in to powdery forms.
2. 1.5 g asafoetida and 5 g turmeric powders should be dissolved in a little amount of water.
3. Finally, the volume of the mixture is to be made up to 10 liters by pouring required quantity of water into it.
4. The mixture is now ready for soil drenching.

APPENDIX XII

Preparation of some common fungicides

A) BORDEAUX MIXTURE (1%)

- i) Dissolve 100 g of powdered copper sulphate in 5 liters of water in a plastic bucket.
- ii) Prepare milk of lime in another plastic bucket by dissolving 100 g of quick lime in 5 litres of water.
- iii) Pour the copper sulphate solution and the milk of lime from the above two vessels into a third one by gently stirring the mixture all the while. This will give a final volume of 10 liters.
- iv) The mixture is to be tested before use for the presence of free copper which is toxic to the plant. Dip a polished knife in the mixture. If the blade shows a reddish colour add more lime to the mixture till the blade does not show staining on dipping.

B) BORDEAUX PASTE :

Dissolve 100 g of copper sulphate and 100 g of quick lime each in 500 ml of water in two separate plastic vessels. Mix these two solutions together in a third vessel to make one litre of the paste.

C) CHESTNUT COMPOUND :

- i) Powder of 60 g of copper sulphate and 330 g of ammonium carbonate and mix well. This dry mixture can be stored in air tight containers for 24 hours before use.
- ii) Take 25 g of this mixture and dissolve it in a little amount of hot water.
- iii) Make up the volume of the mixture to 8 liters by adding cold water.
- iv) The mixture is now ready for soil drenching.

APPENDIX XIII

List of government/private agencies supplying various horticultural inputs

Agencies	Materials supplied
1. Division of Vegetable Indian Institute of Horticultural Research. 255 Upper Palace Orchards Bangalore, Pin 560080.	Seeds of vegetable crops
2. Indo-American Hybrid Seeds Co. P.O. Box 7099 Bana Shakari II stage, Bangalore- 560070	Hybrid seeds/planting materials of Horticultural crops.
3. National Seeds Corporation Ltd. Beej Bhawan, Pusa Complex New Delhi 110012.	Seeds of vegetable Crops.
4. Assam Seeds Corporation Ltd. Guwahati-22.	Seeds/Planting materials of horticulture crops.
5. Indian Agricultural Research Institute, Pusa, New Delhi-110012	Seeds/planting materials of horticultural crops.
6. Indian Petrochemical Corpn. Ltd. P.O. Petrochemicals. Vadodara-391346, Gujrat <i>Regional Office :</i> A.G. Tower, 7 th floor 125/Park Street, Kolkata - 17	UV-stabilized LDPE glazing Materials for plastic house, Plastic, mulching materials.
7. Sutton & Sons (India) Pvt. Ltd. 13 D Russell Street, Calcutta-70071.	Seeds/planting materials of vegetables and ornamental plants.
8. Maharashtra Hybrid Seeds Co.Ltd (Mahyco seeds) Jalan-431203.	Hybrid seeds of vegetables
9. American Spring & Pressing Works Pvt. Ltd., P.O. Box No. 7602, Malad, Mumbai – 4000 064.	Sprayers and Dusters since last 38 years.

APPENDIX XIV

Safe waiting period of pesticides in vegetables

Pesticides	Rates (kg ai/ha)	Waiting period (days)	Maximum residue Limit (MRL)(PPM)
BHENDI			
Endosulfan 35 EC	0.25	2	2.0
	0.50	3	
	0.75	3	
Fenvalerate 20 EC	0.05	1	1.0
	0.10	1	
	0.15	2	
Monocrotophos 36 WSC	0.18	12	0.2
	0.36	15	
	0.54	16	
Deltamethrin 2.8EC	0.014	1	0.5
	0.028	3	
BRINJAL			
Carbofuran 3G	3g/plant	7	0.2
	5g/plant	18	
Phorate 10G	5g/plant	32	0.1
	10g/plant	32	
Quinalphos 25 EC	0.5	7	0.25
	1.0	10	
Quinalphos 20 AF	0.5	5	0.25
	1.0	6	
CABBAGE			
Quinalohose 25 EC	0.25	6	0.25
	0.5	15	
CHILLIES			
Malathion 50EC	0.076% spray	6	0.5
	0.15% spray	11	
Monocrotophos	0.06% spray	10	0.2
	0.14% spray	25	
FRENCHBEAN			
Malathion 50 EC	0.085% spray	2	2.0
	0.15% spray	3	
Monocrotophos 36 WSC	0.06% spray	13	0.2
	0.12% spray	17	
TOMATO			
Metalaxyl (Ridomil MZ 72 WP)	0.2% 5 spray	10	1.0
	0.25% 5 spray	10	

APPENDIX XV
Conversion table for various units

Multiply	By	To get
Hectare	2.4	Acre
	7.5	Bigha
Acre	3.125	Bigha
Bigha	5	Katha
Parts per million (ppm)	1.001	Gram per litre
Parts per million	0.0001	Percent solution
Percent solution	10000	ppm
Kg N	2.17	Kg. Urea
Kg P ₂ O ₅	6.25	Kg. SSP (Single)
Kg K ₂ O	1.67	Kg. MOP