STATUS OF AGRICULTURE IN THE TTAADC.

In TTAADC about 20% of the total geographical area is available for cultivation. The cropping intensity remains at a level of 125% only. About 13% net cropped area is under assured irrigation. The main crops grown are paddy, Maize, Pulses, oil seeds, Jute & Mesta, Vegetables etc.

2. LAND CLASSIFICATION:-

According to classification of terrain, the land under TTAADC area is divided into 5(five) major groups, which are reflected in the following table:-

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Category</th>
<th>Area in Sq.Km.</th>
<th>% of total geographical area.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High Area</td>
<td>2718.00</td>
<td>38%</td>
</tr>
<tr>
<td>2</td>
<td>Tilla land with moderate steep slope.</td>
<td>1069.00</td>
<td>15%</td>
</tr>
<tr>
<td>3</td>
<td>Tilla land with gentle to moderate slope</td>
<td>500.00</td>
<td>7%</td>
</tr>
<tr>
<td>4</td>
<td>Rolling Topography</td>
<td>1783.00</td>
<td>21%</td>
</tr>
<tr>
<td>5</td>
<td>Plain land</td>
<td>1062.50</td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>Total:-</td>
<td>7,132.50</td>
<td>100%</td>
</tr>
</tbody>
</table>

3. LAND USE PATTERN:-

73% of geographical area of TTAADC is under forest 20% of total area is available for Agriculture propose including Jhum. Rest 7% area used for road path etc.

4. CLIMATE:-

The climate of this region can be divided into four characteristic Seasons. Viz i. Winter (December to February). ii. Pre-monsoon (March to April) iii. Monsoon (May to September) and iv. Post Monsoon (October to November).

The monsoon period lasting for about 5(five) months from May to September is the longest seasons of the state. The amount of total, annual rainfall in the state varies between 1500 mm. to 2500 mm. The maximum and minimum temperatures during winter are 27 0C & 9 0C and during Summer are 37 0C & 24 0C respectively. The ICAR has categorized the Tripura under Agro Climate Zones of Humid Eastern Himalayan Region.

5. FERTILITY STATUS OF SOIL:-

a) \( pH \) Value: - Highly acidic \( pH \) value very from 4.05 to 6.05 and in more than 90 percent of the soil of Tripura \( pH \) is below 5.6.

b) Organic ebon content: - On an average 52.1 percent of soil are medium 22.5 percent soil are low and 25.4 percent soils are high in organic carbon content.

c) Available Phosphorus: - about 60.5% soils are deficient in Phosphorus, 26.9% soils are medium and 12.6% are high in available Phosphorus.

d) Available Potash: - As a whole 67.3% of the Soils are Low, 24.7% soil are medium and 8% soils are high in available potash.

The Physic characteristic of some tilla soils:-

| 1. Sand % | 45.06% | 69.60 |
| 2. Silt % | 14.30% | 20.10 |
| 3. Clay % | 16.40% | 28.40 |
| 4. Org. Carbon % | 0.12% | 1.37 |
Jhum Cultivation and Jhumias

Traditionally, most of the tribal population practiced shifting or jhum cultivation and were termed jhumias. The term jhumia is a generic term used for tribal people dependent on shifting cultivation as the primary source of livelihood.

A significant number of persons and families in Tripura continue to depend on forests and jhum cultivation as their main source of livelihood. J.B. Ganguly’s book on the Problems of Jhumias in Tripura (1968) showed that in 1961 there were about 25,000 families who were dependent on jhum for their livelihood. By 1978, this number had increased to 46,854 families, of which about 23,292 families were primarily dependent on jhum for their livelihood. By 1987 the estimate was revised to 55,049 families that were more or less dependent on jhum for their survival. Of these, 48,000 were in TTAADC areas. Further, 21,677 families were primarily dependent on jhum, and 33,372 families were partially dependent on jhum for their livelihood. In 1999, according to the Department of Tribal Welfare, 51,265 families were dependent on jhum, and the large majority of them were fully dependent on jhum. The big concentration of jhumia families was in Dhalai and South District. In 2007,
the Forest Department completed a first-ever Census enumeration of hard core shifting cultivators and found 27,278 families (or 1,36,000 persons) dependent on jhum. The total count shows a clear decline in the number of jhumia families.

All the same, the continued dependence on jhum of more than 10 per cent of tribal families is of concern since jhum is a high-risk system of cultivation and, in the current circumstances (with reduced years of the jhum cycle), cannot provide an adequate means of livelihood. Jhum has been and continues to be a precarious system of cultivation that yields barely enough to survive. Even thirty years ago, the average cost of production on 1 acre of jhum land was about Rs 226, and it provided about 65 person-days of employment and yielded an income of about Rs 218.3 A decade later, in the 1980s, another analysis showed that many jhumia families earned a large portion of their incomes from non-traditional wage employment, especially through the Forest Department. The estimated average annual income of a jhumia household was Rs 184 from cultivation; Rs 539 from collection of bamboo, firewood and sungrass; and Rs 1,750 from labour for the Forest Department and forest traders who paid the jhumias minimum prices for the collection of forest produce. A case study conducted in May 2005 in Halodia village of Mungiakami block revealed that one adult worker earned only Rs 1,000 to Rs 1,100 each year from jhum (from a combination of rice cultivation and harvest of muli bamboos).
Name of Scheme : Integrated Scheme for Improvement of production and productivity of Jhum crops.

Majority of Jhumia families are yet to be brought under any project for improving their lots. It is an expected fact that Jhuming will continue for many more areas to come until they could be brought under settled cultivation practices. It is, therefore, absolutely necessary to provide a programme for improving the productivity from existing Jhum crops as well as to encourage them to take up cultivation of horticultural crops in and around their homestead.

With these objectives the present scheme envisaged to cover 10,000 Nos. of families to undertake the following activities.

- Introduction of improved Jhum practices for increasing productivity of Jhum crops like Paddy, Maize, Arhar, Cotton etc. through supply of production inputs viz. improved seeds,
- Supply of Horticultural inputs like Zinger, Turmeric, Black pepper etc.

In order to maintain organic character of Jhum crop, application of Bio- fertilizers will be introduced in place of chemical fertilizer.

Programme for improvement of annual Agricultural crops in Jhum areas.

i. **SEEDS / SEED MATERIALS (FOR 0.40 HA./UNIT)**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Crop</th>
<th>Varieties:</th>
<th>Quantity</th>
<th>Rate/Kg</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Paddy:</td>
<td>NDR-97, Kiski Badam, Garo Malati, Jhum Malati, Taru Kamal, Mukhumai makal, Vandana, Randil, Kanchali</td>
<td>20 Kg.</td>
<td>Rs. 14.00</td>
<td>Rs. 280.00</td>
</tr>
<tr>
<td>2</td>
<td>Cotton</td>
<td>Chittagung hills, red stappled &amp; Comilla</td>
<td>0.5 Kg</td>
<td>Rs. 30.00</td>
<td>Rs. 15.00</td>
</tr>
<tr>
<td>3</td>
<td>Sesamum</td>
<td>White Jhum type</td>
<td>0.5 Kg</td>
<td>Rs. 35.00</td>
<td>Rs. 18.00</td>
</tr>
<tr>
<td></td>
<td>Arhar</td>
<td>Local Jhum Variety, Pant-A-3</td>
<td>0.5 Kg</td>
<td>Rs.32.00</td>
<td>Rs. 16.00</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>Local / Navjyot</td>
<td>1.0 Kg</td>
<td>Rs.22.00</td>
<td>Rs. 22.00</td>
</tr>
<tr>
<td></td>
<td>Local Jhum Vegetables</td>
<td>As per Jhumias Choice</td>
<td>L.S.</td>
<td>-----</td>
<td>Rs. 49.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Rs. 400.00</strong></td>
</tr>
</tbody>
</table>
ii. **BIO-FERTILIZER (FOR 0.40 HA./ UNIT)**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Bio-fertilizer</th>
<th>Quantity</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Azospirillum/Azotobator for Cereals &amp; other Crops</td>
<td>1.6 Kg</td>
<td>Rs. 50.00</td>
</tr>
<tr>
<td>2</td>
<td>Rhizobium for Leguminous Crops</td>
<td>1.6 Kg</td>
<td>Rs. 50.00</td>
</tr>
<tr>
<td>3</td>
<td>PSB for all crops</td>
<td>1.6 Kg</td>
<td>Rs. 50.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>Rs. 150.00</strong></td>
</tr>
</tbody>
</table>

C) **PROGRAMME FOR BAMBOO PLANTATION :.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount/ Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bamboo Plantation</td>
<td>Rs. 200/-</td>
</tr>
</tbody>
</table>

D) **Training of Jhumia Families :**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 days training to Jhumia cultivator, one day for Agricultural Crops and another day for Horticultural crops at Block Level</td>
<td>Rs 200 per trainee</td>
</tr>
<tr>
<td>2</td>
<td>Misc awareness/ publicity/crop cut expt. Etc</td>
<td>Rs 50/- per unit</td>
</tr>
<tr>
<td></td>
<td><strong>Sub Total:</strong></td>
<td><strong>Rs. 250.00 per Unit</strong></td>
</tr>
</tbody>
</table>

| e) Assistance for Intercultural Operation Jhumia (In 3 equal installments) | Rs.900.00 per Jhumia |

| Grand Total (a+b+c+d+e) Jhumia                                               | Rs.1900.00 per Jhumia |
I) Fruits:

A) MANGO (Mangifera indica)

Mango is adaptable to a wide range of climate and soil conditions and grows well from sea level up to about 1500 m above mean sea level. It withstands both fairly dry conditions and heavy rainfall.

Varieties
Himsagar, Alphonso, Neelum, Langra, Dashehari, Ratna etc.

Season
Plant one year old grafts with the onset of monsoon showers so that they get established before the rains.

Vegetative propagation
Stone grafting is successful in mango. Select four month old scion materials. Defoliation of scion shoots 10 days prior to grafting is beneficial. The dieback disease of grafts caused by Colletotrichum can be controlled by spraying 1% Bordeaux mixture.

Planting
Select good grafts for planting. Planting can be done according to the square system or hexagonal system. Prepare pits of size 1 x 1 x 1 m at a spacing of 9 m one month before planting and allow to weather. Refill pits with mixture of topsoil and 10 kg of compost or FYM per pit to a level higher than the adjoining ground. Plant the grafts at the same depths as they were in the containers, preferably in the late evening. Deep planting results in poor growth of the plant. Ensure that the graft joint is above the soil level. Tie the plants to stakes to prevent snapping at the graft joints.

Manuring
Apply FYM/compost and fertilizers at the rate indicated below:

<table>
<thead>
<tr>
<th>Age of plant</th>
<th>FYM kg/plant/year</th>
<th>N:P2O5:K2O g/plant/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td>10</td>
<td>20:18:50</td>
</tr>
<tr>
<td>2nd year</td>
<td>15</td>
<td>50:27:75</td>
</tr>
<tr>
<td>3-5 years</td>
<td>25</td>
<td>100:36:100</td>
</tr>
<tr>
<td>6-7 years</td>
<td>40</td>
<td>250:172:200</td>
</tr>
</tbody>
</table>
Green leaves (25 kg/plant) and wood ash (10-15 kg/plant) may be applied additionally. Apply organic manures in May-June with the onset of monsoon. Apply the fertilizers in one dose during May-June until bearing stage and thereafter in two equal split doses, the first during May-June and the second during August-September. Apply manures and fertilizers in trenches 30 cm deep taken at a distance of 2.5 to 3 m from the base of the tree.

**After cultivation**
Irrigate twice a week during summer months till the plants are 4-5 years old. Carry out intercultural operations by ploughing or digging twice during the year in June and October. For reducing fruit drop and to improve productivity, NAA at 10-30 ppm concentration may be sprayed to the entire inflorescence at the pea stage in the second week after fruit set.

**Plant protection**

The important pests of mango are hoppers, stem borers, shoot midges, leaf feeding insects, fruit flies and psyllids. The common diseases are anthracnose and dieback. To control mango stem borer, apply paste made of crude carbolic acid (130 ml), soft soap (1 kg) and hot water (3.7 litres) to holes in the bark and plug the holes. Alternatively, inject aluminium phosphide tablets into the burrows after chiselling the opening and widening the burrows with an auger. To control fruit fly, spray malathion 0.1% emulsion / suspension containing 2% sugar. Collect and destroy attacked fruits that rot and drop down. Fruit flies can be effectively managed by keeping Ocimum trap @ 4 / tree and a bait spray of 0.1% malathion with 2% sugar at monthly intervals from initial fruit set up to harvest. To control dieback of twigs and branches, cut the affected twigs below the infected region and apply Bordeaux paste to the cut ends.
B) **BANANA (Musa spp.)**

Banana prefers tropical humid lowlands and is grown from the sea level to 1000 m above MSL. It can also be grown at elevations up to 1200 m, but at higher elevations growth is poor. Optimum temperature is 27°C. Soils with good fertility and assured supply of moisture are best suited.

**Season**

*Rain fed crop:* April-May  
*Irrigated crop:* August-September

Adjust planting season depending upon local conditions. Avoid periods of heavy monsoon and severe summer for planting. Adjust the time of planting so as to avoid high temperature and drought at the time of emergence of bunches (7-8 months after planting).

**Varieties**

Dwarf Cavendish, Champa, Sabri,, G-9

**Preparation of land**

Prepare the field by ploughing or digging and dig pits for planting. Size of pits depends upon soil type, water table and variety. In general, pit size of 50 x 50 x 50 cm is recommended. In low-lying areas, take mounds for planting suckers.

**Selection of suckers**

Select 3-4 month old disease free sword suckers from healthy clumps. The rhizomes are to be smeared with cow dung solution and ash and dried in the sun for about 3-4 days and stored in shade up to 15 days before planting.

**Planting**

Plant suckers upright in the centre of pits with 5 cm pseudo stem remaining above soil level. Press soil around the sucker to avoid hollow air spaces.

**Manuring**

1. Apply compost, cattle manure or green leaves at the rate of 10 kg/plant at the time of planting.  
2. Apply N:P₂O₅:K₂O at the following dose (g/plant/year).

Plant crop followed by two ratoon crops gives maximum yield. Two suckers per clump should be retained for ratooning.

Apply the fertilizer 60-75 cm around the plant in two equal split doses; the first, two months after planting and the second, four months after planting. For ratoon crop, the entire fertilizers have to be applied in a single dose immediately after the harvest of the preceding crop. Irrigate immediately after manuring.
Irrigation
1. During summer months, irrigate once in three days.
2. Ensure good drainage and prevent water logging.
3. About 6-10 irrigations per crop may be given depending upon soil conditions.

Weed control
During early stages, complete control of weeds could be obtained by raising cowpea in the interspaces. Weeds emerging later could be controlled by the application of paraquat 0.4 kg/ha or glyphosate 0.4 kg/ha. If hand weeding is resorted to, give 4-5 surface diggings depending on weed growth. Avoid deep digging. Do not disturb soil after plants start producing bunches.

De suckering
Remove side suckers produced till the emergence of bunch. Retain one or two suckers produced after the emergence of bunch.

Plant protection

Pests

*Banana pseudostem weevil (Odoiporus longicollis)*. The weevil resembling the rhizome weevil of banana. Adult female weevil punctures and inserts eggs into the pseudostem. Grubs emerging out feed extensively on the pseudo stem and thereby the entire plant collapses.

Control
1. Field sanitation is the most important factor in the prophylactic and curative control of this pest.
2. Remove affected plants along with the rhizome in full and destroy them by burning the life stages of the insect using kerosene or by burying the material in deep pits in soil.
3. Destroy the parts of rhizome and pseudo stem of harvested plants in the field and destroy them as described above.
4. Remove the dry outer sheaths of the pseudo stem of all infested and un-infested plants in the endemic areas and spray any of the recommended insecticides. Drenching all the leaf axils, rhizome and surrounding soil and all round the entire pseudostem inserting the nozzle through the bore holes made by the larvae if any and also within the outer sheathes by slightly raising the same at different spots is also effective.

*Banana rhizome weevil (Cosmopolites sordidus)*. The attack by this pest is reported to be serious in all localities where banana is cultivated. Female adults puncture healthy rhizomes and insert eggs through it. Grubs tunnel within and feed resulting in the stunting of rhizome development. If the infestation occurs on a mature rhizome, damage symptoms appear through the reduction in leaf number, bunch size and the fruit number.
Control

1. Adopt strict field sanitation.
2. Select only healthy planting material.
3. Deep plough the land so as to expose the inner soil layer to sun.
4. Cut and remove the outer layer of the rhizome and sundry for 3-4 days after smearing it with slurry of cowdung and ash.
5. Set traps using pseudostem of approximately 1/2 m length, which are split lengthwise and laid in the field. Adults attracted to it during nights may be collected and destroyed.

Nematodes
Major species are burrowing nematode (*Radopholus* sp.), root knot nematode (*Meloidogyne incognita*), root lesion nematode (*Pratylenchus coffeae*) and cyst nematode (*Heterodera oryzicola*).

In case of severe infestation there will be high reduction in the number of leaves, total bunch weight and the number of fruits.

Control

Apply neem cake @ 1 kg/plant and carbofuran @ 0.5 g ai/plant at the time of the planting. When granules are applied around the base of plants, there should be sufficient soil moisture; otherwise, the plants should be watered after broadcasting granular insecticides.

Diseases

*Bunchy top disease*
This is a virus disease transmitted by aphids.

Control

1. Use insecticidal treatments recommended for insect vector control.
2. Eradicate disease affected plants.
3. Use disease free suckers for planting.

*Panama wilt (banana wilt)* (*Fusarium oxysporum f. cubense*)
1. Dip suckers of susceptible varieties in 0.1-0.2% carbendazim solution to prevent spread of the disease.

2. Remove and destroy affected clumps along with corms.
3. Soil application of bioagents like *Trichoderma viride*, *T. harzianum* or *Pseudomonas fluroscence* should be encouraged.

**Sigatoka leaf spot (Mycosphaerella sp.)**

1. Cut and burn all severely affected leaves.
2. Spray 1% Bordeaux mixture soon after the appearance of the initial symptoms of the disease. The disease appears with the commencement of southwest monsoon. Five to six sprayings at fortnightly intervals are to be given depending upon the severity of the disease.
3. Spray carbendazim (0.1%) or give alternate sprays of tridemorph (0.05%), mancozeb (0.2 %) and carbendazim (0.1%) soon after the appearance of initial symptoms of the disease. Three to four sprayings at fortnightly intervals are to be given depending on the severity of disease.

**C. PINEAPPLE (Ananas comosus)**

Pineapple is mostly grown at low elevations in areas with a temperature range of 15 to 30°C. Pineapple is tolerant to drought because of the special water storage cells. They can be grown with a wide range of rainfall from 600-2500 mm / annum, the optimum being 1000-1500 mm. Pineapple can be grown in a wide range of soils, but does not tolerate water logging. It can be grown as a pure crop on plantation scale or as an intercrop in coconut gardens.

**Season**
The planting season is May-June. Planting should be avoided during the periods of heavy rains.

**Varieties**
There are two varieties viz., Kew and Queen

Cultivation practices of Kew is given below:

1. **KEW**

**Preparation of the land**
Prepare the land for planting by ploughing or digging followed by levelling. Depending on the nature of land, prepare trenches of convenient length and about 90 cm width and 15-30 cm depth. The trenches are to be aligned at a distance of 165 cm from centre to centre.
Selection and treatment of suckers
Select healthy suckers of uniform size weighing 500-1000 g. Keep suckers in open space under shade in a single layer for about 7 days for drying. Strip off a few lower old dried leaves. Allow the suckers to dry and cure for another 7 days. Dip the cured suckers in 1% Bordeaux mixture at the time of planting.

Planting
Rake the soil and plant the suckers in double rows at spacing of 70 cm between rows and 30 cm between plants. Limit the depth of planting to 7.5 to 10 cm. Adopt triangular method of planting in each trench so that the plants in two adjacent rows are not opposite to each other (plant population 40400 / ha).

Manuring
Apply compost / cattle manure at 25 t/ha as basal dressing. Apply fertilizers at the following dosage:

<table>
<thead>
<tr>
<th>Dose</th>
<th>N:P₂O₅:K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per plant per year (g)</td>
<td>8:4:8</td>
</tr>
<tr>
<td>Per hectare per year (kg)</td>
<td>320:160:320</td>
</tr>
</tbody>
</table>

Apply full dose of P₂O₅ at the time of planting. Nitrogen and K₂O may be applied in four splits, during May-June (at planting), August-September, November and May-June (2nd year)

Note: In places where rains are scanty during November, N and K₂O may be applied in three equal splits - two doses in 1st year (May-June and August-September) and the third in May-June of the second year. After application of fertilizers, cover with soil by scraping the sides of trenches.

Irrigation
During summer months, pineapple should be irrigated wherever possible at 0.6 IW/ CPE ratio (50 mm depth of water). It requires five or six irrigations during dry months at an interval of 22 days. Mulching the crop with dry leaves at 6 t/ha will help to conserve moisture.

Weed control
For effective and economic weed control, use weedicides If there is subsequent growth of weeds, herbicide application may be repeated at half the above dose. Spraying should be done when there is adequate moisture in the soil. Avoid periods of heavy rainfall for spraying.
**Induction of flowering**
For inducement of uniform flowering, apply 25 ppm ethephon (2-chloro ethyl phosphonic acid) in aqueous solution containing 2% urea and 0.04% calcium carbonate as follows:

The mixture (50 ml/plant) is to be applied pouring into the heart of 16-17 month old plants (39-42 leaf stage) during dry weather. For treating 1000 plants, 50 litres of the solution would be required. (The ingredients for preparing 50 litres of the aqueous solution are ethephon 1.25 ml, urea 1 kg and calcium carbonate 20 g, made up to 50 litres with water. The dosage has to be fixed depending on the availability of commercial formulation and the active ingredient contents)

Flowering will commence from 40th day after application and complete on the 70th day.

**Plant protection**
No serious pests or diseases are noticed in the crop except for light incidence of leaf spot disease and of the mealy bugs.

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**D. JACK FRUIT (Artocarpus heterophyllus)**

Jackfruit comes up well in humid regions up to an elevation of 1000 m. Soil should be deep and well drained. Any rise in water table or poor aeration of the soil is detrimental to the crop.

**Varieties / types**
Jackfruit differs in size, shape and quality. The jackfruit may be classified into two groups: (i) soft fleshed and (ii) firm fleshed. The firm fleshed type is highly tasty, sweet and crisp. The two groups are further classified depending on the taste, size of fruit, odour of flesh, nature, shape and diversity of prickles on the rind.

**Planting materials**
Use seedlings or grafts for planting. For grafting, raise seedlings in polythene bags and when they are 9-12 months old do inarching. One month after grafting, behead the rootstock above the graft joint.

Epicotyl grafting can be undertaken successfully in jack. Three to four month old, 10 cm long scions are grafted on five-day old rootstocks in polythene bags by the cleft method during the month of June and kept under moist conditions. The scions should be pre-cured 10 days before grafting by clipping the leaf blades and keeping the petioles intact on the twig. The graft union is complete by 80 days after grafting operations.

**Season**
Plant seedlings or one year old grafts at the onset of monsoon showers.
Planting
Prepare pits of size 60 x 60 x 60 cm at a spacing of 12-15 m. Refill pits with mixture of topsoil and 10 kg compost or FYM per pit to a level higher than the adjoining ground. Plant the grafts in the same depth as they were in the containers, preferably in the late evening. Deep planting results in poor growth of the graft. Ensure that the graft joint is above the soil level. Stake the plants to prevent snapping at the graft joints. Excellent drainage and adequate watering result in better performance. At no stage it should be exposed to drought or frost. It is useful to provide some protection, especially to young trees. Jack is rarely manured. Even without fertilizer application, the jack trees come up well under Tripura conditions.

Harvesting
The seedling plants generally bear after eight years and the grafted plants after three years of planting. The fruiting season lasts about four months from January-February to May-June. The average yield from one tree is about 50-100 fruits per year.

Plant protection
The important pests of jack are shoot borer caterpillar, mealy bug and jack scale.

1. To control shoot borer caterpillars spray with any contact insecticide.
2. To control jack scale apply contact insecticide.
3. To control mealy bug, spray contact insecticides like lime sulphur or dust sulphur.

The common diseases that attack the tree are the pink disease, stem rot and fruit rot. Pruning of affected plants and protecting the cut-ends with Bordeaux paste are recommended against these diseases.

E. MANDARIN ORANGE (Citrus reticulata)

Mandarin orange is a subtropical fruit growing in high ranges of Tripura. It requires deep soil rich in humus. The crop cannot withstand water logging. It is grown in regions having good drainage.

Preparation of land
Dig pits of size 70 x 60 x 70 cm at a spacing of 7-8 m at least one month in advance of planting.

Planting material
Use seedlings and budded plants for planting. For raising seedlings, extract seeds from selected fruits by squeezing. Wash the seeds free of pulp and dry them. Make seedbeds 1.5 m long, 1 m wide and 15 cm high. Sow the seeds giving a spacing of 13 cm in a row and 3 cm between the rows. Thin the seedlings if necessary or plant selected seedlings in secondary nursery.
**Time and method for planting**
Planting is done during July-August. Lift the plants carefully with a ball of earth around the roots and plant them carefully without disturbing the roots. While planting, remove the bandage around the bud joint and keep the bud joint at least 10-15 cm above soil surface. Remove the vegetative growth arising below the bud union periodically.

**Manuring**
The manuring schedule recommended is given below.

<table>
<thead>
<tr>
<th>Time after planting</th>
<th>FYM kg/plant</th>
<th>N:P₂O₅:K₂O g/plant/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td>2</td>
<td>40:20:25</td>
</tr>
<tr>
<td>2nd year</td>
<td>4</td>
<td>80:35:50</td>
</tr>
<tr>
<td>3rd year</td>
<td>6</td>
<td>160:75:100</td>
</tr>
<tr>
<td>4th year</td>
<td>8</td>
<td>300:100:150</td>
</tr>
<tr>
<td>5th year</td>
<td>10</td>
<td>600:175:300</td>
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<tr>
<td>6th year</td>
<td>10</td>
<td>800:275:750</td>
</tr>
<tr>
<td>7th year onwards</td>
<td>10</td>
<td>800:275:1000</td>
</tr>
</tbody>
</table>

Apply organic manure in May and fertilizers in two equal split doses during June-July and in September-October. In addition to the above manures and fertilizers, spray micronutrients such as zinc sulphate: 500 g, copper sulphate: 500 g, manganese sulphate: 300 g and lime: 500 g in 100 litres of water per ha twice in a year during March and October-November.

**After cultivation**
Give a light digging or ploughing when the rains start.

**Pruning**
In the early stages, give some formative pruning to establish a strong framework. Remove all shoots arising from rootstock below the bud union. Remove dead branches and smear the cut ends with Bordeaux paste. Do not prune the roots.

**Intercropping**
Crops like coffee, cardamom, banana and pineapple can be planted as intercrops depending on soil fertility status.

**Plant protection**
For controlling citrus butterfly, hand picking of caterpillars and spraying with a contact insecticide is to be followed.
To control stem borer incidence, chip off the affected new shoots and spray Trizophos 40 EC once in three months. If borer tunnels have already been formed, inject 1% dichlorvos into the tunnels. To control aphids spray Thiamethoxam @ 2 g/ 10 litre of water.

Stem borers (Chelidonium sp., Chloridolum sp. and Nupserha sp.) cause withering of branches. Gum exudes from holes on stems and branches. Accumulation of wood dust on ground around the base is another symptom of borer damage.

Cutting and burning of the affected branches, injecting petrol using syringe and painting the stem with suspension of recommended insecticides during May are recommended against the borers.

Among diseases, dieback, root and collar rot are important. Periodical removal of dried twigs and application of Bordeaux paste on cut ends and application of Bordeaux mixture can control dieback disease.

Against root and collar rot, removal of soil from the base of the trunk, scraping of the dead bark and application of lime-sulphur have to be done. As an alternative, smear Bordeaux paste over the treated roots and stem. Exposing the main roots to a depth of about 30 cm is also advised.

**F. GUAVA (Psidium guajava)**

Guava thrives well in places receiving medium rainfall not exceeding 100 cm. In heavy rainfall areas, plants grow luxuriantly, but the quality of the fruits is found to be very poor and insipid. It grows well on any type of soil. Red sandy loam soil with good drainage is most ideal for commercial cultivation of guava.

**Varieties**
Allahabad Safeda, Sardar (Lucknow-49) etc.

**Planting material**
Seed propagation is not practiced because of high degree of variation among the progenies. Air layering is widely adopted for propagation of selected varieties. Layers strike roots within 3-5 weeks. When the roots grow through the ball of moss, the stem may be severed below the girdled area in stages. The polythene film is removed from the finally severed rooted stem, which is then potted and kept in the shade until new leaves appear. When the new flushes are produced, the plant can be hardened in full sunlight preparatory to transplanting in the field.
**Planting**

Pits of one metre cube are made 6 m apart. Fill the pits with topsoil, sand and cowdung. Layers are planted in the centre of the pit. Staking of plants is also done, if necessary. After planting, mulching with dry leaves should be done to conserve moisture. June-July is the ideal time for planting the layers and seedlings. Plants should be irrigated in summer. Square system of planting facilitates easy orchard operations. Guava can be grown as an intercrop in coconut gardens.

**Manuring**

A fully grown-up bearing plant should be manured with about 80 kg of FYM, 200 g N, 80 g P$_2$O$_5$ and 260 g K$_2$O. These may be applied in two or three split doses when there is sufficient moisture in the soil.

**Yield**

Guava starts bearing from 3-4 years after planting. About 500-800 fruits per year can be obtained from a 10 year old tree.

**Plant protection**

*Guava wilt*

In affected trees, the branches wither and die one after another and in a few weeks or months the tree, which seemed entirely healthy will be dead. It is better to remove such trees as soon as the symptoms are identified to prevent the spread of the disease. Soil application of bioagents like *Trichoderma viride*, *T. harzianum* or *Pseudomonas fluorescense* should be done at recommended doses.

*Fruit fly*

This is a serious pest of guava. The insect affects the fruit when it matures. The infested fruits show depression with dark green punctures.
2. Vegetables

A. BHINDI (*Abelmoschus esculentus*)

The three main planting seasons for Okra are February-March, June-July and October-November.

**Varieties**

*Green / light green fruited:* Pusa Sawani, Pusa Makhmali, IARI Selection 2, Kiran, Salkeerthi

*Yellow vein mosaic resistant/tolerant:* Arka Anamika, Arka Abhay, Susthira (all green fruited)

**Seed rate**

The seed rate is 8.5 kg/ha for the summer crop sown in February-March and 7 kg/ha for kharif crop.

**Storage of seeds**

Packing of okra seeds in polythene cover (700 gauge) increases the storage life up to 7 months.

**Planting**

For kharif crop, sow the seeds at a spacing of 60 cm between rows and 45 cm between plants. For the summer crop, soak the seeds in water for 24 hours before sowing and give a spacing of 60 x 30 cm.

**Manuring**

Apply FYM or compost as basal dose @ 12 t/ha. At the time of sowing, apply N, P₂O₅, and K₂O @ 25, 8 and 25 kg/ha. Another 25 kg N per ha may be applied one month after sowing.

**After Cultivation**

Give pre-sowing irrigation, if soil is not moist enough. During summer, irrigate at intervals of 2 to 3 days. Conduct weeding regularly and earth up rows during rainy season.
Plant protection

The important pests are jassids, fruit and shoot borer and root knot nematode. For controlling fruit and shoot borers, remove all drooping shoots and damaged fruits. For the control of nematodes, apply sawdust or paddy husk at 500 g/plant or neem leaves or *Eupatorium* leaves at 250 g/plant in basins one week prior to planting and water daily. The effect of this treatment persists up to 75 days after sowing in summer season. Application of *Bacillus macerans* or *B. circulans* (1.2 x 10^6 cells per pit) before sowing is recommended for the control of root knot nematode (ad hoc recommendation). In general, insecticides of plant origin may be used, as far as possible.

Yellow vein mosaic

This is a common disease in okra, which shows vein clearing and vein chlorosis of leaves. The yellow network of veins is very conspicuous and veins and veinlets are thickened. Fruits become small and yellowish green in colour. White fly (*Bemisia tabaci*) and leaf hopper (*Amrasca biguttula biguttula*) are vectors of this virus. Hence, their control is very important. Use of resistant varieties like Arka Anamika, Arka Abhay and Susthira, and destruction of host weeds (*Croton sparsiflora* and *Ageratum sp.*) are also effective.

- **CUCURBITACEOUS VEGETABLES**

  **B. BITTER GOURD (Momordica charantia)**

Bitter gourd is an important cucurbit vegetable in Tripura.

**Season**

January-March and September-December are the ideal seasons. For the rainfed crop, sowing can be started after the receipt of first few showers during May-June.

**Varieties**

Priya, Preethi, Priyanka and Arka Harit are high yielding varieties.

**Seed rate:** 5.0-6.0 kg/ha

**Spacing:** 2.0 m x 2.0 m

**Sowing**

Pits of 60 cm diameter and 30-45 cm depth are taken. Well rotten FYM and fertilizers are mixed with topsoil in the pit and seeds are sown @ 4-5 per pit. Unhealthy plants are removed after two weeks and only 3 plants are retained per pit.
Manuring

Apply FYM @ 20-25 t/ha as basal dose along with half dose of N (35 kg) and full doses of P₂O₅ (25 kg) and K₂O (25 kg). The remaining dose of N (35 kg) can be applied in several split doses at fortnightly intervals.

After cultivation

During the initial stages of growth, irrigate at 3-4 days interval, and alternate days during flowering/fruiting. Irrigation at 15 mm CPE (approximately at 3 days interval for sandy loam soils) is more economical than irrigating once in two days especially during summer months for water economy. Conduct weeding and raking of the soil at the time of fertilizer application. Earthing up is done during rainy season.

Pests

Red pumpkin beetle

Adult beetle eats the leaves, makes hole on foliage and causes damage on roots and leaves. Spray insecticide according with Economic Threshold Level.

Diseases

Downy mildew: It is severe during rainy season. This can be checked by spraying mancozeb 0.2% or metalaxyl + mancozeb @ 2.5 g / l of water

Mosaic

Control the vector. Uprooting and destruction of affected plants and collateral hosts should be done.

C. CUCUMBER (Cucumis sativus)

Cucumber is mainly used as a salad crop.

Season

The ideal seasons are January-March and September-December.
Varieties

Cucumber varieties such as Pusa Seethal, Poinsette, Poona Khira are exclusively used for salad purpose.

Seed rate: 0.5-0.75 kg/ha

Spacing: 2.0 m x 1.5 m

Preparation of land

Pits of 60 cm diameter and 30-45 cm depth are taken. Well rotten FYM and fertilizers are mixed with topsoil in the pit and four or five seeds are sown in a pit. Remove unhealthy plants after two weeks and retain three plants per pit.

Manuring

Apply FYM @ 20-25 t/ha as basal dose along with half dose of N (35 kg) and full dose of P₂O₅ (25 kg) and K₂O (25 kg/ha). The remaining dose of N (35 kg) can be applied in two equal split doses at the time of vining and at the time of full blooming.

After cultivation

During the initial stages of growth, irrigate at an interval of 3-4 days. Irrigate in alternate days, during flowering and fruiting. For trailing cucumber and melon, spread dried twigs on the ground. Conduct weeding and raking of the soil at the time of fertilizer application. Earthing up may be done during rainy season.

Pests

The important pests are epilachna beetle and red pumpkin beetle. They can be controlled by adopting the measures recommended for bitter gourd.

Diseases

The important diseases are downy mildew, powdery mildew and mosaic. The control measures as recommended for bitter gourd can be adopted. Harvesting can be done only after 10 days (at least) of insecticide / fungicide application. The fruits should be washed thoroughly in water before cooking.
D. WATER MELON (Citrullus lanatus)

Season: The ideal season is Dec-April.

Varieties: Sugar Baby, Arka Jyothi etc

Seed rate: 1 to 1.5 kg/ha

Spacing: 3.0 m x 2.0 m

Preparation of land

Pits of 60 cm diameter and 30-45 cm depth are taken. Well rotten FYM and fertilizers are mixed with topsoil in the pit and four or five seeds are sown in a pit. Remove unhealthy plants after two weeks and retain two or three plants per pit.

Manuring

Apply FYM @ 20-25 t/ha as basal dose along with half dose of N (35 kg) and full doses of P<sub>2</sub>O<sub>5</sub> (25 kg) and K<sub>2</sub>O (25 kg/ha). The remaining dose of N (35 kg) can be applied in two equal splits at the time of vining and full blooming.

After cultivation

During the initial stages of growth, irrigate at an interval of three or four days. Irrigate on alternate days during flowering and fruiting. When fruits are mature, the frequency of irrigation may be reduced.
For trailing the water melon, spread dried twigs on the ground. Conduct weeding and raking of the soil at the time of fertilizer application.

Pests

The important pests are red pumpkin beetle and epilachna beetle. They can be controlled by adopting measures suggested for bitter gourd.

Diseases

Stem Rot: In Tripura Stem Rot of Watermelon is mainly caused by Soil Borne Fungi, Soil amendment with Trichoderma viride or Pseudomonas fluorescence should be followed up to avoid its incidence. Harvesting can be done only after 10 days (at least) of insecticide / fungicide application. Only well ripe fruits should be harvested.
**E. BOTTLE GOURD (Lagenaria siceraria)**

**Season**

Bottle gourd can be successfully grown during January-March and Sept-December. For the rainfed crop, sowing can also be started after the receipt of the first few showers during May-June.

**Varieties**

Pusa Summer Prolific Long, Arka Bahar

**Seed rate:** 3-4 kg/ha

**Preparation of land**

Pits of 60 cm diameter and 30-45 cm depth are taken at 3 m x 3 m spacing for growing on pandals. For trailing on the ground, make pits at a spacing of 2 m in rows 3-4 m apart. Well rotten FYM and fertilizers are mixed with topsoil in the pit.

**Sowing**

Four or five seeds are sown per pit. Remove unhealthy plants after two weeks and retain three plants per pit.

**Manuring**

Apply farm yard manure at the rate of 20-25 t/ha as basal dose along with half dose of N (35 kg) and full dose of P₂O₅ (25 kg) and K₂O (25 kg/ha). The remaining dose of N (35 kg) can be applied in several split doses at fortnightly intervals.

**Aftercultivation**

During the initial stages of growth, irrigate at an interval of three or four days. Irrigate on alternate days during flowering and fruiting periods. Conduct weeding and raking of the soil at the time of fertilizer application. Earthing up may be done during rainy season.

**Pests**

The important pests are epilachna beetle and red pumpkin beetle. They can be controlled by adopting measures recommended under bitter gourd.

**Diseases**

Downy mildew and powdery mildew are important diseases in bottle gourd. Refer control measures recommended for bitter gourd. Harvesting can be done only after 10 days (at
least) of insecticide / fungicide application. The fruits should be washed thoroughly in water before cooking.

**F. PUMPKIN (Cucurbita moschata)**

**Season**

Pumpkin can be successfully grown during January-March and September-December. For the rainfed crop, sowing can also be started after the receipt of the first few showers during May-June.

**Varieties:** Ambili, Suvarna and Saras

**Seed rate:** 1.0 to 1.5 kg/ha

**Preparation of land**

Pits of 60 cm diameter and 30-45 cm depth are taken at a spacing of 4.5 x 2.0 m. Well rotten FYM and fertilizers are mixed with topsoil in the pit.

**Sowing**

Four of five seeds are sown per pit. Remove unhealthy plants after 2 weeks and retain three plants per pit.

**Manuring**

Apply FYM @ 20-25 t/ha as basal dose along with half dose of N (35 kg) and full dose of P<sub>2</sub>O<sub>5</sub> (25 kg) and K<sub>2</sub>O (25 kg). The remaining dose of N (35 kg) can be applied in two equal split doses at the time of vining and at the time of full blooming.

**After cultivation**

During the initial stages of growth, irrigate at an interval of three or four days. Irrigate on alternate days during flowering and fruiting periods. For trailing, spread dried twigs on the ground. Conduct weeding and raking of the soil at the time of fertilizer application. Earthing up may be done during rainy season.

**Plant protection**

**Pests**

Fruit flies, epilachna beetle and red pumpkin beetle are important pests affecting pumpkin. They can be controlled as in case of bitter gourd.
Diseases

Downy mildew, powdery mildew and mosaic are important diseases affecting pumpkin. Harvesting can be done only after 10 days (at least) of insecticide / fungicide application. The fruits should be washed thoroughly in water before cooking.

G. ASH GOURD (Benincasa hispida)

Season

Ash gourd can be successfully grown during January-March and September-December. For rainfed crop, sowing can also be started after the receipt of the first few showers during May-June.

Varieties: Indu

Seed rate: 0.75-1.0 kg/ha

Preparation of land

Pits of 60 cm diameter and 30-45 cm depth are taken at 4.5 x 2.0 m spacing. Well rotten FYM and fertilizers are mixed with topsoil in the pit.

Sowing

Seeds are sown at the rate of four or five per pit. Remove unhealthy plants after two weeks and retain two or three plants per pit.

Manuring

Apply FYM @ 20-25 t/ha as basal dose along with half dose of N (35 kg) and full dose of P₂O₅ (25 kg) and K₂O (25 kg/ha). The remaining dose of N (35 kg) can be applied in two equal split doses at the time of vining and at the time of full blooming.

After cultivation

During the initial stages of growth, irrigate at an interval of three or four days. Irrigate on alternate days during flowering and fruiting. For trailing, spread dried twigs on the ground. Conduct weeding, and raking of the soil at the time of fertilizer application. Earthing up may be done during rainy season.

Pests

Fruit fly, epilachna beetle and red pumpkin beetle are important pests affecting ash gourd. They can be controlled as given under bitter gourd
**Diseases**

Powdery mildew and mosaic are important diseases in ash gourd. They can be controlled as in bitter gourd. Harvesting can be done only after 10 days (at least) of insecticide / fungicide application. The fruit should be washed thoroughly in water before cooking.

- **SOLANACEOUS VEGETABLES**

Brinjal, chilli and tomato are the important solanaceous fruit vegetables grown in the state. The cultural operations of the above three crops are similar with only slight variations.

**A. BRINJAL (Solanum melongena)**

**Varieties**

Surya, Swetha and Haritha (bacterial wilt resistant open pollinated varieties), Neelima (bacterial wilt resistant F1 hybrid), Pusa Purple Cluster.

**Seed rate:** 370-500 g/ha

**Raising seedlings**

Brinjal is a transplanted vegetable. Seeds are sown in the nursery and one-month-old seedlings are transplanted to the main field. For sowing the seeds, raised seed beds of 90 to 100 cm width and convenient length are prepared in open space with fertile topsoil to which well decomposed organic matter has been incorporated. After sowing the seeds, mulch with green leaves and irrigate with a rose-can daily in the morning. Remove the mulch immediately after germination of the seeds. Restrict irrigation one week before transplanting and irrigate heavily on the previous day of transplanting.

**Time of planting**

For rainfed crop, transplant the seedlings during May-June before the onset of southwest monsoon. Planting can also be done during September-October for irrigated crop.

**Land preparation and transplanting**

Land is prepared to a fine tilth by thorough ploughing or digging. Well rotten organic manure is incorporated in the soil and seedlings are transplanted in shallow trenches / pits during May or on ridges / levelled lands during rainy season. Transplanted seedlings may be given temporary shade for 3-4 days during summer.
Spacing

Transplant less spreading varieties at 60 x 60 cm. For spreading varieties provide wider spacing of 75-90 x 60 cm.

Manuring

Apply well rotten FYM / compost @ 20-25 t/ha at the time of land preparation and mix well with the soil. 
A fertilizer dose of 75:40:25 kg N: P2O5: K2O / ha may be given. Half the dose of nitrogen, full phosphorus and half of potash may be applied as basal dose before transplanting. One fourth of nitrogen and half of potash may be applied 20-30 days after planting. The remaining quantities may be applied two months after planting.

After cultivation

Irrigate at three or four days interval during summer. Stake the plants if necessary. Weeding followed by fertilizer application and earthing up may be done one and two months after transplanting.

Plant protection

For avoiding damping off of the seedlings in the nursery, sow the seeds as thin as possible in the raised beds prepared in the open area during summer months. Follow mechanical removal and destruction of pest / disease affected portions for control of fruit and shoot borer and Phomopsis fruit rot. Uproot plants affected by little leaf and spray insecticides for further control.

The root knot nematode can be managed by the application of Bacillus macerans or B. circulans 1.2 x 10^6 cells per m² in nursery bed two days before sowing (ad hoc recommendation). For the control of pests, application of granules of carbofuran at the rate of 0.5 kg ai/ha or phorate at the rate of 1 kg ai/ha at seeding followed by need based application of foliar insecticides has been recommended. The application of granules is recommended only at the time of seeding. In general, insecticides of plant origin may be used, as far as possible.
B. CHILLI (Capsicum annuum)

Varieties

High yielding varieties: Jwalasakhi, Jwalamukhi, Jwala, Pant C-1, K-2
Bacterial wilt resistant varieties: Manjari, Ujwala, Anugraha

Seed rate: 1.0 kg/ha

Raising seedlings

Chilli is a transplanted crop. Seeds are sown in the nursery and one-month-old seedlings are transplanted to the main field. For sowing the seeds, raised seed-beds of 90 to 100 cm width and of convenient length are prepared to which well decomposed organic matter has been incorporated. After sowing the seeds, mulch with green leaves and irrigate with a rose-can daily in the morning. Remove the mulch immediately after germination of the seeds. Restrict irrigation one week before transplanting and irrigate heavily on the previous day of transplanting.

Time of planting

For a rainfed crop, transplant the seedlings during May-June before the onset of southwest monsoon. Planting can also be done during Sept-October for an irrigated crop.

Land preparation and transplanting

Land is prepared to a fine tilth by thorough ploughing / digging. Well rotten organic manure is incorporated in the soil and seedlings are transplanted in shallow trenches / pits during May or on ridges / level lands during rainy season. Transplanted seedlings may also be given temporary shade for three to four days during summer.

Spacing

Transplant less spreading varieties at 45 x 45 cm. For spreading cultivars provide a wider spacing of 75 x 45-60 cm.

Manuring

Apply well rotten FYM / compost @ 20-25 t/ha at the time of land preparation and mix well with the soil. A fertilizer dose of 75:40:25 kg N:P₂O₅: K₂O / ha may be given. Half of nitrogen, full phosphorus and half of potash may be applied as basal dose before transplanting. One fourth of nitrogen and half of potash may be applied 20-30 days after planting. The remaining quantity may be applied two months after planting.
**After cultivation**

Irrigate at three to four days interval during summer. Stake the plants if necessary. Weeding followed by fertilizer application and earthing up may be done at one and two months after transplanting.

**Plant protection**

For avoiding damping off of the seedlings in the nursery, sow the seeds as thin as possible in raised beds prepared in the open area during summer months. Spray nursery and main field with 1% Bordeaux mixture at monthly intervals during rainy season. Uproot and destroy the plants affected by bacterial wilt and mosaic.

**C. TOMATO (Lycopersicon esculentum)**

**Varieties**

*Bacterial wilt resistant varieties:* Sakthi, Mukthi, Anagha  
*High yielding variety:* Pusa Ruby

**Seed rate:** 400 g/ha

**Raising seedlings**

Tomato is a transplanted vegetable. Seeds are sown in the nursery and one-month-old seedlings are transplanted to the main field. For sowing the seeds, raised seed beds of 90 to 100 cm width and of convenient length are prepared to which well decomposed organic matter has been incorporated. After sowing the seeds, mulch with green leaves and irrigate with a rose-can daily in the morning. Remove the mulch immediately after germination of the seeds. Restrict irrigation one week before transplanting and irrigate heavily on the previous day of transplanting.

**Time of planting**

Transplant the seedlings during October-November for an irrigated crop.

**Land preparation and transplanting**

Land is prepared to a fine tilth by thorough ploughing or digging. Well rotten organic manure is incorporated in the soil and seedlings are transplanted in shallow trenches / pits / levelled lands. Transplanted seedlings may be given temporary shade for three to four days during hot days.

**Spacing**

Transplant the seedlings at 60 x 60 cm.
Manuring

Apply well rotten farm yard manure / compost @ 20-25 t/ha at the time of land preparation and mix well with the soil. A fertilizer dose of 75:40:25 kg N: P2O5:K2O / ha may be given. Half the dose of nitrogen, full phosphorus and half of potash may be applied as basal before transplanting. One fourth of nitrogen and half of potash may be applied 20-30 days after planting. The remaining quantity may be applied two months after planting.

After cultivation

Irrigate at two or three days interval. Stake the plants if necessary. Weeding followed by fertilizer application and earthing up may be done at one and two months after transplanting.

Plant protection

For avoiding damping off of the seedlings in the nursery, sow the seeds as thin as possible in raised beds prepared in the open area. Spray nursery and main field with 1% Bordeaux mixture at monthly intervals. Uproot and destroy the plants affected by bacterial wilt and mosaic

- COOL SEASON VEGETABLES

A. CABBAGE (Brassica oleracea var. capitata)

Cabbage can be grown in high ranges during winter season. Well-drained sandy loam to clay loam soil is suited for this crop.

Varieties

September, Pusa Drum Head, Golden Acre, Kaveri, Ganga, Sri Ganesh and Pride of India.

Planting requirements

Since it is a cool season crop, sowing is done from August-November. Seed rate is 500-750 g/ha. Seeds are to be sown in nursery beds. Three to five weeks old seedlings are used for transplanting. Field is prepared by three or four ploughing. Seedlings are transplanted at a spacing of 45 x 45 cm.

Manures and fertilizers

Apply 25 t/ha FYM or compost. Fertilizer dose is N:P2O5:K2O 150:100:125 kg/ha. Apply
full dose of P₂O₅ and half dose of N and K₂O before transplanting. Apply remaining half
dose one month after transplanting.

**After cultivation**

A continuous supply of moisture is necessary for proper development of heads. Very
shallow hoeing should be done to remove weeds and to make the soil better aerated. In
order to produce large heads, earth up plants one month after transplanting.

**B. CAULIFLOWER** *(Brassica oleracea var. botrytis)*

Cauliflower can be grown during winter in high ranges. Well-drained sandy loams to clay
loam soils are suited for the crop.

**Varieties**

Pusa Early Synthetic, Himani, Swathi, Pusa Deepali, Early Patna,

**Planting requirements**

Since it is a cool season crop, sowing is to be done from Aug-Nov. Seed rate is 600-750
g/ha. Seeds are to be sown in nursery beds. Three to five week old seedlings are used for
transplanting. Field is prepared by three or four ploughings. Seedlings are transplanted at
a spacing of 60 x 45 cm.

**Manures and fertilizers**

Apply FYM or compost @ 25 t/ha and fertilizers @ 150:100:125 N:P₂O₅:K₂O kg/ha.
Apply full dose of P₂O₅ and half dose of N and K₂O before transplanting and remaining
N and K one month after transplanting.

**After cultivation**

A continuous supply of moisture is necessary for proper development of curds. Very
shallow hoeing should be done to remove the weeds and to loosen the soil for better
aeration. In order to produce large curds, earth up the plant one month after transplanting.

**C. CARROT** *(Daucus carota)*

Carrot can be grown in high ranges from August to January. Well-drained sandy loam
soil is best suited for the crop.
Varieties

Pusa Kesar, Nantes, Pusa Meghali

Planting requirements

Seed rate is 5-6 kg/ha. It is usually sown on ridges to facilitate good root production. Ridges of about 20 cm height are made 45 cm apart and seeds sown 10 cm apart on the rows. The seed is mixed with fine sand and sown in rows by hand and covered with soil to make it firm around it.

Manures and fertilizers

Apply 25 t/ha FYM before sowing and a fertilizer dose of 37.5 kg N, 62.5 kg P₂O₅ and 50 kg K₂O / ha as basal. Topdressing with 37.5 kg N / ha may be done one month after sowing.

After cultivation

It is necessary that enough soil moisture is available to help uniform seed germination and growth of plant. Uproot excess seedlings (thinning) three weeks after sowing leaving a plant to plant spacing of 10 cm to facilitate better tuber growth. Weeding should be done at regular intervals to keep down the weeds. Shallow hoeing is necessary to facilitate root growth. When the root starts growing, earthing up should be done.

D. RADISH (Raphanus sativus)

Radish can be grown in high ranges from June to January. Well drained sandy loam soils are best suited for the crop.

Varieties

Japanese White, Arka Nishanth, Pusa Chethki, Pusa Reshmi, Pusa Desi and Bombay Red Long

Planting requirement

Seed rate is 7 to 8 kg per hectare. It is usually grown on ridges to facilitate good root production. Ridges of about 20 cm height are taken 45 cm apart and plants are grown 10 cm apart on the rows. The seed is mixed with fine sand and sown in rows by hand, covered with soil to make it firm around it.

Manures and fertilizers

Apply 20 t/ha FYM as basal. N: P₂O₅: K₂O 75:37.5:37.5 kg/ha is the fertilizer
requirement. Full dose of \( P_2O_5 \) and \( K_2O \) and half dose of \( N \) are applied as basal. Remaining half dose of nitrogen is applied as topdressing when the plant starts growing vigorously.

**After cultivation**

It is necessary that enough soil moisture is available to help uniform seed germination and growth of plant. Thinning may be done at 10 cm distance as in carrot. Weeding should be done at regular intervals to keep down weeds. Shallow hoeing is necessary to facilitate root growth. When the roots start growing, earthing up should be done.

**F. POTATO (Solanum tuberosum)**

Potato can be successfully cultivated in Tripura. A day temperature of 20-30ºC is optimum for growth and tuberisation in potato. Tuber formation is adversely affected, if the temperature goes above 30ºC.

**TRUE POTATO SEED (T.P.S.)**

Tiny botanical seeds of potato obtained by crossing two parental lines, of Potato, a substitute of traditional seed tubers. Cost of production of potato using T.P.S. is approximately 55 per cent less in comparison to cost of production of potato using seed tuber. At the same time production may be obtained up to the level of 35 m.t. per hectare.

**Package of practices for production of Potato using T.P.S.:**

**Raising Seedling**:
Seeds are sown a 0.5 cm depth in raised nursery beds (6 inches or 15 cm) prepared to good tilt with finely powdered dry cowdung in rows at 10 cm apart & provide shed. Water with fine rose can. Apply foliar spray 0.01% Urea solution from 15th day after sowing on alternate days till the seedlings are ready for transplanting (25 to 28 days) with 3 to 4 leaf stage. Care should be taken against termite and damping-off.

**Cultivation in the main field**:
Prepare main field to a good tilt. After leveling apply fertilizers @ 75:100:150 kg. NPK per hectare. Make ridges (6 inches or 15 cm. height) furrows at 50 to 60 cm. apart in east - west direction. Irrigate the furrows to 3 inches or 7.5 cm height. Transplant the seedlings on the next day on the northern side of ridges at half the height at 15cm apart. on 35th day apply 75 kg. Nitrogen per hectare after weeding and earthing up is to be done in such a way that the plants come up on top of the earth. Provide irrigation as and when required.
What is tuberlet?
Small tubers up to 20 grams in size are used as seed tubers. Seed tuber requirement could be brought down to one-third by using tuberlets.

Package of practices of production to Tuberlet using T.P.S.:

At present there are two methods in practice for producing seedling tubers in bed – Single Row Method, Double Row Method

Single Row Method:
Prepare beds of 6 inches or 15 cm. height, 1 mt. width and according to convenient length” at 0.75 cm apart. Bring to good tilth mixing with finely powdered well-rotten dried cow dung. Apply Urea, S.P and M.O.P. @ 20 gms, 60 gms & 25 gms./ Sq.mt. respectively as basal dose. Sow 2-3 seeds per hole at 0.5 cm. depth with 20 cm. X 5 cm. spacing. Provide shade to avoid scorching sun and irrigate the beds with fine rose cane as per necessity. Earth up with the mixture of finely prepared soil and cow dung along with Urea @ 5 gms./sq. mt. at 30th, 45th and 60th day. Cut the haulms at 85th day. During the Whole production period, need base spraying with P.P.C. should be undertaken. Treat the Tuberlets with 3% Boric-acid and store in cold storage for next year after proper drying in shade.

Double Row Method:
Preparation of field and other operation are same as single row method except sowing of seeds. In Double Row method seeds are sown 4 cm. apart in a line and row to row distance is 10 cm. In between two double row distance is 30 cm. Top dressing with 5 gm. Urea per Sq.mt. at 30th, 45th and 60th day followed by earthing up as practiced in normal crop so that two lines can be covered by a single furrow.

T.P.S can be obtained by sending Demand Draft in advance drawn in favour of the Vegetable Seed Production Officer, Horti. Research complex, Nagicherra, Agartala, Tripura (West), Pin - 799 004. Phone-(0381) 240 0068 Rate of T.P.S. is Rs. 16,000/- per Kilogram within India. Rate for abroad is 650 U.S. Dollar per Kilogram excluding Central Excise duty (CED), Freight charge etc..

Soil:
Loose friable sandy loam or silt loam, rich in organic matter are ideal for potato. Hard clay should be avoided. Optimum pH range is 5.2-7.0
**Planting**

Whole potato tuber or cut pieces (50-60 g size) longitudinally cut from bud-end to stem-end can be used for plating. For planting 1 ha, 1000-2000 kg seed tubers are required. Seed tubers are treated with 1 ppm of GA 3 for one hour and then dried in shade for getting uniform sprouting. Tubers are filled in gunny bags after drying and kept in vertical position in well-ventilated dark room for 10 days for encouraging sprouting. Seed pieces should be treated with mancozeb (@ 1 kg in 450 litres of water) before planting to protect them from soil borne diseases. Tubers can be planted on ridges 50-60 cm wide at a spacing of 15-20 cm between the plants. Earthing up is needed during the growing phase (30 days after planting) and 70 days after planting.

**Manuring**

A basal application of FYM (20 t/ha) is required during field preparation. Apply 60 kg N, 100 kg P$_2$O$_5$ and 120 kg K$_2$O as basal. Topdressing with 60 kg N, 30 days after planting at the time of first earthing up is essential.

**Plant protection**

Early blight and late blight are the important fungal diseases. Spraying zineb (2 g per litre of water) is effective to control early blight. Copper fungicides can control late blight. Cut worms, aphids and jassids are common pests of potato.
3) **Flowers:**

**A. MARIGOLD (Tagetes spp.)**

Marigold is a popular annual flower that could be grown on a commercial scale. Free flowering habit, short duration to produce marketable flowers, wide spectrum of colour, shape, size and good keeping quality make marigold an acceptable commercial crop.

**Cultivars**

There are two species of marigold, namely, African marigold (Tagetes erecta) and French marigold (Tagetes patula).

*African marigold varieties*


*French marigold varieties*

Rusty Red, Naughty, Marietta, Flame, Star of India and Harmony.

**Soil**

A wide range of soils with good drainage is suitable for cultivation of marigold. Sandy loam soil with pH 5.6 to 6.5 is ideal for its cultivation.

**Propagation**

Seeds are used for raising the crop.

**Cultural practices**

Seedlings are prepared by sowing the seeds in the nursery beds as follows: Prepare nursery beds of 6 m length, 1.2 m width and 10-20 cm height. Apply 30 kg FYM along with 0.5 kg of 15:15:15 fertilizer mixture and mix them well in the soil. Sow the seeds in rows 7.5 cm apart. Cover the seeds with fine FYM and irrigate. The seedlings will be ready for transplanting within one month.

For the main-field, the land should be ploughed well and FYM @ 20 t/ha should be incorporated to the soil. Apply a basal dose of fertilizers @ 112.5 kg N, 60 kg P₂O₅, and 60 kg K₂O per ha. Transplant the seedlings at a spacing of 30 x 30 cm in case of
French marigold and 45 x 45 cm in case of African marigold on one side of the ridge and irrigate. Topdress the crop with 112.5 kg N per ha at the time of pinching (30-45 days after transplanting) and earth up. Pinching is done to increase the total yield. It consists of removing terminal portion of the plant 30-45 days after transplanting.

Irrigate once in 4-6 days depending upon soil moisture and weather conditions. Weeds have to be removed at monthly intervals.

**Plant protection**

Marigold is not attacked by many pests. However, flower beetles, leaf hoppers, stalk borers, mites etc. cause occasional problems. These plants are rarely attacked by diseases. In poorly drained soils, foot rot caused by *Phytophthora* may occur. Stem rot caused by *Sclerotinia sclerotiorum* is also reported. Drenching with copper oxychloride is helpful in checking foot root, while stem rot is controlled by soil drenching with fungicides.

**Harvest and yield**

Marigold flowers will be ready for harvest in about 2½ months time from the date of transplanting. The plant continues to bear flowers for another 2-2½ months from the date of first harvest. The flowers are harvested when they have attained full size. Harvest the flowers in the evening along with a portion of stalk. Yield of French marigold will be 8-12 t/ha and that of African marigold 11-18 t/ha.

**B. TUBEROSE (*Poliantha tuberosa*)**

Tuberose occupies a very special position among the ornamental bulbous plants because of its prettiness, elegance and fragrance. It has good economic potential for loose/cut flower trade and essential oil industry.

**Cultivars**

There are four groups of cultivars as given below:

1. **Single**: Flower is pure white and has only a single row of corolla segments. Cultivars are Sringar, Culcutta Single, Mexican Single and Suvarna Rekha.

2. **Double**: Flowers are white, tinged with pinkish red. Petals are in several whorls. Cultivars are Suvasini, Culcutta Double and Pearl.

3. **Semi-double**: Similar to double but with only 2 to 3 rows of corolla segments.

4. **Variegated**: This has variegated leaves with yellow margins.
Soil

Porous, well-drained sandy loam soils are the best suited for tuberose cultivation.

Propagation

Propagation is by bulbs. Boat shaped bulbs of size 2 to 3 cm are preferred for planting. About 1.25 to 1.50 lakh bulbs (800 to 900 kg) are required for planting one hectare.

Cultural practices

Land is prepared well by ploughing two or three times. FYM @ 30 t/ha is mixed well with soil. Best time for planting is May-July. The bulbs preferably those of size 2-5 cm or above are to be planted at a depth of 7-10 cm, with a spacing of 20 x 25 cm. A fertilizer dosage of 100:50:50 kg/ha N:P₂O₅ :K₂O is recommended. Of these, half N, complete P₂O₅ and K₂O are applied at the time of planting. Remaining N is applied when the flower spikes start to appear. A heavy irrigation once in 5-10 days is necessary depending upon the weather conditions. The peak flowering is between June and October.

Ratoon crop

After the harvest of the main crop, the flower stalks are headed back and the plot is manured and irrigated. Three or four ratoon crops can be taken from single planting. If the bulbs are not uprooted and replanted after three or four ratoons, the spikes tend to become smaller and unattractive.

Plant protection

Slugs and grass hoppers, which feed on the leaves, and thrips which damage and cause distortion of the spikes are the major pests. No major disease is noticed. Sclerotium fungus, which attacks the leaves and flower stalks at ground level causes defoliation and toppling of spikes. This can be controlled by drenching of soil around the plant with fungicides.

Harvest and yield

Tuberose is harvested by cutting the spikes from the base for table decoration or the individual flower is picked from the spike for making garlands and other floral ornaments. The average yield of flower is as follows.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant crop</td>
<td>5-10</td>
</tr>
<tr>
<td>First ratoon</td>
<td>9-12</td>
</tr>
<tr>
<td>Second ratoon</td>
<td>4-6</td>
</tr>
</tbody>
</table>
C. GLADIOLUS (*Gladiolus* spp.)

Gladiolus is grown for its attractive flower spike having florets of huge form, dazzling colour and varying sizes, with long vase life.

Varieties

There are a number of varieties in gladiolus. Friendship, Spic and Span, Mansoer Red, Dr. Fleming, Peter Pears and White Friendship are some of the common varieties.

Soil

It can be grown in a wide range of soils, light sandy to clay loam. Deep well-drained acidic soils with a pH of 5.5-6.5 are the best for cultivation.

Propagation

Gladiolus is propagated by corms and cormels. Size of the corm markedly influences the growth and flowering of gladiolus. Medium and large sized corms are preferred for planting, as small corms produce only small flower spikes.

Planting

The land is ploughed two or three times and FYM @ 25 t/ha is applied and mixed well with the soil. Ridges are made 20 cm apart. Fertilizer application is made @ 50:60:60 kg N: P2O5:K2O per ha. The corms are planted at a distance of 30 cm and at 5 cm depth. Topdress the crop with 50 kg N, 45 days after planting, and earth up. Best season for planting is September-November.

Irrigation

The crop has to be irrigated once in two or three days depending upon soil and weather conditions.

Plant protection

Gladiolus is attacked by many insect pests. Several species of aphids like green peach aphid, potato aphid and melon aphid damage developing foliage and flowers. They can be controlled by using botanical insecticides like Neem. *Fusarium* wilts are the major diseases. Spraying the crop with 30 g copper oxychloride dissolved in 10 litres of water or drenching carbendazim 0.1% is recommended when diseases are noticed.
Harvesting and yield

The plant starts flowering in 2-3 months after planting based on the variety. The entire spikes along with two leaves are cut, when the basal flower bud starts opening. Nearly 2 lakh flower spikes can be obtained from one hectare.

After harvest of flowers, the plants are left undisturbed in the field. When they start yellowing, the plants are uprooted for harvest of corms and cormels.
4. Commercial Crops of Tripura

CASHEW (*Anacardium occidentale*)

Cashew is adapted to warm humid tropical conditions. It can be grown in almost all types of soils from sandy to laterite and up to an elevation of 600-700 m including wastelands of low fertility. It grows and yields best in well-drained red sandy loams and light coastal sands. Heavy clay soils, poor drainage conditions, very low temperature and frost are unsuitable for the crop.

**Planting materials**
Cashew can be propagated by seedlings, air layers and softwood grafts. Since it is a cross-pollinated crop, vegetative propagation is recommended to obtain true to type progeny. Field establishment of air layers have been found to be poor. Hence softwood grafts, which give a high rate of establishment and early flowering, are recommended for planting.

1. **Propagation by seedlings**

   **Selection of mother trees**
   Select mother trees having the following characteristics: (1) Good health, vigorous growth and intensive branching habit with panicles having high percentage of hermaphrodite flowers. (2) Trees of 15-25 years of age. (3) Bearing nuts of medium size and weight (5-8 g/nut) with an average yield of 15 kg nuts per annum. (4) Bearing 7-8 nuts per panicle.

   **Selection of nuts**
   Select mother trees in February and collect seed nuts in March-April. Select good, mature, medium sized nuts, which sink in water as seeds after drying in sun for two to three days.

   **Raising seedlings**
   Raise seedlings in polythene bags during May. Use polythene bags of size 20 cm x 15 cm and fill the bags with garden soil, leaving a gap of 1 to 1.5 cm above. Soak seed nuts in water for 18 to 24 hours to hasten germination. Sow the pre-soaked seed nuts in polythene bags filled with garden soil at a depth of 2-3 cm with the stalk end up. Seeds germinate in seven to ten days.
**Propagation by air layering**

Prepare air layers during February-March, so that they will be ready for planting in June-July. Select 9-12 month old pencil-thick terminal shoots. Remove carefully a strip or ring of bark, 0.6 to 1.2 cm thick by using a sharp knife without injuring the underlying wood. Wind a string around the cut area and cover it with moist moss or wood shavings or sand and saw dust mixture or ordinary potting mixture and wrap round with 150-200 gauge polythene film of size 23 x 15 cm. Secure loose ends of film with jute fibre. When roots emerge from the ringed portion in 40-60 days, give a 'V' cut at lower end of treated shoot. After about 15 days, deepen the cut slightly. Cut and separate shoot about 7 days later. Pot the layers along with the container in the prepared pits with the onset of southwest monsoon. Provide shade and mulch with dry leaves to reduce sun-scorch in tender plants. It is advisable to defoliate the layers two weeks before separation from the mother plant.

3. **Propagation by grafting / budding**

Different methods of grafting viz., epicotyl grafting, softwood grafting, veneer grafting, side grafting, patch budding etc. have been tried in cashew with varying degrees of success. Among them, softwood grafting was found to be the best for commercial multiplication of cashew.

**Softwood grafting**

Selection of seed nuts

1. Seed nuts may be collected during the peak period of harvest (February-March) and sun-dried for 2-3 days.
2. Quality seed nuts may be selected by immersing in water or 10% saline solution. Seeds, which sink in water, may be selected.
3. Medium sized nuts (7-9 g) may be selected to get vigorously growing seedlings.

**Raising rootstocks**

1. Fresh seed nuts are to be used for raising rootstock. Seed nuts stored for more than one year may be avoided.
2. The seed nuts should be soaked in water overnight before sowing.
3. Use polythene bags (size 25 cm x 15 cm, 300 gauge thicknesses) for filling potting mixture.
4. Punch about 16-20 holes on the polythene bags to ensure good drainage.
5. Prepare the potting mixture (1:1:1 ratio of red soil, river sand and compost) mixed with rock phosphate @ 5 g per 2 kg potting mixture.
6. Fill the polythene bags up to the brim of the bag.
7. Sow the pre-soaked nuts in the centre of the bag with stalk end up, at a depth of 2.0-2.5 cm.
8. Water the bags immediately after sowing and daily thereafter. Avoid excess irrigation.
9. Nuts usually germinate within 15-20 days after sowing during monsoon months and within 8-10 days during dry months.
10. Nuts should be sown at weekly intervals to get continuous supply of rootstocks.
11. During summer, provide partial shade to the seedlings till they change their bronze colour to green and then keep them in the open.
12. The seedlings will be ready for grafting in 50-60 days after germination.
13. Prevent damage to germinating nuts from squirrels, birds etc.
14. During the rainy season, damping off of young seedlings is common. To control this disease, spraying/drenching Bordeaux mixture (1%) is effective.

**Selection of rootstock**
Select 50-60 day old healthy seedlings having single main stem grown in the centre of the polythene bag, as rootstock.

**Selection of scions**

(1) Select a high yielding variety of cashew as a mother plant to collect adequate number of scions.
(2) Select 3-5 month old non-flowering lateral shoots of current season's growth.
(3) The selected scions should be 10-12 cm long, straight, uniformly round and pencil thick with brown colour having dormant plumpy terminal bud. The top 4-5 leaves should be dark green in colour indicating proper maturity of the scion.

**Pre-curing**

(1) Pre-cure the selected scions by clipping off three fourth portion of leaf blades.
(2) Scions will be ready for grafting in 7-10 days after leaf removal.

**Collection of scions**

(1) The pre-cured scions are to be cut early in the morning to avoid desiccation.
(2) The scions should be collected before the terminal buds sprout.
(3) Wrap scions in moist cloth and put in polythene covers as soon as they are cut from the mother tree and bring them to the nursery for grafting. If necessary, they can be stored for 3-4 days and used for grafting.

**Preparation of rootstock**

(1) Retain two pairs of bottom leaves and remove others from the selected seedlings using a sharp knife.
(2) Give a transverse cut on the main stem, 15 cm above ground level.
(3) A cleft of 4-5 cm deep is made in the middle of the decapitated stem of the seedling by giving a longitudinal cut.

**Preparation of scion**
(1) Select a matching scion stick (same thickness as that of the rootstock).
(2) The cut end of the scion is shaped to a wedge of 4-5 cm long by chopping the bark and wood from two opposite sides.

Grafting

1. The wedge of the scion is inserted into the cleft of the rootstock, taking care to ensure that the cambium layers of stock and scion are in perfect contact with each other.
2. The graft joint is secured firmly by a polythene tape (1.5 cm wide and 30 cm long).
3. The scion of the graft is to be covered with a wet polythene cap (15 x 12.5 cm, 100 gauge thicknesses) and tied at the bottom to maintain humidity inside and to protect the apical bud from drying. The polythene cap should not touch the terminal bud.
4. The grafted plants are to be kept under shade for 10-15 days to enable sprouting of the terminal buds.
5. The polythene caps are to be removed and the grafts shifted to open place. The successful grafts show signs of growth within 3-4 weeks after grafting.
6. The grafts will be ready for planting 5-6 months after grafting.

Care in the nursery

1. The grafts are to be watered regularly using a rose can or micro-sprinkler.
2. Remove new sprouts emerging from rootstock at frequent intervals.
3. Panicles, if produced by the grafts, may be removed as and when observed.
4. Shift the grafts frequently from one place to another to prevent them from striking roots into the ground.
5. Frequent spraying of insecticide is required for controlling the infestation of sucking insects.

Planting and management of grafts

The softwood grafts will be ready for planting in 5-6 months after grafting. The pits are filled with topsoil and 5-10 kg of compost or dried cowdung / pit and the grafts are planted after carefully removing the polythene bags. Care should be taken while planting to see that the graft union is 2.5 cm above the ground level. The polythene tape is to be carefully cut and removed subsequently. Staking should be done immediately after planting to protect the grafts from damage.

Planting and management of plantation

Plant seedlings, air layers or softwood grafts in pits of size 50 x 50 cm during June-July.

Planting may be done at a spacing of 7.5 m for poor and 10 m for rich and deep soils and sandy coastal area. On very sloppy lands, the rows may be spaced 10-15 m apart with spacing of 6-8 m between trees in a row.
Depending upon the weed growth, weeding operation may be done during August-September. Mulch the plant base with dry leaves to reduce sun-scorch to tender plants.

**Initial training / shape pruning**

The sprouts coming from the rootstock portion of the graft that is from the portion below the graft joint should be removed frequently during the first year of planting. Initial training and pruning of young cashew plants during the first 3-4 years is essential for providing proper shape. Thereafter, little or no pruning is necessary. The plants should be allowed to grow by maintaining a single stem up to 0.75-1.00 m from ground level. This can be achieved by removing the side shoots or side branches gradually as the plants start growing from the second year of planting. Weak and criss-cross branches can also be removed. Branches growing unwieldy may also be cut off. Proper staking of the plants is required to avoid lodging due to wind during the initial years of planting. Initial training and pruning of cashew plants facilitate easy cultural operations such as terrace making, weeding, fertilizer application, nut collection and plant protection. The flower panicles emerging from the grafts during the first and second year of planting should also be removed (deblossoming) in order to allow the plant to put up good vegetative growth. The plants are allowed to flower and fruit only from the third year onwards.

**General pruning**

In older cashew plantations, removal of dried or dead wood, criss-cross branches, water shoots etc. should be attended to at least once in 2-3 years. This allows proper growth of the canopy and receipt of adequate sunlight on all the branches. Pruning of cashew plants should be done during May / June.

**Manuring**

A fertilizer dose of 750 g N, 325 g P₂O₅ and 750 g K₂O per plant is recommended for cashew. Apply 1/5th dose after the completion of first year, 2/5th dose during second year and thus reaching full dose from 5th year onwards. Broadcast the fertilizer within an area of 0.5 to 3.0 m (15 cm deep) around the tree and incorporate by light raking.

**Intercropping**

Pineapple is the most profitable intercrop in cashew plantation in the early stages of growth. It can be planted between two rows of cashew in trenches opened across the slope. Paired row of pineapple suckers can be planted in each trench at 60 cm between rows and 40 cm between two suckers with in the row. These trenches can be opened at 1 m between two rows of cashew.
High density planting

High density planting is a recent technique recommended for enhancing the productivity of cashew plantations. This technique involves planting more number of grafts per unit area and thinning at later stages. Instead of the normal planting density of 64 to 177 plants per hectare (spacing ranging from 7.5 to 10 m in the square system of planting) or 74 to 204 plants (spacing ranging from 7.5 to 10 m in the triangular system of planting), 312 to 625 grafts will be planted per hectare, initially. During later years, as the canopy develops, plant population is to be regulated by selective felling to minimize competition.

While adopting a high density planting technique, grafts may be planted initially at a spacing of 4 x 4 or 8 x 4 m so that there will be 625 or 312 plants respectively. This population can be retained for a period of seven to nine or ten years depending upon the canopy expansion rate. If the soil is very rich the canopy development rate will be faster. High density planting would be more useful in poor soils where the rate of canopy expansion is slow. Considering the fertility status of the soil, the level of management in terms of fertilization, irrigation etc. the initial plant population is to be decided carefully for every agro-climatic condition. Later, after monitoring the canopy pressure between adjacent plants, the alternate plants are to be removed. Finally, when the plants attain full growth, the spacing between the plants will be 8 x 8 m.

If uniform management practices are adopted, during early years of yield, the per tree nut yield will be more or less the same with all the trees, in both the conventional system of planting and in high density planting. But the per hectare yield will be more from high-density plantations (due to higher plant populations) compared to the normal density plantations. During later years, when the plant population is equalized to that of normal density plantation, the productivity of both the plantations would be more or less the same. The bonus yield obtained during the early years of yield would be substantial in high-density plantations.

In addition to obtaining higher yields, substantial quantities of firewood can be obtained during thinning, which may fetch additional revenue to the farmer. The weed growth in the interspace can be effectively checked to a greater extent.

Top working

Top working is a technique evolved to rejuvenate unproductive and senile cashew trees. Top working can successfully rejuvenate poor yielder’s in the age group of 5-20 years. The unproductive trees are to be beheaded at a height of 0.75 to 1.00 m from ground level. The stem should be cut with a saw to avoid stump splitting. The best season for beheading trees is May-September. Soon after beheading, the stumps and cut portions should be given a swabbing with copper oxychloride. Sprouts emerge 30-45 days after beheading. Sprouting will be profuse in young trees. New, 20-25 days old shoots should be grafted with scions of high yielding varieties using softwood grafting technique. To ensure at least six or seven successful grafts, 10-15 grafting are to be done on the new
shoots of every tree. The best season for grafting is July-November. Thinning of the extra shoots arising from the stumps should be done to obtain better growth of the grafts. Removal of sprouts below the graft joint and removal of polythene strip from the graft joint should be done. Top working is simple and can be done by farmers after getting proper training.

The top worked trees start yielding right from the second year after top working. Thus precocity can be considered as one of the best advantages of this technique. The major disadvantage associated with top working is the huge casualty of trees due to stem borer attack. Intensive care and management to ward off stem borer is essential. As such, adoption of top working on a larger scale would be difficult.

**Pest and diseases**

*Tea mosquito bug*
This is the most serious pest affecting cashew. The pest usually appears with the emergence of new flushes and panicle. Drying of inflorescence and dieback of shoots are the symptoms. A rational rotation of insecticides would be desirable to counteract the tendency of the pest to develop field resistance. Spraying may be done once, twice or thrice depending upon necessity.

First spraying is to be given synchronizing with the emergence of new vegetative flushes in October-November. The second spraying may be given synchronizing with the commencement of panicle emergence in December-January. The third spraying may be given at completion of flowering / initiation of fruit set in January-February.

*Dieback or pink disease*
This disease is prevalent in cashew plantations during rainy season. Main symptom of attack is the appearance of white patches on branches followed by drying of twigs from the tip.

Control

Chisel out the affected parts and apply Bordeaux paste. Give prophylactic sprays of 1% Bordeaux mixture during May-June and October.

(5) Spray Bordeaux mixture 1% to seedlings as a prophylactic measure against fungal diseases.
Rural population grows and agricultural lands get scarcer, farmers face the challenge of increasing their productivity beyond subsistence to ensure the sustainability of their food security within extremely limited land spaces. The situation calls for profound improvement in the farmer’s agricultural knowledge system in food production by employing integrated soil fertility management, ecological pest management and applicability of various sustainable farming technologies. The above matters can be successfully addressed by employing “System of Rice Intensification” (SRI). Recent research demonstrations conducted by Department of Agriculture has revealed that “SRI significantly increases production of rice in different hilly regions of Tripura when compared with traditional or conventional method of cultivation”.

**Various Technical Details / Package of Practice of SRI under Shifting Agriculture**

**System of Tripura:**

**Planting System:**

- Dibble or plant 3-4 seeds per hill, at a spacing of 30 cm x 30 cm departing from the traditional system of 8-12 seeds per hill.
- Place only paddy seeds in the hills.
- Thinning and weeding operation has to be done after 10-15 days of sowing.
• Keep only one healthy seedling/plant having 2-3 leaves minimum

**Soil Fertilization:**

• Along with the thinning side dressing by applying FYM/Poultry Manure + Bio fertilizer @ 20 gm / hill (Azotobacter + Azospirillum + PSB) + *Pseudomonas fluorescence* @ 5 gm

**Mulching:**

• For suppression of weeds as well as for conserving moisture Mulching has to be followed up in the base area of hill or in between two rows.
• Gliricida Leaf/Neem leaf or any other green leaf having quick decomposing nature can be used for this purpose.

**Weeding:**

• 1st weeding after 10-15 Days of Sowing
• 2nd weeding after 30-40 Days of Sowing
• 3rd weeding after 60-70 Days of Sowing
  
    Following these Technical Guidelines additional yield of 240 kg (6 Mon) to 280 kg (7 Mon) / ha of rice can be easily obtained.

**Varieties to be selected for cultivation:**

• Traditional varieties grown and favored by Jhumia farmers can be selected for the SRI in Jhum but care should be taken against genetic degeneration of varieties.
SRI

THE SYSTEM OF RICE INTENSIFICATION

We recently learned about a method of raising rice that produces substantially higher yields with the planting of far fewer seedlings and the use of fewer inputs than either traditional methods (i.e., water) or more “modern” methods (chemical fertilizer or agrochemicals). It involves using different practices for plant, soil, water and nutrient management. This system of rice intensification has been successfully used in a number of countries.

What is SRI?

SRI involves the use of certain management practices which together provide better growing conditions for rice plants, particularly in the root zone, than those for plants grown under traditional practices. SRI was developed in Madagascar in the early 1980s by Father Henri de Laulanîe, a Jesuit priest who spent over 30 years in that country working with farmers. In 1990, Association Tefy Saina (ATS) was formed as a Malagasy NGO to promote SRI. Four years later, the Cornell International Institute for Food, Agriculture and Development (CIIFAD), began cooperating with Tefy Saina to introduce SRI around the Ranomafana National Park in eastern Madagascar, supported by the U.S. Agency for International Development. It has since been tested in China, India, Indonesia, the Philippines, Sri Lanka and Bangladesh with positive results.

The results with SRI methods are remarkable. In Madagascar, on some of the poorest soil to be found and where yields of 2 tons/hectare were the norm, farmers using SRI are now averaging over 8 tons/hectare, with some getting 10 to 15 tons/hectare. A few farmers have even gotten over 20 tons/hectare. In other parts of the country, over a five-year period, hundreds of farmers averaged 8 to 9 tons/hectare.

SRI methods have at least doubled the yields of any variety of rice that has been tried. No external inputs are necessary for a farmer to benefit from SRI. The methods should work with any seeds that are now being used. However, you do need to have an open mind about new methods and a willingness to experiment. With SRI, plants are treated as the living organisms that they are,
rather than as machines to be manipulated. The potential within plants is drawn out by giving them the best possible conditions for their growth.

At first, the practices that constitute SRI seem somewhat counterintuitive. SRI challenges assumptions and practices that have been in place for hundreds, even thousands of years. Most rice farmers plant fairly mature seedlings (20-30 days old), in clumps, fairly close together, with standing water maintained on the field for as much of the season as possible. Why? These practices seem to reduce the risk of crop failure. It seems logical that more mature plants should survive better; that planting in clumps will ensure that some plants will survive transplanting; that planting more seedlings should result in more yield; and that planting in standing water means the plants will never lack water and weeds will have little opportunity to grow.

Despite this reasoning, farmers have not found that using SRI practices puts their crops at any more risk than do traditional methods. Four “novel” practices in particular are key in SRI.

1. **Seedlings are transplanted early.** Rice seedlings are transplanted when only the first two leaves have emerged from the initial tiller or stalk, usually when they are between 8 and 15 days old. Seedlings should be grown in a nursery in which the soil is kept moist but not flooded. When transplanting seedlings, carefully remove them from the nursery bed with a trowel, and keep them moist. Do not let them dry out. The seed sac (the remains of the germinated seed) should be kept attached to the infant root, because it is an important energy source for the young seedling. Seedlings should be transplanted as soon as possible after being removed from the nursery—within half an hour and preferably within 15 minutes. When placing seedlings in the field, carefully lay the roots sideways in the soil with a horizontal motion, so that the root tip is not inadvertently left pointing upward (this happens when seedlings are plunged straight downward into the soil). The root tip needs to be able to grow downward. Careful transplanting of seedlings when they are very young reduces shock and increases the plants’ ability to produce numerous tillers and roots during their vegetative growth stage. Grains of rice are eventually produced on the panicles (i.e. the “ears” of grain above the stalk, produced by fertile tillers). More tillers result in more panicles, and with SRI methods, more grains are produced on each panicle.

2. **Seed Rate and Choice of Varieties:** - The rate of seed usually is 5kg per ha. In case of the finer grains the rate may be further lowered down depending upon the grain type.

   All the paddy varieties i.e. traditional, HYV, Hybrids can be adopted with SRI. At least 50% yield advantage over tradition method is observed in all the varieties in the farmer’s field.
Nursery Management:

Rice seed is sparsely sown in beds prepared by mixing soil, Cow dung / FYM, rice hull / burned husk mixture forming 1.5 to 2cm thick layer at the top of the nursery bed. The rate of seeding should not exceed 20 gm per sqm. Immediately after sowing of the sprouted seeds the seed beds should be covered by the thin layer of the soil mixture prepared by mixing soil, Cow dung and rice hull / burned husk. Nursery beds should be covered by paddy straw at least for 2 days to keep the moist condition of the beds as well as to save the seeds from birds’ ands direct heat of rain drops due to sudden rainfall which needs removal from the bed after emergence of the seedling. Maintaining straw cover more than two - three days may invite disease infestation. Usually the seedlings get ready for transplanting within 8-10 days after sowing.

2. Seedlings are planted singly rather than in clumps. Seedlings are transplanted singly rather than in clumps of two or three or more. This means that individual plants have room to spread and to send down roots. They do not compete as much with other rice plants for space, for light, or for nutrients in the soil. Root systems become altogether different when plants are set out singly, and when the next practice is followed.
3. **Wide spacing.** Rather than in tight rows, seedlings are planted in a square pattern with plenty of space between them in all directions. Usually they are spaced at least 25 cm x 25 cm. Feel free to experiment with the spacing, because the optimum spacing (producing the highest number of fertile tillers per square meter) depends on soil structure, soil nutrients, temperature, moisture and other conditions. The general rule is that plants should have plenty of room to grow. If you also use the other practices mentioned here, seldom will the best spacing be closer than 20 cm x 20 cm. The maximum yields have been obtained on good soil with 50 x 50 cm spacing, just four plants per square meter.  

To space the plants carefully (which makes weeding easier), you can place sticks at appropriate intervals (e.g. every 25 cm) along the edge of the field, then stretch strings between them. The strings should be marked at the same intervals so that you can plant in a square pattern. Leaving wide spaces between each plant ensures that roots have adequate room to grow, and the plants will be exposed to more sunlight, air and nutrients. The result is more root growth (and thus better nutrient uptake) and more tillering. The square pattern also facilitates weeding. Operations of mechanical weeder become easier which saves the labour requirement of weeding operation.  

When farmers are more experienced, they can save time by just marking cross-hatched lines on the field surface with rakes or other devices. Notice that SRI uses a much lower seeding rate than do traditional methods; on evaluation of SRI revealed that the rate of seed application was only 5 kg/ha, compared to the traditional seeding rate of 50-100 kg/ha! Yet yields were doubled because each plant produced so much more grain.

4. **Moist but un-flooded soil conditions.** Rice has traditionally been grown submerged in water. Clearly rice is able to tolerate standing water. However, standing water creates hypoxic soil conditions (lacking in oxygen) for the roots and hardly seems to be ideal! Rice roots have been shown to degenerate under flooded conditions, losing ¾ of their roots by the time the plants reach the flowering stage. This die-back of roots under flooded conditions has been called “senescence,” implying that it is a natural process. But it actually represents suffocation, which impedes plant functioning and growth.  

With SRI, farmers use less than half of the water they would use if they kept their paddies constantly flooded. Soil is kept moist but not saturated during the vegetative growth period,
ensuring that more oxygen is available in the soil for the roots. Occasionally (perhaps once a week) the soil should be allowed to dry to the point of cracking. This will allow oxygen to enter the soil and will also induce the roots to grow and “search” for water. After all, when the soil is flooded, roots have no need to grow and spread, and they lack enough oxygen to grow vigorously.

Un-flooded conditions, combined with mechanical weeding, result in more air in the soil, and greater root growth means that the rest of the plant will have access to more nutrients. When soil is saturated, air pockets (known as aerenchyma) form in the roots of submerged plants in order to transport oxygen. These air pockets take up to 30-40% of the roots' cortex and probably impede the transport of nutrients from the roots to the rest of the plant. More water may be applied before weeding to make the process of weeding easier. Otherwise, water is best applied in the evening (if there has been no rain during the day), and any water remaining on the surface is drained in the morning. This leaves the field open to both air and warmth during the day; flooded fields will reflect a good part of the solar radiation reaching them, and absorb less of the warmth which helps plants grow. With SRI, un-flooded conditions are only maintained during the period of vegetative growth. Later, after flowering, 1-3 centimeters of water can be kept standing, if required, on the field considering possibility of acute moisture stress at grain filling stage as is done with traditional practices. The field is drained completely 25 days before harvesting.

In addition to these four principal practices, two other practices are extremely beneficial when using SRI. These practices are not controversial and have long been recognized as valuable for rice crops.

5. **Weeding.** This can be done by hand or with a simple mechanical tool. Farmers in Madagascar find it advantageous, both in terms of reducing labor and of increasing yield, to use a mechanical hand weeder developed by the International Rice Research Institute in the 1960s. It has vertical rotating toothed wheels that churn up the soil as the weeder is pushed down and across the alleys formed by the square formation of planting. Weeding is labor-intensive—it may take up to 25 days of labor to weed one hectare—but the increase in yield means that the work will more than pay for itself.

The first weeding should be done ten to twelve days after transplanting, and the second weeding within 12 - 14 days after completion of first weeding. Similarly third weeding is also done, if required, 12 - 14 days after completion of second weeding. At least two or three weedings are
recommended, but another one or two can significantly increase the yield, adding one to two tons per hectare. Probably more important than removing weeds, this practice of churning the soil seems to improve soil structure and increase aeration of the soil.

**Nutrient Management Schedule:**

Rice can be cultivated with or without chemical fertilizer. But our field trials and demonstrative experiments in the farmers field shows that SRI performs better under organic source of fertilizer. Experiencing this result we recommend to get best result by application of organic fertilizer i.e., FYM, Bio-fertilizers, green manure, Leaf manure etc. But the availability of organic fertilizer may be the problem for farmers in some parts of the world. Considering this problem we have recommended the nutrient management schedule blending Chemical and organic fertilizers. Generally we may recommend 25 percent of the chemical fertilizer (N: P: K / Ha) of particular location / area with 15-20 Kgs of Bio-Fertilizer (Microbial fertilizer – N-fixing, PSB etc) per hectare as basal (soil) application. Nutrient schedule for Tripura Condition has given below which may need to be standardized in the every location considering their soil fertility status.

- **N: P: K: 20: 10: 10 Kg/ Hectare** as basal during Kharif
- **N: P: K: 25: 12.5: 12.5 Kg/ Hectare** as basal during Rabi

**Bio-fertilizer:**
- **Azosprillium @ 4 Kg/ ha**
- **Azotobactor @ 4 Kg/ ha**
- **Phosphate Solubilizing Bacteria @ 4 Kg/ ha**
- **FYM: Cow dung / FYM / Neem oil cake / Compost etc @ 10-15 Mt / Ha**

**Organic inputs.** SRI was developed initially with chemical fertilizers to increase yield on the very poor soils of Madagascar. But when subsidies were removed in the later 1980s, recommendations switched to use of compost, and even better results were observed. The compost can be made from any biomass (e.g. rice straw, plant trimmings and other plant material), with some animal manure added if available. Banana leaves can add more potassium, cuttings from leguminous shrubs add more nitrogen, and other plants such as *Tithonia* and *Afromomum angustifolium*, may be high in phosphorous. Compost adds nutrients to the soil slowly and can also contribute to a better soil structure. It seems fairly intuitive that some form of nutrient input is necessary on poor
soils if chemical fertilizer is not added. With huge yields of rice being harvested, something needs to be returned to the soil!

**SEED BED PREPARATION**

- SOIL+COW DUNG+RICE HULL / BURNED HUSK MIXTURE
  - 1.5 to 2 Cm THICK LAYER AT TOP OF THE RAISED NURSERY BED

- SOIL 75%
- COW DUNG / FYM 20%
- RICE HULL / HUSK(BURNED) 5%

**RAISED NURSERY BED**
RAISED NURSERY BED

AFTER SOWING OF SPROUTED SEEDS SEED BED SHALL BE COVERED BY THIN LAYER OF SOIL MIXTURE
Different types of Nursery Bed

NURSERY BED SHALL BE COVERED BY PADDY STRAW FOR 2 DAYS ONLY
INDIGENOUS TECHNOLOGY KNOWLEDGE (ITK)

ITK TO SAVE NURSERY FROM BIRDS
Pine apple leaves
CROSS SECTION OF NURSERY BED

SOIL AND TOP LAYER OF MIXTURE OF SOIL + COW DUNG + RICE HULL
(5.0 to 6.0 Cm thick Layer)
TRANSPLANTING

Main Field Preparation
Innovative method-I
Kanchan Prabha Riyang
Dhalai dist

Careful transportation of seedling to the main field to avoid shock as well as to transplant within 30 minutes

Innovative Method-II
Bidyut Das, BA, Rajnagar

Uprooting of young seedling without any trauma and transplanting in the main field within 30 minutes
Uprooting of young seedling without any trauma and transplanting in the main field within 30 minutes

Innovative Method-III

Tribal woman SRI cultivator: Durga Rani Tripura, Mohini Nagar, Belonia
Depth of transplanting significantly reduces the tiller numbers and yield.
Root Development & Health

12 days after irrigation / watering

Bubbles in the upper surface of the soil - At mycelial activity and population - Aerobic Condition
Drainage channel of 25 cm width and 25 cm depth

60 DAT
65 tillers
Per hill / plant
MTU 7019
WEED MANAGEMENT

Rotary Weeder

Weeding Schedule:
3 weeding at the interval of 10 -12 days
1st weeding shall be 10-12 DAT
NUTRIENT MANAGEMENT

YIELD

Educated young SRI Farmer: Prabir Baidya, B.A,
Rangamura, South Tripura

Nos. of grains and Filled grains more in SRI
Heavy tillered single plant of Swarna
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