

ACHARYA N.G.RANGA AGRICULTURAL UNIVERISTY

**SOUTHERN ZONE
PRODUCTION
RECOMMENDATIONS
FOR
KHARIF & RABI 2016-17**

REGIONAL AGRICULTURAL RESEARCH STATION

TIRUPATI - 517502

**PACKAGE OF PRACTICES FOR DIFFERENT CROPS FOR KHARIF
& RABI 2016-17**

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**PRODUCTION RECOMMENDATIONS OF MAJOR CROPS
FOR KHARIF & RABI 2016-17**

I. RICE

Varieties Recommended for *Kharif*

Situation	Varieties for Southern Zone
Early Kharif Plantings	Bharani (NLR 30491), Somasila (NLR 33358), Swetha (NLR 40024), MTU 1010
Kharif Normal Plantings	Simhapuri, Pinakini, Sriranga, NLR 9674, Pardhiva, NLR 3041(Nellore Sona)
Kharif Aged Nursery (Aged seedlings)	Simhapuri, Sriranga
Low land submerged areas	Badava Mahsuri, Savitri
Saline soils	Swarnamukhi, Somasila, Deepti, Nellore mahsuri
Late kharif plantings	Swarnamukhi
Rainfed areas	Sri satya, Varalu, JGL 17004 (Prathyumna)
Irrigated dry situation	Simhapuri
BPH prone areas	Deepti, Vijetha, Cottondora sannalu

Varieties Recommended for *Rabi*

Situation	Varieties for Southern Zone
Rabi Normal Plantings	Swarnamukhi, Cottondora sannalu (MTU 1010), Vijetha (MTU 1001), Nellore Mahsuri (NLR 34449), NDLR 8 (Nandyal sannalu), NLR 3041 (Nellore Sona)
Saline soils	Somasila (NLR 33358), Nellore Mahsuri (NLR 34449)
Late Rabi plantings	Satya, Somasila
BPH prone areas	Cottondora Sannalu (MTU 1010), Vijetha (MTU 1001)

Brief Description of Varieties

Southern Zone

Variety	Duration (days)	Yield (T/ac)	Pest/ Disease Resistance	Special Features
Bharani	125	2.5	Tungro Virus	Fine grain
Somasila	105-110	2.5	Blast	Super fine grain
Simhapuri	160-170	3.0	Blast	-
Pinakini	160	2.5	Blast (T)	-
Savitri	150	2.5	-	Bold grain
Sri Ranga	170	2.5	Blast	Fine grain
NLR 9674	165-170	2.5	Blast (T)	-
Pardhiva	155	2.2	Blast	Fine grain
Swarnamukhi	135	3.2	Stemborer, Blast, Gallmidge	Super fine grain
MTU 4870	150	2.5	BPH, BLB (T)	Non lodging, fine grain
MTU 1001	140	2.5	BPH, Blast	Fine grain
Varalu	90-95	1.6	Gallmidge 1, 3, 5	Superfine grain
Sri satya	110	2.0	Gallmidge	Coarse grain, suitable for rainfed situation

Variety	Duration (days)	Yield (T/ac)	Pest/ Disease Resistance	Special Features
MTU 1010	125	3.0	BPH, Blast (T)	Super fine grain
Nellore Mahsuri	125	3.0	Blast	Fine grain
Nandyal Sannalu	125	2.5	Tolerance to Blast	Fine grain
JGL 17004 (Prathyumna)	100	2.25	Blast	Fine grain and suitable for contingency situations

Sowing Nurseries and Seed Rate

- Early Kharif – April first fortnight
- Sowing up to August 15th during Kharif and from November first fortnight in Rabi
- For Nursery transplanting 20-25 Kg, for dry seed nurseries 25-30 Kg, For Direct seeding 10-12 Kg, for Direct Seeding with Gorru 16 Kg.

Nursery Management (Wet)

- Select an area of nursery, which has good irrigation and drainage facility.
- Prepare the nursery field one month before sowing
- Prepare nursery field by ploughing twice in the summer subsequently by puddling 3-4 times at an interval of 5-6 days.
- Level the field after final puddling and prepare raised beds of one-meter width and of convenient length duly forming channels for irrigation and proper drainage.
- Apply Well-decomposed FYM/ compost @ 200 kg/ 5cents nursery to improve soil condition.
- Soak the paddy seed for 16-24 hours and incubate for 24-36 hours before sowing of sprouted seed.
- Apply 2 kg Nitrogen (4.4 kg of Urea), 1 kg of 'P₂O₅' (6.25 kg of SSP) and 1kg of 'K₂O' (1.6 kg of MOP) for a nursery bed of 5 cents (200 m²).
- Apply total 'P' & 'K' fertilizers and ½ 'N' as basal (before final leveling and thoroughly mixed in the soil).
- Apply the remaining ½ 'N' at 10-15 days after sowing depending up on seedling growth.
- Sow the sprouted seed @ 5 kg/cent (40 m²) of nursery bed and 20 kg seed is sufficient for one acre of main field.
- Broadcast sprouted seed uniformly in seedbeds by keeping thin film of water and drain the water next day morning for proper aeration.
- Maintain alternate wet and dry during first week, after that beds can be flooded 2-3 cm depth depending up on height of seedlings.
- Apply @ 75 ml Benthicarb or Pretilachlor with safener @ 40 ml or Butachlor @ 50 ml or Pyrazosulfuron ethyl @ 5 g in 10 litres of water as pre emergence application for five cents nursery to overcome weed problem
- Apply *Cyhalo fop P butyl* @ 20 ml/ 10 litres of water at 12-15 DAS to control *Echinochloa spp.* effectively.
- At the time of uprooting, the nursery should be flooded two days before to avoid root damage

Main Field

- Plough the soil once or twice in midsummer prior to main field preparation; it will help in checking the weed growth by exposing the root system of weeds. It also exposes egg masses and hibernated stages of different pests and disease to the hot Sun and helps soil to retain moisture received during summer.
- Under canal irrigation green manuring is very much suggested
- Initiate puddling at least 15 days before transplanting
- Tractor / power tiller puddling to a depth of 15 cm is enough.
- Level the field perfectly after final puddling and allow it to settle for 2-3 days before transplanting in heavy soils which helps in better water and weed control.
- Transplant 30 days old rice seedlings during Kharif and 20-25 days old seedlings for Rabi.
- Avoid usage of over aged seedlings for transplanting in rice as use of 60 or more days for long duration while more than 40 days for medium duration and more than 30 days for short duration varieties reduce the yield drastically.
- Transplant 33 hills/m² during Kharif and 44 hills/m² during Rabi at 2-3 cm depth @ 2-3 seedlings /hill
- In less fertile soils and in the case of over aged seedlings, transplant 44 hills / m² to reduce the yield loss to some extent.
- Make 20 cm alleyways at every 2 meters apart to facilitate free aeration and for uniform application of fertilizers, Weedicides and pest management practices.

Water Management

- Proper water management facilitates good tillering, increased nutrient use and reduce weed infestation.
- Maintain shallow depth of water (1-2 cm) at the time of transplanting.
- Increase the water level up to 5 cm depth after transplanting till crop establishment
- Maintain shallow depth of water (2-3 cm) during tillering phase of crop.
- Maintain 5 cm of water during panicle initiation to physiological maturity (10 Days before harvest) of the crop.
- Crop should not face water stress at panicle initiation, flowering and milk stages.

Nutrient Management

Recommended Fertilizers for Different Agro-Climatic Zones of A.P

Zone	Kharif (kg/acre)			Rabi (kg/acre)		
	N	P	K	N	P	K
Southern Zone	32	24	16	48	24	16

- Soil fertility and productivity of rice can be improved and maintained through integrated use of organic, inorganic and bio fertilizers in a balanced manner.
- 25-50% of recommended N through Green manures/compost /FYM/ poultry manures results sustainable yields.
- Green manuring insitu with Sesbania / Crotalaria / Pillipesara or grain legume crop residues like black gram/ green gram can sustain the soil fertility and productivity.
- Bio fertilizers like blue green algae, Azolla, Azospirillum Phosphobacteria can save about 10 – 20 % 'N' & 'P' requirement of rice crop.
- Apply N, P₂O₅ and K₂O @ 80: 60: 40 kg /ha during *kharif* and @ 120: 60:40 kg /ha during *rabi*. Apply entire 'P₂O₅' & 'K₂O' as basal while 'N' in three equal splits (Basal + Active tillering + Panicle initiation stage). In light textured soils apply 'K₂O'

in two splits half at basal and half at panicle initiation along with 2nd top dressing of 'N'.

- Drain out the field before N topdressing and irrigate the field after 2 days only.
- Avoid top dressing of Phosphorus or Phosphorus containing complex fertilizers after 15 days of planting.
- Apply Zinc Sulphate @ 50 Kg / ha to avoid the Zn deficiency. Deficiency in the standing crop can be corrected by spraying zinc sulphate @ 0.2% (2 g /L of water). The spraying should be repeated at 5 days interval depending on the severity of the problem.
- If Iron deficiency noticed Spray of ferrous sulphate @ 20-25 g and citric acid @ 2-2.5 g/L is suggested. 2-3 sprays at 5-day interval are needed.

Weed Management

- The crop should be maintained weed free especially till 45 DAT.
- Hand weeding at 20 and 40 days after transplanting in areas where sufficient manual labour is available
- To overcome weed problem apply any one of the following herbicides keeping thin film of water. Butachlor @ 1.25 litres /acre (or) Anilophos @ 500 ml/acre (or) Pretilachlor @ 600 ml /acre (or) Oxadiargyl @ 40 grams (mixed with one litre of water) within 3 to 5 days of transplanting or spray Pyrazosulfuran ethyl @ 80-100 g/ acre at 8-12 DAT or Bensulfuron methyl @ 35 g /acre as pre to post emergence (3-25 DAT). 2,4- D SS @400 g / acre at 20-25 DAT to control broadleaved weeds .

Insect Pests and Diseases

Cultural Practices Recommended for Reducing the Build up of Insect Pests

- Summer ploughing
- Grow suitable resistant varieties
- Use recommended doses of fertilizers
- Clipping of the leaf tips of seedlings while planting
- Adopt normal spacing
- Formation of alleyways.
- Alternate wetting and drying
- Weed management

Economic Threshold Levels of Insect Pests

S. No.	Insect Pest	Stage of the Crop	Economic threshold level
1	Stem borer	Nursery and Tillering	One adult or one egg mass per one sqm or 5% of dead hearts per sqm.
2	Gall midge	Nursery and Tillering	One silver shoot per hill or 5% galls per sqm.
3	BPH/WBPH	Tillering	10-15 insects per hill
		After Flowering	20-25 insects per hill
4	Leaf folder	All stages	One to two damaged leaves per hill
5	Hispa	Tillering stage	Two adults per hill or two damaged leaves per hill
6	Green leaf hopper	Nursery	One or two insects per sqm
		Tillering	10 insects per hill
		Flowering	20 insects per hill
7	Gundhi bug	Flowering	One to two adults per hill

Chemical Control

Tillering Stage

Stemborer, Thrips and Hispa

Spray monocrotophos @ 36 SL 1.6 ml or chlorpyriphos 20 EC @ 2.5 ml or phosphamidon 40 SL @ 2.0 ml/litre of water.

Gallmidge

- Apply phorate 10G @ 12.5 kg/ha or carbofuran 3 G @ 25 kg/ha at 15 DAT in 1– 2 inches of standing water.

Leaf folder

- Spray profenophos @ 2.0 ml or chlorpyriphos @ 2.5 ml or monocrotophos 36 SL @ 1.6 ml/litre of water.

Hispa

- Spray profenophos @ 2.0 ml or chlorpyriphos @ 2.5 ml or monocrotophos @1.6 ml/litre of water

Leaf mite

- Dicofol @ 5.0 ml or wettable sulphur @ 3 g /l of water.

Panicle Initiation to Booting Stage

BPH/WBPH

- Spray acephate @ 1.5 g or monocrotophos @ 2.2 ml or ethofenprox @ 2.0 ml or thiamethoxam @ 0.2 g or Buprofezin 1.6ml or Pymetrozine 0.6 g or Imidacloprid + Ethiprole 0.25 g or Dinotefuron 0.4 g per litre of water.
- Spray fluid (200 litres/acre) should be directed towards the base of the plant.
- Avoid spraying of combination of insecticides and synthetic pyrethroids.
- If second spray is warranted alternate the previous chemical preferably belonging to another group.

Stemborer

- Cartaphydrochloride 50 WP 2.0 g or acephate 1.5 g or or Chlorantriliprole 0.4 ml/litre of water (or) apply cartaphydrochloride 4G @ 8 kg/at panicle initiation stage.

Leaf folder

- Spray cartaphydrochloride 2.0 g or acephate 1.5 g or profenophos 2.0 ml /litre of water.

Panicle mite

- Spray profenophos 2.0 ml or dicofol 5.0 ml/litre of water

Post Flowering

BPH/WBPH

- The insecticides as recommended at boot stage should be used.

Cutworm

Irrigate the field and spray in the evening hours with any of the following combinations of dichlorovos 1.0 ml + chlorpyriphos 2.5 ml/litre of water.

Rice Diseases

Disease	Time of application	Fungicide	Dose	No. of applications & time interval
Sheath blight	At the initiation of the disease. Normally around 45 days after transplanting in <i>kharif</i> and 30 days after transplanting in <i>rabi</i>	Hexaconazole 5EC Validamycin 3L Propiconazole 25 EC	@ 2ml/l @2ml/l @ 1ml/l	2 sprays at 15-day interval
Blast a) Leaf blast	At the initiation of the disease under favourable weather conditions	Tricyclazole / Isoprothiolane	75 WP @ 0.6g/ml 40 EC @1.5 ml/l	2 to 3 sprays depending on the severity & spread of the disease at 15 days interval
b) Neck blast	i) Under disease favourable weather conditions just before panicle emergence stage	Tricyclazole / Isoprothiolane	75 WP @ 0.6g/ml 40 EC @1.5 ml/l	One spray
ii) On appearance of the disease	Tricyclazole 75WP/ Isoprothiolane 40 EC	@ 0.6g/ml @1.5 ml/l	One spray	
BLB	No chemical available. Management is mainly through rationalization of nitrogenous fertilizer application	---	---	---
Stem rot	At the appearance of the disease (Normally from maximum tillering to crop maturity stage)	Trifloxystrobin + Tebuconazole Hexaconazole 5EC / Propiconazole 25 EC /Carbendazim 50 WP/Benomyl 50 WP	@ 0.4 g/l @2ml @1ml/l @ 1g/l @1 g/l	2 to 4 sprays at 10-15 days interval depending how much early the disease has been noticed
Red stripe	At the appearance of the disease from advanced boot leaf to crop maturity stage	Carbendazim 50 WP	@ 1g/l	One spray
Sheath rot	At the appearance of the disease or at panicle emergence stage	Carbendazim 50WP	@ 1g/l	One spray
False smut	At flowering stage	Propiconazole 25 EC/ Carbendazim 50WP	1.0ml/l 1.0g/l	One spray during evening hours

Rodent Control

For Endemic Areas

- Destruction of rodent harborage and observe rat moment.
- Reducing the number and size of field bunds
- Complete the sowing and planting uniformly in one area.
- From puddling to one month after planting, setup local traps @ 20 /acre.

- Installation of permanent bait stations from planting to flowering stage @ 5 /ha Four at corners of the field one meter inside the cropped area from the field bund and one at the centre, Bromadiolone bait @ 30 g per bait station should be replenished twice in a week.
- During crop period baiting with bromadiolone 0.005% in baits prior to primordial initiation stage of the crop.
- From primordial initiation to crop harvest smoking of burrows with “burrow fumigator“developed by APRRI & RARS, Maruteru.

Management of Rodents with Bromadiolone 0.005%

- Identify live burrows and simultaneously place 15 gm freshly prepared bromadiolone (2% poison) loose bait in packets inside the burrow when LBC is 50/ha.
- Repeat bromadiolone (2% poison) loose baiting in the active /live burrows as and when the incidence is above ETL.

Note: Control schedules should be executed on community basis to check cross infestation through migration.

Harvesting and Storage

- Harvesting should be done when at least 80 % of the grains are matured. If the crop is harvested without proper maturity it leads to loss of viability of grains and broken in milling.
- The harvested material should be dried in the field for 2-3 days.
- The grain should be free from inert material after threshing and winnowing.
- The winnowed grains should be sun dried until the moisture content reaches < 13%.
- Both over drying and under drying will lead to breakage of the grain during processing.

High moisture content during storage leads to loss of viability due to increased grain respiration and attack of storage insects and pests.

II. GROUNDNUT

1. INTRODUCTION:

Groundnut is the most important edible oilseed crop of Andhra Pradesh in terms of acreage and economy. During 2014-15, the crop was cultivated in 8.74 lakh hectares with a production of 5.64_lakh tones. The productivity in Andhra Pradesh during 2014-15 was 493 kg/ha.

The Groundnut will continue to remain a very important vegetable oil; however, its prime place among the crops for vegetable oil may not remain assured in future, given the competition from other conventional and non-conventional sources of oil. But a very good opportunity remains to tap the potential for using Groundnut for food, nutrition, feed, fodder and export.

2. VARIETAL RECOMMENDATION:

Condition	Suitable Varieties	Duration (Days)	
		<i>Kharif</i>	<i>Rabi</i>
a) For Scarce Rainfall areas	Kadiri-9, Kadiri Harithandhra, Anantha, Kadiri-6, Narayani, Dharani & ICGV-91114,	105- 110	110-120
b) For excess rainfall conditions	Kadiri-7Bold & Kadiri-8Bold,	125 – 130	125-140
	Abhaya, Kadiri-9 and Dharani	105 – 110	115-120
c) For assured rainfall areas with supplementary irrigations	Kadiri-7 Bold, Kadiri-8Bold , Abhaya kadiri-6 Kadiri-9, Kadiri Harithandra, Greeshma, Abhaya, Narayani, Rohini, ICGV-91114, Dharani, Kadiri Anantha	125 – 130	125-140
		105 – 110	115-120
d) Varieties having tolerance to leaf spot	Kadiri-9, KadiriHarithandra ,Greeshma, Kadiri Anantha, Abhaya, Dharani	105 – 110	115-120
e) Nematode infected Areas	Kalahasti , Prasuna, Kadiri-9	100 - 105	110-115
f) For delayed Monsoons	Kadiri-9, Kadiri Ananthav&vKadiri Harithandra	90-100 105-110	100-110
g) Varieties having drought tolerance	Kadiri-9, Anantha, Abhaya, ICGV-91114, Dharani	105 – 110	115-120
h) For rice fallow conditions	Kadiri-6, Greeshma, Kadiri Harithandra, TAG-24, Rohini, Dharani	100 – 105	100-110
i) Coastal sands	Kadiri-6, Greeshma, TAG-24 & Narayani, Dharani, Rohini, Greeshma	95-100	100-110

3. LAND PREPARATION:

- ❖ Prepare the land till fine tilth is attained.
- ❖ It facilitates root growth, peg penetration and pod development.
- ❖ Weeds and clods are to be avoided.

4. SEED RATE: Depends on variety and season

Varieties	Seasons	
	<i>Kharif</i>	<i>Rabi</i>
Narayani, Kadiri-6	150kg. Kernel/ha	180kg Kernel/ha
Kadiri-7Bold, Kadiri-8Bold, Abhaya , Kadiri-9, ICGV 91114, Kadiri Harithandra, Greeshma and Kadiri Anantha, Dharani	125 kg. Kernel/ha	150kg. Kernel/ha

- With traditional sowing 2 ha of area can be covered in a day while, with tractor drawn seed drill an area of 5-6 ha can be covered.
- 25 Kg of seed per hectare can be saved due to tractor drawn seed planters compared to traditional method behind the plough or bullock drawn gorru sowing.
- Hence, sowing with tractor drawn seed drill will reduce the seed and sowing cost .

5. SPACING:

Varieties	Seasons	
	Kharif	Rabi
Spanish Bunch Varieties Kadiri-6, Narayani, ICGV-91114, Kadiri Harithandra, Greeshma, Kadiri-9, Rohini and Kadiri Ananta, Dharani	30 x 10 cm	22.5 x 10cm
Virginia Bunch Varieties Kadiri-7Bold, Kadiri-8Bold	30 x 15 cm	22.5 x 15 cm

6. SEED TREATMENT:

- ❖ Seed should be treated with Imidachloprid @ 2 ml / kg seed followed by Tebuconazole 2DS @ 1g or Mancozeb @ 3 g / kg seed.
- ❖ If the seed is dormant, soak it in 0.05 % Ethrel solution for 12 hours followed by shade drying or mix 1.25 ml. Ethophon in 5 lt. water and spray on 100kg. seed 12 hours before sowing in air tight bag.
- ❖ *Trichoderma viride* seed treatment @ 4 g/kg seed for rot prone areas
- ❖ *Rhizobium* inoculation is necessary for groundnut in non-traditional areas and rice fallows.

7. SOWING TIME:

Area	Kharif	Rabi
North coastal Andhra	First fortnight of June to last week of June	First FN of November to first FN of December
Rayalaseema	First fortnight of July to 1 st FN of August	First FN of November to first FN of December

8. FERTILIZER RECOMMENDATIONS:

- ❖ Application of farm yard manure/ compost @ 10 tonnes /ha once in 2 – 3 seasons
- ❖ NPK recommendations should be on soil test basis
- ❖ Apply 20N + 40 P₂O₅ + 50 K₂O kg/ha as basal for kharif crop. Phosphorus should be applied through single super phosphate.
- ❖ For rabi apply 20N + 40 P₂O₅ + 50 K₂O kg/ha as basal and 10N kg/ha at flowering
- ❖ Apply Gypsum @ 500 kg /ha at flowering stage by placement.
- ❖ Wherever Zinc deficiency is observed, apply Zinc sulphate 50 kg/ha. once in 3 seasons.
- ❖ Wherever Iron deficiency is noticed on crop, spray 0.5 % ferrous sulphate along with 0.1 % citric acid two times with one week interval.
- ❖ Seed treatment with *Rhizobium* and soil application of Phosphorous Solubilising Bacteria will reduce the chemical fertilizers requirement.
- ❖ Apply 50 kg Zinc Sulphate, 10 kg Borax & 10 kg Ferrous sulphate per hectare as basal to avoid deficiency.

9. WEED MANAGEMENT:

- ❖ Crop must be weed free up to 45 days after sowing.
- ❖ Intercultivation at 20 and 40 DAS followed by one hand weeding.
- ❖ The crop should not be disturbed by weeding or intercultivation after 45 DAS.
- ❖ Preplanting application of Fluchloralin @ 2.5 to 3 l. / ha.

- ❖ Pre-emergence application of Butachlor /Metalachlore/ Pendimethalin @ 2.5 to 3 l./ ha. or Oxyflourfen @ 1.5 to 2.0 l./ha followed by one intercultivation and one hand weeding will effectively control the weeds.
- ❖ Wherever, pre-emergence herbicides could not apply, weeds can be controlled by post-emergence herbicides by spraying Imazethaphyr @ 750 ml/ha or Quizalofop ethyl @ 1.0 l/ha for monocots at 20 DAS when the weeds are at 2 leaved stage.
- ❖ In heavy soil higher dose of chemical should be used.

10. IRRIGATION MANAGEMENT:

- ❖ Groundnut crop requires on an average 400 to 450 mm depth of water.
- ❖ Good crop of groundnut requires 8 to 9 irrigations at 10 day interval starting from 25 DAS.
- ❖ After the crop is established, it is necessary to withhold irrigation for about 25 days to create stress which helps in synchronization of flowering.
- ❖ The last irrigation is to be at 90 days after sowing.
- ❖ About 24-30 % irrigation water can be saved due to use of sprinklers.

Soil moisture conservation practices should be followed in rainfed crop viz.,

- ❖ Apply 12.5 tonnes of groundnut shells per hectare at 15-20 DAS as mulch to reduce evaporation losses of soil moisture.
- ❖ To reduce transpiration losses from crop canopy, spray calcium sulphate solution (50 g/l).
- ❖ Spray urea solution (20 g/l) during dry spell period in order to make recover the crop from stress.

Critical stages for water requirement: Flowering, peg penetration and pod development,

11. PEST MANAGEMENT:

A. Insect Pest management:

1. Red hairy caterpillar:

Identification:

- ❖ Young larvae feed gregariously on the undersurface of leaves.
- ❖ Grown up larvae feed individually by devouring leaves, flowers and growing points.
- ❖ When the pest is severe only the bare stem points remain resulting in heavy yield loss.
- ❖ Early instar larvae are ash brown in color, but when fully grown assume reddish brown with black color hairs on the body.

Problem areas: Srikakulam, Visakhapatnam, Kadapa, Kurnool, Anantapuramu and Chittoor districts.

Remedies:

- ❖ Pre-monsoon deep ploughing (two/three times) will expose the hibernating pupae to sunlight and predatory birds.
- ❖ Removal and destruction of alternate wild hosts which harbour the hairy caterpillars.
- ❖ Use trap crops around main crop Eg. Cowpea.
- ❖ Collect the grown up larva by keeping calotropis branches between the rows.
- ❖ Monitor the emergence of adult moths through light trap.
- ❖ Organize bonfires on community basis from 7.30 PM to 11.0 PM to attract the newly emerging moths for 3 or 4 succeeding days when good showers are received.
- ❖ Collect and destroy egg masses and early instars larvae.

- ❖ Dust Quinolphos or Carbaryl @ 25 kg /ha to control early instars of the caterpillar.
- ❖ To control grown up larvae, spray Dimethoate @ 2.0 ml or Monocrotophos 1.6 ml/l of water.
- ❖ Trap and kill the migrating larvae in deep cut straight trenches by dusting Methyl parathion 2% in the trench around the field.

2. Root grub: Identification:

- ❖ Young grubs feed on rootlets and nodules.
- ❖ Old grubs devour the entire taproot.
- ❖ Affected plants wither and die. Such plants when pulled from the soil, the devoured taproot can be clearly seen.
- ❖ Damage usually occurs in patches.
- ❖ Pest usually occurs in August and September months.

Distribution: Anantapuramu, Kadapa, Kurnool, and Chittoor districts.

Remedies:

- ❖ Pre-monsoon deep ploughing (two/three times) will expose the hibernating pupae to sunlight and predatory birds.
- ❖ Mass collection and distribution of beetles from the branches of neem, bar, drumstick and subabul trees.
- ❖ Apply 10 G Phorate granules @ 1.5 kg a.i. /ha at the time of sowing.
- ❖ Seed treatment with chlorpyrifos @ 6 ml /kg in root grub problem fields or Imidachloprid 2ml/kg seed or Chlothianidin 50 WDG @ 1g/kg seed.

3. Leaf miner: Identification:

- ❖ Small blister like mines appear initially on the upper surface of the leaf.
- ❖ At severe stages entire leaflet becomes brown and it rolls, shrivels and dries up.
- ❖ Severely infected crop may die and give burnt appearance in the field when we see from distance.

Problem areas: Presently it is a major pest in all parts of the state.

Remedies:

- ❖ Rotation of groundnut with non-leguminous crops should be followed to reduce the pest incidence.
- ❖ Rotation of groundnut with soybean should be avoided.
- ❖ Collection and destruction of moths by setting light traps early in the season.
- ❖ Keeping pheromone traps in the field @ 10 per acre.
- ❖ Spraying of Quinolphos 2.0 ml or Monocrotophos 1.6 ml/l of water should be followed.

4. Tobacco caterpillar (*Spodoptera litura*)

Identification

- ❖ Larvae long, Stout, pale green (or) brown with black half moon shaped spots on the body
- ❖ During daytime it hides under soil clods and stores..
- ❖ Eggs are small and in masses, covered with yellow tufted hairs.
- ❖ In initial stages larvae congregate and scrapes later skeletonises on the leaves.
- ❖ Leaves become white papery at early stage.
- ❖ In severe cases it defoliates.
- ❖ Grown up larvae disburses and make irregular holes

Problem Areas

All groundnut areas (Anantapuramu, Cuddapah, Chittoor).
Severe in the months of September, October and November.

Remedies

- ❖ Monitor the pest from September last week onwards by Pheromone traps @ 10 per ha.
- ❖ Collection and destruction of eggs masses and damaged leaves along with gregarious larvae.
- ❖ Grow the castor plants in the field at the time of sowing act as trap crop.
- ❖ For early stages spray neem oil 5ml or Chlorpyrifos 2.5 ml or Monocrotophos 1.6 ml per liter of water.
- ❖ Arrange bird perches @ 25 per ha.
- ❖ Spray *SLNPV* @ 500 LE/ha @ 1 kg / 70 meters.
- ❖ Make deep furrow around the field and dust with methyl parathion or Endosulfan dust to control migratory caterpillars
- ❖ For late instar (3rd onwards) larvae spray Thiodicarb 1.0 g or Novaluron 1.0 ml or Chlorfenpyr 2.0 ml/l. of water
- ❖ Use poison bait to attract and to control late instar larvae per hectare

Rice bran	-	12.5 kg
Jaggery	-	1.25 kg
Carbaryl	-	1.25 kg (or)
Monocrotophos	-	1.25 litres (or)
Methomyl	-	0.75 kg
Water	-	10-12 litres
- ❖ Mix the above and make small pellets and apply them in one hectare, during evening hours near base of plants.

5. Sucking pests (Jassids, Aphids and Thrips):

Identification:

- ❖ Jassid infestation results in yellowing of the leaves at early stage and later turn brick red.
- ❖ Thrips infestation results in curling of leaves and stunting of the plant.
- ❖ Aphid infestation results in chlorotic plants and curling of leaves.
- ❖ Aphids transmit Rosette, Thrips transmit and Carried Bud necrosis and PSND diseases in groundnut.

Distribution: Present in all groundnut growing areas.

Remedies: Spraying of Monocrotophos 1.6 ml or dimethoate 2.0 ml or Imidachloprid @ 0.2 ml /lit of water.

6. Storage Pests:

- ❖ Groundnut bruchid and *Coreyra* which occurs in storage.
- ❖ Maintain minimum moisture percentage (9 %) in pods during storage.
- ❖ Spray 5% Malathion on pod and gunny bags.
- ❖ Fumigation with aluminium phosphide tablets 3-5 tablets /tonne of groundnut pods.
- ❖ Mixing neem oil 5 ml/kg of pods protect from bruchid.

B. DISEASE MANAGEMENT:

1. Tikka leaf spot

Identification:

- In case of early leaf spot, the lesions are sub circular and 1-10 mm diameter and dark brown on the upper surface of the leaf
- In case of late leaf spot, the lesions on the leaf are small, more nearly circular and darker than those of early leaf spot.
- Both the lesions may also appear on the stem, petiole and pegs

Problem areas: Both the leaf spots are commonly present in all groundnut-growing areas, but, the incidence is relatively more in North coastal and heavy rainfall areas.

Remedies:

- Removal of infected plant debris
- Crop rotation should be followed
- Seed treatment with Tebuconazole 2DS @ 1g or mancozeb @ 3 g/kg of seed
- Growing tolerant varieties viz., Vemana, Kadiri Harithandra, JCG-88, Abhaya and Kadiri 7 bold, Kadiri-9
- Spraying of mancozeb @ 1000 g + Carbendazim @ 500 g /ha or Hexaconazole @ 1000 ml or Chlorothalonil @ 1000 g or Tebuconazole @ 500 ml/ha in 500 liter of water at fortnightly intervals from first disease appearance.

2. Rust:

Identification:

- Orange coloured pustules appear on the lower surface of the leaflets
- In severe cases, lesions also appear on other plant parts except flowers

Problem areas: Occurs in all groundnut-growing areas

Remedies:

- Removal of infected areas
- Collect seed from disease free areas
- Seed treatment with Tebuconazole 2DS @ 1g or 3 g of mancozeb/kg of seed
- Spraying of mancozeb @1000 g or Chlorothalonil @1000 g or Tridemorph @1000 g /ha in 500 liter of water at 15 days interval starting from disease appearance.

3. Collar rot: Identification:

- Rapid desiccation of the affected plant
- Affected tissue is covered with black mass of spores
- In mature plants, lesions develop on the stem just below the soil surface and then spread upward along the branches.
- In mature plants, symptoms generally do not appear until the wilting of the entire plant is apparent

Problem areas: More prevalent in light sandy soils

Remedies:

- Select healthy seed
- Seed treatment with Tebuconazole 2DS @ 1g or mancozeb 3 g/kg or Captan 2 g/kg of seed
- Deep sowing of seed should be avoided
- Deep ploughing of fields and destruction of plant debris

4. Dry root rot:

Stem rot:

Identification:

- Appears generally 70 days after sowing
- Yellowing and wilting of branches just above the soil
- White mycelium of the fungus develops around the affected stem above the soil level
- Infection of pegs and pods occurs in severe cases and seeds turn to bluish colour\

Problem areas: Occurs in areas where the soils are heavy

Remedies:

- Deep ploughing in summer
- Selection of healthy seed
- Seed treatment with Tebuconazole 2DS @ 1g or mancozeb @ 3 g/kg of seed
- Soil application before sowing with *Trichoderma viride* developed by mixing 225 kg farm yard manure +25 kg neem cake + 5 kg *Trichoderma viride*/ha and allow to grow for 15 days under shade
- Gypsum application @ 500 kg/ ha
- Timely management of foliar diseases leads to reduction of incidence of stem rot

5. Peanut Stem Necrosis Disease (PSND)

Identification:

- Necrotic lesions on terminal leaf lets, death of top growing bud on main stem followed by necrosis of all top buds on primaries. Complete stem necrosis and often-total necrosis of entire plant in early infection
- Infected plants become stunted and showed auxiliary shoot proliferation with small and chlorotic leaflets
- Necrotic spots on pods. Testa are not discolored or mottled

Problem Areas: Anantapur, Mahaboobnagar, Kurnool and Chittoor districts of A.P.

Remedies:

- Seed treatment with Imidachloprid @ 2 ml/Kg of seed
- Weeds such as *Parthenium hysterophorus*, *Tridax procumbence*, *Ageratum conyzoides*, *Cleome viscosa*, *Commelina benghalensis*, *Vernonia cineraria*, *Achyranthus aspera*, *Acanthospermum hispidum*. should be removed before flowering in and around the field
- Barrier crops namely bajra, maize and sorghum should be planted in 4-8 rows around the groundnut field. These will prevent thrips and borne weed pollen carrying virus
- Spraying of monocrotophos @ 800 ml or Dimethoate @ 1000 ml or Imidachloprid @ 200 ml/ha in 500 liters of water at 25-30 days after sowing

6. Peanut bud necrosis disease:

Identification:

- Initial symptoms appear on young leaflets as chlorotic spots and develop in to chlorotic or necrotic ring spots
- Terminal bud necrosis on main stem followed by death of top buds on all primaries
- Stunting growth with reduced size of leaflets and petioles
- Leaflets produced on auxiliary shoot showed reduction in size, distortion of lamina and mosaic symptoms.

Remedies:

- Use of tolerant varieties viz., R-8808, ICGS-11, 44
- Intercropping with bajra (7:1)
- Spraying of monocrotophos @ 800 ml or Dimethoate @ 1000 ml or Imidachloprid @ 200 ml/ha in 500 liters of water at 25-30 days after sowing
- Maintenance of recommended plant population (44 plants/sq.m)
- Grow inter crop with bajra/ sorghum/ maize in the ratio of 7:1 or 11:1

12. HARVESTING:

- ❖ Should be done at right stage of maturity
- ❖ At the time of 70-80% leaves and stems turn yellow
- ❖ When the inner side of the shell turn black
- ❖ When sufficient moisture is available in the root zone

13. STORAGE:

- ❖ Seed should not contain more than 9% moisture for storage
- ❖ Prefer poly ethylene/gunny bags for storage
- ❖ Spray Malathion 5 ml / liter of water once in 2-3 weeks on storage bags against storage pests.

14. TIPS FOR INCREASING PRODUCTION

- ❖ Deep summer ploughing
- ❖ Adoption of quality seed of HYV
- ❖ Adoption of recommended seed rate
- ❖ Use small seed with out shrivelling of improved varieties
- ❖ Seed treatment
- ❖ Ensure optimum population
- ❖ Adopt recommended fertilizer dose
- ❖ Adoption of Ferti-cum- seed drill to ensure right placement of seed and fertilizer
- ❖ Apply Gypsum and SSP to provide calcium and Sulphur
- ❖ Avoid inter cultivation/weeding after 45 DAS.
- ❖ Adopt IPM Package
- ❖ Practice crop rotation and intercropping
- ❖ Use mechanization for sowing, inter cultivation ,harvesting and stripping to reduce cost of cultivation

III. SUGARCANE

1. Varieties

- | | |
|----------------------|--|
| a. Early maturing | Co 6907, 85 A261, 84 A 125, Co 8014, 83 A 30, 87 A 298, 99 V 30, 86 V 96, 91 V 83, 2000 V 59, 2003 V 46, 93 A 145, 97 A 85, 2001 A 63, 2003T 121, 2005T 16, 83 R 23 and 2003A 255. |
| b. Mid-late maturing | Co T 8201, Co A 7602, Co 7805, 83 V 15, 86 A 146, 88 A 162, 96 A 3, 97 R 129, 2000 V 48, 2000 A 225, 98 A 163, 99 A 5 and 2000A 225 |
| c. Late maturing | Co 8011, Co 7219, Co 7706, 87 A 380 and Co R 8001. |

- d. Moisture stress Co T 8201, Co 6907, 87 A 298, 97 A 85, Co 7219, Co A 7602 and 83 R 23, 98A 163 and 2000A 56.
- e. Swamp water logged conditions 84 A 125, 87 A 298, 86 V 96, 97 V 118, Co 6907, Co T 8201, Co 7219, 85 A 261, 2000 V 59, 83 V 15, Co 7706, Co A 7602, 2003 V 46 and Co R 8001.
- f. Saline – Alkaline soils Co T 8201, 97 A 85, 93 A 145, 99 V 30 and Co 7219.
- 2. Soils / Areas** Alluvial and red delta soils. Well-drained loamy soils.
- 3. Land preparation** Soils are to be worked to fine filth to a depth of 20-25 cm. Form furrows of 30 cm width and 20 cm depth by manual drawn or tractor drawn iron plough or ridgemark.
- 4. Seed rate** 40,000 three budded setts per hectare. Seed from short crop of 6-7 months age ensures good germination and improve cane yield by 2-3 tones/acre
- 5. Seed treatment** Dip the setts in Carbendazim (1g/litre) and Malathion (2 ml/litre) to eliminate pineapple disease and scale insect.
- 6. Spacing** 80 cm between rows for early varieties and 90 cm for mid-late varieties.
- 7. Time of planting**
- | | |
|-----------------|--------------------|
| Early varieties | December – January |
| Mid varieties | February |
| Late varieties | March |
- 8. Fertilizer management**
- Farm yard manure @ 25 tonnes per hectare or press mud cake @ 12.5 tonnes per hectare in the last ploughing.
 - Nitrogen @ 224 kg/ha (pocket application) has to be applied in two equal split doses at 45 and 90 days after planting.
 - Phosphorus @ 100 kg and Potassium @ 120 kg per hectare are to be applied as basal at the time of planting. Spray Zinc sulphate (2 gm/lt) and Ferrous sulphate (10-20 gm/lt) at 45-60 days after planting where zinc and iron deficiencies are observed.
 - Use of biofertilizers like azatobactor (4kg/acre) , azospirillum (4kg/acre) saves nitrogen to an extent of 25%
 - Use of phospho bacteria (4kg /acre) and VAM (5kg /acre) saves phosphorus to an extent of 20 to 25%

9. Weed management:

Pre emergence:

Spray Atrazine @ 5 kg/ha or metribuzine @ 1.5 kg/ha in 1125 lts of water on the third or fourth day after planting, depending on soil moisture.

Post emergence

Spray 2,4-D (4 ½ kg) + Gramoxone (2.5 lts) in 1125 lts/ha at 20 & 60 DAP between cane rows with hood to protect the crop or spray metribuzine @ 1.0kg + 2,4-D Sodium salt @ 2.0kg /ha at 25-30 DAP as blanket application.

Other cultural operations:

1. Earthing up at about four months after planting, propping the crop by trash twist, twice or thrice, depending on crop growth.
2. Keep the crop erect by TT propping twice or thrice depending upon crop growth leaving 6-8 green leaves in the crown.
3. For control of creeper weeds spray almix @ 20g/ha at 75 DAP
4. Inter cultivation between 45-60 DAP control weeds besides improving aeration.

10. Irrigation

Once in six days during summer and once in 15-21 days from November to harvest. During grand growth period, irrigation is to be provided when dry spell exceeds 15 days. If, only one irrigation is possible during formative phase, it has to be given at 30 days after planting and trash mulching has to be done three days after planting @ 3 t/ha.

11. Harvesting

Crop has to be harvested at peak maturity depending upon variety, date of planting and juice quality.

12. Post harvest management

Sugarcane harvested in a field should be free from root material, soil etc., The immature top portion should be cut to the first visible top internode. Such dressed cane should be crushed within 24 hours either in a sugar factory or jaggery crusher to avoid loss in the cane weight and sugar recovery.

Management for bud chip / single node seedling cultivation:

In sugarcane, seed cost itself accounts for 25% of the total cost of cultivation. Generally, 10.0 tonnes of seed cane is being utilized for getting optimum cane and sugar yields. Hence, to reduce seed cost and increase the cane production per unit area growing of sugarcane through bud chip or single bud seedlings is found to be the new innovative technology and becoming popular among the farming community.

Advantages of growing bud chip / single bud seedlings

1. Budchip / single bud seedlings can put forth more tillers at a time which will be more homogenous and gives higher number of millable canes with higher cane weight and sucrose content. The yield increase was up to 5 tonnes per acre over traditional method of sett planting in coastal areas.
2. Easy to adopt seed treatment with required pesticides because of less quantity of seed material.
3. Saving of one month period in main field similarly, water and critical inputs can be saved during that period.
4. After removal of budchip or single bud the remaining cane can be utilized for making jaggery or sugar.

5. More time will be available for preparation of main field after harvest of paddy which ensure deep ploughing and thorough land preparation.
6. Cane crop comes to maturity early by one month.
7. Mechanization can be adopted in seedling transplanted crop which will reduce cost of cultivation and increase net monetary returns.
8. Ratoon crop yields can also be improved due to maintenance of optimum population and uniform tillering .

Raising of Nursery:

Selection of seed cane:

- For growing sugarcane seedlings high yielding varieties suitable for that particular region are to be selected. It is always better to use 6-7 months aged healthy short crop as seed material.

Preparation of budchips / single nodes from the seed cane:

- Budchip cutting machine and node cutting machines are available for removing budchips or single nodes from the cane with little or no damage to bud.
- In traditional method of 3 bud sett planting 4-6 t/ac. of seed material is required. But in bud chip seedlings planting method, only 750-800 kgs of seed cane is sufficient for raising seedlings required / acre.
- Trays of 98C.C. pit size and 5 cm along bud chip / cane node will give good germination and healthy seedlings.
- Selection of healthy and undamaged budchips or single buds by grading method will not only improve germination percentage but also gives strong seedlings.
- Treating the bud chips / single nodes with 0.5 g carbendazim + 1.0 ml malathion / lit of water for 15 minutes to reduce the incidence of pine apple disease and scale insect.
- Protrays (Plastic trays) having 50 pits can be used for sowing of budchips. For sowing of single nodes trays with large size pits are to be used.
- To get 90-95% germination, use healthy bud chips or single buds by following grading method.
- Fill the pits (half) with coco peat or well decomposed FYM / vermi compost + sand mixed in equal proportion. Then put the treated budchips or single buds at 60-70° angle and eye should be towards upward direction. Then fill the trays completely with coco peat and press gently
- Arrange trays in a shade net in such a way that each series contains 10 trays and cover and tie with black polythene sheet tightly so that heat will be produced and germination of buds will be initiated.
- After 3-4 days, with the start of germination, arrange trays side by side in shade net and watering should be done in alternate days with rose can or sprinklers. Within one week all the buds will germinate. At 3-4 weeks after sowing every seedling will put forth 3-4 leaves with profuse root growth.

Preparation of main field and planting:

- For planting one acre field, 7,500-8,000 budchip seedlings are required. (150-175 plastic trays are sufficient). Growth and vigour of the seedlings also depends on type of rooting media used. Spray 19:19:19 @ 0.1% or vermi wash 1.0% to improve the seedling growth.
- Seedlings raised from single bud setts are found to be more vigorous and stronger than budchip seedlings and giving relatively higher yield.

- Main field is to be thoroughly prepared by ploughing with 2 M.B. plough or rotavator and perfect leveling should be done.
- Furrows are to be formed at 60/120 cm spacing i.e. paired rows of 20 cm depth within the row and seedlings are to be planted at 45-60 cm distance. In the inter space between rows pulse crops like blackgram, greengram and Groundnut can be grown which will improve soil fertility besides suppressing weed growth to certain extent. Drip system can be installed in the pairs to improve water use efficiency. While planting, seedlings are to be planted without disturbing root mass along with coco peat which holds moisture also
- Seedlings can also be planted with tractor drawn seedling transplanter.
- Light irrigations are to be given at 3-4 days interval at initial stages for quick establishment of the seedlings.
- Early planting in January – February is essential for good establishment of seedlings and synchronous tillering.

Nutrient Management:

Application of fertilizers at frequent intervals up to earthing up (90-100 days) found to give higher cane yields as compared to traditional method of application.

- 1.5 t/ac FYM + 12.5 kg Diammonium phosphate (Urea + S.S.P can also be applied) to be applied at planting nearer to the seedling and covered with soil.
- 12.5 kg D.A.P along with FYM at 10-15 days after planting.
- 25 kg D.A.P. along with FYM at 30-35 days.
- 25 kg urea + 25 kg M.O.P /ac at 50-55 days.
- 50 kg urea + 25 kg M.O.P/ac. at 70-75 days.
- Last dose of 100 kg urea + 100 kg M.O.P. per acre is to be applied at 90-100 days age and earthing up is to be done.
- Application of fertilizers at regular intervals to seedlings improves tillering ability and reduces water shoots formation and finally increases number of millable canes at harvest which is a pre-requisite for improving cane yield.

Weed management:

- Spraying atrazine @ 2.0 kg or metribuzin @ 600 g/ac in 450 lit of water as pre-emergence spray within 3rd day after planting seedlings.
- At 20-25 days after planting, spraying of metribuzin @ 400 g + 2,4-D @ 800 g /ac. mixed in 450 lit. of water will control the weeds effectively. Weeding and hoeing within the rows will reduce the weed growth and improves aeration.
- Tractor drawn weeders or rotavators can also be used to reduce weed growth.

Water management:

Light irrigations at frequent intervals (3-4 days) is very much essential during initial stage of the seedling growth. During formative phase irrigations are to be given at weekly interval. Irrigation through drip system saves water and improves water use efficiency also. Nitrogen fertilizer can also be applied through fertigation in 20 splits starting from 15 days after planting.

Other cultural operations:

Earthing up is to be done at 90-100 days age to prevent water shoots and protect the crop from lodging.

Trash twist propping is to be done at 180 days age depending on crop growth. At maturity crop is to be harvested at ground level and used for jaggery or sugar.

Intensive cultivation is very much essential for realizing higher yields under seedling cultivation.

Ratoon crop management

1. Varieties The same varieties indicated for plant crop are suitable for ratoon crop

2. Soils/Areas Alluvial, red and well drained loamy soils

3. Stubble shaving and interculture

Plant crop has to be harvested to the ground level or just below ground level. Stubble shaving has to be done with spades without disturbing the stools. The interspaces have to be ploughed to 12 to 15 cm depth to break the crust and improve aeration for better ratooning.

4. Trash mulching

Trash mulching @ 3 t/ha at 3-5 days after ratooning ensures conservation of soil moisture and suppression of early shoot borer and weed growth.

5. Manures and fertilizers

336 kg N/ha has to be applied in two split doses at ratooning and 45 days later. P_2O_5 @ 100 kg / ha and K_2O @ 120 kg / ha are to be applied at the time of ratooning. If deficiency of iron is noticed Ferrous sulphate (2%) is to be sprayed on foliage immediately.

6. Gap filling:

Gap filling has to be done with seedlings raised in polythene bags or in nursery from single budded setts within two weeks after ratooning.

7. Weed management:

Weeding and hoeing at 1st, 4th and 7th week after ratooning or spraying Atrazine @ 5.0 kg / ha immediately after ratooning followed by one hand weeding at 45 days after ratooning or metribuzin @ 1.5 kg/ha in 450 lit. of water within three days after ratooning followed by one hand weeding at 45 days after ratooning.

8. Harvesting:

Ratoon crop matures earlier than plant crop. Therefore crop has to be harvested earlier than plant crop at peak maturity.

Management under saline / alkaline conditions

1. Varieties 93 A 145, 97 A 85, Co T 8201 and Co 7219.

2. Land preparation Deep ploughing is to be avoided with other aspects are similar to plant crop.

3. Seed rate 45,000 three budded setts per hectare. Seed material should be selected from matured crop.

4. Planting time

Early planting December – January

5. Manures and fertilizers

Gypsum has to be applied @ 2-5 t/ha depending upon P^H ranging from 8.5 – 9.2. Farm yard manure @ 25 t/ha or press mud cake @ 12.5 t/ha and Zinc sulphate @ 50 kg / ha are to be applied in the last ploughing. P_2O_5 @ 100 kg / ha and K_2O @ 120 kg / ha for early planted crop and 50 kg K_2O / ha for late planted crop at the time of formation of ridges and furrows. For early planting, Nitrogen @ 168 kg/ha in two splits at 60 and 120 days after planting should be applied.

6. Inter cultivation and other management practices

- i. Provision of drainage and leaching with good quality water.
- ii. Earthing up at 4 months after planting and trash twist propping 2-3 times depending upon the growth of the crop.
- iii. Trash mulching @ 3 t/ha three days after planting.

7. Irrigation

For early planted crop – once in six days during summer and once in 15-21 days from November to harvest. During rainy season if dry spells prevails one to two irrigations may be provided. Late planted crop is usually rainfed. Yield can be improved with supplemental irrigation during post monsoon period

8. Harvesting

Crop has to be harvested at peak maturity depending upon variety, date of planting and juice quality.

Management of Pests and Diseases

Insect pests:

Early shoot borer

- Planting of setts in deep furrows.
- Application of phorate 10 G granules @ 15 kg/ha or carbofuran 3 G @ 33kg/ha or Fipronil 0.3 G @ 25 kg/ha at the time of planting.
- Trash mulching @ 3 t/ha at 3 days after planting in plant crop and immediately after stubble shaving in ratoon crop.
- Irrigate the crop at frequent intervals during summer.
- Spray chlorpyrifos (2.5 ml/lts) or acephate (1g/litre) at 4, 6 and 9 weeks after planting in 450, 675 and 900 lts of water, respectively.
- Early ratooning in the months of December – January coupled with closer irrigations in the formative phase of the crop.
- Use synthetic pheromones in water traps @ 3 /acre commencing from 35 days after planting or ratooning for monitoring of the pest.
- Release egg parasitoid, *Trichogramma chilonis* @ 50,000/ha at 30 days after planting or ratooning and subsequent releases should be made at 7-10 interval.

Internode borer

- Control early shoot borer in early stages of the crop growth.
- Detrash the crop to destroy the larvae and pupae attached with the leaf sheaths.
- Remove water shoots at eighth/ ninth month age.
- Avoid high dose of nitrogen
- Drain out excess of water in low-lying areas.
- Use synthetic pheromones in water traps @ 3 /acre commencing from the internode formation stage of the crop for monitoring of the pest.
- Release egg parasitoid, *Trichogramma chilonis* @ 50,000/ha at fortnightly intervals from 120 days after planting until a month before harvest.
- Spray chlorpyrifos (2.5 ml/lit) 0.05 % or monocrotophos (2.1 ml/lit) twice at 15 days interval during June-July months.

Scale insect

- Dip the three budded setts in malathion (2 ml/lit) or dimethoate (1.7 ml/lit) for 15 minutes before planting.
- Detrash the cane in the first weeks of July, August and September months followed by spraying with dimethoate 1.7 ml/lit or malathion 3 ml/litre.

- Dimethoate is preferred for spraying during heavy rains.
- Avoid ratooning of plant crop affected with heavy scale infestation .

Mealy bug:

- Avoid ratooning of the plant crop infested with mealy bugs .
- Destroy alternate host plants (certain grasses like *Cymbopogon*) near sugarcane fields.
- Avoid excess usage of nitrogenous fertilizers.
- Avoid multi ratooning in areas prone to mealy bug.
- Detrash the grown-up crop and spray dimethoate @ 1.7 ml/lit or malathion @ 2ml/lit. by using foot sprayer with long lance.

White fly:

- Provide adequate drainage facilities
- Heavy rainfall washes out the pest.
- Apply 'N' fertilisers at recommended dose at stipulated time.
- Avoid ratooning in low lying areas prone for water logging.
- Spray malathion 2ml/lit or chlorpyrifos 2.5 ml/lit or monocrotophos 1.6 ml/lit or imidacloprid 0.3 ml/lit using foot sprayer with long lance.

Termites:

- Systematic digging of termite mounds and destruction of queens. Apply methylparathion 2%D @ 200g/ mound followed by proper leveling.
- Apply methyl parathion 2%D in the furrows @ 25 kg/ha at planting.
- Spray chlorpyrifos 20 EC @ 5ml/lit wherever damage is noticed in standing crop

Cane fly:

- Detrash the lower leaves
- Use Nitrogenous fertilizers Judiciously.
- Prevent lodging by timely TT propping.
- Spray malathion @ 2 ml/lit or dimethoate 1.7 ml/lit or monocrotophos @ 1.6 ml/litre with foot sprayer
- Release *Epiricania melanoleuca* 4000-5000 cocoons/ha or 4-5 lakhs eggs per hectare.
- Avoid spraying of insecticides if Epricania is observed in the field

9. Mites:

- Removal and destruction of infested leaves
- Removal and destruction of grasses on the bunds.
- Spray wettable sulphur @ 3g/lit at 15 days interval starting from the appearance of the pest on crop as well as grassy weeds.
- Adopt balanced nutrition.
- Provide frequent irrigations during the pre-monsoon if possible.

10. Woolly aphid:

- Harvest affected matured crop on priority basis.
- Avoid transport of cane with infested leaves.
- Avoid ratooning, if the plant crop is heavily infested with woolly aphid.
- Adopt paired/wider row planting.
- Removal and burning of affected leaves.
- Wrapping and propping of canes to avoid spread of pest.
- Use Nitrogenous fertilizers and irrigation water judiciously.

- Provide proper drainage.
- Conserve the existing natural enemies like *Chrysoperla carnea*, Syrphid fly, Brown lace wing, *Micromus timidus* (Ord. Neuroptera) and *Dipha aphidivora* (Ord. Lepidoptera). Release the bioagents if infestation is severe.
- Monitor the pest incidence through yellow traps.
- Spray with malathion @ 2ml/lt or monocrotophos @ 1.6 ml/lt. or dimethoate @ 1.7ml/lt or chlorpyrifos @ 2.5 ml/lt. or methyl demeton @ 2ml/lt. or acephate @ 1g/lt.

11. Root grub

- Root grub is more problematic in light soils.
- Apply phorate 10 G granules @ 15 kg/ha or fipronil @ 25 kg/ha at planting in endemic areas.
- In standing crop, flooding of fields for 2-3 days is effective in reducing the severity.
- Avoid ratooning of infected fields

DISEASES:

1. Smut

- i. Systematic eradication of smutted clumps.
- ii. Avoid second ratoon if incidence is severe.
- iii. Treat three budded setts in hot water at 52° C for 30 minutes or aerated steam at 51° C for two hours followed by dipping setts in carbendazim and raise special seed nurseries.
- iv. Select seed material from disease free areas atleast 40m away from affected fields.
- v. Treat the setts with propiconazole (1 ml/lt) or hexaconazole (2ml/liter) for 15 minutes before planting the susceptible varieties like 87A 298, Co 6907.
- vi. Spray propiconazole (1.05 ml/lt) immediately after ratooning and 30 days after 1st spray in ratoon crop.

2. Red rot

- i. Select healthy seed material from disease free areas
- ii. Systematic eradication of affected clumps.
- iii. Uproot and destroy un-germinated setts of plant crop and un-sprouted clumps of ratoon crop.
- iv. Avoid ratooning of infected plant crop
- v. Provide good drainage and avoid stagnation.
- vi. All stubbles and debris should be burnt and further cane planting should not be done up to four months in the infected field.
- vii. Harvest the infected crop as early as possible and burn the crop residues.
- viii. Keep the crop erect without lodging by trash twist propping.
- ix. Grow resistant varieties like Co 7706, Co A 7602, Co 7219, CoT 8201, Co R 8001, 98A163, 85A 261, 83 A 30, 87 A 298, 86 V 96, 83 V 15, 83 R 23, 90 A 272, Co 7219, 97A 85 and 2001A 63.

3. Grassy shoot disease

- Uproot and destroy affected clumps.
- Avoid ratooning of severely affected plots.
- Select seed material from disease free plots.
- Treat the setts in hot water at 52° C for 30 minutes or aerated steam at 50° C for one hour and raise special seed nursery.
- Spray Malathion (2 ml/ lt) or Dimethoate (2 ml/lt) to check vector population.

4. Pineapple disease:

- Treat the setts by dipping in carbendazim solution (150 g of Carbendazim in 300 litres of water for 40,000 three budded setts sufficient to plant in one hectare).

5. Wilt:

- Provide frequent irrigations during summer
- Avoid water logging
- Use disease free seed material
- Control the diseases and pests effectively to avoid primary infection
- Apply recommended dose of nitrogen within the stipulated time

6. Leaf scald:

- Grow healthy short crop seed material for planting
- Sterilize harvesting knives with 5 % formaldehyde or on direct flame
- Treat the setts in hot water at 52°C for 30 minutes followed by dipping in carbendazim (0.05 %) for 15 minutes.

7. Top rot:

- Two sprays of mancozeb (3 g/lt) at 2-3 weeks interval during rainy season.

8. Ring spot:

- Spray either carbendazim (0.1 %) or mancozeb (0.3 %) or copper oxychloride (0.04 %) twice or thrice at three weeks interval starting from the first appearance of disease.

9. Rust:

- Spray tridemorph @1 ml / lt. or Mancozeb @ 3 g/ lt. at 15 days interval starting from the first appearance of disease.

10. Viral diseases (YLD and Mosaic)

- Uproot and destroy affected clumps
- Avoid ratooning of severely affected crop
- Use disease free seed material, preferably cane raised from tissue culture seedlings
- Spray Dimethoate 2ml/lt to control vector population

IV. PULSES

1. BLACK GRAM

Varieties

Kharif: LBG 787, LBG 752, LBG 20, LBG 623, T 9, Pant U 31.

Rabi-Uplands: LBG 787, LBG 752, LBG 685, LBG 645, LBG 709, LBG 20, PBG 107, T 9, Pant U 31

Rice fallows: LBG 787, LBG 648, LBG 645, LBG 685, LBG 709, LBG 752.

Summer: LBG 752, PU 31, LBG 20, T 9.

Soils/Areas

All types of soils with good drainage facilities. Saline soils are not suitable.

Land preparation

Land should be prepared to fine tilth with 1 or 2 ploughings followed by harrowing.

Sowing time

Optimum sowing time limits for different seasons

<i>Kharif</i>	: June 15 th – July 15 th .
<i>Rabi</i> (ID)	: 15 th October to 15 th November
<i>Rabi</i> rice fallows	: 15 th November to 15 th December
Summer rice fallows	: March 15 th to March ending.
Summer (ID)	: February – March 15 th .

Sowing of blackgram soon after the onset of monsoon was found ideal during *kharif* season. The progressive delay in sowing resulted in steady decline in yields. A reduction in yield up to 80 % was recorded when sowing was delayed by three weeks from the onset of monsoon mainly due to biotic and abiotic stresses.

Seed rate & spacing

<i>Kharif</i>	–	18-20 kg/ha; 30 x 10 cm.
<i>Rabi</i> (ID)	-	18-20 kg/ha; 30 x 10 cm.
<i>Rabi</i> (Rice Fallows)	-	40-42 kg/ha
Summer	-	20 kg/ha

A 25 % higher than the normal population (3.3 lakhs/ha) should be maintained under late sown conditions

Seed treatment

Captan or thiram or mancozeb or carbendazim @ 2.5 g per kg seed; imidacloprid 600 FS @ 5 ml or thiamethoxam 70 WS @ 5g /kg seed to protect the crop from sucking pests and diseases up to 15-20 days after sowing. First treat the seed with fungicide and allow to dry for 30 – 60 min, then treat the seed with insecticide and dry them in shade. Later treat the seed with Rhizobium @ 2 g/kg seed before sowing.

Rice fallows

- As there is no field preparation for sowing, the weed growth is severe and highly competes with the crop.
- Varieties like LBG-402, LBG-611, LBG-685 and LBG-645 grow quickly and smother weeds and were found best suited in rice fallows .
- Quizalofop ethyl at 50 g ai/ha, Fenoxoprop ethyl at 56.5 g a.i/ha and Clodino fop propargyl at 52 g a.i/ha and Cyhalo fop butyl at 100g a.i./ha were found effective in controlling the dominant weed *Echinochloa colonum* and other annual grasses only. Results indicated that all these chemicals were found to be selective to blackgram when applied at 14-28 days after sowing, though Imazitapyr at 62.5 gm.a.i/ha had caused initial damage to crop yield.

2. GREEN GRAM

Varieties:

Kharif: LGG 450, LGG 407, LGG 460, TM 96-2, Pusa 105, PDM 54, WGG 42

Rabi-Uplands: LGG 460, LGG 407, TM 96-2, WGG 42

Rice fallows: LGG 460, TM 96-2, LGG 410, LGG 407

Summer: LGG 460, PDM 54, LGG 407, WGG 42

Soils/Areas: All types of soils with good drainage facilities. Saline soils are not suitable.

Land Preparation: Land should be prepared to fine tilth with 2 ploughings followed by harrowing.

Sowing time

Optimum sowing time limits for different seasons

Kharif	: June 15 th – July 15 th .
Rabi (ID)	: 15 th October to 15 th November
Rabi rice fallows	: 15 th November to 15 th December
Summer rice fallows	: March.15 th to March ending.
Summer (ID)	: February – March 15 th

Seed rate & spacing

Kharif	–	15-16 kg/ha; 30 x 10 cm.
Rabi (ID)	-	15-16 kg/ha; 30 x 10 cm.
Rabi (Rice Fallows)	-	30-32 kg/ha
Summer	-	16-18 kg/ha

A 25% higher than the normal population i.e 3.3 lakhs/ha should be maintained under late sown conditions.

The rest of the following packages of practices are common for both black gram and green gram

Fertilizer management

20:50:0 N:P:K kg/ha. is required for optimum yields. Integrated nutrient management is necessary. Seed treatment with *Rhizobium* culture @ 500 g/ha. If the seed is treated with fungicide / insecticide the dose will be 1 kg/ha. Application of *Rhizobium* can save 20 to 25 % of required nitrogen. Along with nitrogen farmers can use phosphorous solubilising bacteria (PSB @ 5 kg /ha) can be applied which can convert the unavailable phosphorous into available form.

Inter-cultivation and Weed management

Spray pendimethalin @ 1-1.5 l/acre in 200 L of water within 48 hours after sowing (as a pre emergence). Intercultivation with gorru and guntaka at 20 and 40 DAS wherever possible. If it is not possible, application of Imazithapyr @ 200 ml/acre to control post emergence weeds at 25 - 30 DAS. If the broad leaved weeds are dominant. Use Quizalofop-ethyl @ 400 ml/acre, if the grassy weeds are dominant.

Irrigation : Usually grown as rainfed. Irrigate twice if water is available at 30 to 50 DAS to get higher yields.

Pest management:

Stem fly: Seed treatment as above. Spray acephate @ 1.0 g/l or monocrotophos @ 1.6 ml/l or dimethoate @ 2.0 ml/l twice at weekly intervals from 10 days after sowing

Flea beetles: Seed treatment as above. Spray acephate @1.0 g/l or monocrotophos @ 1.6 ml/l if the incidence is more severe

Thrips: Spray either monocrotophos @ 1.6 ml/l acephate @ 1.0 g/l or fipronil @1.0 ml/l

White fly : Foliar application of 5 % NSKE at 20 DAS as prophylactic spray against whitefly that transmits YMV. Spray monocrotophos @ 1.6 ml/l or triazophos @ 1.5 ml/l or acetamiprid @ 0.2 g/l.

Aphids: Spray either acephate @ 1.0 g/l or monocrotophos @ 1.6 ml/l or imidacloprid @ 0.3 ml/l.

Maruca Pod borer

- Monitor the occurrence of adult moths at flower bud initiation stage of blackgram/greengram (i.e at 35-40 DAS).
- Application of 5% NSKE or neem oil @ 5 ml/l should be taken up before flower bud initiation to avoid egg laying by Maruca adults.
- Spray acephate @ 1.0 g or chlorpyrifos @ 2 ml/l or quinalphos @ 2.5 ml or thiodicarb @ 1.0 g at the time of flowering initiation. Add dichlorvos @1.0 ml/l to the above chemicals if more number of webbings were observed in the crop.
- In case of severe incidence spray either novaluron @ 1.0 ml or spinosad @ 0.3 ml or emamectin benzoate @ 0.4 g or chlorantraniliprole @ 0.3 ml or flubendiamide @ 0.2 ml/l
- First spray should be given one week before flowering initiation as and when the adult population is noticed in the crop.
- Use 500 liters of spray fluid per hectare with hand compression sprayer
- Use 150-170 liters of spray fluid per hectare and increase the insecticide dose three times while using power or Taiwan sprayer,
- Repeat the spray twice at 7 days interval by changing the insecticide depending on the intensity of the pest.
- Do not spray the crop during early morning hours until the dew on leaf surface dries off

Tobacco caterpillar

Adoption of IPM practices such as

- Erection of Pheromone traps @ 10/ha
- Growing of castor as trap crop to monitor egg laying and hatching,
- Collection and destruction of skeletonized leaves along with first instar larvae.
- Spraying of SNPV @ 500 LE/ha.
- Spray either chlorpyrifos @ 2.5 ml/l or acephate @ 1.0 g/l or quinalphos @ 2 ml/l against early instars.
- Apply poison bait containing rice bran, jaggery and insecticide (carbaryl /chlorpyrifos / monocrotophos) @ 10:1:1 ratio against grown up caterpillars at the evening hours.

IPM Practices in blackgram and greengram

- Seed treatment with either Imidacloprid 600 FS @ 5 ml or Thiamethoxam 70 WS @ 5g /kg seed
- Intercropping with redgram (7:1)
- Erection of yellow sticky traps for monitoring of whiteflies
- Spraying of 5 % NSKE or neem oil @ 5 ml/lt (3000 ppm) as prophylactic spray at 20 and 35 DAS against both whiteflies and Maruca pod borer
- Need based application of recommended insecticides

Disease management

Collar rot: Seed treatment with captan/ thiram / mancozeb / carbendazim @ 2.5 g per kg seed

Anthracnose and Cercospora leaf spot: Seed treatment as above. Spray with carbendazim @ 1 g/l or mancozeb @ 2.5 g/l twice at 10 days interval.

Powdery mildew: Spray carbendazim @ 1 g/l or thiophanate methyl @ 1 g/l twice at 10 days interval soon after noticing the disease.

Angular black leaf spot: Grow resistant varieties like LGG 407, LGG 450. Spray carbendazim @ 1g/l twice at 10 days interval.

Plant Protection Schedule in rice fallows

- 30-35 days : First spray with copper oxy chloride @ 3 g or mancozeb @ 2.5 g/l to control *Corynespora* leaf spot.
- 45-50 days : Second spray with dinocap @ 1 ml + mancozeb @ 2.5 g/l to control powdery mildew and *Corynespora* leaf spot.
- 60-65 days : Third spray with tridemorph @ 1 ml or dinocap @ 1 ml + mancozeb @ 2.5 g/l to control rust, *Corynespora* leaf spot and powdery mildew.

Yellow mosaic virus

1. Grow resistant varieties like LGG 407, LGG 460, WGG 37, ML 267, PDM 54 of greengram and LBG 752, PU 31 and T 9 of blackgram
2. Seed treatment with imidacloprid 600 FS @ 5 ml/kg or thiamethoxam 70 WS @ 5 g/kg seed
3. Spraying of 5% NSKE or Neem oil 5 ml/l at 20 DAS as prophylactic measure
4. Roughing of YMV infected plants at initial stages of disease appearance
5. Spray triazophos @ 1.5 ml/l or acetamiprid @ 0.2 g/l for control of whitefly to check further spread of disease.

Leaf curl virus: Seed treatment with imidacloprid 600 FS @ 5.0 ml or thiamethoxam 70 WS @ 5.0 g per kg seed.

Critical Interventions

1. Adoption of line sowing in uplands and maintenance of optimum plant population @ 30-35 plants/sq.m

2. Seed treatment imidacloprid @ 5 ml/kg or thiamethoxam @ 5g/kg or carbosulfon @ 30g/kg seed at the time of sowing
3. Pre emergence application of herbicides for suppression of weeds upto 20-30 days
4. Timely pest and disease management
 - a. Plant protection measures should be taken up at flower bud initiation stage for effective management of Maruca pod borer.

3. REDGRAM

Varieties

Medium duration LRG 41, LRG 30, LRG 38, ICP 8863, ICPL 332, ICPL 87119, ICPL 85063, TRG 22

Short duration : ICPL 84031 (Durga), ICPL 85010 and CORG 9701

Wilt resistant varieties: ICPL 87119, ICP 8863.

SMD resistant varieties: ICPL 87119, BSMR 736 and BSMR 853.

Rabi varieties: ICPL 85063, LRG30, LRG 38, LRG 41

Soils/areas: All types of soils with good drainage. Saline soils are not suitable.

Land preparation: Land should be prepared to fine tilth by ploughing 2 to 3 times followed by a harrowing.

Seed rate *Kharif:* Medium duration varieties: 5-10 kg/ha
 Short duration varieties: 15-18 kg/ha depending on type of soils
Rabi: 12-15 kg/ha.

Spacing

Kharif: Medium duration varieties: 150 to 240 cm x 20 cm (depending on soil type)
 Short duration varieties: 90 cm x 20 cm (black soils) or 60 cm x 20 cm (light soils)

Rabi: 45-60 x 10 cm rainfed, 90 x 10 cm under ID conditions

Sowing/planting with cut off dates: *Kharif:* June 15th – August
Rabi: 20th September – 20th October

Weed control: Spray pendimethalin @ 2.5 to 3.5 l/ha. immediately after sowing

Manures and fertilizers

Kharif: Apply 20 N + 50 P₂O₅ kg/ha as basal dose.

Rabi: 20 kg N and 50 kg P₂O₅/ha as basal+ 20 kg N as top dressing at 25 DAS

Irrigation: Flowering and pod formation stages are most critical for moisture stress. Light irrigations at above stages enhance the yield.

Inter-cultivation and other management practices, if any

One or two hoeings to keep the crop free from weeds up to 60 DAS or application of pendimethalin @ 1.5 kg/ha as pre-emergence herbicide immediately after sowing will be effective in controlling the weeds.

INTEGRATED PEST MANAGEMENT OF *HELICOVERPA* ON REDGRAM

I. Cultural

- Summer ploughing
- Avoid mono-cropping
- Follow crop rotation
- Seed treatment with Rhizobium culture
- Adopt wider row spacing (more than 2 meters)
- Use recommended dose of fertilizers
- Cultivate tolerant/recouping varieties (LRG 41, ICPL 332, LRG 38 and LRG 30)
- Grow intercrops (Kharif : maize, sorghum, soybean, gingelly, greengram, blackgram, dry paddy and bajra)(Rabi: Coriander, Cowpea, Greengram, Blackgram, Groundnut)
- Sow rabi redgram under irrigated conditions in September to escape Helicoverpa
- Grow single variety on large scale.
- Cultivate slightly early maturing varieties in light soils to escape from the terminal moisture stress.

II. Mechanical

- Monitor with Pheromone traps 10/ha
 - Dislodge the larvae by shaking the plants

III. Biological

- Release *Trichogramma* twice at weekly intervals 65,000/ha
- Keep bird perches 50/ha up to flowering stage
- Spray NPV and *Bt* (NPV @ 500 LE/ha or *Bt* @ 1 kg/ha)

IV. Plant products

- Use Neem oil @ 5 ml/l or Repelin @ 10 ml/l or NSKE 50 g/l

V. Synthetic pesticides

- Follow need based application
- Avoid cocktail mixtures.
- Aim the sprayings at early instars with chlorpyrifos @ 2.5 ml/l or quinalphos @ 2 ml/l or acephate @ 1g/l or spinosad @ 0.3 ml/l, emamectin benzoate @ 0.4 g/l alternatively during the flowering & pod formation stage.
- Ensure thorough coverage (400-500 l/ha)
- Use Hydraulic/Pneumatic hand compression sprayers (900-1000 l/ha)
- Discourage synthetic pyrethroids
- Avoid sub-lethal dosage
- Adopt community approach

Maruca Pod borer: Spray a combination of chlorpyrifos @ 2.5 ml + dichlorvos @ 1 ml/l at flowering stage, spinosad @ 0.3 ml/l or emamectin benzoate @ 0.4 g/l or chlorantraniliprole @ 0.3 ml/l or flubendiamide @ 0.2 ml/l in case of severe infestation.

Pod fly: Spray with monocrotophos @ 1.6 ml/l or acephate @ 1.0 g/l or profenophos @ 2.0 ml/l or dimethoate @ 1.0 ml/l at the time of pod formation and development stages on need basis.

Disease management

Wilt : Grow resistant varieties, ICPL 87119, ICP 8863, WRG 65, PRG 158. Apply developed *Trichoderma viride* (80 kg well decomposed FYM + 20 kg neem cake + 2-3kg *Trichoderma viride* incubate for 25-30 days in shade) at the time of sowing. Crop rotation for 3 years.

Sterility mosaic virus : Grow resistant varieties, BSMR 853, BSMR 736 and ICPL 87119.

Macrophomina blight : Grow resistant varieties, MRG 66 and MRG 1004.

Post harvest technology: Properly dried produce can be stored in nylon bag, polythene lined gunny bag or compactly knitted gunny bag up to a period of 180 days.

4. BENGALGRAM

Varieties

Desi: Dheera (NBeG 47), Nandyala Sanaga-1(NBeG 3), JG 11, JAKI 9218 and JG 130

Kabuli : Nandyala Gram -1 (NBeG 119), KAK 2, Vihar (Phule G 95311) and LBeG 7

Sowing : October to November

Soils : Medium to deep black soils

Seed rate : 85-90 kg/ha (Desi); 100-110 kg/ha (kabuli)

Spacing : 30 cm x 10 cm

Fertilizers: 20 kg N, 50 Kg P₂O₅, 40 kg S/ha as basal dose

Inter-cultivation: Twice at 20 and 30 DAS,

Weed Control: spray pendimethalin at 2.5 to 3.5 l/ha immediately after sowing or the next day to check the weed growth for the first 20-25 days.

Irrigation : Rainfed, but One or two light irrigations at flowering and pod formation stage will increase the yields

Pest control

***Helicoverpa* Pod borer**

Adopt IPM practices against *Helicoverpa* in bengalgram

- Follow stripcropping of bengalgram with coriander (8:2 or 16:4)
- Sow 4 rows of sorghum all round the plot
- Transplant 50-100 marigold seedlings all round the plot
- Monitoring with pheromone traps @ 10/ha to target the pest at right stages.
- Use bird perches (50/ha)
- Use neem formulations for insect repelling (NSKE 5%) soon after the pest occurrence.
- Use biocides like *Bt* @ 1 kg/ha and NPV @ 500 LE/ha twice at an interval of 7-10 days in the evening hours.

- If necessary spray chlorpyrifos @ 2.5 ml/l or quinalphos @ 2 ml/l or acephate @ 1.0 g/l. In severe case, spray spinosad @ 0.35 ml/l or Rynaxypyr @ 0.2 ml/l or Indoxacarb @ 1 ml/l.

Spodoptera exigua

The incidence of *S. exigua* generally appears at early vegetative stage i.e., up to 20-30 days after sowing. Larvae damage the lower leaves by scraping. In severe case, foliage will drop down. Spray either monocrotophos @ 1.6 ml/l or acephate @ 1.0 g/l or quinalphos @ 2.0 ml/l or thiodicarb @ 1 g/l.

Diseases

Wilt : Seed treatment with captan or thiram @ 2.5 g/kg seed or *Trichoderma* (4 g/kg). Grow resistant varieties such as NBeG 3, JG 11, JG 130, JAKI 9218. Apply developed *Trichoderma viride* (80 kg well decomposed FYM + 20 kg neem cake + 2- 3kg *Trichoderma viride* incubate for 25-30 days in shade) at the time of sowing.

Dry root rot: Seed treatment with captan or thiram 2.5g or Rhizocin 2.5 g/kg seed. Grow resistant variety ICCV 10.

Post Harvest Technology

Storage : Properly dried un-infested produce can be safely stored in Nylon bag, polythene lined gunny bag or compactly knitted gunny bag even upto a period of 180 days.

CRITICAL INTERVENTIONS

1. Maintenance of optimum plant population (30-35 plants/sq.mt.)
2. Seed treatment with captan or thiram @ 3g/kg
3. Pre emergence application of herbicides for suppression of weeds upto 20-30 days
4. Timely pest and disease management
5. Foliar nutrition of KNO₃ @ 10 g/l in saline soils
6. Light irrigation at 30-35 days after sowing will increase the yield.

5. SOYBEAN

Varieties : JS 335, PK 1029, MACS 58, MACS 201, MACS 124, MACS 450, PK 471, PK 472, LSB-1, JS 80-21, LSB 18 (Bheem) and ADB 22 (Basara).

Soils/Areas: Medium clay soils, light soils under irrigation.

Land preparation: Plough the field twice followed by harrowing to achieve fine tilth.

Seed rate: 60-65 kg/ha

Seed treatment : Seed treatment with captan or thiram 3 g and carbosulfan 30 g/kg seed. Treat the seed with *Rhizobium japonicum* bacteria before sowing.

Spacing : 45 cm x 5.0 cm or 30 cm x 10 cm

Sowing : End of July to I F.N. of August for coastal region

Manures and fertilizers: 30 N + 60 P₂O₅ + 40 K₂O kg/ha, if inoculated with Rhizobium. 60 to 90 N + 60 P₂O₅ + 40 K₂O kg/ha, if not inoculated. Use of FYM and Sulphur containing fertilizers should be encouraged. Treat the seed with *Rhizobium japonicum*.

Intercultivation and other management practices: Keep the crop free from weeds upto 45 DAS. Use pendimethalin @ 3.3 l/ha as pre-emergence to check weed growth.

Irrigation: Under irrigate dry conditions irrigate at critical stages i.e., at pre-flowering and pod filling stages.

Pest Management

Stem fly : Spray monocrotophos @ 1.6 ml/l or acephate @ 1.0 g/l or quinalphos @ 2.0 ml/l

Leaf folder/webber and *Spodoptera exigua* : Spray with quinalphos @ 2 ml/l or acephate @ 1.0 g/l.

Gram caterpillar : Spray with quinalphos @ 2 ml/l or chlorpyriphos @ 2.5 ml/l.

Pod borers including *Spodoptera*: Collection and destruction of egg masses and skeletonized leaves. Need based spray with quinalphos @ 2 ml/l or chlorpyriphos 2.5 ml/l.

Whitefly : Spray with triazophos @ 1.5 ml/l or Neem oil @ 5 ml/l .

Jassids : Spray with monocrotophos @ 1.6 ml/l

Thrips : Spray with Acephate @ 1.0 g/l.

Disease Management

***Cercospora* leaf spot:** Spray carbendazim 1g/l

***Alternaria* blight:** Seed treatment with captan or thiram @ 3 g/kg of seed.

Rust: Spray mancozeb @ 1.5 kg/ha

Bacterial leaf spot: Spray chlormycitin @ 100 ppm

Mosaic: Spray with acephate @ 1.0 g/l to check vector

YMV: Spray with triazophos @ 0.2 kg a.i/ha or dimethoate @ 0.3 kg a.i/ha to check whitefly.

Harvesting and Storage: The crop is harvested when majority of leaves have become golden yellow and ready to fall and the lower pods are yellowish and dry. Seed is to be dried properly to a moisture level of 11-12 % before storage.

V. MILLETS

JOWAR

S. No	Operation	Details
1	Varieties along with recommended area	KHARIF Varieties: PSV-1, Palem-2, CSV-10, CSV-11, CSV-13, CSV-15 and Srisaila (PSV 56) Low rainfall areas of Rayalaseema: CSV-15, PSV-1, Srisaila (PSV 56) Hybrids: CSH-10, CSH-11, CSH-14, CSH-16, CSH- 18, CSH-21

		<p>Low rainfall areas of Rayalaseema: CSH 6, CSH 14, CSH 23, Srisaila (PSV 56)</p> <p>RABI</p> <p>Varieties : NTJ-2, NTJ-4, CSV 216R, CSV 14R, M35-1, Kinnera</p> <p>Early rabi areas of Rayalaseema : CSV 14 R, NTJ2, NTJ4, N14</p> <p>Hybrids: CSH-15 R, CSH-16</p>
2	Land preparation	One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better insitu moisture conservation
3	Seed treatment	Treat the seed with Thiomethaxam @ 3 g/kg seed and Thiram or Captan @ 3 g/kg seed.
4	Sowing time	Kharif: 1 st week of June to 2 nd week of July Rabi: 2 nd fortnight of September to October end
5	Seed rate and Spacing	8-10 kg/ha 45 x 12-15 cm Remove excess plants at 15-20 days age of the crop.
6	Fertilizer doses and time of application	FYM : 10 t/ha Light soils with low rainfall Basal : 30N + 40P + 30K kg/ha Top : (30-40 days crop) : 30 N kg/ha Fertile soils with assured rainfall Basal : 40N + 60P + 40K kg/ha Top : (30-40 days crop) : 40 N kg/ha
7	Weed control (name of chemical and mechanical)	<ul style="list-style-type: none"> • Two manual weedings along with two intercultural operations with danti are effective. • Pre emergence application of Atrazine @ 4 g/litre with in 48 hrs of sowing coupled with one manual weeding and one intercultural operation is also economical. <p>Witch weed:</p> <ul style="list-style-type: none"> • Pre emergence spray of Atrazine @ 4 g/L. • Spray Ammonium sulphate @ 50 g/l or Urea 200 g/l on striga plants. • Destroying the parasites before flowering.
8	Major disease and pest control	<p>Pests:</p> <p>1. Shoot fly:</p> <ul style="list-style-type: none"> • Deep ploughing to expose larval and pupal stages present in the stubbles. • Sowing with the onset of monsoon before 15th July. • In the late sown crop, use high seed rate of 10-12 kg/ha and thinning out the affected and extra plants at 4 weeks after sowing. • Seed treatment with Imidacloprid @ 4 ml/kg of seed Carbosulfan 50 sp @ 100 g/kg seed. • In heavy infested areas, soil application of carbofuran 3G

		<p>at 20 kg/ha in seed furrows.</p> <p>2. Stem borer:</p> <ul style="list-style-type: none"> • Deep ploughing to expose larval and pupal stages present in the stubbles. • Sowing with the onset of monsoon. • Removal and destruction of dead hearts • Intercropping with the non cereal crop. • Whorl application of Carbofuran 3G @10 kg/ha at 25 and 35 days after emergence. <p>3. Corn leaf Aphid :</p> <ul style="list-style-type: none"> • Lady bird beetles and horse flies devour Aphids • Spraying of Methyldemeton or Dimethoate @ 2 ml/litre. <p>4. Ear head bug:</p> <ul style="list-style-type: none"> • Early sowing minimizes bug damage. • Application of carabaryl 5% Malathion 5D @ 20 kg/ha at pre bloom and again at milk stages. <p>5. Panicle worm :</p> <ul style="list-style-type: none"> • Application of Malathion 5D @ 20 kg/ha • Spraying of Monocrotophos 1.6 ml/l. <p>6. Mite:</p> <ul style="list-style-type: none"> • Spray Dicofol @ 3 ml/l or Monocrotophos @ 1.6 ml/l. <p>7. Sorghum midge :</p> <ul style="list-style-type: none"> • Application of Malathion 5D @ 20 kg/ha at 90 % ear head emergence stage. <p>Diseases:</p> <p>1. Grain molds:</p> <ul style="list-style-type: none"> • Spray Propiconazole (Tilt) @ 0.5 ml/l twice at 50% flowering and 10-15 days later. <p>2. Smuts:</p> <ul style="list-style-type: none"> • Seed treatment with Thiram @ 3 g/kg seed. <p>3. Ergot:</p> <ul style="list-style-type: none"> • Mechanical removal of sclerotia from seeds by washing in 2% salt solution followed by rinsing with plain water before sowing. • Spraying with benlate @ 1 g/l or Propiconazole (Tilt) @ 0.5 ml/l or mancozeb @ 2 g/l at 10% flowering and another spray at 50 % flowering
9	Irrigation schedule along with critical stages	In irrigated crop, irrigation should be given at sowing, 20-25 days after sowing, ear head emergence / flowering and grain filling stages.
10	Harvesting	In general the maturity duration is 110-115 days
11	Quality characteristics	--
12	Expected yield of the variety / Hybrid	In general the varieties give grain yield of 25 – 30 q/ha and hybrids will give a grain yield of 35-40 q/ha

BAJRA

S. No	Operation	Details
1	Varieties along with recommended area	<p>Open pollinated varieties (Composites & synthetics): ICMV 221, ICTP 8203, Raj 171</p> <p>Hybrids: HHB 67, ICMH 356, RHB 121 and PHB - 3</p> <p>These varieties / hybrids are suitable in all Bajra growing areas of Andhra Pradesh</p>
2	Land preparation	One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better insitu moisture conservation
3	Seed treatment	Treat the seed with Thiram or Captan @ 3 g/kg seed. Soak the seed in 2% (20 g /lit) salt solution for 10 minutes to remove ergot infected seed.
4	Sowing time	<p>Kharif : Complete sowings by 15th July</p> <p>Rabi : September- October</p> <p>Summer : January 15 – February end</p>
5	Seed rate and Spacing	<p>4 kg/ha</p> <p>45 x 12 - 15 cm</p> <p>Remove excess plants at 15-20 days age of the crop.</p>
6	Fertilizer doses and time of application	<p>FYM: 2-3 t/ha</p> <p>Irrigated conditions: Basal: 40 N + 40 P + 30 K kg/ha Top (30-35 days crop): 40 N kg/ha</p> <p>Rain fed conditions Basal: 30 N + 30 P + 20 K kg/ha Top (30-35 days crop): 30 N kg/ha</p>
7	Weed control (name of chemical and mechanical)	<ul style="list-style-type: none"> • Two manual weedings along with one or two intercultural operations with danti is effective. • Pre emergence application of weedicide Atrazine @ 4 g/lit with in 48 hrs of sowing coupled with one manual weeding and one intercultural operation is also economical.
8	Major disease and pest control	<p>Pests:</p> <p>1. White grub:</p> <ul style="list-style-type: none"> • Apply Phorate @ 12 kg/ha or Carbofuran granules @ 20 kg/ha in seed furrows at the time of sowing. <p>2. Shoot fly:</p> <ul style="list-style-type: none"> • Application of carbofuran 3G at 20 kg/ha in seed furrows <p>3. Grey weevil and other leaf feeding and ear head pests:</p>

		<ul style="list-style-type: none"> • Dust Methyl parathion 2% or Fenvalerate 0.4% or Quinolphos 1.5% @ 25 kg/ha <p>Diseases:</p> <p>1. Downy mildew:</p> <ul style="list-style-type: none"> • Treat the seed with Apron SD 35 @ 6 g / kg seed. • Foliar spray of Ridomil 25WP @ 1 g/lit at 21 days after sowing if infection exceeds 5%. • Uproot and burn the infected plants. • Avoid monoculture of particular cultivar. <p>2. Ergot:</p> <ul style="list-style-type: none"> • Dip the seeds in 2 % brine solution, stir and remove the floating seeds and sclerotia, dry the seeds lying at the bottom and sow. • Need based spray of Mancozeb (2.5 g/lit) or Carbandazem (1gm/lit) or Ziram @ 2 g/litre at boot leaf and flowering stage. • Plough the field soon after harvest to bury the ergot inoculum
9	Irrigation schedule along with critical stages	In irrigated crop, irrigation should be given at sowing, tillering, ear head emergence / flowering and grain filling stages.
10	Harvesting	In general the maturity duration is 80-85 days
11	Expected yield of the variety	In general the varieties give grain yield of 20 – 25 q/ha and hybrids will give a grain yield of 30-35 q/ha

RAGI

S. No	Operation	Details
1	Varieties along with recommended area	<p>KHARIF:</p> <p>Short duration (80-90 days): Maruthi and Champavathi</p> <p>Medium duration (100-115 days): Saptagiri, Bharathi, Godavari, Srichaitanya and Vakula</p> <p>RABI:</p> <p>Short duration (80-90 days): Maruthi and Champavathi</p> <p>Medium duration (100-115 days): Saptagiri, Bharathi, Godavari, Vakula and Hima (White ragi variety suitable for growing in Rabi season)</p>
2	Land preparation	One deep ploughing with mould board plough followed

		by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better <i>in situ</i> moisture conservation.
3	Seed treatment	Treat the seed with Carbendazim @ 2 g or Mancozeb @ 3 g/kg seed.
4	Sowing time	<p>Khariif: July- August</p> <p>Rabi: November – December</p> <p>Summer: January – February</p> <p>Spacing:</p>
5	Seed rate and Spacing	5 kg/ha (Raise nursery in 400m ²) 22.5 cm X 10 cm
6	Fertilizer doses and time of application	<p>FYM : 2-3 t/ha</p> <p>Basal : 30N + 40P + 30K kg/ha</p> <p>Top (35-40 days crop): 30 N kg/ha</p>
7	Weed control (name of chemical and mechanical)	<ul style="list-style-type: none"> • In line sown crop, 2-3 inter cultivations with one hand weeding. • In broad cast crop, two hand weedings. • In assured rainfall areas: • Spray pendimethalin 30 % (stomp) @ 3 ml/lit as pre emergence weedicide application. • 2, 4-D Sodium salt @ 2 g/lit as post emergence weedicide application around 20-25 days after planting.
8	Major disease and pest control	<p>Pests:</p> <p>1. Army worms and Cut worms:</p> <ul style="list-style-type: none"> • Dust Malathion 5% or Phosalone 5% or Quinolphos 1.5% @ 20-25 kg/ha. • Spray chloripyriphos @ 2.5 ml/lit or quinolphos 2 ml/l <p>2. Leaf aphid:</p> <ul style="list-style-type: none"> • Spray Dimethoate 2 ml/l <p>3. Stem borers:</p> <ul style="list-style-type: none"> • Spray Dimethoate 2 ml/l or Phosphamidon 2 ml/l or Monocrotophos 1.6 ml/l <p>4. Ear head caterpillars:</p> <ul style="list-style-type: none"> • Dust Malathion 5% or Phosalone 5% or Quinolphos 1.5% @ 20-25 kg/ha. Spray chloropyrophas @ 2ml/L <p>Diseases:</p> <p>1. Blast:</p> <ul style="list-style-type: none"> • Treat the seed with Carbendazim @ 2g / kg seed • If necessary spray the nursery with

		<p>Carbendazim 1g/l, or Kitazin 2 ml/l or Saaf 2.5 g/l</p> <ul style="list-style-type: none"> • Spray any of the above fungicides at 50% flowering and repeat 10 days later to control neck/ finger blast. <p>2. Brown leaf spot :</p> <ul style="list-style-type: none"> • Damage could be severe if the crop is subjected to drought or nutrition deficiency. The disease can be effectively managed by proper nutrition and water management. • Need based spray of Mancozeb or Saaf 2.5 g/l <p>3. leaf blight:</p> <ul style="list-style-type: none"> • Seed treatment with captan or thiram @ 3g/l • Spray mancozeb @ 2.5 g/l
9	Irrigation schedule along with critical stages	In irrigated crop, irrigation should be given at 3 days after transplanting, tillering, ear head emergence / flowering and grain filling stages.
10	Harvesting	For short duration varieties : 80-90 days For medium duration varieties: 110 – 115 days For long duration varieties: 120-130 days
11	Quality characteristics	--
12	Expected yield of the variety	In general the varieties give grain yield of 25 – 35 q/ha

KORRA

S. No	Operation	Details
1	Varieties along with recommended area	KHARIF AND RABI Prasad, Krishnadevaraya, Narasimharaya, Srilakshmi, Suryanandi, SiA 3085 and SiA 3156 These varieties are recommended for Andhra Pradesh korra growing areas
2	Land preparation	One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better insitu moisture conservation.
3	Seed treatment	Treat the seed with Carbendazim @ 2g / kg seed
4	Sowing time	Kharif: July- August Rabi: December – January Spacing:
5	Seed rate and Spacing	5 kg/ha for line sowing 10 kg/ha for broad casting Line sowing : 25 x 10cm
6	Fertilizer doses and time of application	FYM : 5 t/ha Basal : 20N + 30P + 0K kg/ha Top (30 days crop) : 20 N kg/ha

7	Weed control (name of chemical and mechanical)	In line sown crop, 2-3 inter cultivations with one hand weeding. In broad cast crop, two hand weedings.
8	Major disease and pest control	PESTS: Army worms, Cut worms and Leaf scraping beetles: Need based dust application of Malathion 5% @ 20 -25 kg/ha. Spray chloripyriphos 2.5 ml or quinolphos 2 ml/l DISEASES: 1. Blast, Brown spot and Rust: If these diseases appear at the early stages of the crop, spray Mancozeb 2.5 g/l. 2. Grain smut: Seed treatment with Carbendazim @ 2 g/ kg seed. 3. Downy mildew: Seed treatment with Ridomil MZ @ 2 g/l or metalaxyl @ 3 g/Kg seed. Roguing out and destroying the affected plants. Spray 1g/l metalaxyl or 2.5 g/l mancozeb.
9	Irrigation schedule along with critical stages	In irrigated crop, irrigation should be given after sowing, tillering, ear head emergence / flowering and grain filling stages.
10	Harvesting	For early duration varieties: 70-75 days For medium duration varieties: 80-85 days
11	Quality characteristics	--
12	Expected yield of the variety	In general these varieties gives grain yield of 25 - 30 q/ha

SAMA

S. No	Operation	Details
1	Varieties along with recommended area	KHARIF OLM 20, OLM 36, OLM 203 and Co 2 These varieties can be grown in Andhra Pradesh
2	Land preparation	One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better <i>in situ</i> moisture conservation.
3	Seed treatment	Treat the seed with Carbendazim @ 2g / kg seed
4	Sowing time	Kharif: June – July
5	Seed rate and Spacing	8 kg/ha 25 cm X 10 cm
6	Fertilizer doses and time of application	FYM: 5 t/ha 20:20:20 NPK kg/ha – Basal
7	Weed control (name of chemical and mechanical)	In line sown crops- 2-3 inter cultivations with one hand weeding. In broad cast crop- Two hand weedings.
8	Major disease and pest control	PESTS: Shoot fly: Early sowing; Reduce Nitrogen by 50 % and replace FYM or

		bio fertilizers. DISEASES:Grain smut: Seed treatment with carbendazim @ 2 g/kg seed
9	Irrigation schedule along with critical stages	In irrigated crop, irrigation should be given at tillering, ear head emergence / flowering and grain filling stages.
10	Harvesting	In general the maturity duration is 100-105 days
11	Quality characteristics	--
12	Expected yield of the variety	In general these varieties gives grain yield of 10 - 15 q/ha

VI. MAIZE

Maize is the most widely distributed cereal crop of India after rice and wheat. Of late, the economic importance of maize crop has been increasing because of its diversified agro-based industrial uses apart from its food, feed and fodder value. Rabi maize favorably responds to better crop management as it is one of the most efficient users of solar energy with high yield potential. The possibility of *rabi* maize can provide a major break through for rapid increase in productivity as yields are much higher as compared to *kharif*.

The following package of practices has to be adopted to achieve higher yields during *kharif* and *rabi*

Soils: Red sandy loams to medium black soils with good drainage facilities are preferable. Maize does not come up well in saline, alkaline and waterlogged soils. The optimum pH range should be 6.5 to 7.5.

Time of sowing

Kharif : Middle of June to middle of July. In case of delayed monsoon, sowings may be extended upto first week of August using short duration hybrids under assured irrigation facilities.

Rabi: October 15th to November 15th

Recommended hybrids/varieties

I. Hybrids

Long duration (100-120 days) : DHM 113, 900 M Gold, Bio 9681, Pro-311, 30 B 07, NK-30, NK 6240, SMH 3904, MCH 36 and JKMH 2492.

Medium duration (90-100 days): DHM 111, DHM 117, DHM-119, KH 510, Bio 9637, KH 9541, MCH 2, Kohinoor, Prabhal, Bisco 855, KMH 25K60 and JKMH 175

Short duration (<90 days): DHM 115, Prakash, KH 5991, JKMH 1701, DKC 7074 R, PEH-1, PEH-2, Him 129, VL 49, MMH 133 and 3342

II Speciality corn Hybrids

Sweet corn: Sugar 75, Bright Gene

Popcorn: BPCH 6

Baby corn: HM 4, PEH-1, PEH-2, DHM 115

Quality protein: Amber Shakti, HQPM-1, HQPM-4, HQPM-5, HQPM-7, Vivek QPM 9

III Speciality corn varieties

Sweet corn: Madhuri, Priya, Win Orange, Almora sweet corn.

Popcorn : Amber popcorn, Pearl popcorn, VL popcorn

Baby corn: VL 42, Him 123, Him 128, Him 129, Madhuri, Prakash, VL78, VL Baby corn 1

III Quality protein: Shakti 1, Shakti 7

Seed treatment: Seed treatment with captan or dithane M-45 @ 3 g/kg of seed.

Seed rate: 17.5-20 kg per hectare for normal hybrids, 7.5-10 kg per hectare for sweet corn, 12-15 kg per hectare for pop corn and 25 kg per hectare for baby corn.

Spacing : 60 cm between rows and 20 cm between plants which gives an optimum plant population of 83,333 plants /ha and 75 cm x 20 cm spacing can also be taken up where the intercultivation operations are attended by tractor drawn implements which gives an optimum plant population of 66,666 plants per hectare for all the hybrids and speciality corns except baby corn (45 cm x 20 cm).

Method of sowing : Sowing on sides of ridges at a distance of 1/3rd from top facilitates irrigation as well as drainage. Excess seedlings should be thinned 10 days after emergence to have single seedling per hill.

Fertilizers

For *kharif* crop, a dose of 150-200 kg N, 60 kg P₂O₅, 60 kg K₂O per hectare is recommended. Nitrogen may be applied in three splits i.e., at sowing, knee high stage and at flowering stages. For *rabi* crop 200-250 kg N, 80 kg P₂O₅, 80 kg K₂O per hectare is recommended. Nitrogen may be applied in four splits *viz.*, at sowing, knee high stage (30-35 DAS), at flag leaf emergence (50-55 DAS) and at tasseling-silking stage (60-65 DAS). In both seasons, 50 kg of commercial zinc sulphate per hectare may be applied if soils are known to be deficient in available zinc. If symptoms appear later, the crop can be sprayed with 2 g/l solution of zinc sulphate.

Weeding

Pre-emergence spraying with atrazine (atrataf) 50WP @ 2-3 kg/ha depending on soil type and at 30 days after sowing, spraying of 2,4-D sodium salt 80 WP @ 1.25 kg a.i/ha in 500 litres of water will control most of the broad leaved weeds effectively. After 30-35 days, crop may be inter-cultivated and earthing up should be done. Atrazine is recommended when maize is grown as a pure crop only.

Irrigation

Though the crop is grown under rainfed conditions, if drought occurs during flowering stage, irrigation helps to give good yields. When the crop is in initial stages, provide proper drainage facilities to drain out excess water in case of heavy down pour. Four to six irrigations are needed during the *rabi* season. If six irrigations are given, two irrigations upto flowering at an interval of 20-25 days, one at the time of flowering, two after flowering and one at the early grain filling stage. If five irrigations are given, one irrigation at the vegetative stage may be avoided and if only four irrigations are given, one irrigation after the dough stage may be avoided. The irrigation schedule may however be changed suitably based on the soil conditions.

Plant protection

a) Pests: The stem borer, *Chilo partellus* infests the crop during *kharif* and pink borer *Sesamia inferens* infests during *rabi* season. The borers cause dead hearts in early stage of crop. The pest incidence is recognized by the presence of shot holes in the leaf blades as well as exit holes on the stem. To control the pest, prophylactic spraying of monocrotophos 36 SC @ 1.6 ml/l or Coragen 0.3 ml/l when the crop is 10-12 days old and or application of carbofuran 3 G in leaf whorls @ 7.5 kg/ha is recommended when the crop is 25-30 days old.

b) Diseases

The important diseases of maize are leaf blight (*Exserohilum turcicum*), late wilt (*Cephalosporium maydis*) and charcoal rot (*Macrophomina phaseolina*). Spraying of mancozeb 75 WP @ 2.5 g/l or dithane Z-78 @ 3 g/l at 7-10 days interval starting from knee high stage of the crop controls the leaf blight. Banded leaf and sheath blight is observed in some of the districts and when the symptoms are noticed, stripping of the affected bottom 2-3 leaves along with their sheath and spraying of propiconazole @ 1 ml/l is recommended. For late wilt & charcoal rot - crop rotation, removing plant debris, summer ploughing, avoiding moisture stress after flowering and growing tolerant hybrids should be followed.

Critical interventions

- Maintaining optimum plant population of 83,333 plants/ha
- Plant protection measures against stem borer within 10-12 days after germination
- Keep the crop weed free upto 45 days
- Top dressing of urea coinciding with the rains
- Irrigation at silking and dough stages

Rice-fallow Maize under zero tillage

Importance

Rice-Pulse System is prevalent in black soils of coastal districts like East and West Godavari, Guntur and Krishna. In some areas of these districts, irrigation water is available with filter points. In such areas, rice-fallow *rabi* maize has gained popularity in place of

rice-fallow pulses. Some important tips are furnished for obtaining maximum yields with a saving of Rs. 5000/ha and 2-3 irrigations.

- ✚ No preparatory tillage
- ✚ Dibble the seed after harvesting *kharif* rice at 2-3 cm depth, in optimum moisture, or else, give light irrigation before dibbling depending on the soil type.
- ✚ Practice line sowing by adopting a spacing of 60 cm x 20 cm
- ✚ Spray gramoxone @ 5 ml /l to prevent the regrowth of rice stubbles
- ✚ Spray atrazine @ 4 g/l immediately after sowing or next day to prevent broad leaved weeds
- ✚ Combination of gramoxone 2.5 l/ha and atrazine 2.5 kg/ha can also be used for controlling regrowth of rice stubbles and broadleaved weeds.
- ✚ Ensure proper moisture at the time of spraying herbicide
- Intercultivation and earthing up to be practiced at 25-30 DAS
- A recommended dose of 250-80-80 kg N-P₂O₅-K₂O per hectare is applied. Entire Phosphorous as basal, nitrogen in four splits *viz.*, at sowing, knee high stage (30-35 DAS), at flag leaf emergence (50-55 DAS) and at tasseling-silking stage (60-65 DAS) and potassium in two splits i.e., basal and flowering stage.
- ✚ Provide 5-6 irrigations based on the soil type and climatic conditions
- ✚ Adopt need based plant protection measures like normal Maize

VII. OTHER OILSEED CROPS

1. SUNFLOWER

1. Soils: The crop performs well on a wide range of soils such as sandy loams, black soils and alluvials. Fertile, well drained neutral soils are best. Ideal p^H 6.5 – 8.0. It can tolerate slight alkalinity but not acidity. Water logging areas should be avoided.

2. Recommended varieties/hybrid

S. No.	Variety/ Hybrid	Duration (Days)	Yield (kg/ha) under rainfed conditions	Oil Content (%)	Plant Height (cm)	Special Characters
1	Morden	80-85	1000	35-38	90-120	Suitable for intercropping
2	DRSF-108	90-95	1250	40	150-160	High oil content
3	KBSH-1	„	1500	40-42	„	High oil content
4	NDSH-1	80-85	1500	40-42	120-130	Resistant to downy mildew, tolerant to rust and moisture stress
5	DRSH-1	90-95	1500	42-44	150-160	Resistant to Downy mildew, tolerant to Alternaria.
6	APSH-66	90-95	2000	40-42	150-160	Tolerant to Alternaria leaf spot

3. Time of sowing

Rainfed : September to First fortnight of October
Irrigated : November
Summer irrigated : 15th January to first week of February

4. Seed rate and spacing: Rain fed crop requires more seed (7.5-10 kg /ha for varieties and 5-6.25 kg for hybrids) than irrigated (6.25-8.75 and 5 kg/ha), respectively, for varieties and hybrids). In light soils, 45 x 20-25 cm and in heavy soils 60 x 30 cm is recommended.

5. Seed treatment Seed should be treated with quintal (iprodione 25 % + carbendazim 25 %) @ 2 g/kg seed for controlling *Alternaria* leaf spot. In the necrosis prone areas treat the seed with imidacloprid 5 g/kg or thiamethoxam 4 g/kg seed. Seed should be treated with metalaxyl @ 3 g/kg seed for managing downy mildew.

6. Thinning: Maintain a single seedling per hill by thinning out other seedlings in a hill, 10-15 days after germination for obtaining higher yields.

7. Fertilizers: Apply FYM 7.5 t/ha 2-3 weeks prior to sowing.

	N*	P	K (kg/ha)
Rain fed	60 (30+30)	60	30
Irrigated (Black soils)	75 (25+25+25)	90	30

➤ First dose as basal and second and third as top dressing at 30 and 50 days after sowing.

Prefer single super phosphate as source of P

8. Water management: During *rabi*/summer irrigations can be given based on soil type. In light soils irrigation can be given 6-10 days interval while in heavy soils 15-20 days interval. Flower bud initiation, flowering and seed set are sensitive stages for irrigation.

9. Intercultivation

Use of alachlor or pendimethalin @ 1.5 kg a.i/ha in 600 litres of water as pre-emergence spray followed by hand weeding at 35 DAS provides effective control of weeds.

10. Plant protection

10.1 Insects

Sucking pests

Leafhoppers: Spray with monocrotophos @ 1.6 ml/l or dimethoate @ 2 ml/l or Methyl demeton @ 2 ml/l

Whitefly: Spray with triazophos @ 2 ml/l or acephate @ 1 g/l or monocrotophos @ 1.6 ml/l or thiamethoxam @ 0.5 g/l

Thrips: Spray with monocrotophos @ 1.6 ml/l or imidacloprid @ 4 ml/ 10 l or thiamethoxam @ 0.5 g/l

Mealybug: Spray profenofos 50 EC @ 2 ml/l or quinalphos 25 EC @ 2 ml/l or acephate 75 SP @ 1.5 g/l two times at 10-15 days interval

Tobacco caterpillar

Poison bait preparation with rice bran 10kg + jiggery 1 kg + 1 litre monocrotophos or 1 kg carbaryl 50% WP and distribution in the field at base of the plant in the evening hours or spraying with spinosad @ 0.5 ml/l

Bihar hairy caterpillar

For management of early instars, sprays with NSKE 5% and for grown up larvae, spray with chlorpyrifos @ 2.5 ml/l or dichlorvos @ 1 ml/l

Gram pod borer

Spray with Ha NPV @ 250 LE/acre or thiodicarb @ 1 g/l or spinosad @ 0.5 ml/l or novaluron @ 1 ml/l quinalphos @ 2ml/l or chlorpyrifos @ 2.5 ml/l or monocrotophos @ 1.6 ml/l

10.2. Diseases

10.2.1 *Alternaria*

- For controlling *Alternaria* along with seed treatment spray quintal (iprodione 25 % + carbendazim 25 %) @ 2 g/l or saaf @ 2 g/l or propiconazole @ 1 ml/l

10.2.2. **Head Rot:** Spray fenthion 1 ml/l + wettable sulphur @ 3g /l twice within 10 days interval.

10.2.3. Downy mildew

- Remove infected plants and destroy.
- Spray metalaxyl 8% MZ @ 2 g + mancozeb 64% WP @ 2 g or copper oxy chloride 50 % @ 3 g/l.

Necrosis

- Summer ploughing should be done.
- Plant four rows of either sorghum or pearl millet or maize as border crop.
- Treat the seed with imidachloprid 5 g/kg or thiamethoxam 4 g/kg seed.
- Remove the parthenium weed around the bunds and also necrosis affected sunflower plants before flowering.
- To control the vectors, thrips methyl o dematon 25 % EC @ 2 ml/l or imidachloprid 17.8 % SL @ 0.4 ml/l or thiamethoxam 70 % WP @ 0.5 g/l twice within 15 days interval.

10.2.4. Powdery mildew

- * Spray wettable sulphur @ 3 g/l or dinocap @ 1 ml/l or propiconazole @ 1 ml/l or difenconazole 0.5 g/l twice within 15 days interval.

10.3 Parrots: Bird scaring with reflecting ribbons.

11. Harvesting and storage: Harvest when back side of the head turns yellow. Thresh after drying for 2-3 days and store the seed with 9-10 % moisture.

2. SAFFLOWER

- 1. Soils and preparation:** Heavy soils with good drainage are ideal. Acidic soils should be avoided but slight alkaline soils will be alright. Deep ploughing in summer followed by 2-3 harrowings during Kharif for fallows or two harrowings after Kharif pulse crop.

2. Seed and sowing

Variety/hybrid	Duration (days)	Yield (q/ha)	Characters
Manjira	115-120	7.5-10	Yellow flowers turn orange; 27-30 % oil
Sagarmutyalu	115-125	10-12	Yellow flowers; 27-32% oil; rust resistant
TSF-1	130	15-17	Wilt tolerant; 32 % oil

During second fortnight of September to first fortnight of October, 10 kg seed/ha for sole crop or 4.5 kg/ha for intercropping with bengal gram or coriander in 1:2 can be sown after treating each kg of seed with 3 g thiram/captan or 1 g carbendazim. Seed can be sown behind plough or with the drill at 5 cm depth in 45 cm x 20 cm spacing.

- 3. Fertilizers:** 40 kg N and 25 kg P (preferably in single super phosphate form) /ha.

4. Pest management

Leaf eating caterpillars: Sprays with quinalphos @ 2 ml/l or chlorpyrifos @ 2.5 ml/l

Aphids: Spray with dimethoate @ 2 ml/l or monocrotophos @ 1.6 ml/l or chloripyriphos @ 2.5 ml/l

Disease management

Alternaria leaf spot: Spray saaf 1 g/l or carbendazim 2 g/l as soon as spots appears and one more spray within 7-10 days after first spray.

Fusarium wilt: Rotate the crop with bengalgram to reduce intensity of *Fusarium* wilt. Cultivate tolerant varieties like TSF -1. Treat the seed with carbendazim 1 g/kg seed.

- 5. Parrots:** damage will be severe for discrete small holdings which need scaring morning and evening during seed filling.
- 6. Harvest and storage:** Harvesting in morning prevents seed shedding and spines will be soft. Threshing by tractor or beating with sticks and storing with 5-8 % moisture. Harvesting petals 15-20 days after flowering can be done for herrbal tea.
- 7. Intercropping:** Chickpea + Safflower (3 : 1).

3. CASTOR

- 1. Soils:** Castor can be cultivated on almost all types of well-drained soils. Saline soils and soils with water stagnation are not suitable.

2. Recommended varieties/hybrids

S. No.	Variety / Hybrid	Duration (Days)	Yield (q/ha)	Special Characters
1.	Kranthi	90-150	15-20	Bold seed, early maturing
2.	Haritha	90-180	15-20	Resistant to wilt
3.	Kiran	90-150	15-20	Tolerant to drought and to grey rot due to

				non spiny capsules
4.	Jyothi	„	15-20	Wilt resistant
5.	Jwala	90-180	15-20	Tolerant to wilt and grey rot
6.	GCH-4	„	18-20	Tolerant to wilt and root rot
7.	DCH-32	„	18-20	
8.	DCH-177	„	20-25	Resistant to wilt
9.	DCH- 519	„	20-25	Resistant to wilt
10.	PCH-111	„	20-25	Resistant to wilt
11	PCH-222	„	20-25	Resistant to wilt

3. Sowing Season: October - December

4. Seed Rate and Sowing

Situation	Seed rate (kg/ha)	Spacing (cm)
Heavy soils, irrigated	5.0	90 cm x 90 cm
Light soils, irrigated	7.5	90 cm x 60 cm

Treat one-kilogram seed with 3 g captan/ thiram or 1 g carbendazim.

5. Nutritional Management: Basal application of 2 t of FYM, 12-16-12 Kg N: P₂O₅ :K₂O/ha and top dress 6 kg N 30-35 DAS and 60-65 DAS. For hybrids additional dose of 6 kg N as at 90-95 DAS can be given.

6. Intercultivation: Thinning should be done 15-20 DAS and harrowing at 20 and 40 DAS.

7. Plant protection

7.1. Insects

Red hairy caterpillar

- For stopping the movement of grown up larvae from one field to another, digging a trench and dusting methyl parathion 2% dust or quinalphos 1.5 % dust (@ 1 kg per 70 m length)
- For grown up larvae sprays with monocrotophos @ 1.6 ml/l or dimethoate @ 2 ml/l

Semilooper

- Hand picking and destruction of grown up larvae
- Arranging bird perches @ 10/ acre
- Sprays initially with neem oil @ 5ml/l
- For management of grown up larvae sprays with acephate @ 1.5 g or profenophos @ 2 ml/l or novaluron @ 1 ml or thiodicarb @ 1.5 g per litre of water

Tobacco caterpillar

- For early instars management spray initially with neem oil @ 5ml/l
- For management of grown up larvae (2nd instar) sprays with chlorpyrifos @ 2.5 ml/l or monocrotophos @ 2 ml/l
- For management of 3rd instar larvae sprays with acephate @ 1.5 g or profenophos @ 2 ml/l or thiodicarb @ 1.5 g per litre of water

- Poison bait preparation with rice bran 5 kg + jiggery 0.5 kg + 500 ml monocrotophos or 500ml chlorpyriphos or 500 g carbaryl 50% WP and distribution in the field at base of the plant in the evening hours
- In severe cases, sprays with indoxacarb @ 1 ml/l or novaluron @ 1 ml/l or lufenuron @ 1 ml/l
- For grown up larvae sprays with emamectin benzoate @ 0.5 g/l or rynaxypyr @ 0.3 ml or flubendiamide @ 0.2 ml/l

Shoot and capsule borer

For management of this pest protective sprays with monocrotophos @ 2ml or acephate @ 1.5 g or indoxacarb @ 1ml per litre of water first at the time of flowering and later at capsule formation

Bihar hairy caterpillar

For management of early instars, sprays with neem oil @ 5ml and for grown up larvae , spray with chlorpyriphos @ 2.5 ml/l or dichlorvos @ 1 ml/l or acephate @ 1.5 g/l

Sucking pests

Leafhoppers: Early sprays with neem oil @ 5 ml/l and at later stages with monocrotophos @ 1.6 ml/l or dimethoate @ 2 ml/l or acephate @ 1.5 g/l

Serpentine leafminer: Sprays with neem oil @ 5 ml/l

7.2.Diseases

7.2.1. *Fusarium* wilt

- Use tolerant varieties like Haritha, 48-1, GCH-4, and Jyothi.
- Treat the seed with thiram or carbendazim @ 3 g/kg.
- Intercropping with Redgram and crop rotation with bajra.
- As soon as disease appears drench carbendazim 1 g/l or copper oxy chloride 3 g/l.
- Removal and destruction of affected plants.

7.2.2. *Botrytis* Grey Rot

- Soon after cyclone warning is given in Radio/T.V., spray carbendazim @1 g/l
- Remove infected spikes and destroy.
- Spray carbendazim @1 g/l after the rains.
- Apply 50 kg urea and 25 kg potash/ha after cessation of rains.

8. Harvesting and storage

Harvest when 80 % capsules turn yellow in a spike. Thresh after drying and store the seed with 9-10 % moisture.

4. SESAMUM

Soils: Low lying soils with water stagnation, acidic and saline soils are not suitable.

Recommended varieties

S. No.	Variety	Duration (Days)	Yield (kg/ha)	Oil Content (%)	Seed colour	Special Characters
1.	Gouri	85	750	50	Dark Brown	Tolerant to gall fly.
2.	Madhavi	70	625	50-51	Light Brown	Suitable for sequence cropping.
3.	YLM-11	80	875	53	Dark Brown	Matures at a time
4.	YLM-17	75	750	52-53	Light Brown	Tolerant to powdery mildew
5.	Chandana	85	750	50-51	Dark Brown	Tolerant to phyllody

Sowing time: Second fortnight of January

Seed Rate and Sowing: Treat one-kilogram seed with 3 g capton / thiram/ mancozeb. Sow 2 kg acre of seed mixed with 6 kg sand with seed drill. A spacing of 30cm x 15 cm is recommended. Thinning should be done at 15 DAS.

Fertilisers : Basal application of 4 t of FYM, 50 kg N - 50 kg P₂O₅/ ha (Calcium and Sulphur will also be available when applied in the form of Single super phosphate)

Water management: Irrigate immediately after sowing and at flowering and seed set (35 and 70 days).

Weed management: Harrowing at 20-25 DAS.

Pests

Sucking pests

- Leafhoppers and thrips: sprays with monocrotophos @ 1.6 ml/l or dimethoate @ 2 ml/l
- For management of white mite, sprays with dicofol @ 5 ml/l or dimethoate @ 2 ml/l

Leaf webber and capsule borer

- Removal of webs and destroying the larvae inside
- Sprays with monocrotophos @ 1.6 ml/l or quinalphos @ 2 ml/l or chlorpyrifos @ 2.5 ml/l

Gall fly

- Removal and destruction of infested pods
- Spray with monocrotophos @ 1.6 ml/l or dimethoate 2 ml/l or acephate @ 1.5 g/l

Bihar hairy caterpillar

- Removal and destruction of egg masses and also the first instar larvae along with the infested leaves
- Spray with chlorpyrifos @ 2.5 ml/l or acephate @ 1 g/l

Diseases

Root and stem rot : Treat the seed with thiram or captan or carbendazim @ 3 g/kg. Spray copper oxychloride or mancozeb @ 3g/l. Removal and destruction of affected plants.

Alternaria : Remove infected parts and destroy. Spray carbendazim (1g/l) or mancozeb (2.5 g/l) 2-3 times with 15 days interval.

Phyllody : Remove infected parts and destroy. Spray methyl demeton @ 1 ml or dimethoate @ 3 ml per litre of water.

Powdery Mildew: Spray wettable sulphur @ 3 g per litre of water.

Harvesting and storage

Harvest when 75% pods turn yellow in a spike. Thresh after drying for 5-6 days and store the seed with 8% moisture.

VIII. COTTON

Desi Cotton Varieties (*G.arboreum.L*) : Aravinda, Srinandi (NDLA-2463), Yaganti (NDLA-2933)

Amerecian Cotton Varieties (*G. hirsutum L.*): Kanchana (LPS 141), LK-861, L-389, L- 603, L-604, Narasimha (NA-1325), Sivanandi (NDLH-1755), NDLH-1938, MCU5 VT, LRA-5166 and LRK-516.

Intra-specific Cotton Hybrids : LAHH-1, LAHH-4, LAHH-5, Lam Cotton Hybrid-7, NDLHH-390, NDLHH-240 and Orugallu Krishna (WGHH-2), NHH-44, JKHy 1, Savitha, H-6, H-8 and H-10.

Egyption Cotton Varieties / Inter-specific Cotton Hybrids : Suvin / Jayalakshmi (DCH-32)

Bt. Cotton Hybrids : Officially identified private Bt cotton hybrids being cultivated and found suitable for the last 3-4 years.

Soils : Deep black Cotton and Red fertile soils with irrigated or assured rainfall conditions.

Land Preparation

For rainfed cotton, deep ploughing once in 3 years with mould board plough or disc harrow facilitates deep infiltration of water and charging of soil profile with large quantities of water. The land has to be ploughed 2 to 3 times and work with harrow to bring the soil to good tilth. Seeds can be dibbled by maintaining spacing in between plants after running a marker in one or two direction(s). For irrigated crop, ridges and furrows are to be formed at recommended spacings after deep ploughing.

Seed Rate

Americian Cotton Varieties (<i>G.hirsutum</i> .L)	:	2 kg / acre
Desi Cotton Varieties (<i>G.arboreum</i> .L and <i>G.herbaceum</i> .L)	:	4-5 kg / acre
Intra-/Inter-specific Cotton Hybrids	:	0.75-1 kg / acre

Seed Treatment :

For acid delinting, seed should be treated with 80-100 ml H₂ SO₄ per kg of seed for 2-3 minutes followed by lime solution and thorough washing with water 2-3 times to make the seed acid free. Seed treatment with appropriate insecticide(s); imidacloprid 70 WS @ 5 g / kg or thiomethoxam 70 WS @ 4 g / kg or imidacloprid 48 FS@ 9ml/kg or carbosulfan 25 DS @ 40 g/kg of seed. followed by, treatment with *Pseudomonas fluorescens* @ 10 g / kg or *Trichoderma viride* or *T. harzianum* @ 10 g / kg or carbendazim 50 WP @ 2 g / kg or mancozeb 75 WP @ 3 g / kg or captan 50 WP 3 g / kg or thiram 75 WP @ 3 g / kg.

Spacing

Desi Cotton Varieties (cm)	:	60 x 30
American Cotton Varieties (cm)	:	90 x 60 or 105 x 60
Conventional Hybrids (cm)	:	90 x 60 or 120 x 60
Bt. Cotton Hybrids (cm)	:	90 x 45 or 90 x 60 or 120 x 45 or 120 x 60

Sowing with Cut-off dates

Red soils	:	June – 1 st Fortnight of July
Black soils	:	July – 1 st Fortnight of August

Inter Cropping in Cotton: Inter cropping with mungbean / urdbean / soybean / cluster bean in 1:2 or 1:3 ratio, and pigeonpea 4:1 or 6:1 or 8:1 ratio.

Gap filling and Thinning: Gap filling should be done preferably within 10 DAS. Thinning should be done within three weeks after sowing retaining two plants per hill in case of varieties, one plant per hill in case of hybrids.

Manures and Fertilizers: Apply FYM @ 4 t / acre (10 cart loads) besides the recommended fertilizers.

For Desi Cotton Varieties: 8 N + 8 P₂O₅ kg/acre. Entire P as basal. N is in two splits at 30 DAS and 60 DAS by pocketing method.

For American Cotton Varieties: 36 N + 18 P₂O₅ + 18 K₂O kg/acre. Entire P as basal, N and K in three splits 30, 60 and 90 DAS by pocketing method.

For Conventinol Cotton Hybrids: 48 N + 24 P₂O₅, 24 K₂O kg/acre. Entire P as basal, N and K in three splits 30, 60, 90 DAS by pocketing method.

For Bt Cotton Hybrids: 25% excess N over recommended N should be applied. The recommended N and K should be given in 3-4 splits at 20 days interval starting from 20 DAS. Foliar application of 2% urea/ 2% DAP/ 2% KNO₃ at flowering and boll development stages.

For correcting magnesium, boron and zinc deficiencies, foliar application of MgSO₄ @ 1% twice at 45 and 75 DAS; Boron @ 0.15% twice at 60 and 90 DAS; and ZnSO₄ @ 0.2% twice at 4-5 days interval at 45 DAS is recommended. For correcting iron deficiency due to heavy moisture stress in early crop growth stage, foliar application of 0.5% FeSO₄ along with citric acid should be done twice at weekly interval.

Weed Management:

The first 40-60 days after sowing is very critical for weed competition. The sew cotton yield reduction due to uncontrolled weed infestation may be 50%-85%. For effective weed control spray pendimethalin @ 1.5 to 2.0 l/acre immediately or within 48 hours of sowing. Inter cultivation with tyned harrow and blade harrow 2-4 times upto 90 DAS. For control of the grasses and broad leaved weeds post emergence spray of quizalofopethyl @ 400 ml/acre (2.00 ml/l) and pyrithiobac sodium @ 250 ml / acre (1.25 ml/l) is recommended at 25-30 DAS. Post emergence directed spray of parquat @ 5.0 ml/l of water or glyphosate 10.0 ml + 10.0 g of urea or ammonium sulphate/l of water is recommended for control of the weeds in the cotton crop, where inter-cultivation or manual weeding is not possible due to unfavourable weather conditions.

Irrigation: Generally cotton crop requires 2-4 irrigations depending upon the soil type. Square formation, flowering and boll development stages are critical for moisture stress. For moisture conservation and effective weed control furrows for every row or alternate rows should be opened during the last inter cultivation operation.

Pest Management in Cotton

Management of Sucking Pests in cotton:

1. Grow sucking pest tolerant / resistant varieties / hybrids.
2. Seed treatment with imidacloprid 70 WS 5.0 g /kg or thiamethoxam 70 WS 4.0 g / kg or imidacloprid 48 FS @ 9.0 ml/kg or carbosulfan 25 DS @ 40.0 g/kg of seed, gives early protection against sucking pests.
3. Growing of intercrops like mungbean or urdbean or soybean or cluster bean in 1:2 or 1:3 ratio will facilitate the buildup of native natural enemy populations that in turn keep sucking pests under check
4. Growing of cowpea as bund crop is advantageous to encourage predacious insects like coccinellids, syrphids and chrysopids
5. Maize or sorghum or pearl millet grown as barrier crops in the border prevents spread from neighbouring fields.

6. Stem application at 30 & 45 DAS with monocrotophos (1:4) and at 60 DAS with imidacloprid (1:20) for protecting the crop from early season sucking pests is highly effective.
7. Setting up of yellow sticky traps @ 10 per acre for monitoring whitefly incidence.
8. Economic Threshold Level (ETL) for sucking pests on cotton is presented hereunder :

Name of the Pest	ETL
Jassids	Two adults or nymphs per leaf or appearance of second grade injury (yellowing in the margins of the leaves)
Thrips	10 adults per leaf
Aphids	15% affected plants
Whiteflies	6-8 adults per leaf
Mealy bugs	5% affected plants
Mites	10 per cm ⁻¹

9. **ETL based application of insecticides**

Leafhoppers / aphids / thrips - Monocrotophos 36 SL @ 1.6 ml/l or
 Acephate 75 SP @ 1.5g/l or
 Imidacloprid 17.8 SL @ 0.4 ml/l or
 Acetamiprid 20 SP @ 0.2 g/l or
 Thiamethoxam 25 WG @ 0.2 g/l or
 Fipronil 5 SC @ 2.0 ml/l
 Diafenthiuran 50 WP @ 1.25 g/l
 Flonicamid 50 WG @ 0.3 g/l

Whitefly - Triazophos 40 EC @ 2.0 ml/l or
 Profenophos 50 EC @ 2.0 ml/l or
 Acetamiprid 20 SP @ 0.2 g/l or
 Diafenthiuron 50% WP @ 1.25 g/l or
 NSKE @ 5% (extract from 10.0 kg of Neem powder/acre)

Red mite - Wettable sulphur 80 WP @ 3.0 g/l or
 Dicofol 18.5 SC @ 5.0 ml/l

Insecticide Resistance Management Strategies to manage cotton pests in Bt-cotton

Early Sucking Pest Window 1: 0-60 DAS: No foliar spray upto 60 DAS.

- Cultivation of sucking pest tolerant varieties / hybrids
- Use dual gene cotton hybrids such as Bollgard II (Cry I Ac + Cry 2 Ab)
- Raising densely planted border rows of maize / sorghum / pearl millet / pigeonpea
- Mechanical control of *Parthenium* and *Abutilon* weeds to avoid build up of initial mealy bug inoculum.
- Stem application of monocrotophos at 30 and 45, and imidacloprid at 60 DAS.
- Neem oil sprays @ 1.0 l/acre + detergent powder @ 1.0 g or sandovit @ 0.5 ml or Teepol 0.5 ml/l. for the control of whitefly.

Window 2: 60-90 DAS : Initial boll worm infestation. Mostly eggs and young larvae: Biological and bio-pesticide window.

- Hand picking of *Helicoverpa* and *Spodoptera* larvae, and egg masses of *Spodoptera*.
- One spray of novaluron @1.0 ml/lt or lufenuron @1.25ml/lt for the control of *Spodoptera* on need basis only.
- Installation of yellow sticky traps @ 10.0 / acre for monitoring of the whitefly.
- Application of 5% NSKE for bollworm and whitefly infestation.
- No spray against minor lepidopteran pests.
- Follow Integrated Nutrient Management practices including foliar spray of nutrients to reduce leaf reddening.
- Neonicotinoids like imidacloprid or acetamiprid or thiomethaxam for the control of sucking pests.
- Spinosad or emamectin benzoate only on non-Bt cotton.

Window 3: 90-120 DAS: Peak Boll worm infestation.

- One application of chlorpyrifos or quinalphos or thiodicarb or spinosad on conventional or Bt-cotton plants showing flared up squares.
- Poison bait (10 kg rice bran +2.0 kg jaggery + chlorpyrifos 500-700 ml or thiodicarb 250-300 g) for the control of grown up larvae of *spodoptera*.

Window 4: >120 DAS : Boll worms & Mealy bugs.

- In case of minimum infestation of mealy bug, uprooting and destroying of infested plants.
- Surrounding weeds especially, *Parthenium* are sprayed with chlorpyrifos and destroyed subsequently.
- In severe mealy bug infestation drenching the affected stems with malathion @ 2.0 ml/l or buprofezin @ 2.0 ml/l or acephate @ 2.0 g/l along with sticky agents.
- Insecticides like chlorpyrifos, quinalphos, profenophos, carbaryl are used in case of severe economic damage due to mealy bug.
- Need based use of insecticides: Spraying of persistent insecticides like thiodicarb 75 WP @ 1.5 g/l or quinalphos 25 EC @ 2.5 ml/l or chlorpyrifos 20 EC @ 2.5 ml/l at 15 days interval.
- Hand picking of surviving bollworm larvae from Bt-cotton fields and destruction of residual pupae by deep ploughing immediately after harvest.

Integrated Pest Management in Cotton:

1. Avoid monocropping of cotton.
2. Application of chemical fertilizer as supplement to organic or biological fertilizers as per the recommended doses.
3. Growing intercrops/strip crops/barrier crops with greengram, blackgram, soybean cowpea, clusterbean, groundnut, foxtail millet and coriander were found better intercrops in increasing the effectiveness of natural enemies like coccinellids, syrphids, chrysopids, spiders, *Trichogrammids*, *Apantelids* etc. Growing fodder sorghum or maize as barrier crops and castor as ovipositional trap crop with in the cotton was also found to be more advantageous to manage the pests of cotton.
4. Seed treatment with recommended insecticides and fungicides.
5. Stem application of Monocrotophos at 30 and 45, and imidacloprid at 60 DAS.
6. Monitoring pests by using light, sticky and pheromone traps. The adults monitoring should be supported by egg and larval monitoring following sequential sampling technique at frequent intervals in case of boll worms.

7. Bird perches should be arranged @ 10 per acre for encouraging bird predation on bollworm larvae.
8. The buildup of broad spectrum predators viz., spiders, coccinellids and chrysopids should be synchronised in other cultural operations. Release of *Trichogramma* egg parasite @ 50,000/ha and *Chrysopa* egg larval predator @ 10000/ha, should be done as soon as the first brood of bollworms are noticed.
9. Topping of cotton plants when maximum egg laying of *Helicoverpa armigera* is noticed (October-November months).
10. Application of HNPV @ 500 LE/ha or neem seed kernel extract (5%) in synchrony with early larvae of *Helicoverpa*. Neem oil formulation to manage initial whitefly.

11. ETLs for Bollworms

Name of the Pest	ETL
American bollworm (<i>H. armigera</i>) and Spotted Boll worm (<i>E. vitella</i>)	Five per cent damaged fruiting bodies or one larva per plant or total three damaged square per plant taken from 20 plants selected at random for counting.
Pink bollworm (<i>P. gossypiella</i>)	Eight moths per trap per day for three consecutive days or 10 % infested flowers or bolls with live larvae.
Tobacco caterpillar (<i>S. litura</i>)	One egg mass or skeletonized leaf / ten plants

12. Poison bait (10.0 kg of rice bran + 2.0 kg jaggery + 500-750 ml of chlorpyrifos or 250-300 g of thiodicarb) for the control of grownup larvae of *Spodoptera*.
13. Resorting to chemical insecticides for the control of leafhoppers spray monocrotophos 36 SL @ 1.6 ml/l or acephate 75 SP @ 1.5 g/l or fipronil 5% SC @ 2.0 ml/l or imidacloprid 17.8 SL @ 0.4 ml/l or acetamiprid 20 SP @ 0.2 g/l or thiamethoxam 25 WG @ 0.2 g/l or flonicamid 50 WG @ 0.3 g/l. For the management of whitefly spray triazophos 40 EC @ 2.0 ml/l or profenophos 50 EC @ 2.0 ml/l or diafenthiuron 50 WP @ 1.25 g/l or neem seed kernel extract @ 5% or neem oil @ 5.0 ml/l; for the control of *Helicoverpa armigera* spray quinalphos 25 EC @ 2.5 ml/l or chlorpyrifos 20 EC @ 3.0 ml/l or acephate 75 SP @ 1.5 g/l or indoxacarb 14.5 SC @ 1.0 ml/l or thiodicarb 75 WP @ 1.5 g/l or spinosad 45 SC @ 0.3 ml/l or flubendiamide 48 SC @ 0.3 ml/l or chlorantraniliprole 18.5 SC @ 0.3 ml/l. For managing red spider mites, application of wettable sulphur 80 WP @ 3.0 g/l or dicofol 18.5 SC @ 5.0 ml/l. Similarly if mealy bugs spread in patches to alarming level spray acephate 75 SP @ 2.0 g/l or profenophos 50 EC @ 3.0 ml/l mixing with sandovit or teepol.
14. Removal of cotton stubbles after last picking without opting for ratoon crop or prolonging the crop growth with irrigations and fertilizer applications. This is essential to break the cycles of problem pests in the system as a whole

Mealy bug management in Cotton

- Adopt crop rotation
- Removal and burning of alternate weed hosts like *Parthenium*, *Abutilon* etc. in the vicinity of cotton crop

- Control mealy bug population on the alternate crop hosts during on and off season
- Stem application of monocrotophos diluted with water in 1:4 ratio during vegetative and early reproductive stage of the cotton crop at 30, 45 and 60 DAS as a prophylactic measure.
- Monitoring the initial infestation of mealy bug, particularly on border plants and shaded areas for timing of control measures.
- Need based spraying of insecticides, triazophos 40 EC @ 3.0 ml/l or profenophos 50 EC @ 3.0 ml/l or acephate 75 WP 2.0 g/l mixed with stickers like triton or sandovit or teapot etc @ 1ml/l of spray fluid
- Spot application of insecticides is desirable when the infestation is confined to isolated pockets in the field.
- Removal and destruction by burning of heavily infested dried / dead cotton plants may be taken up to arrest further spread of the pest incidence.
- Removal and burning of left over cotton stubbles after harvesting.

Management strategies for pink bollworm:

ETL for Pink bollworm:

- Eight moths per pheromone trap per day for three consecutive days.
- One rosette flower/ 10 flowers (10 % infested flowers).
- One live larvae / 10 bolls (10 % infested bolls).

Sampling technique:

- Scout cotton crop for PBW incidence and determine ETL through
 - (i) Examination of 50 flowers across the whole field randomly for rosette flowers
 - (ii) Collect 20 bolls/acre randomly, not more than one boll per plant and cut open them for damage and larval presence at 10 days interval.

Integrated Management of Pink bollworm in Bt Cotton:

Off Season Practices:

Certain off-season cultural practices which aim to maintain a host-free period play a key role in minimizing carry-over of pink bollworm to the succeeding season

- Gin Sanitation: Destroy damaged seed trash by burying them in pits or through burning. Install four pheromone traps around the pile of waste lint from the gins to trap the emerging male moths
- Field sanitation. Pink bollworm larvae remain hidden in dried or improperly opened bolls. So, destroy leftover cotton stalks with dried/unopened green bolls by burying them in pits or through burning.
- Allow cattle, sheep and goats to graze upon immature green bolls and attacked bolls after final picking to prevent carry-over of the pest to the next season.
- Prompt removal and destruction of cotton stubbles to prevent carryover of pest to next season without stacking in the fields.
- Spread awareness on the importance of destroying pink bollworm damaged cotton seeds after ginning. These seeds could contain diapausing pink bollworm larvae hidden within the half-eaten seed.
- Destroy trashed and stained cotton with damaged seeds whether lying in the farmer's house or in the Gins. This is a rich and concentrated source of resting pink bollworm larvae.
- Avoid ratooning and summer cotton.
- Restrict the movement of cotton seed from other areas/states
- Crop rotation to break the life cycle of the pest

Pre Season Practices:

This is the key period to create awareness amongst growers on the good agricultural practices which need to follow.

- Deep summer ploughings should be done to destroy the diapausing larvae of pink bollworm in soil and plant debris.
- Non-*Bt* refuge has to be planted along with Bollgard II cotton as this delays development of resistance in bollworms to *Bt* crops and is important for the sustenance of benefits from *Bt* cotton technology.
- Grow early maturing varieties so that the cotton bolls mature before the heavy population of pink bollworm builds up.
- Avoid staggered sowing in an area and take up timely sowings.

In season (June-January) Practices:

- Monitoring for pest build up with pheromone traps @ 10 nos/ha. and random destructive sampling of green bolls.
- Mass trapping and mating disruption technique on wide area through integrated approach
- Destroy rosette flowers and remove the dropped squares, dried flowers and pre-matured bolls to suppress pest population periodically at the initial stage.
- Adopt efficient and timely agronomic practices such as use of organic manures and recommended doses of 'N' fertilizers only.
- Release of *Trichogramma* @ 60,000/acre at the time of peak flowering stage to facilitate the egg parasitism
- Need based use of insecticides: Spraying of persistent insecticides like thiodicarb 75 WP @ 1.5 g/l or profenophos @ 2 ml/l or quinalphos 25 EC @ 2.5 ml/l or chlorpyrifos 20 EC @ 2.5 ml/l at 15 days interval.
- If the crop is at final stage, spray synthetic pyrethroids such as cypermethrin 10 EC @ 1.25 ml/l or lambda cyhalothrin 5 EC @ 1.0 ml/l (caution- Use of synthetic pyrethroids will increase the incidence of sucking pests).

Timely crop termination without extending the crop through irrigation and fertilizers as late formed bolls may severely attract pink boll worm incidence

Management of Cotton Diseases:

Bacterial blight: Angular leaf spots develop and spread through veins causing vein blight. Under severe conditions disease spreads to branches causing black arm. Dark green spots develop on bolls which turn black and bolls rot.

Control: Seed treatment with *Pseudomonas fluorescens* @ 10.0g/kg seed; spraying copper oxy chloride 3.0 g/l + streptomycin 100 mg/l starting from 50 days after sowing, 2-3 times, at fortnightly intervals.

Alternaria leaf spot: Brown spots with concentric rings develop on leaves, join together and dry; defoliation occurs. Lesions on stem extend and break.

Helminthosporium leaf spot: Light brown spots with ashy centres and red margins

Cercospora leaf spot: Dark brown circular spots with white centres and purple margins develop on leaves.

Control: For the control of leaf spots seed treatment with *P. fluorescens* @ 10.0 g or carbendazim 2.0g or thiram 3.0g or vitavax 2.0 g/kg of seed; spraying copper oxy chloride 3.0 g/l or mancozeb 3.0 g/l or propiconazole 1.0 ml/l or captan + hexaconazole 1.0 g/l starting from 50 DAS, 2-3 times, at fortnightly intervals.

Grey mildew: Angular, white, powdery spots develop on leaves, spread and defoliation occurs. Control: Spraying water soluble sulphur 3.0 g/l or carbendazim 1.0 g/l, 2-3 times, at 10-15 days interval.

Rust: Yellowish brown to reddish brown pustules develop on both sides of the leaves.

Control: Spraying water soluble sulphur 3.0 g/l or tridemorph 1.0 ml/l or propiconazole 1.0 ml/l, starting from 75 DAS, 2-3 times, at fortnightly intervals.

Boll Rots: Dark spots or lesions develop on bolls.

Control: Spray copper oxy chloride 3.0 g/l + streptomycin 100 mg/l or carbendazim 1.0 g/l, 2-3 times at 7-10 days interval.

Root rot: Sudden death of young plants in patches, roots become sticky and bark shreds in grown up plants.

Fusarium wilt: Damping off symptoms at seedling stage, lower leaves wilt early and drop. Brown streaks are visible in split open branches or stems, sometimes with black spores.

Verticillium wilt: Interveinal chlorosis and dark lesions develop on leaves with appearance of tiger stripes, brown discoloration is visible in split open stems, branches and also inside the bark, plants die in the centre of infected patch.

Control: Seed treatment with *Trichoderma viride* @ 10.0 g or *P. fluorescens* @ 10.0 g or carbendazim 2.0 g or thiram 3.0 g or vitavax 2.0 g/kg of seed; soil application of *T. viride* or *P. fluorescens* @ 1.0 kg/acre developed in 90.0 kg FYM or vermicompost along with 10.0 kg of neem cake; balanced Nitrogen application and correcting micronutrient deficiencies; soil drenching at the base of infected plants with copper oxy chloride 3.0 g/l or carbendazim 1.0 g/l or benomyl 1.0 g/l.

Harvesting :

1. Kapas from fully opened bolls should be collected during cooler times of the day.
2. Kapas picked should be free from debris like dried leaves, dried bracts etc.
3. Kapas from the first and last pickings should not be mixed with middle pickings, which are of better quality.
4. Kapas damaged by bollworms should be picked separately.
5. The cleaned kapas is to be graded and stored in heaps or in gunny boras in dry and well ventilated godowns.

Post-harvest Technology:

1. It is essential that proper care is taken at various stages of handling and processing to ensure that the quality of cotton is not adversely affected so as to realize maximum price.
2. Watering the kapas before weighment should be avoided.
3. Admixtures of different varieties should be avoided. The admixture of the inferior type lowers the quality of the superior type, due to differences in the fiber quality traits.
4. Only one variety of cotton should be heaped and packed to maintain the purity and quality of the cotton.
5. For supply of high quality of cotton, proper packing should be done to protect from contamination and dampness.
6. Improper drying due to lack of proper yard at village level generally results in to the discoloration of the fibres.
7. Even at the market level, the conventional packing of kapas in bales gives rise to problems such as requirement of large space and possible fire hazards. Storing in open yards at the market should be avoided.
8. The seeds from insect attacked and immature bolls being more fragile get crushed during ginning resulting in staining of lint by the oil oozing out of the cut-seeds. This

oil acts as a medium for growth of the micro-organisms which will destroy the lint. So, the insect infested kapas should be separated.

9. Difficulties in handling of kapas due to its bulky nature – adequate storage space is to be provided both at the farmer's level as well as at the market.

IX. HORTICULTURAL CROPS

1. VEGETABLES

Bhendi, tomato and brinjal are the major vegetable crops grown during *Kharif* and *Rabi*.

Varieties

Bhendi : Parbhani Kranthi, Arka Anamika.

Tomato : Pusa Ruby, Pusa Early Dwarf and Arka Vikas.

Brinjal : Pusa purple, Long Bhagyamathi, Green Spiny, Polur (local preferred variety)

Sowing time

Bhendi is sown during June-July in *kharif* tomato and brinjal during June. The seed rate for bhendi is 18-20 kg ha⁻¹ with a spacing of 45 cm x 20 cm, In raising nurseries 500 g ha⁻¹ tomato, 650 g/ ha⁻¹ brinjal seed is required. For tomato adopt spacing of 50 cm x 50 cm and for brinjal 60 cm x 60 cm.

Fertilisers : Apply FYM at 20-25 t ha⁻¹ and fertilisers 100 N, 50 P₂O₅, 50 K₂O kg ha⁻¹ for bhendi, tomato and brinjal.

Pest management

Shoot and fruit borers

Spray Carbaryl 50 WP @ 3.0 g or quinalphos @ 2.0 ml or monocrotophos @ 1.6 ml per litre of water. Repeat the spraying on need basis.

Jassids, aphids and white flies

Spray dimethoate @ 2.0 ml or fipronil @ 2.0 ml or monocrotophos @ 1.6 ml or triazophos @ 1.5 ml per litre of water.

Mites Spray dicofol @ 5 ml or wettable sulphur @ 3.0 g/litre of water.

Gram caterpillar

Grow marigold as trap crop (1:16). Keep bird perches @ 25/ha. Spray HaNPV @ 500 LE/ ha, along with 0.1 % jaggery and 0.1 % sandovit solution. Application of acephate 75 SP @1.5 g or quinalphos 25 EC @ 2.5 ml per litre water will minimise the incidence. Hand pick and destroy grown up larvae.

Disease management

Powdery mildew (Bhendi) : Spray wettable sulphur @ 3 g or dinocap @ 1 ml per litre of water at 10-15 days interval starting from first symptom appearance.

Yellow vein mosaic virus (Bhendi) : Remove and destroy infected plants and spray acephate @ 1.5 g/l or dimethoate @ 2 ml/l for the control of vector.

Damping off (Tomato) Raise the nursery in raised seed beds. Treat the seed with thiram or captan @ 3 g/ kg. Drench the bed with copper oxychloride @ 3 g /l.

Early blight (Tomato): Spray mancozeb @ 3 g/l or propiconazole @ 1 ml/l twice at 15 days interval.

Little leaf of brinjal (MLO disease): Remove and destroy the infected plants. Spray dimethoate or methyl demeton @ 2ml/l at 7-10 days interval.

2. CHILLIES

Varieties : G 3, LCA 235, LCA 206, G 4, Sindhur, LCA 305, LCA 334
Soils : Black soils, Chalka soils, Sandy loams and Red loams
Seed rate : Nursery 650 g/40 m²
Direct sowings : 6.25 kg/ha.
Seed treatment : Imidacloprid @ 8 g / kg seed followed by 3 g Captan / kgseed. (or)
Soil application of fipronil granules @ 80 g/ 40 m² nursery followed by 3 g Captan / kg seed.

Spacing : Irrigated : 56 cm x 56 cm or 60 X 60 cm - two seedlings per hill
Rainfed : 56 cm x 15 cm – Single seedling per hill.

Sowing / planting : Direct sowing : July to Aug.
Nursery : July
Transplanting : September.

Manures and Fertilizers: 25 tonnes of FYM/ha.
Irrigated : 300 N + 60 P₂O₅ + 120 K₂O kg/ha

Intercultivation : Work with blade harrow or tined harrow or junior hoe and finally with plough.

Irrigation : 3-4 irrigations.

Pest Control

Thrips : Acephate @ 1.5 g or fipronil @ 2 ml or spinosad @ 0.25ml or chlorfenpyr @ 2 ml, diafenthurion @ 1.5 g or monocrotophos @ 1.6 ml or phosalone @ 3 ml or carbaryl @ 3g/litre of water.

Mites : Dicofol @ 5 ml or wettable sulphur @ 3 g or micronized sulphur @ 2.5 g/litre of water.

Aphids : Monocrotophos @ 1.6 ml or acephate @ 1.5 g or methyl-o-demeton @ 2 ml / litre of water.

Pod borers : Thiodicarb @ 1 g or spinosad @ 0.25ml or acephate @ 1.5 g or chlorpyrifos @ 2.5 ml/litre of water.

Disease Control

Damping off : Seed treatment with captan @ 3 g/ kg seed.
Drench the seed bed with 1% bordeaux mixture or copper oxychloride @ 3g/l, 2-3 times at weekly intervals starting from 13th day of sowing.

Choanephora blight : Spraying streptomycin @ 1 g mixed with copper oxychloride @ 30 g per 10 lit of water twice at one week interval.

Bacterial leaf spot : Spraying streptomycin @ 1 g mixed with copper oxychloride @ 30 g per 10 lit of water twice at one week interval.

Cercospora leaf spot: Spray carbendazim @ 1g/l or mancozeb @ 3g/l of water 2-3

times at one week interval.

Dieback or Fruit rot: Seed treatment with captan or mancozeb @ 3 g/kg seed. Spray or copper oxy chloride @ 3.0g/l or propiconazole @ 1ml, difenconazole @ 0.5ml/l, copper hydroxide @ 2.5g/l of water 3-4 times.

Powdery mildew: Spray dinocap @ 1 ml/l or Wettable sulphur @ 3 g/l.

Virus complex: Treat the seed with imidacloprid @ 8 g/kg seed against thrips to prevent PBNV

- Control vector by applying carbofuran 3 G @ 30 kg/ha or fipronil granules @ 20 kg / ha twice at 15 & 45 days after transplantation.
- Spray acephate @ 1.5 g/l or fipronil @ 2 ml/l or Spinosad @ 0.25 ml/l
- Select virus resistant varieties like LCA 334, G 4, LCA 235 and LCA 305.
- Sowing of barrier crops like jowar, maize or sunflower.
- Destroy alternate weed hosts on field bunds.

Harvesting: Harvest fully ripe fruits at periodical intervals.

Tips for quality improvement of chilli

1. Timely harvests improve quality of chilli
2. Delayed harvests develop wrinkles on pods due to over ripening
3. Heap the ripe pods over night to get uniform ripening
4. Avoid insecticide sprays before picking to prevent pesticide residues
5. Dry the produce till the moisture reaches 10-11% level
6. Optimum drying of the harvested chilli on polythene sheets or cement floors to prevent Aflatoxins
7. Keep the produce free from dust and other foreign material while drying to prevent contamination. Keep the dogs, cats and poultry away from the drying floor
8. Sort out the damaged and white spotted fruits to market the graded quality produce
9. Cold storage retain colour and quality of produce and fetch remunerative price
10. Do not use any chemical for improvement of color like Sudan R-I as they are hazardous(toxic) and are prohibited for use
11. Do not write with ink on chilli field gunnies to prevent contamination of toxic chemical Rhodamine B which will be observed by the dried and packed chillies.

3. ONION

Varieties: Bellary Red, Pusa Red, Nasik Red, Agrifound Dark Red, Agrifound Light Red.

Seeding: Sow nursery during June-July. 7-8 kg seed sown on raised beds in 500 m² will be sufficient to transplant one hectare. The seedlings will be ready within 45 days. Plant on both the sides of ridges or beds with a spacing of 30 x 10 cm. Dip the seedlings in 1% Bordeaux mixture before transplanting.

Fertilizers:

Incorporate FYM at 25 t ha⁻¹ during preparatory cultivation and apply fertilisers @ 100:50:60 NPK kg ha⁻¹. Apply entire P, K and half of the N as basal and the remaining 50 N has to be top dressed in two equal doses at monthly intervals.

Weed management: Spray pendimethalin @ 3.5 L ha⁻¹ one week after transplanting onion seedlings.

Pest Management

Thrips: Spray dimethoate @ 2.0 ml or methyl dematon @ 2.0 ml or monocrotophos @ 1.6 ml

per litre of water.

Disease management

Blight : Spray mancozeb @ 3 g or ziram @ 2 g or carbendazim @ 1 g per litre of water four to five sprays at 7-10 days interval starting from first symptom appearance.

Post harvest technology: Store the bulbs in aerated and ventilated structures, turn periodically and remove rotted bulbs.

4. ACID LIME AND SWEET ORANGE

Well drained soils, free from salinity and alkalinity and uniform texture up to a depth of 2-3 m are ideal.

Varieties

In acid lime, Balaji (Tenali clone) is a recently released variety with a yield potential of 117 kg of fruit/plant/year. It is resistant to canker and dry root rot diseases and tolerant to leaf miner. In sweet oranges, Sathgudi, which is superior to Mosambi is recommended.

Planting

Acidlime is usually raised from seed. Buddings on Gajanimma root stock are also recommended. In case of sweet oranges, buddings on Rangpur lime root stock are recommended. Buddings from registered nurseries should be used for planting.

Pits of 1.0 x 1.0 x 1.0 m have to be dug with 6.0 m spacing, refilled with soil and manure mixture (1:1) for planting during July-December. Lower branches should be pruned up to 45 cm from ground. Water sprouts and stock sprouts should also be removed periodically.

Manuring

One year old plants may be given 25 kg FYM and 3 kg castor cake in equal splits during January, June and October. The dose should be increased by equal amounts every year. Four year old plants should receive 100 kg FYM along with 12 kg castor cake during the period as in the case of one year old plants. About 1.5 kg of urea, 2.5 kg single super phosphate and 0.75 kg muriate of potash may be given to all bearing trees once in a year.

A combined micronutrient spray - zinc sulphate 500 g, magnesium sulphate 200 g, ferrous sulphate 250 g, copper sulphate 300 g, borax 200 g, lime 100 g, urea 1000 g and water 100 l can prevent deficiency of minor elements, besides improving the quality.

Irrigation

Frequency of irrigation depends on the nature of the soil. Light soils need frequent (weekly) irrigations than heavy soils (10-15 days). Plants should not be subjected to stress during flowering. Double ring method of irrigation is ideal. Drip irrigation greatly economises the irrigation water.

Pest management

Leaf miner: Spray dimethoate @ 2 ml or monocrotophos @ 1.6 ml per litre of water twice at weekly intervals beginning with the production of flush or sprinkle the neem cake solution on trees @ 250 g of neem cake mixed in 4-5 L of water at the early stages of infestation.

Leaf weevils: Spray monocrotophos @ 1.6 ml or carbaryl @ 3 g per litre of water two or three times at 10 days interval.

Citrus butterfly: Spray dichlorvos @ 1.0 ml or monocrotophos @ 1.6 ml or *B.t* @ 1g per litre of water

Bark and stem borer: Pour petrol in the holes and plug them with mud or inject solution of dichlorvos @ 1 ml per litre of water.

Mangu or pinkish mites: Spray wettable sulphur @ 3 g or dicofol @ 5 ml per litre of water.

Fruit sucking moths: Clean cultivation and removal of alternate hosts are of primary importance. The fruit damage can be minimised by bagging the individual fruits with palmyrah baskets.

Aphids: Spray dimethoate @ 2 ml per litre of water.

Scales: Rubbing the affected portion with a piece of gunny bag and spray dimethoate @ 2.0 ml per litre of water.

Disease management

Twig blight and *diplodia* gummosis: Pruning blighted twigs before onset of monsoon and spraying carbendazim @ 1 g /l four times at quarterly interval.

Canker: Spraying streptomycin @ 1 g mixed with copper oxychloride @ 30 g per 10 lit of water thrice at monthly intervals during rainy season. For sweet orange first spray should be given when fruits are of marble size.

Pre harvest stem end rot: Spray carbendazim @ 1.0 g per litre of water thrice at monthly intervals during June, July and August.

Virus diseases : Use certified bud material free from virus diseases. Greening and tristeza in sweet orange can be prevented by using Rangpur lime as rootstock.

5.MANGO

India contribute 64 percent of total World Production of the 25 million metric tonnes and 83 per cent of Asia's production of 11.8 million metric tonnes. In India, Andhra Pradesh has second largest area under mango, being next to Uttar Pradesh covering about 3.70 lakh ha, but ranks first in production of about 29.6 lakh tonnes per year. Krishna, Chittoor, Vijayanagaram, Khammam and West Godavari are five major growing districts in Andhra Pradesh.

Varieties

Andhra Pradesh has the largest number of commercial varieties (table, juicy, pickle, off season, exotic and export varieties) and is endowed with the unique position of having the richest varietal wealth in the world.

Table purpose

i. Banganpalli (Baneshan, Safeda): This is the leading commercial variety of the state. Tree medium, fruit large sized (2 to 3 per kg), fruit colour golden yellow, quality very good, mid season (it is good in taste if tasted towards later half of May), moderate yielder and fairly regular, moderately tolerant to hoppers and winds, keeping quality good, suitable for canning.

ii. Totapari (Bangalore, Collector, Chittoor mamidi): Better suited to dry regions, more regular and heavy yielder. Tree medium, mid season (bearing later than Banganpalli) fruits medium to large (2 to 3 per kg), skin thick, shape oblong (bottle necked towards the base) fruit quality poor to medium, trees vulnerable to cyclone damage, fruit keeping quality is excellent.

iii. Suvarnarekha (Sundari, Lal Sundary): Popular in Srikakulam and Visakhapatnam districts. Tree medium, bearing heavy and regular, early in coastal area (i.e. about last week of April) and mid season in Telangana region. Fruit medium size (4 to 6 per kg), skin

medium thick, shape ovate-oblong, colour light cadmium with a blush of deep red, flesh firm, fibreless, fruit quality medium to good, with an acidic blend, susceptible to powdery mildew, keeping quality is good.

iv. Neelum

More popular in Rayalaseema region. Tree medium, highly regular and heavy bearer, late season, fruits medium sized (4 to 6 per kg), skin medium thick, shape oval-oblique (roundish), sinus some what prominent and beak distinct, colour orange yellow, flesh fibreless fruit quality better than Totapari, with an acidic blend, more susceptible to anthracnose keeping quality good.

v. Dashehari

More suitable for Telangana Zone. Tree medium to vigorous biennial bearer moderate yielder, mid season, fruits small to medium in (4 to 8 per kg), skin medium thick shape elliptical-oblong, colour greenish yellow, flesh firm, fibreless, fruit quality excellent, with more sugar acid blend, keeping quality good.

vi. Kesar

Tree medium, mid-season, biennial in bearing, moderate fruits medium to large size (3 to 4 per kg), shape oblong, fruit colour light apricot yellow with red blush on shoulders. Taste is very good and sugar / acid blend is excellent.

vii. Mahmooda Vikarabad

A dwarf variety suited for high density planting. Tree small, regular and heavy bearer, mid season to late, fruit medium, skin thin, yellowish green, flesh moderately firm, fibreless, fruit quality very good to best, susceptible to hopper tolerant to winds, keeping quality of fruit good.

Hybrids

i. Mallika (Neelum x Dashehari) : Tree medium, mid to late season, fairly, fruits large sized (2 to 4 per kg), skin medium thick fruit shape oblong elliptic, colour cadmium yellow, flesh firm, fibreless fruit quality excellent, with more sugar acid blend. Keeping quality good.

ii. Neeleshan (Neelum x Banganpalli): A hybrid between Neelum and Banganpalli, released from Agricultural Research Station, Anantharajpet. This has become quite popular among the farmers of Rayalaseema region. It excels Banganpalli in productivity and regularity of bearing, fruit large sized and similar in appearance.

iii. Manjeera (Rumani x Neelum) : Hybrid of Rumani x Neelum released from Fruit Research Station, Sangareddy, fruit very attractive and large (300 to 350 g) looks like Rumani. It is dwarf variety, suitable for high density planting. About 500 plants can be accommodated per hectare adopting a spacing of 4.5 m x 4.5 m. It is a prolific and regular bearer.

Juicy Varieties

i. Peddarasam : Popular in Godavari and Krishna districts. Tree medium in height, fruit large, greenish yellow when ripe, juice is abundant fibrous, sub-acidic, bearing early, fairly regular.

ii. Chinnarasam : Popular in Nuzvid area, tree medium, fruit medium sized, juice abundant, characteristic strong flavour fruit quality very good, bearing regular and heavy (mid-season to late), keeping quality fair.

iii. Navaneetham (Panchadara Kalasa) : Tree medium to large, fruit medium, juice abundant fibre short and soft, fruit quality very good, bearing regular and heavy mid-season susceptible to powdery mildew and moderately tolerant to hopper.

Pickle Varieties

Jalal: Regular bearer, fruit size medium to large. It is a late variety.

Soils

The most desirable soil for mango should be of medium texture, deep (2 to 2.5 m), well drained, low water table (below 180 cm in all the seasons) and having a pH range of 5.5 to 7.5 for good growths and production of mangoes provided they are not very alkaline. Higher calcareous soils are unsuitable for mango. Saline and alkaline conditions are not conducive for profitable mango cultivation.

Localities which experience bright sunny days and relatively low humidity during flowering period are ideal for mango growing. It can do well in area having an average rainfall as low as 25 cm if irrigation can be provided.

Planting material

One or two year old vegetatively propagated plants on desirable rootstock should be collected from an authentic source. Under Fruit Research Station, Sangareddy conditions, Movadhan and Turpentine rootstocks are suitable for better growth of the tree. For better stand and longevity of the trees, it is advisable to go for *in situ* grafting.

Planting and spacing

It is generally planted at the beginning of the monsoon (June-July). In areas with heavy rainfall it is done at the end of rainy season. Dig pits about 1 m X 1 m X 1 m and fill with soil well-mixed with 25 kg farm yard manure, 2 kg superphosphate and 150 g aldrin dust. The planting distance will vary with the vigour of the variety and location ranging from 8 to 12 meters. The dwarf hybrid varieties should be planted at closer spacing. Plant the graft with its earth ball intact and press the soil all around. The graft jointing should be above ground level. It is always better to adjust it at the same height/depth at which it was in the pot or nursery bed. Stake the plant to prevent wind damage. Remove rootstock sprouts below the graft joint.

Manures and fertilizers: To improve the texture of light soils add adequate tank silt and FYM. Fertilizer schedule for mango is as follows

Age of the Tree	Nitrogen(g/tree)	Phosphorus (g/tree)	Potash(g/tree)
First year	100	100	100
Second year	200	200	200
Third year	300	300	300
Fourth year	400	400	400
Fifth year	500	500	500
Sixth year	600	600	600
Seventh year	700	700	700
Eighth year	800	800	800
Ninth year	900	900	900
Tenth year and onwards	1000	1000	1000

Fertilizers should be applied through placement in circular trenches dug 4 cm deep and 20 cm away from the stem in the first year of application and increasing the depth and lateral distance in the multiples during later years. Manuring is generally done in the beginning of monsoon. Wherever irrigation is available, is advantageous to apply part of the manures after fruit set. In the absence of irrigation, foliar sprays of 2% urea and phosphorus through orthophosphoric acid may be sprayed in September – November and March. This zinc deficiency can be corrected by 0.5% ZnSO₄ at the beginning of the growing season thoroughly wetting the foliage.

Intercultivation and intercrops

Intercrops like vegetables, low-growing field crops and fruits like phalsa or papaya can be profitably grown in all young orchards. Redgram is not advisable as it is a deep rooted plant and also an alternate host for mealy bug. In old orchards shade tolerating crops like ginger, turmeric etc., can be taken up.

Pruning to remove the criss-cross dead & dried branches may be done so that the center of the tree is opened with less dense canopy and inner branches are exposed to sunlight. Spraying 1% Urea & 0.5% Zinc Sulphate has been recommended during October & November months for uniform flowering and fruiting every year.

Irrigation

The young plants at pre-bearing stage should be irrigated frequently. In bearing trees, for obtaining good flowering, irrigation must be stopped at least 2 to 3 months before flowering period. Irrigation at regular intervals during fruit development period is necessary; beginning from fruit set stage to full development stage and stopped 30 days before harvesting the crop.

Fruit drop

Controlled by spraying 2, 4-D at 10 ppm or Naphthalene acetic acid at 20 ppm twice at an interval of 15 days during the early stage of fruit development. Avoid any spray at peak time of flowering (full bloom stage).

Harvesting

The characteristic taste and flavour of the variety develops only by harvesting full size matured fruits. The minimum total soluble solid content for harvesting without sacrificing the quality is 9.0 in case of Banganpalli and 8.5 for Dashehari. For judging the maturity, fruit samples from various directions of the tree are taken and dropped in bucket of water, the dipped fruits being, indicative of correct maturity. In case of pickle mangoes, time of harvest is relatively more flexible and any time between stone hardening and attainment of physiological maturity appears to be suitable. Harvesting should be done, using mango harvester.

1. All the fruits harvested with pedicel avoiding injury to the fruits.
2. Avoid shaking and injuries to branches and thus no loss by way of fruit drop from trees during harvesting.

Post-harvest Technology

The harvested fruits should be covered or taken to the ripening room immediately to

avoid damage. Remove the sap before keeping for ripening.

Coating the fruit with 6% wax emulsion delays ripening by 2-4 days, minimizes the weight loss and disease incidence. The fruits can be kept for about 6 weeks in cold storage at a temperature of 5.5°C to 7.2°C and relative humidity of 85-90%. Storage life of mango can be extended by 20 days by hydro cooling (12°C) and 0.1% carbendazim treatment.

Recommendations for production of export quality mango

Integrated Nutrient Management

1. Add organic manures profusely. Add 100 kgs of well decomposed FYM or 10 kgs vermicompost per tree.
2. Add bio-fertilizers like phospho-bacteria, azospirillum @ 250 g per tree.
3. Raise green manure crops in the interspaces (sun hemp and dhaincha) in the month of June or July and incorporate in the field after 45 to 50 days.
4. To avoid micro-nutrient deficiency apply 50 to 100 g of Borax, 25 g of Zinc Sulphate and 50 g of Magnesium Sulphate per tree.
5. Apply 100 g each of NPK per one year old plant (217 g Urea + 625 g SSP + 167 g MOP). Increase 100 g each of NPK every year up to 10 years. For 10 years and above old plantation apply 2.17 kg Urea + 6.25 kg SSP + 1.67 kg MOP per tree.
6. Foliar application of Zinc Sulphate @ 5 g + 2 g Borax and 10 g Urea per litre of water at new vegetative growth.
7. Apply Potassium Nitrate @ 10 g per litre of water or 13-0-46 (multi K) @ 10 g per litre based on leaf analysis in the month of October
8. Before flowering for good fruit set, spray Borax (Solubor) @ 2 g per litre along with first spray schedule.

Pest and disease management

Fruits should be free from pests and diseases. Plant protection measures should be taken at the time of flowering and fruiting against thrips, hoppers, mealybugs, powdery mildew, anthracnose and stem end rot.

a. Spray schedule for control of pests and diseases

- 1st spray – 15-20 days before panicle emergence / budburst- spray with monocrotophos @ 1.5 ml + wettable sulphur @ 3 g per litre of water on the entire tree.
- 2nd spray – To control leaf hopper at budburst stage- spray carbaryl @ 3 g or imidacloprid @ 0.3 ml + carbendazim @ 1 g per litre of water.
- 3rd spray – To control powdery mildew and hopper at flowering and fruit set stage - spray Imidacloprid @ 0.3 ml + dinocap @ 1 ml per litre of water.
- 4th Spray – At marble fruit stage spray Multi K @ 10 g + mancozeb or copper oxy chloride @ 3 g per litre of water.
 - Add adjuvant @ 0.5 ml/l to spray solution.

b. Precautions at the time of harvest

1. Avoid injury to the fruit at the time of harvest. Use Dapoli harvester.
2. Harvest the fruits at 70-80% maturity. The recommended weight of the fruit at harvest are as following:
 1. Banganpalli - 350 g (10 g more or less)
 2. Chousa, Dashehari - 300 g (10 g more or less)
 3. Alphonso - 250 g (10 g more or less)
 4. Kesar - 235-265 g (10 g more or less)
 5. Suvarnakha - 240-270 g (10 g more or less)
3. Harvest the fruit with 5-7 cm stalk and cut it to 1 cm before shifting to pack house.
4. Harvest fruits between 6-10 AM. Do not harvest the fruit when the temperatures are high.
5. For export by sea select fruits which are green in colour without prominent lenticels and with TSS of 7-9°B. Shelf life of these fruits is 20-25 days.
6. For export by air harvest the fruit at 100-105 days and when the fruits are green in colour with prominent lenticels. Shelf life of fruits is 17-20 days.
7. For export to other states harvest the fruits at 108-110 days, with 9-11°B TSS, shelf life is 10-12 days.
8. Arrange the fruits in plastic crates by padding the vehicle for transport to pack houses.

Pests

Mango hopper (*Idioscopus clypealis*; *Amrotodus atkinsonii*): Spray carbaryl @ 3 g or monocrotophos @ 1.6 ml or phosphamidon @ 2 ml/l or dimethoate @ 2ml/l. First spray should be given at the early stage of panicle formation (bud burst stage). The second spray at full length of panicle but before full bloom and the third spray after fruits are set and have attained pea and marble stage.

Hoppers suck the sap from flower panicles due to which flowers dry up and drop prematurely leaves become curled.

Mealy bug (*Drosicha mangiferae*): The early instar nymph can be controlled by spraying monocrotophos @ 1.6 ml or carbaryl @ 3 g or methyl parathion @ 1 ml/l or imidacloprid @ 0.3 ml/l. Use polyethylene band on the trunk region to prevent climbing.

Mealy bugs drain out the plant sap and reduce the vitality and vigour of the plant. Processive and continuous draining of plant sap causes wilting and finally drying of infested tissue.

Shoot borer (*Chlumetia transversa*): The attacked shoots may be clipped off and destroyed. Spraying of monocrotophos @ 1.6 ml or quinalphos @ 2 ml/l at fortnightly intervals from the commencement of new flush, total 2-3 sprays may be given depending on infestation.

Caterpillars enter the young shoot from the terminal end and bores down to a depth of 8-10 cm. The affected shoots wilt and dry up.

Stem borer (*Batocera rufomaculata*): They can be destroyed by inserting a hard wire into the tunnel. Seal the tunnel with wet clay after applying Methyl parathion 50 EC @ 1 ml/l or petrol or few crystals of para-dichloro benzene (PDC).

The grubs bore into the bark and stem. This can be identified from the chewed material coming from the bores and by the hollow sound when the branch is tapped, in severe cases the plant dies.

Stone or Nut weevil (*Cryptorrhynchus mangiferae* Syn. *Sternochaetus mangiferae*): Destroy the adults in bark should be washed with wiped kerosene emulsion. Spray monocrotophos @ 1.6 ml/l or fenitrothion @ 1 ml/l.

The grubs of the insect damage the pulp and cotyledons of the stone. Alphonso, Neeleshan and Totapari varieties are susceptible to this pest.

Diseases

Powdery mildew (*Oldium mangiferae*): It can be controlled by spraying wettable sulphur @ 3g or dinocap @ 1 ml/l along with second spray of insecticide given for hoppers. If the powdery persists, repeat after 3 weeks.

White powdery out growth appears on young leaves and inflorescences. In severe cases young shoots wither & drop. Affected leaves become distorted.

Anthracnose (*Colletotrichum gloeosporioides*): Dead twigs should be pruned to reduce inoculum potential, spraying copper oxychloride @ 3 g/l or carbendazim @ 1 ml/l in the nursery. Instantaneous dip of fruits in benomyl solution (1000 ppm) before storage reduces the incidence of the disease.

Brown fungal spots appear on the leaves and inflorescences, resulting in shedding of flowers. Black spots appear on fruits.

6. GUAVA

In India, Guava is cultivated in more than sixteen thousand hectares. But in Andhra Pradesh the area under guava is estimated as only 4,770 hectares.

Varieties

Allahabad Safeda

Tree vigorous, medium tall, 5.8 to 6.2 m, branching with dense foliage, tendency to produce long shoot, crown broad and compact, leaves 9.5 to 9.8 cm long and 4.8 cm wide, elliptical to oblong in shape. Fruits medium in quality, roundish in shape and weigh 180 g and keeping quality good.

Lucknow-49 or Sardar Guava

Semi dwarf tree, vigorous, heavy branching, crown flat. Leaves large, elliptic, ovate to oblong in shape. Fruits roundish ovate in shape. Skin colour primrose-yellow with occasional red dots on the skin. Early bearing in season. Taste sweet and keeping quality excellent. Profuse bearer.

Safed Jam

Tree medium sized drooping branches, fruits round, average weight 150 g, thin skin, tasty. It is a hybrid of Allahabad Safeda and Kohir and evolved at Fruit Research Station., Sangareddy. Seeds soft, located at the core. Flesh soft and dull white in colour.

Kohir Safeda

It is in hybrid between Kohir Safeda selection and Allahabad Safeda and evolved at Fruit Research Station, Sangareddy. Tree is large, dome-shaped, bears profusely. Fruits are large, oblong, average weight 200 g and some what hard seeded.

Soils

Almost all soils are suitable for guava cultivation. However, deep loams with good drainage are highly suitable. It is sensitive to water logging. Although it survives upto 8.2 pH, planting should not be done on saline or alkaline soils.

In areas, having a distinct winter season, the yield tends to increase and quality improves. It requires dry atmosphere at the time of flowering and fruiting. High temperature at the time of fruit development causes fruit drop.

Propagation

Planting is done in June-July or October-November depending on rainfall and its distribution and the type of soil. Pits of 60 cm X 60 cm X 60 cm are dug in summer season at a spacing of 6 to 7 meters on either side. The pits are filled with Farm yard manure and soil in equal proportions at the commencement of monsoon. About 100 g of BHC 10% dust is also mixed to ward off termites. Layers taken from good pedigree trees should be obtained for planting.

Manures and fertilizers

Age of the tree	Nitrogen (g/tree)	Phosphorus (g/tree)	Potash (g/tree)
1 – 3 Years	50	20	75
4 – 5 Years	100	40	150
7 – 10 Years	200	80	300
11 – Years above	300	160	450

In case of zinc deficiency identified by interveinal chlorosis, sparse foliage, reduced leaf size and meagre fruit production, pre-flowering spray of 0.3% zinc sulphate along with 0.15% lime should be given.

Intercultivation

The root suckers should be removed frequently. The tree should be pruned and trained to good shape and with strong branches.

Intercrops like vegetables and fruits like Bhalsa can be profitably grown in all soils in young orchards upto 4th year. Good crops can be obtained if the trees given Bahar treatment, i.e., withholding water for about a week expose the surface roots and then irrigate the trees after the application of manures and covering the roots before flowering.

Irrigation

For young plants, irrigation at 2-3 days interval and for grown up trees at 10 days interval. Basins should be widened as the tree grows in size.

Plant protection

Stem borer: Attacks the tree between February and April month. The grubs should be removed and petrol is injected into the holes and plugged to kill any young ones remaining inside.

Wilt: Yellowing and browning of leaves at the tips of twigs is the characteristic symptom. Splitting of bark and drying of leaves on terminal branches is followed by complete wilting of plants in 10-15 days.

Control: Soil may be treated with lime or gypsum @ 1 to 2 kg/tree, to prevent the disease. Dry branches may be removed and wilted plants uprooted.

7. SAPOTA

India is considered to be the largest producer of sapota in the world, though it is considered to be a minor crop in India. At present, total area and production under sapota is estimated at 25,824 hectares and 3.38 lakh tones. In Andhra Pradesh sapota is cultivated in an area of 3,490 ha with a production of 8.50 tonnes/ha. But the productivity of 8.5 tonnes/ha. In Andhra Pradesh is far less than the All-India productivity level of 14.19 tonnes/ha.

Varieties

Cricket Ball (Calcutta Large)

This bears the largest sized fruits, which are round in shape. Pulp is gritty and granular and moderately sweet. This variety is free from leaf spot disease.

Kalipatti

Fruits are oval shaped, less seeded with a sweet mellow flesh of excellent quality. Fragrance is mild. Each fruit has 1-4 seeds. Fruits appear singly. The main harvest is in winter. This variety has higher T.S.S, ascorbic acid and total sugar.

Pala (Gutti)

The fruits are small to medium sized and oval or egg shaped, with apex broadly pointed and are very sweet. The bearing is heavy and fruits are borne in clusters. The fruit has thick skin and good flavour.

Kirthabharthi

On the rind 4-6 ridges are seen. Fruit skin is rough, medium thick and buff coloured, and pulp is sweet. Fruit apex is rounded. The fruits can be transported to distance markets.

Dwarapudi

The fruits resemble those of cricket ball but small in size, fruits have a sweet pulp.

Oval

The fruits are small to medium sized and oval or egg shaped. Pulp is coarse grained and less sweet.

Soils

Sapota prefers a warm and moist weather and grows both in dry and humid areas. Coastal climate is best suited. Areas with an annual rainfall of 125-250 cm are highly suitable. The optimum temperature is between 11 and 34⁰C. A high temperature of 41⁰C during summer causes flower drop and fruit scorching. The soils must be well drained and should not have high lime content which induces chlorosis.

Spacing

Light soils	-	10 m x 10 m
Heavy soils	-	13 m x 13 m

Planting

Prepare land by ploughing and harrowing. Dig pits of about 1 m X 1 m X 1 m. Fill the pits with top soil and compost. Plant the grafts in the middle of pit keeping the graft joint above the ground level. Provide support by staking. Planting should be done during rainy or late winter season.

Manures and Fertilizers

F.Y.M

Before planting	---	50 kg/plant
Every year	---	50 kg/plant

Age of the tree	Nitrogen (g/tree)	Phosphorus (g/tree)	Potash (g/tree)
1 – 3 Years	50	20	75
4 – 5 Years	100	40	150
7 – 10 Years	200	80	300
11 Years onwards	400	160	450

Manure the plants in the beginning of rainy season. The fertilizers should be applied in trenches 20 – 30 cm deep and 30 cm wide along the drip line of the tree.

Interculture

The tree basin should be kept free of weeds. Bromacil @ 3 kg a.i/ha proved to be the best herbicide for controlling both broad-leaved weeds and grasses and was effective for a period of 6 months.

Vegetative and other field crops can be grown as intercrops in the first 6 to 7 years.

Application of SHADU at 100 ppm before flowering and again at peak flowering stage results in higher fruit set and NAA at 300 ppm after fruit set results in better retention.

Irrigation

When plants are young irrigation may be given throughout the year depending upon soil condition. In later stages, during summer, irrigation should be given at 20 –25 days interval and in winter at 30 to 35 days interval. Over irrigation results in flower and fruit shedding and also large number of fruits and flat limb malady (fasciation of shoots).

Plant protection

Sapota does not suffer from serious pests and diseases. But some times, chiku moth, chiku bud borer, leaf miner, mid rib folder, leaf spot disease, sooty mold and flattening of branches (*Botryodiplodis theobromes*) are seen. Hence for sapota there is no regular spray schedule and needful control measures have to be adopted. In case of severe infestation of bud borer, whose larva damages the flower bud, spraying of monocrotophos (1.6 ml/l) is recommended. The leaf disease can be effectively controlled by monthly spray of mancozeb (3g/l).

8. SEETHAPHAL

Among the annonaceous fruits, only Seethaphal and Atemoya, a hybrid between Seethaphal and Cherimoya (*Annona Cherimola*) are of commercial importance.

Varieties

Balanagar

It is a local seedling variety collected from Balanagar area of Mahaboobnagar district (A.P.). The fruit quality is good. Fruit size big with large tubercles and plenty of very sweet pulp.

Red seethaphal

The fruits are purple coloured and the leaves of the plant are purplish at the midrib, Sweet in taste but seeds are many. This variety has got the disadvantage of developing stone fruits. Its seedlings come true to type and are very prolific.

Washington P.1107005

This is an introduced variety. The fruit is large, pulpy, few seeded and greenish white in colour. Bearing is sparse.

British guinea

Fruit large, greenish white in colour, pulpy, few seeded, quality good, bearing sparse. Fruits kept for about a week after ripening without spoilage.

Island gem

This is an Australian variety, the fruit is very large in size, smooth, surface, very large segments, very pulpy, very sweet, excellent flavour, bearing is sparse, fruits irregular in shape, keeps for about a week.

Atemoya

This is a hybrid between Seethaphal and Cherimoya, Atemoya grows to a height of about 5-6 m and has luxuriant growth. Hence, planting distance must be 7 m X 7 m. Ripe fruits are whitish green in colour, juicy, delicious pulpy with an excellent acidic flavour, very few seeded. Keeping quality good, can be kept even upto 10 days, bearing is erratic. For every 8-10 plants of Atemoya, one plant of custard apple should be planted in the middle to act as polliniser plant. Otherwise the bearing of Atemoya will be poor and erratic. Atemoyas fruits will come to harvest from October to December.

Pink's mammoth

This is a variety of Atemoya, introduced from Australia. The fruit is very large, ovoid, pulpy, delicious, very few seeded and round segments, excellent in quality, bearing is poor. Fruits are irregular in shape. Fruits kept for about a week after ripening without damage.

Propagation: By veneer grafting on its own root stock.

Soils / Climate

Seethaphal grows on varying soils. The sandy, marginal and waste lands may be utilized for growing these fruits. Since water/logging causes tree decline, heavy soils with poor drainage, sub-soils with hard pan or high water table are to be avoided. Seethaphal is capable of growing in soils having upto 50 per cent lime and 300 ppm of chlorine in irrigation water.

Areas with high humidity, occasional rains and warm temperature are ideal for seethaphal in terms of fruit set and development.

Planting

Pits (50 cm x 50 cm) are dug and filled with a mixture of 20 kg farmyard manure and 300 g fertilizer mixture of urea, superphosphate and muriate of potash in equal proportion at least a fortnight before planting. Planting is done in rainy season at a distance of 5 m X 5 m.

Manures and fertilizers

The bearing trees of seethaphal should be given 250 g N, 125 g P₂O₅, 125 g K₂O per plant before the commencement of rainy season. The Atemoya should be fertilized with 450 g N, 450 g P₂O₅, 450 g K₂O per plant of about 5 years age.

Interculture

In the initial years of planting, intercrops like groundnut, minor millets and linseed can be grown during rainy season and pea, oilseeds and gram during winter season.

Seethaphal bears flower on the current season growth and very rarely on older wood. The early completion of leaf fall is essential for the initiation of new growth. Therefore manual defolixation during the mid-summer is recommended.

Irrigation

Seethaphal does not require irrigation as it prefers semi-arid conditions. For Atemoya, after manuring an irrigation may be given. Afterwards when the fruits are developing 1 or 2 irrigations will improve fruit size and yield.

Harvesting

Harvesting should be done at proper stage of maturity. Fruits are harvested when the colour is light green, segments become flat, the interspaces between segments become yellowish white and initiated cracking of the carpels. Fully mature fruits ripen in 2-3 days after harvest. The temperature between 15 and 30 °C and low relative humidity accelerates the process of ripening

Post harvest technology

The seethaphal fruits can be stored at 15-20 °C temperature, 85-90% relative humidity, low oxygen and ethylene tension and 10% CO₂ . Wax emulsion @ 8 per cent also extends the storage life.

Plant protection

Seethaphal is generally free from the attack of any serious pests or diseases.

Disorders

Stone fruits

Some fruits instead of attaining full size, remain very small and become brown and dry up. These are known as stone fruits, which are retained on tree for a long period. Competition among the developing fruits and high temperature are supposed to cause stone fruit formation.

Fruit Cracking: This usually happens from a heavy rainfall or irrigation after a prolonged dry spell. Evenly distributed irrigation schedule and constant and uniform moisture level in the soil will reduce this problem.

9. BER

It can be grown on a wide variety of soils. It can withstand alkalinity and salinity. It can be grown even in the soils with pH 8.5.

Varieties

Gola, Kaithili, Umran, Seb and Mundia are suitable to arid zones of AP.

Planting

Buddings should be planted in pits of 0.60 x 0.60 m with spacing of 6 m x 6 m. Pits should be filled with 1 kg single super phosphate at the base and with mixture of 1:1 good top soil + FYM and 100 g of endosulfan 4% dust.

Pruning

Pruning in the month of May immediately on receipt of monsoon rains for rainfed crops is good. For high yield and quality fruits, pruning up to 4-6 secondaries should be done.

Manures and Fertilizers

Entire FYM, half the dose of nitrogen and entire dose of P₂O₅ and potash should be given after pruning in June, taking advantage of rains. The remaining nitrogen should be applied in September.

Age of plant	FYM (kg)	N (g)	P (g)	K (g)
1 st year	10	100	50	50
2 nd year	30	200	100	100
3 rd year	50	300	150	150
4 th year	70	400	200	200
5 th year onwards	90	500	250	250

Intercrops like groundnut, greengram and horsegram can be grown up to 3 years after planting. Spray GA 10 ppm after fruit set for increasing size of the fruit.

Pest management

Fruit fly: To minimise the pest infestation, orchard soil should be ploughed during March-April, May-June and August to expose the hibernating pupae to the bright sun and birds. The dropped fruits infested with fruitfly should be collected and buried deep in to the soil, to destroy the pest. During fruiting season spray methyl euzinol @ 2ml/l or dimethoate @ 2 ml or monocrotophos @ 1.6 ml or dichlorvos @ 1.25 ml per litre of water.

Fruit borer: Fruit borer can be effectively controlled by foliar spraying at pea size of the fruit and again after 20 days with monocrotophos @ 1.6 ml or profenophos @ 1 ml per litre of water.

Disease management

Powdery mildew: The disease can be effectively controlled by foliar spraying after appearance of the disease and again after 10 days with dinocap @ 1 ml or with wetttable sulphur @ 3 g per litre of water.

10. POMEGRANATE

Light to medium soils with good drainage are suitable. It performs well on light soils with good colour. It can tolerate salts to certain extent.

Varieties

Ganesh (GPG 1) and Mridula are suitable to AP.

Planting

Air layers or cuttings can be planted with a spacing of 4 x 4 m. For light soils 4 x 3.5 m can be adopted.

Manures and Fertilizers

The following fertilizer doses should be given.

Age (year)	FYM (kg)	N (g)	P (g)	K (g)
1	10	250	125	125
2	20	250	125	125
3	40	500	250	250
4	80	625	300	300

Full doses of FYM, P, K and half of the N should be given at Bahar treatment prior to first irrigation. The remaining quantity can be given in single dose, 40-45 days after first dose. Application of Boron at 0.2% controls cracking of fruits and improves fruit colour.

Irrigation

Irregular irrigations induce fruit cracking. Irrigation should be given at definite intervals depending upon soil and seasonal conditions.

Pest management

Fruit borer: Spray carbaryl @ 4 g or monocrotophos @ 1.6 ml per litre of water from flower bud stage onwards at 2-3 weeks interval. A maximum of four sprays may be necessary.

Disease management

Fruit spot: Spray copper oxychloride @ 3 g or carbendazim @ 1 g per litre of water twice at 20 days interval after the appearance of the disease.

X. SOILS

Classification of salt affected soils

Class	pH	ECe (dS m ⁻¹)	ESP (%)
Saline soils	< 8.5	> 4	< 15
Saline-Alkali soils	> 8.5	> 4	> 15
Alkali soils	> 8.5	< 4	> 15

Saline soils :

- Scratch the soil surface with spade to remove salt flakes.
 - Growing of salt tolerant varieties.
 - Application of P to saline soil is necessary to maintain soil fertility status and to reduce the Chloride toxicity for plants.
 - Application of organic manure is essential. Best results may be achieved by using optimum combination of organic manure, bio-fertilizer and chemical fertilizer.
 - Application of 25% extra nitrogen fertilizers than the recommended.
 - Increasing the density of plant population.
- In ridge and furrow system, the plants are to be planted on the sloping side of the ridge.

Alkali soils :

- Level the land and divide the field in to small compartments with slope of 0.1% to remove drain water
- Grow dhaincha crop upto 50% flowering stage and incorporate into field which reduce the ESP over a period of time.
- Planting of old aged seedlings and increasing the density of planting
- FYM application should be accompanied by the gypsum application. To mitigate the adverse affect of alkalinity, application of FYM without gypsum will not have much use.
- Gypsum should be applied @ 500 Kg ha⁻¹ for each crop especially where RSC waters are used for irrigation. It varies with the type of soil.
- Application of 25 percent extra nitrogen is needed as compared to the normal condition.
- Zinc sulphate @ 25 Kg ha⁻¹ should be added particularly to the rabi crops grown with alkali water.

Water

Grouping of poor quality ground waters for irrigation

Water quality	EC _{iw} (dSm ⁻¹)	SAR _{iw} (mmol L ⁻¹)	RSC (meq L ⁻¹)
A. Good water	<2	<10	<2.5
B. Saline water			
i. Marginally saline	2-4	<10	<2.5
ii. Saline	>4	<10	<2.5
iii. High-SAR saline	>4	>10	<2.5
C. Alkali waters			
i. Marginally alkali	<4	<10	2.5-4.0
ii. Alkali	<4	<10	>4.0
iii. Highly alkali	Variable	>10	>4.0

Saline Water

Waters with EC_{iw} more than 4 dS m⁻¹, SAR less than 10(m mole L⁻¹)^½ and RSC more than 4 meq L⁻¹ called saline water. They are divided in to three types viz., marginally saline, saline and high SAR saline. Saline water is prominent in the following districts...

- Selection of salt tolerant crops and varieties.
- Marginally saline water can be used for irrigation in light textured soils without any problem either on crop yield or on soil properties.
- Marginally saline water can also be used in heavy textured soils with precautions such as selection of crops which needs less number of irrigations and avoid summer irrigation.
- Application of organic manures like FYM @ 5-10 t ha⁻¹ will mitigate the adverse effect of marginally saline/saline water irrigation.
- Proper irrigation and leaching practices can prevent excessive accumulation of salts in the root zone. A shift towards micro-irrigation systems such as drip and sprinklers, where a better control on salt and water distributions.
- Application of amendment like gypsum @ 1-2 t ha⁻¹ is recommended for saline water having Mg:Ca > 3.

- Split application of nitrogen to prevent N losses through volatilization and denitrification. Correction of nutrient deficiencies by foliar application of nutrients.
- Addition of 50 percent more phosphoric fertilisers than recommended dose if irrigated water is rich in chlorides and the soils having low available phosphorous.
- For sulphate rich waters, no additional application of phosphate fertilisers is required and the dose recommended under normal conditions may be applied.
- Dilution and cyclic use of good and saline waters.

Alkali water

Waters with EC_{iw} less than 4 dS m^{-1} , SAR more than $10 \text{ (m mole L}^{-1}\text{)}^{1/2}$ and RSC less than 4 meq L^{-1} are called alkali water.

- Selection of crop varieties tolerant to sodicity /alkalinity.
- Alkali waters should not be used for growing summer crops in the month of April to June.
- Application of dhaincha @ 25 kg ha^{-1} and incorporate at 50% flowering as insitu
- Application of 25 per cent extra nitrogen is needed as compared to the normal conditions to avoid the nitrogen losses through volatilisation and denitrification.
- Zinc sulphate @ 50 kg ha^{-1} is recommended particularly to rice due to precipitation of zinc as hydroxides and carbonates .
- Phosphorus, potassium and other limiting nutrients may also be applied on the basis of soil test values.
- Some alkali waters may be rich in nutrients like nitrogen, potassium and sulphur. Such waters should be analysed and the fertiliser dose of concerned nutrient reduced accordingly.
- Soil application of calcium bearing and amendments like Gypsum, sulphuric acid, pyrites, Passing water through gypsum beds etc., among all gypsum is the cheapest source, low cost and easy handling.
- Gypsum requirement to neutralise residual alkalinity of water: The quantity of agricultural grade gypsum (70% purity) for neutralization of each meq L^{-1} of RSC is 100 kg ha^{-1} per irrigation. The quantity of gypsum is thus determined by the quality of water (RSC to be neutralised) and the quantity of water required for irrigation during a growing season.
- Gypsum application is recommended when high RSC waters are used for irrigation taking into consideration number of meq L^{-1} of RSC over and above the safe limit of 4 meq L^{-1} , soil texture and number of irrigations.

XI. SOIL HEALTH MANAGEMENT

India being an agrarian country two thirds of its population depends mainly on agriculture. The current food grain production of 241 m T will not be sufficient to meet the growing population. It is estimated that the estimated population of 1.44 billion in 2025 needs around 300 m T of food grains. To achieve this there is every need to raise food grain production by more than 4 m T per annum. The scope for increasing area under cultivation is negligible. Hence, agricultural production can only be achieved through efficient resources utilization and improving soil fertility. The present stagnation

in crop yields is the major concern. The challenges facing Indian agriculture are: depleting soil organic matter, imbalanced fertilizer usage, emerging multi nutrient deficiencies especially secondary and micro nutrients, declining nutrient use efficiency and crop response ratio, negative soil nutrient balance, stagnation/slow growth in food grain production.

a. Depleting soil organic matter

The causes for soil organic matter depletion are-

1. Residue* removal for fodder or fuel
2. Burning of crop residues
3. Excessive grazing and using dung as fuel
4. Accelerated erosion, desertification and soil degradation

b. Management practices for soil organic carbon sequestration

1. Green manuring
 2. Conservation tillage
 3. Afforestation/Agro-Forestry
 4. Grazing management
 5. Integrated Nutrient Management (INM)
 6. Diverse cropping system/Diversification
- *About 330 m T of crop residues produced per year which can supply 5.1 m T of K in addition to Organic matter.

c. Imbalance in fertilizer use

1. The imbalance in fertilizer use is evidenced by wider fertilizer consumption ratios (4.3:2.0:1.0 - N: P₂O₅:K₂O).
2. K balance is worst as the K consumption is very low
3. How long the soil K reserve sustains?
4. We need to think balanced fertilizers beyond NPK ...i.e., S, Zn, B, ...?

d. Emerging multi-nutrient deficiencies in soils

Year	Nutrient Deficiencies identified
1950	N
1970	N, P, K, Fe, Zn,
1990	N, P, K, Fe, Zn, Mn, S,B,
2010	N, P, K, Fe, Zn, Mn, S,B, Mo
2025	N, P, K, Fe, Zn, Mn, S, B, Mo...?

1. Sulphur deficiency is wide spread in India covering 40 – 45 % districts and found more in southern region.
2. Zinc deficiency was identified maximum in southern states (70%) followed by central states (55%) and northern states (24%).
3. Boron deficiency was identified to occur in 20 – 30 % samples analyzed across the country.

e. Management of micro nutrient deficiencies

1. Application of Zinc Sulphate @ 5-10 kg/ha in alluvial, red and lateritic soils and 15-20 kg/ha in case of vertisols.

2. Application of boron @ 1.0 – 1.5 kg/ha for alternate crops in oil seed cropping systems.
3. Regular application of FYM @ 8–10 t/ha can control micronutrient deficiencies. Whenever 4–5 t/ha FYM is applied the rate of Zinc applied may be reduced to 50%.
4. Basal application of micronutrients found more efficient than foliar spray.
5. Application of liquid fertilizers through fertigation in drip irrigation found more efficient.
6. When soil applications are not done, 2 – 4 sprays of 0.5% micronutrients (Zn, Fe and Mn) could effectively control deficiencies in standing crops.

Low nutrient use efficiency, negative soil nutrient balance (more removal and mining from soil and less additions), declining crop response ratio and declining fertilizer response ratio are the major concerns. To ensure productivity and national food security managing soil health is a formidable challenge. *The United Nations Millennium Development Task Force on 'Hunger' made soil health enhancement as one of the five recommendations for increasing agricultural productivity and fight hunger in India.*

f. Nutrient Management Options available

1. Integrated Nutrient Management (INM)
2. Balanced fertilization through inorganic fertilizers.
3. Fortified/ Coated fertilizers, customized and 100% water soluble fertilizers.
4. Soil Test Based Fertilizer Recommendation (STBFR)
5. Improved nutrient management practices.

g. Enhancing availability of organic manures

1. Recycling and composting/vermicomposting of urban, animal and agro-industry waste.
2. About 57 MT of urban solid waste is generated in India per annum with potential to supply 8 MT of good quality compost.
3. Present organic manures availability of 383m T per annum is moderate against the requirement of 900 m T per annum (@ 5t/ha for 185 m ha gross cropped area).

h. Fertilizer policy measures taken by Govt. of India to encourage balanced use of fertilizers

1. To encourage industry to produce products based on soil and crop requirement.
2. Specialty fertilizers like fortified fertilizers (9No.s) with appropriate grades of secondary and micronutrients, customized fertilizers (36 No.s), 100 % water soluble fertilizers (12 No.s) are approved by Govt. of India and incorporated in Fertilizer Control Order, 1985.
3. To increase the use and availability of SSP as an alternative source of P, the GOI modified its specification.
4. Phospho-gypsum a byproduct of fertilizer industry containing 16% S and 21% Ca a potential source of S and Ca was incorporated in FCO.

5. In order to curtail the diversified use of urea for other than agricultural purposes the GOI introduced neem coated urea.
6. The main purpose of promoting customized fertilizers is to promote site specific nutrient management to achieve maximum fertilizer use efficiency/ applied nutrient in a cost effective manner.
7. Promoting bio fertilizers (Rhizobium, Azatobacter, Azospirillum, PSB and Mycorrhiza) – besides providing nutrients these improve soil health.
8. Promoting organic fertilizers (City Waste Compost and Vermi-compost) – Soil Organic Matter is an important soil health parameter for agricultural production, nutrient supply to plants and fertilizer management; in addition to direct source of plant nutrients, indirectly influences availability of plant nutrients in soil from native soil pools.
9. To promote balanced fertilizer use GOI brought nutrient based subsidy to encourage usage of 24 complex fertilizers (P & K) containing Zn and B other than urea.

CONCLUSIONS

- Soil fertility depletion due to inadequate and imbalanced fertilizer use is the major factor in stagnation of productivity.
- Wide spread nutrient deficiencies and deteriorating soil health are cause of low nutrient use efficiency, productivity and profitability.
- Lack of adoption of Soil Test Based Fertilizer Recommendation (STBFR) has aggravated imbalanced fertilizer use.
- Sustainable production achieved by site-specific balanced fertilizer application and INM involving major, secondary and micro nutrients, addition of organic matter and use of bio-fertilizers.
- In addition to secondary and micro nutrients, there is a requirement of 45 m T of NPK to produce 300 m T of food grains for the projected population of 1.4 billion by 2025.
- For this we need to utilize all local nutrient resources to reduce dependence on imports; need to develop new efficient fertilizer products; need to create awareness among farmers on the benefit of INM.

XII. WEED CONTROL

1.Rice

A) Direct sown Rice:

i) Drill sowing in optimum soil moisture:

Before sowing:

when the fields are infested with weeds viz., *Cyperus spp.*, *Cynodon dactylon*, *Echinochloa spp.* and when the weeds are in active growing stage, spray 10 ml Glyphosate 41% + 10 g. Ammonium sulphate/Urea per 1.0 litre of water. After 10-15 days, sowing can be done after ploughing under optimum moisture condition.

Pre emergence:

- Spray pendimethalin 30% @ 2.50 to 3.75 l/ha or pretilachlor 50% @ 1.0 l/ha immediately after sowing or the next day.

Post emergence:

- At 15-20 days after sowing, when grassy weeds like *Echinochloa spp.* are dominant, spray of cyhalofop butyl 10% @ 1.0 l/ha.
- At 15-20 days after sowing, when both grasses and broad leaf weeds are present, spray of bispyribac sodium 10% @ 200 ml/ha.
- After 30 days of sowing, when dicot weeds are problematic, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or ethoxysulfuron 15% @ 125 g/ha.
- After 30 days of sowing, when both grasses and broad leaf weeds are present, spray metsulfuron methyl (10%) + chlorimuron ethyl (10%) @ 20g/ha.

ii) Broadcasting or drum seeding in Puddled field:

Pre emergence:

- Oxadiargyl 80% @ 90 g/ha or pyrazosulfuron ethyl 10% @ 200 g/ha in 1.25 liters of water and apply as sand mix application (50kg sand/ha) in a thin film of water at 3-5 days after sowing.

For post emergence application, follow the package as given in the drill sown rice.

B) Transplanted rice:

i) Nursery:

a) Pre emergence:

- In case of dry nurseries, spray pretilachlor 50% @ 1.0 l/ha immediately or with in two days after sowing for the control of *Echinochloa* and other annual monocot and dicot weeds
- In case of wet nurseries, mix oxadiargyl 80% @ 90 g/ha in 1.25 liters of water and apply as sand mix application (50kg sand/ha) at 3 to 5 days after sowing in a thin film of water.

b) Post emergence

- Spray cyhalofop butyl 10% @ 1.0 l/ha at 15 days after sowing for the control of *Echinochloa spp.*
- Spray of bispyribac sodium 10% @ 200 ml/ha at 15 days after sowing for the control of grasses and broad leaf weeds.

ii) Main field:

With in 3 to 5 days after planting (as sand mix application at 50 kg sand /ha):

- For the control of *Echinochloa* and other annual grassy weeds,
 - apply butachlor 50% @ 2.5 to 4.5 L/ha (or)
 - apply anilophos 30% @ 1.33 to 1.67 L/ha (or)
 - pretilachlor 50% @ 1.0 L/ha.
- When both grasses and broad leaf weeds are present,
 - apply 2, 4-D ethyl ester granules @ 10 kg ha⁻¹ + butachlor @ 2.5 L/ha (or)
 - 2, 4-D ethyl ester 4% granules @ 10 kg ha⁻¹ + anilophos 30% @ 0.70 L/ha (or)

- 2,4-D ethyl ester 4% granules @ 10 kg/ha + butachlor 5% granules @ 10 kg/ha (or)
- bensufuron methyl(0.6%)+ pretilachlor (6.0%) granules @ 10kg/ha (or)
- oxadiargyl 80% @ 125 g/ha in 1.25 liters

At 15-25 days after transplanting:

- when both grasses and broad leaf weeds are present
 - spray bispyribac sodium 10% @ 200 ml/ha

At 25-30 days after planting:

- when dicot weeds are problematic
 - Spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha (or)
 - Spray 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha (or)
 - Spray ethoxysulfuron 10% @ 125 g/ha
- When grassy and dicot weeds are problematic
 - spray metsulfuron methyl+chlorimuron ethyl 20% @ 20g/ha.

2. MAIZE

Upland maize:

Pre emergence: (immediately or within three days after sowing)

- Spray atrazine 50% @ 2.5 to 3.5 kg/ha (or)
- Spray alachlor 50% @ 3.75 to 5.0 l/ha (or)
- Spray pendimethalin 30% @ 2.50 to 3.75 l/ha (or)
- Spray oxyflourfin 23.5% @ 500 ml/ha.

Post emergence : (at 20-25 days after sowing)

- for the control of dicot weeds, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha (or) .
- When grassy and dicot weeds are problematic , spray topramezone 33.6% @ 75 ml/ha.

Zero tillage maize in rice fallows:

Pre emergence:

- spray atrazine 50% @ 2.5 kg/ha+glyphosate 41% @ 4.0 l/ha (or)
- atrazine 50% @ 2.5 kg/ha + paraquat 24% @ 2.5 l/ha.

Post emergence :

- for the control of dicot weeds, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha.
- When grassy and dicot weeds are problematic, spray topramezone 33.6% @ 75 ml/ha.

3. SORGHUM

- Spray atrazine 50% @ 1.5 - 2.0 kg/ha immediately after sowing or the next day.
- for the control of dicot weeds, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha at 30 to 35 days after sowing.

Zero tillage sorghum in rice fallows:

Pre emergence:

- spray atrazine 50% @ 1.5- 2.0 kg/ha+glyphosate 41% @ 4.0 l/ha (or)
- atrazine 50% @ 1.5-2.0 kg/ha + paraquat 24% @ 2.5 l/ha.

Post emergence :

- for the control of dicot weeds, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha.

4. RAGI

- Spray pendimethalin 30% @ 2.5 l/ha immediately after sowing or before transplanting
- Spray anilophos 30% @ 1.75 l/ha one week after transplanting ragi seedlings
- Spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha at 25-30 days after transplanting ragi seedlings

5. PULSES

a) PULSES- UP LAND:

- Spray pendimethalin 30% @ 2.50 to 3.75 l/ha or alachlor 50% @ 3.75 l/ha as premergence application immediately after sowing or the next day.
- If grassy weeds are problematic, post emergence spray of fenoxaprop ethyl 9% @ 625 ml/ha or quizalofop ethyl 5% @ 1.0 l/ha or propaquizafop ethyl 10% @ 625 ml/ha at 20 days after sowing
- For the control of grasses and broad leaf weeds post emergence spray of imazethapyr 10% @ 500 ml/ha at 15-20 days after sowing. Crop growth will be stunted for a week and recover later.

b) Rice fallow blackgram

- For the control of *Echinochloa* spp, and broad leaf weeds, apply benthocarb @ 2.5 to 5.0 l/ha or pendimethalin 30% @ 2.0 to 3.75 l/ha immediately after removal of paddy sheaves as sand mix application followed by spraying of water up to 1000 l/ha depending upon the soil moisture condition. Prefer pendimethalin for fields infested with cuscuta.
- For control of *Echinochloa* spp., spray fenoxaprop ethyl 9% @ 625 ml/ha or propaquizafop ethyl 10% @ 625 ml/ha (or) quizalofop ethyl 5% @ 1.0 l/ha as post emergence spray at 15-20 days after sowing.
- For control of grasses and broad leaf weeds, post emergence spray of imazethapyr 10% @ 500 ml /ha at 15-20 days after sowing.
- At 25-30 days after sowing, if cuscuta patches exist in field, spray paraquat 24% @ 5.0ml per litre of water on the patches to kill the parasite and to prevent seed setting.
- For control of *Vicia sativa*, spray acifluorfen 16.5% + clodinofof propargyl 8% @ 1.0 l/ha as post emergence application at 25-30 days after sowing.

6. SOYBEAN :

- Spray pendimethalin 30% @ 2.5 to 3.75 l/ha immediately or within 3 days after sowing (or)

- Spray imazethapyr 10% @ 625 ml/ha at 20-25 days after sowing

7. GROUNDNUT

- Spray pendimethalin 30% @ 2.5 to 3.75 l/ha or alachlor 50% @ 3.75 to 5.0 L/ha immediately or with in three days after sowing.
- For control of grassy weeds, spray fenoxaprop ethyl 9% @ 625 ml/ha or quizalofop ethyl 5% @ 1.0 l/ha or propaquizafop ethyl 10% @ 625 ml/ha as post emergence spray at 15-20 days after sowing.
- For control of grasses and broad leaf weeds, post emergence spray of imazethapyr 10% @ 625 ml /ha at 15-20 days after sowing

8. SESAMUM

- Spray pendimethalin 30% @ 2.5 l/ha or alachlor 50% @ 2.5 l/ha immediately or with in three days after sowing
- For control of grassy weeds spray fenoxaprop ethyl 9% @ 625 ml/ha or quizalofop ethyl 5% @ 1.0 l/ha as post emergence spray at 20 days after sowing.

9. COTTON :

- Spray pendimethalin 30% @ 2.5 to 3.75 l/ha immediately or within 3 days after sowing
- Spray quizalofop ethyl 5% @ 1.0 l/ha + pyriithiobac sodium 10% @ 625 ml/ha as tank mixture at 20-25 days after sowing if inter-cultivation is not possible due to incessant rains

10. SUGARCANE :

- Spray atrazine 50% @ 3.3 to 5.0 Kg/ha (or) oxyfluorfen 23.5% @ 250 g/ha (or) metribuzin 70 % @ 1.5 kg/ha (or) alachlor 50% @ 2.5 kg/ha immediately or within three days after planting sugarcane sets .
- spot application of paraquat 24% @ 5 ml per litre of water for the control of emerged weeds at 7-10 after planting without any problem to planted sets in the soil.
- post emergence spray of 2,4-D sodium salt 80% @ 1.5 -2.0 kg/ha (or) 2,4-D sodium salt 80% @ 1.25 kg/ha +metribuzin 70% @1.25 kg/ha at 30 and 45 days after planting.
- At maturity stage, if twining weeds viz., Ipomoea, Convolvulus are problematic, spray 2,4-D Na salt 80% 1.6 kg/ha (or) 2,4-D amine salt 58% @ 1.25 l/ha as post emergence directed spray.

8. PERENNIAL WEEDS IN ORCHARDS

- Perennial weeds like *Cyperus rotundus*, *Cynodon dactylon* etc. in orchards can be controlled effectively by spraying glyphosate 41% @ 2.5 to 5.0 l/ha dissolved in 500 liters of water using hood. Falling of the spray fluid on young fruit plant foliage should be avoided .Second spray is required when there is regrowth of weeds. Application of glyphosate with 1% ammonium sulphate solution will enhance up take and translocation by weeds .
- Ammonium salt of glyphosate 71% @ 2.5-4.0 l/ha can be used as an alternati

- The efficacy of the glyphosate depends upon the stage of the weed (should be in active vegetative stage), age and duration of infestation (older and longer duration of infestations may require several repeated sprays on active vegetative growth), soil moisture and type of weed and nature of foliage (surface morphology/ herbicide retention and absorption).
- If annual grasses and dicot weeds are prevalent, the herbicide paraquat 24% @ 2.5 to 3.75 l/ha dissolved in 500 l/ha of water can be sprayed using hood. Falling of spray fluid on fruit trees should be avoided.

ANNEXURE

Common name, trade name, active ingredient and approximate cost of the herbicides included in the recommendations.

S.No.	Herbicide		Percent active ingredient	Rate (Rs./Unit)
	Common Name	Trade Name		
1.	Alachlor	Lasso, Alatop	50%EC	390/- L
	Anilofos	Aniloguard, Arozin, weedonil, Anildhan	30 %EC	300/- L
	Atrazine	Atrataf, Solaro, Milzin, Surya, Atratop, Atrafil, Ultrakem	50 %WP	400/kg
	Butachlor EC	Butachlor, Trapp, Teer, Machete.	50 %EC	200/ L.
	Butachlor	Butachlor (G)	5 % Granules	25/- kg.
	Glyphosate (IPA salt)	Glycel, Weed off, Noweed, Glyphos, Brake, Round up, Clean up, Rulout	41%SL	300-350/- L
	Glyphosate (Ammonium salt)	Excelmera, Glyfos dekor, Allkill	71%SG	500/ kg
	Paraquat	Gramoxone, Uniquat, Paralac	24% EC	400/- L.
	Pendimethalin	Stomp, Pendiguard, Pendiherb, Pendistar, Tatapanida, Bond	30%EC	400 - 500/- L
	2,4-D EE	Agrodone conc. 48, Herbonil	36% EC	250/- L.
	2,4-D EE	Agrodex and Knock weed granules	4% Granules	25/- kg.
	2,4-D Na salt	Fernoxone, Weed mar, Salix	80% WP	350/- kg.
	Oxadiargyl	Topstar, Oximain	80 %WP	250/- per 35 g
	Oxyfluorfen	Goal, Oxygold, Galigan, Kroll	23.5%EC	1800/-L
	Pretilachlor	Rifit, Erazo, Preet, Pretiherb	50%EC	400/-L
	Fenoxaprop ethyl	Whip super, Fenixasil, Dell power	9%EC	1500/-L
	Cyhalofop butyl	Clincher, Wrap up	10%EC	1800/-L

S.No.	Herbicide		Percent active ingredient	Rate (Rs./Unit)
	Common Name	Trade Name		
	Quizalofop ethyl	Targa super	5% EC	1600/-L
	Metrbuzin	Tatametri, Sencor, Tribute, Metriagon	70% WP	1000-1500/kg
	Pyrazosulfuron ethyl	Saathi	10% WP	210/80g
	Imazethapyr	Pursuit, Lagam, Dinamaz, Perfect, Weedlock	10 % EC	1600/ L
	Bispyribac sodium	Nominee gold, Tarak, Edora	10% EC	600/100 ml
	Pyriothiac	Theme, Hitweed, Rife	10% SL	2000/L
	2,4-D amine salt	Weedmar super, Dura	58% EC	400/L
	Ethoxysulfuron	Sunrice	15% WDG	250/50g
26	Propaquizafop	Society, Agil, Opal	10 % EC	1600/ L
27	Metsulfuron methyl (10 % + chlorimuron ethyl (10 %))	Almix	20 %	190/8 g
28	Acifluorfen 16.5% + clodinafop propargyl 8%	Iris, patela	24.5%	450/400 ml
29	Topramezone	Tynger	33.6%	1400/30ml
30	Bensulfuron methyl (0.6%)+ pretilachlor (6.0%)	Londax power	6.6% Granules	850/4 kg

XIII. DRYLAND AGRICULTURE

Growing of crops in rainfed situations is known as dry land agriculture. The total geographical area of Andhra Pradesh is 160.2 lakh ha. The net sown area is 67.19 lakh ha, net irrigated area is 28.08 lakh ha. Rainfed area is 39.11 lakh ha and it accounts for 58.21% of net sown area with 60% area under red soils and 25% area under black soils. Among the 13 districts of Andhra Pradesh, Ananthapuramu district is having highest area under rainfed agriculture (9.65 lakh ha) and top rainfed priority rank followed by YSR kadapa, Kurnool, Chittoor and Prakasam districts. Variation in crop yields is more in dry lands due to non receipt of timely rainfall, early cessation of rains, inadequate and uneven distribution of rainfall and prolonged dry spells during crop periods. Adoption of suitable conservation measures and improved management practices will increase higher yields.

Soil and water conservation

Red soils

These soils are shallow in depth with low water holding capacity. Rainwater is lost as runoff causing erosion resulting in loss of fertile top layer of the soil and nutrients. Research efforts were made to reduce these losses and soil conservation measures were found useful in reducing runoff and soil loss.

- When soil depth is 20 cm or more, deep tillage once in three years helps in better infiltration of rainwater and reduces pest and weed problems.
- Cultivation across the slope reduces runoff.

- If slope is multiple and more than 2% construction of contour bunds with a cross section of 0.63 m^2 at 50 m horizontal interval helps in conservation of soil and water. In areas where annual rainfall is more than 750 mm, graded bunds are recommended.
- In soils where surface crusting is a major problem, application of sand @ 40 t/ha before sowing helps in decreasing the crust strength facilitates better infiltration of water in to the soil and improves germination and crop stand.
- To avoid water stagnation on down stream side of contour bunds, formation of compartmental bunds with spacing of 15 m x 10 m before emergence of the crop or formation of conservation furrows with receipt of rainfall after 20 days of sowing of the crop help in reducing the water stagnation on down stream side of contour bunds and facilitates better infiltration of water in to the soil.
- Insitu conservation measures like dead furrow in groundnut at an interval of 3.6 m enhances the availability of soil moisture to the crop.
- Intercropping groundnut with mixed pulses like horse gram, cowpea and red gram in 11:1 ratio helps in reducing the runoff losses and increases net returns.

Black soils

In black soils, water holding capacity of these soils is very high. Deep cracking, low permeability and poor drainage are the major problems in vertisols. Soil conservation and improved management practices enhances the productivity of dryland crops.

- Formation of graded bunds with a cross section of 0.8 m^2 is recommended in these soils. Formation of a channel with a slope of 0.1 – 0.25% along the graded bunds and merging these channels in to a grassed waterway help in drainage of water without any soil erosion.
- Formation of ridges and furrows is useful for deep black soils. Sowing should be done on the ridges. Furrows facilitate easy drainage of water (or) formation of raised bed with 3 m width at 20 cm height help in getting increased yields of crops, as the furrows facilitate better drainage of water.
- Compartmental bunding with 5x5 m before onset of monsoon will improve the soil moisture storage capacity and useful for post rainy season crops.
- Application of FYM @ 20 t/ha help in better infiltration of water.

Rainwater management

Red soils

- Runoff of rain water can be prevented by practicing soil conservation measures. Sub soil chiselling with sub soiler improves the water holding capacity of shallow soils and reduces runoff.
- Mulching with groundnut shells @ 5 t/ha, within 10 days after sowing of the crop reduces evaporation losses.
- Rain water collection and storage for subsequent use is known as water harvesting.
- Runoff constitutes 25 % of rainfall in red soils. Water harvesting in farm ponds and subsequent use as supplemental irrigation helps in increasing the yields of rainfed crops. Water harvested from catchment area of 10 ha can be used to irrigate one hectare. Seepage losses were minimum when farm pond is lined with soil + cement at 6:1 ratio. The size of farm pond is 250 m^3 with dimensions of 10 m length x 10 m breadth x 2.5 m depth. Supplemental irrigation of 10 mm through sprinkler at moisture stress during critical stages, increases groundnut pod yield by 25-30%.

Suitable crops

Red soils

- Groundnut, sorghum, pearl millet, fox tail millet, redgram, greengram, cowpea, castor and horsegram are suitable crops. Groundnut + redgram, groundnut + castor, sorghum + redgram are the profitable intercrops which help in prevention of crop loss during drought years.
- Choice of the crops has to be made depending on the time of receipt of rainfall. Castor or red gram can be sown if the rains are received during June,. If rains are received during July intercropping of groundnut + redgram is profitable. If rainfall is received during August, the suitable contingent crops are fodder pearl millet, fodder sorghum greengram, cowpea and horsegram. If rainfall is received after 15 September, sorghum (fodder), pearl millet (fodder) and horsegram are suitable.

Black soils

- Cotton, chillies, sunflower, bengalgram, Tobacco, sorghum, safflower and coriander are suitable crops. Sorghum and sunflower if sown during first fortnight of September give higher yield.
- Application of zinc sulphate @ 50 kg/ha once in three seasons is necessary, if zinc deficiency is observed.
- If iron deficiency is observed, spraying of ferrous sulphate @ 2 g/l of water is necessary.

Soil health management

- Studies on sheep penning (ITK) at ARS, Ananthpuramu, indicated that the soil fertility will be enhanced significantly with the sheep penning @ 1 sheep /m². The physical, chemical and biological fertility of the soil will be enhanced greatly with this sheep penning in every season for all most all the rainfed crops.
- The basal application of 20 kg N, 40 kg P₂O₅ and 40 kg K₂O/ha are necessary for groundnut and groundnut + redgram. For horsegram, apply 10 kg N and 30kg P₂O₅/ha.

It is better to apply phosphorus and potassium based on soil test values. For groundnut crop grown in alfisols, the following schedule is recommended.

Phosphorous (P ₂ O ₅) (kg/ha)		Potassium (K ₂ O) (Kg/ha)	
Available in the soil	To be applied	Available in the soil	To be applied
<20	40	<150	40
20-40	20	150 -250	20
>40	Nil	> 250	Nil

For correcting zinc deficiency in groundnut, spraying of 0.2% zinc sulphate is recommended at 35 and 45 days after sowing.

Weed management

Intercultivation either with bullock drawn harrows or with intercultivation equipment with slim tyres should be practiced at 25 and 40 days after sowing. In areas where labour is a shortage broadcasting of fine soil mixed with pedimethalin @ 2.5 l/ha or spraying pedimethalin @ 5 ml/l is recommended, within two days after sowing of the crop.

Farming systems research

Under farming system where groundnut is a prevalent cropping system, rearing of sheep (ram lambs) for about four months with groundnut haulms alone or stall feeding of haulms + grazing has been found highly profitable than crop alone. Besides provide 65 man days of employment after harvest of groundnut. Backyard poultry with improves breeds like Rajasri/Vana Raja/Gramapriya (20+5) improves livelihoods of small and marginal farmers.

ENERGY MANAGEMENT

Tractor Drawn Ananta Groundnut Planter: 8 rows

Tractor drawn Ananta planter (8 rows) developed to mechanize the groundnut sowing for timely operation with mechanical advantage and intercropping facility. A 5 cm width covering blade is also fitted behind the furrow openers to cover the furrows after seed placement. The inclined disc plate seed metering mechanism gives correct seed to seed distance and maintains the recommended seed rate of 90 to 100 kg/ha. The seed damage is negligible and placement of seed is at proper depth of 4-5 cm. The field capacity is 6 to 7 ha/day and can cover large area before the soil moisture is dried up. The germination and optimum plant population was possible. The intercropping of redgram or castor can also be sown using Ananta planter along with groundnut sowing. The spring type cultivator of this planter facilitates to sow in stony and pebble slopy soils. The cost of Ananta planter is about Rs.65,000. Ananta planter can also be used with mechanical adjustments for sowing Castor, redgram and chickpea with distinct row to row and seed to seed spacing.

Ananta 4-Row Bullock Drawn Automatic Planter

Ananta 4-row bullock drawn automatic planter developed to mechanize groundnut sowing for timely operation with keeping in view of the small and marginal farmers. Main advantage with this planter is low cost of Rs.4,000 towards the seed metering mechanism attachment to local bullock drawn gorru for groundnut sowing. Total cost of planter is around Rs. 10,000. The trough feed type seed metering mechanism gives correct seed to seed distance about 10 cm in a row and maintains the recommended seed rate of nearly 100 kg/ha by adjusting the depth gauge in the hopper. It covers 4-rows at a time with 30 cm spacing. The seed damage is nil and placement of seed is at proper depth of 4-5 cm. The field capacity is 1.6 to 2.0 ha/day and can cover large area before the soil moisture is dried up compared to bullock drawn local gorru with precise sowing and required seed rate. The weight of planter is only 52 kg, so that two bullocks can easily pull the planter without much stress.

Tractor Drawn Ananta Interculture Implement

Normally weeding in rainfed groundnut is done by *metlaguntaka* and *dantiguntaka* driven by a pair of bullocks in between rows at 20 and 40 days after sowing or by hand with the help of hand hoe. The tractor drawn interculture implement was developed to mechanize the intercultivation in groundnut for timely and reduce the labour cost. This operation can also help earthing up, moisture conservation and soil mulching. The tractor drawn interculture implement can run in between the row spacing of 30 cm without any plant damage. Its field capacity is 4 to 5 ha/day. The pneumatic small tyres of 8.3" X 32" size were fitted to the rear wheels of the tractor. The tractor drawn Ananta interculture implement with small tyres can run in the groundnut field at a row spacing of 30cm. The interculture implement with 8 tynes

was developed with T-shape and V-shape sweeps fitted to the tynes and field tested. The cost of pneumatic tyres and interculture implement with sweeps was about Rs. 55,000.

Tractor Drawn ANGRAU Blade Guntaka

General practice of harvesting is by hand pulling of groundnut crop when the crop comes to maturity. If rain occurs during the crop maturity, hand pulling is easy due to sufficient moisture in soil. However, the soil becomes hard and compacts if there is no rainfall at the time of maturity. The farmers use bullock drawn *madaka* to open the furrow along the rows to loosen the soil and plants are removed from the loosen soil to minimize pod loss. Under these circumstances the harvesting losses are more even upto 20%. Its field capacity is only 1.0 to 1.5 ha per day. The tractor drawn blade guntaka was developed to perform the harvesting operation easy and more economical. It covers 4 rows at a time. The harvesting can be done at right time to avoid other field losses. The cost of blade guntaka is Rs.20,000. The worn out blade can be replaced with a new one in the blade slot which is fixed to the 6" pipe frame. Its repairs can be attended easily by the local artisans.

Pest and disease management

Since the farmers are less resourceful, IPM is a suitable technology. To reduce the cost of pest and disease management, these aspects are to be considered.

1. Pest monitoring and prediction.
2. Monitoring of natural enemies.
3. Forewarning of pest outbreak.
4. Critical stage of chemical intervention.

Relationship between weather parameters and occurrence of pests and diseases has been established in many crops.

Groundnut

- a) **Leaf miner:** Maximum temperature of more than 33⁰C and afternoon relative humidity of less than 40 per cent followed by dry spell of more than one week results in incidence of the pest. If rain occurs, the incidence gets reduced during *Kharif*.
- b) **Red hairy caterpillar:** Rainfall received between last week of June and September causes the emergence of RHC moths. The emergence is noticed on 2nd day after the occurrence of rainfall of 10 mm and more. If heavy rainfall of 80 mm and above is received in one day during June/July, heavy emergence of RHC will take place at a time and subsequent emergence will be less. However, the moths emerged during September though they lay eggs, but mortality of eggs and larvae is observed due to the parasitisation and thereby the influence on the crop will be less.
- c) **Late leaf spot:** Morning relative humidity of 80% and more coupled with night temperature around 22⁰C causes the initiation of the late leaf spot disease on groundnut. If the weather conditions exist for a week, the disease spread will be more. Added to this the leaf wetness index of 2.3 coupled with 10% LLS incidence requires the control measures.

XIV. POST HARVEST TECHNOLOGY

The farmer, in a remuneration point of view, must attend to certain primary processing operations like threshing, winnowing, cleaning, drying, grading, polishing, milling etc. There is a need to adopt appropriate post harvest technologies for cost, time and labour saving towards *enhancement* of quality and marketability to the produce by value addition and by-products utilization. Primary processing by farmers can potentially get more remunerative price and profits by increasing quality by value addition and efficient utilization of by products besides reducing post harvest losses.

1. **Threshing of Paddy by power thresher:**

Power threshers are recommended for threshing paddy crop due to its multiple advantages like low investment, high threshing efficiency, low operational cost compared to traditional tractor threshing. It has additional advantages of simultaneous winnowing and cleaning, besides threshing. Under-utilization of tractor of 35 hp power can be avoided, as the job of threshing to the same extent could be achieved by expending only 7-10 hp, in case of power thresher. About 5-6 litres of diesel could be saved, besides increased output of 1-2 bags of paddy which otherwise goes as threshing loss in case of tractor threshing. Under-utilisation of 35 hp tractor for a 10 hp, job of threshing, if avoided would go a long way in saving fuel energy and foreign exchange.

2. **Threshing benches:**

Threshing benches either with wire mesh top or with perforated M.S. sheet may be used in place of wooden benches for threshing the paddy crop as they are more efficient and have more service life. Four men can thresh about 25 bags of paddy in a day. Each threshing bench costs about Rs. 1600/-. The process is particularly advisable when paddy is collected for seed purpose.

3. **Winnowing machines for grain cleaning:**

Hand and power operated (Power tiller, tractor or small engine operated) winnower can separate chaff, dust etc. from grain. About 500-800 kg of grain can be winnowed in one hour. These machinery are useful when sufficient winds (velocity) are not available and during unfavourable weather conditions.

4. **Husk fired furnace dryer for drying of paddy:**

A half ton capacity husk fired furnace type batch dryer developed at this centre can dry paddy from 25% moisture content to 13% moisture content in a matter of 4-5 h. It is much useful when sun drying is not practicable in inclement weather during rainy season and under sudden cyclone threat conditions.

5. **Agricultural waste fired chilli dryer and its utilisation as multipurpose dryer to dry other crops:**

A two quintal capacity chilli dryer designed and developed at this centre can dry ripe chillies from 70% moisture content to 15% moisture content in 24 hours compared to 12-15 days in open yard sun drying. The chillies dried by this dryer retained colour for a longer time during storage compared to sun dried produce and are dust-free with high quality and appearance. Drying can be done from the crop residue or paddy husk.

This dryer could be used as multipurpose dryer for drying other crops like turmeric, groundnut and coconut.

a) Drying of turmeric:

Drying of turmeric using Agricultural waste fired dryer is advantageous in time and cost saving. The results showed 65.47% of time saving and 7.8% of cost saving compared to traditional method of sun drying. It took 58 hours to dry turmeric of 79.24% moisture content to 12.5% level against 168 hours of time taken for the similar level of drying in open yard drying.

b) Drying of groundnut:

The Agricultural waste fired dryer was also evaluated for drying groundnut. When dried at 40-43°C, it took 25 hours compared to 4 - 5 days required in open yard sun drying for bringing down the moisture content from 28% to 8%. There was no adverse effect on germination of the seed after drying by the dryer.

6.a) Mini Dhal Mill:

The mini dhal mill plant was developed with suitable accessories and attachments like drying cum storage bin with husk fired heat exchanger system, sieve set, mixer for pre-treatment with oil and water, thus mechanising all the processing operations involved in dhal making. It will separate dehusked wholes. It can run with a 3 h.p motor and can mill 150 to 160 kg of blackgram per hour with 65% to 70% wholes and 15% to 18% splits recovery, thus about 80%-82% dhal was recovered compared to only 70-75% in traditional method.

b) TNAU-Power operated mini dhal mill:

The mini-dhal mill was tested. It is capable of splitting 30 kg of blackgram per hour with a recovery of 83.5% split half grains with 12% of broken. In respect to greengram, it can mill 32 kg/h. with recovery of 80% splits and 17% broken.

7. Power operated turmeric polisher:

With suitable alterations and further attachments like 2 h.p motor, V-belt and chain drive mechanism and gear system, the hand operated turmeric polisher was converted into power operated turmeric polisher. It can run at 30-32 rpm. The power operated ANGRAU Turmeric polisher can polish about 600-700 kg of turmeric in an hour with 98% polishing efficiency.

8. ANGRAU Turmeric Grader:

The ANGRAU turmeric grader designed and developed by this centre can grade about 400 kg of turmeric in an hour into four fractions namely bulbs, fingers (3 cm length and above), Polishable Nali (2 to 3 cm length) and un-polishable Nali (less than 2 cm length) in a single pass, thus eliminates tedious and laborious manual grading. This also facilitates better quality and value addition to get higher remunerative price.

9. Batch type rice bran stabilizer suitable for stabilization of rice bran:

Stabilization of rice bran with rice bran stabilizer at 100° C for 10 minutes controls the increase in free fatty acid up to 28 days in storage, by inactivation of lipase enzyme. This facilitates extraction of edible grade oil, thus helps in better utilization of rice bran, the by-product of rice milling industry.

10. Chilli Seed extractor:

The TNAU chilli seed extractor was found to operate at 46-50 kg/hr capacity which is particularly suitable for extracting seed from smaller lots without intermittent cleaning. PKV chilli seed extractor was found to be effective to obtain clean seed i.e., free from broken pericarp and dust. The capacity of the extracting machine is around 100 kg/hr. The extraction efficiency for both the equipment is in the range of 96 to 99%. The high capacity extractor is useful for seed producers and large farmers.

11. Mango Harvester:

Experiments using IIHR mango harvester gave a harvesting capacity of 170-200 kg mangos/hr (500-550 fruits/hr). It was observed that farmers are using a dhoti which is made locally using bamboo stick and net made of jute thread. The net is connected to the curved frame. Local dhoti gave a capacity of about 300-350 fruits/hr. Percentage dropped fruits while harvesting were found to be lower 8-10% compared to 20-25% in local dhoti, thereby reducing the damage to the fruits. However, the IIHR mango harvester is somewhat heavy and difficult to handle for harvesting fruits by standing on the tree particularly for old and well branched trees. Two types of Mango harvesters which are useful to harvest fruits from ground (for small trees / young gardens) and on the tree (for old and well branched trees) as alternatives to local harvester have been designed, fabricated and tested with Banginapalli variety. The light weight harvester when used on large, well branched trees gave a harvesting capacity of 625-650 fruits per hour. The heavy weight model useful to harvest fruits from ground gave a capacity of 600-615 fruits per hour. Local dhoti gave a capacity of 300-350 fruits / h.

12. Survey of rice milling in Andhara Pradesh :

A survey of rice milling system was conducted in Andhra Pradesh and the data collected in the form of a questionnaire. The grain factors that affect the percentage of broken include moisture content, variety, type of soil and time of harvest. The machine factors that affect include the condition of the rubber rollers, speed and wear and tear in sheller and gap between cone and concave, life of rubber packing and wear of emery cone in the polisher. Out turn of rice from paddy after milling differs from sample to sample and type of milling system. Breakage of rice invariably originates from cracked, immature and other damaged grains. The corrective measures suggested to reduce broken percentage of rice are; harvest the paddy at optimum moisture content, thresh the paddy by mechanical thresher, dry the paddy uniformly in steps by maintaining tempering periods, modern rice mills with rubber roll shellers are recommended for minimum broken percentage of rice, to maintain the rice mill timely replacement of rubber rolls, and timely replacement of cone in the cone polisher. Maintaining proper gap between the cone and the rubber brake in the cone polisher is critical to reduce broken in rice milling.

13. Conversion of tobacco barns for chilli drying

Ten to twelve quintals of ripe chillies can be loaded in the existing tobacco barns to dry chillies. G.I. wire mesh trays of size 105 x 75 x 7.5 cm are suitable to hold chillies on the existing tiers. Each tray can be loaded with 7 to 8 kg of ripe pods. Drying time required to reduce moisture from 75 to 10% (w.b.) vary considerably depending upon whether the chilli is hybrid with thick pericarp (eg. Wonder hot) or varieties with medium to thin pericarp (eg. LCA 334). The former takes about 50 hours to dry whereas

the latter type takes about 40 hours only. The temperatures ranging from 50°C to 55°C are appropriate for drying chillies. The open yard sun drying takes 12 to 15 days in comparison to barn drying method. The cost of barn drying is approximately Rs.1.50-2.00 per quintal of dry chilli. The percentage discoloured pods can be reduced to about 3.5 to 4% in barn dried produce in comparison to 9-10% in open yard sun drying. The barn drying method has the advantages such as; 1) quality product with good colour retention and free from external contamination 2) less number of discoloured pods (Talukaya) 3) Reduction in drying time 4) Drying can be accomplished even during inclement weather particularly early in the chilli season i.e., November to February to fetch remunerative price.

14. Drying of chillies in a poly house:

ANGRAU poly house solar dryer of size 12 x 7.8 x 2.1m has been developed to dry about 20 quintals of ripe pods. The dryer essentially consists of an arch type poly house to hold chillies on two different tiers made of wire mesh fixed to frame assembled by nuts and bolts. The whole frame structure is covered with a UV stabilized 150 gsm cross laminated semi-transparent polyethylene sheet with ventilators at bottom and top to facilitate movement of air. The drying time is 5 to 8 days to reduce moisture from 75% to 10% (wb) in comparison to 15 to 20 days required to dry chilli in open yard sun drying. The dryer can be converted into nursery house by replacing poly sheet cover using 50% shade net. About 70,000 chilli seedlings can be raised in the house per batch. The poly house can also be used to raise green Coriander during off season i.e. in May and June when the chilli drying is completed. The poly house can be efficiently used for about 10 months in a year in chilli growing region i.e. Drying of chillies during December to April, Coriander leaf production in May to June, raising Chilli nursery during July to September.

15. Performance of Sonalika thresher for Bengal gram :

The performance evaluation of Sonalika thresher for Bengalgram was evaluated at Chandulur and Dronadula villages of Prakasam district. It was observed that it can thresh about one to one and half acres of Bengalgram crop in one hour. It was also found that the output of the thresher was 10 to 12 quintals of Bengalgram in one hour. The threshing capacity depends upon the crop variety and its yield. The average efficiency of the thresher was found to be 98.33%. Cost of operation was about Rs. 500/- per hour which includes labour and diesel.

16. Mobile Turmeric Steam Boiler

A study was undertaken to first develop as all scale turmeric steam boiler. The developed boiler was tested in comparison to different methods such as bana method, autoclave cooking and water bath boiling. Experiments were conducted to establish the most effective cooking method for turmeric (*Curcuma longa* linn) based on the drying time, curcumin content, colour and physical appearance of the product. The 1000kg/hr capacity mobile turmeric boiler was fabricated with the help of local manufacturer. Preliminary trails were conducted. Manufacturing defects such as leakage of steam, improper functioning of steam valve were observed. The defects were rectified and the boiler was tested. Details of experimental results are furnished.

- | | |
|-------------------------|-------------------------------|
| i. Capacity of cooking: | 1 ton/ h |
| ii. Cooking time: | 10-12 min |
| iii. Steam pressure : | 2 kgf/cm ² (140°C) |
| iv. Fuel consumption: | 6.3 lph |

v. Moisture initial:	75% (w.b)
vi. Moisture final:	78% (w.b)
Vii. Drying time	12 days
Viii. Operation cost:	Rs.1.70/ kg dry

17. On-Farm Paddy dryer for managing high moisture paddy.

A 5 Ton capacity On-farm Paddy has been developed at Post Harvest Technology Centre, Bapatla in collaboration with M/s Kardi Dryers Pvt Limited, Chennai for management of combine harvested high moisture paddy. Extensive tests were conducted and custom hiring of the dryer was also given to the farmers on request. The farmers were expressed their satisfaction on the performance of the dryer and good seed germination was observed. The following are the salient features of the performance of the dryer.

Salient features of On-Farm Paddy Dryer

S.No.	Description	Salient Features
1	Type	Mobile - Flat bed – Non Mixing type Paddy dryer (Mixing mechanism Optional)
2	Capacity	5 ton (Optimized for mobile model)
3	Power source	Genset / 3 phase AC current
4	Loading and Unloading	Loading : Manual (Elevator mechanism Optional) Unloading : Gravity discharge chutes
5	Drying time	29% (IMC) – 12% (FMC) – 13.5 -15.0 h 24% (IMC) – 12% (FMC) – 6 - 8 h
6	Fuel consumption	Kharif : 45 – 60 lt (both for Genset and fuel burner) Rabi : 20-30 lt (both for Genset and fuel burner)
7	Milling tests	Milling Recovery : 62-63 %, Head yield – 58-59 %, Broken – 3-4 %
8	Economics (Diesel Run)	Total operating costs : Kharif : Rs. 3937/ batch or Rs. 59/ bag of 75 kg or Rs. 0.78/kg Rabi : Rs. 2287/ batch or Rs. 34/ bag of 75 kg or Rs. 0.46/kg Total costs : Kharif : Rs. 6019/ batch or Rs. 90/ bag of 75 kg or Rs. 1.20/kg Rabi : Rs. 4369/ batch or Rs. 65/ bag of 75 kg or Rs. 0.87/kg
9	Benefit Cost Ratio	Kharif :1.47 Rabi : 2.02
10	Payback period	5 years

18. Fuel Briquetting machine:

Fuel Briquetting machine is tested for its performance evaluation. Locally available crop residues such as paddy husk, maize, chilly stacks, groundnut shells and Bengal gram stacks etc are being used as raw material for making the briquettes. The Engineering properties like Bulk density, calorific value, ash content, moisture content of these raw materials before and after briquetting were determined. Briquettes made with rice husk, groundnut shells, chilly stacks, maize stacks burned for long duration and can be used in agro dryers to reduce operating cost and to save conventional fuel. Economics of fuel briquetting machine is studied. Cost of production of briquettes Rs. 4.15 / kg.

19. Safe Storage of groundnut:

a) Drying and storage structures:

Groundnut has to be dried to less than 9% moisture for safe storage which can be stored up to 6 months without aflatoxin contamination and loss of viability. The groundnut can be stored better in 1) loosely knitted gunny bags 2) compactly knitted gunny bags, 3) nylon bags and 4) polythene lined gunny bags.

b) Viability of groundnut in storage:

TMV-2 variety of groundnut maintained high viability (83%) with lesser fungal growth (16%) at 240 days of storage while the viability was least in K-150 (24%) followed by K-3 (21.6%) indicating their unsuitability for storage as seed. The viability was 79% in K-1186, 73% in K-153 and 67% in K-1143 at 180 days of storage. However the viability of these varieties drastically fell below 35% level by 240 days of storage.

20. Safe storage of pulses:

Pulses can be safely stored in nylon bags, polythene lined gunny bags for 6 months provided the grain is properly dried before storage. Mixing of 250g of edible oil per quintal of pulses is beneficial for safe storage.

21. Chilli storage:

Chillies stored in amber coloured polythene bags were found to retain colour for longer period of storage. Mechanically dried chillies showed higher colour value in chillies during storage than that of open yard sun dried produce.

22. Biochemical changes in paddy during storage:

Paddy stored up to 10-12 months was found to improve its quality without change in their milling and culinary properties. However, beyond 18 months of storage, there is deterioration in its milling and culinary properties.

23. Use of plant origin materials for safe storage of pulses:

Mixing of neem oil or vegetable oil at 0.25% to the pulse grain was found effective in protecting the pulses from the damage by pulse beetle, *Callosobruchus maculatus* up to 300 days of storage.

24. Curcumin content in stored turmeric varieties:

The Curcumin content in stored turmeric varieties progressively decreased with length of storage period. Among the varieties tested the decrease in Curcumin content in storage was higher with Mydukur followed by PCT-14 and TC-2.

25. Chemical treatment of copra to prevent fungal damage:

Mature coconut halves treated with solutions of 1% acetic acid, sodium bicarbonate or sodium chloride protected the copra from spoilage due to fungal infection.

26. Suitability of storage containers for storage of tamarind:

Tamarind gained moisture when stored in mud pots and gunny bags with reduced total acidity compared to the produce stored in polythene bag, tetra pack or glass bottle. The acidity of the samples stored in tetra pack was highest followed by polythene bags, whereas it was least in case of the samples stored in gunny bags followed by mud pots.

None of the structures however could prevent discolouration of stored tamarind as it is temperature dependent.

27. Use of Maize stalks for oyster and milky Mushroom Cultivation

Maize stalks after harvest of the cobs can be utilized for the cultivation of oyster and milky mushrooms in place of paddy straw. Yield and bio-efficiency of the mushrooms cultivated by using maize stalks will be on par with mushroom yield cultivated with paddy straw.

Addresses and contact phone numbers of Post Harvest & Agricultural Equipment suppliers.

S.No.	Address	Phone No.
1.	The Manager (Implements) AP Agro Industries Development Corporation Agro Bhavan, 10-2-3, A.C. Guards, Hyderabad-500 004	040 - 23396530 23317225
2.	M/s Viswakarma Engineering Company Plot No.138, Road No.26 Industrial Estate, Kattedan, Hyderabad – 500 077	040-24361719
3.	M/s Karshak & Sons Shop No.42, Al Karim Trade Centre M.G. Road, Secunderabad – 500 003	040-27542315
4.	M/s Mekins Agro Products Pvt. Ltd. Plot No.30, IDA, Gandhinagar, Balangar, Hyderabad-500 037	040-23085959
5.	M/s Escorts Tractors, 160/1, Sardar Patel Road, Opp. Global Trust Bank, Secunderabad	040-27907073
6.	M/s Farm Implements (India) Pvt. Ltd., 10, Kumarappa Street, Nungambakkam, Chennai – 600 034	044-28261676
7.	M/s Farm Steel Products PD 17 & 18, Industrial Estate, Vijayawada – 520 007	0866-2472694 (R) 2553958 (O)
8.	M/s Jai Bharathi Engineering Works Plot No. C-25, Industrial Estate, Machilipatnam Road, Gudivada – 521 301	08674 – 243392
9.	M/s Modern Arc Welding Works 16-256, Venkateswara Theatre Road, Gudivada – 521 301	08674- 242029 (O) 246505 (R)
10.	M/s Riteset Industries Gudivada – 521 301	08674-243918 (O) 243997 (O) 243626 (R)
11.	M/s Siri Enterprises Plot No.38, Phase – III, Indira Autonagar, Guntur – 500 001	0863–2211444 (O) 2556678 (R) 2556319 (R) 9440471202
12.	M/s Sri Adhi Vishnu Machine Tool Stores Old Bus Stand, Morrispet, Tenali – 522 202	08644-223320 (O) 228711 (R)
13.	M/s Sri Srinivasa Auto Engineering Works Industrial Estate, Plot No.C2 & C3, Gudivada	08674 – 242862 242374
14.	M/s Navya Industries, Plot No.A-3, Auto Nagar, Gudivada – 521 301	08674 – 244597 245482 98666 31866

S.No.	Address	Phone No.
15.	M/s A.P Agros industries development corporation 504, Heritage complex, Hill ford road, Hyderabad-4 A.P. Agros industries development corporation workshop complex, Narasapur Road, Balanagar, Hyderabad.	040-23391331, 23314246, 23317225.
16.	M/s Mathesis Engineers Pvt. Ltd Plot No. B-35, B.H.E.L – A.I.E, Ramachandrapuram, Hyderabad -3	040- 23020628, 23022298, 23730134.
17.	M/s Kardi Dryers (p) Ltd.Old No:86 (New No:69), Surv No.203/2, 2 nd Extension, Nageswara Rao Road, Athipet Chennai-600086. info@kardridryers.com www.kardidryers.com	Phone:044- 26880001, 9791664050

XV. SERICULTURE

Varieties : Local, M.5 (Kanwa), S-13, S-30 and S-56 etc.

Mulberry cultivation

The mulberry could be grown up in any type of land but preferably in red-sandy loam. The p^H of the soil should be 6.5. The land preparation should be taken up in the months of June and July. Once planted, it remains over 15 years without any deterioration in leaf yield. The land should be given a deep digging to a depth of 30 to 35 cm to loosen the soil. The prepared and levelled land is formed into ridges and furrows. The furrows should be at least 15 cm deep.

Preparation of saplings: It should be propagated through cuttings. Branches of 6 to 8 months having 10 to 12 mm diameter are cut to 18 to 20 cm length with 3 to 4 healthy buds.

System of planting: There are two systems of planting under irrigated condition namely row system and the pit system. In the row system, the rows are made 60 cm apart and cuttings are planted in the row at a distance of 22 cm. In the pit system, the rows are made 60 cm apart and the cuttings are planted at a distance of 60 cm in the row.

Irrigation: During the dry period from December to May, irrigation should be given at an interval of 8 to 14 days depending on soil type.

Fertilizers: The CSR & TI, Mysore recommended 300:120:120 N, P₂O₅ and K₂O kg ha⁻¹ in equal splits after each harvest.

Pruning: The new plantation will be established in six months time. In the first year, two to three harvestings can be taken depending on the growth. From second year onwards, the plantation starts yielding to full capacity.

Silk worm rearing: The silk worm has 5 stages (1-5 stages). The Sericulturists bring the layings from the grainages. After 9th day the first stage larvae comes out from the eggs. Silk worm rearing requires more attention upto cocoon production. Each stage, the silk worm goes for moulting. After the 5th stage, the bulky worm becomes thin and shrinks in golden colour, such worms raise their heads to find a place for spinning. The spinning will be completed within three days. After 5th day from spinning, the larvae enter pupa stage. Harvesting should be done on 5th day after pupation.

During the first year of plantation, only 2 crops can be taken with a rearing capacity 650 to 700 dfls. The plantation is fully established during the 1st year and reaches optimum productivity

from 2nd year onwards. The leaf yields around 35,000 kg ha⁻¹ and rearing capacity of about 4,600 dfls in five crops.

Mulberry diseases

Root rot: Infected plant should be uprooted and burnt. Apply carbendazim @ 1 ml/l or copper oxy chloride @ 3 g/l at the base of the plant.

Leaf spot: Spray copper oxy chloride @ 3 g/l on young leaves. Sprayed leaves can be used after 15 days of spraying

XVI. BEE KEEPING

The equipment required for maintenance of *Apis mellifera* is:

- Bee hive box with stand
- Hiza tool, Smoker
- Bee veil (For protection of face from bees stinging)
- Bee brush
- Rubber gloves 12" length
- Crystal knife (For removing brood frames)
- Queen excluded sheet
- Aluminium plates of 1" depth and 4" to 5" diameter to keep the legs of the stand immersed in water, to prevent from ants and provide water for bees.

For colonies on *Apis mellifera* contact, Horticulturist, ARS, Vijayarai - 534 475, West Godavari.

The best time for introduction of *Apis mellifera* in the state is from middle of December to middle of January. The cost of each transport hive with five frame bee strength colony is about Rs.730/-.

For successful maintenance of *Apis mellifera* colonies, there should be profuse forage, rich in nectar/pollen within a radius of 2 to 5 km for a period of 9 to 10 months. Sunflower, cotton, mustard, peas and all cucumber family plants possess flowers with high nector content. Among plantations, mango, guava, coconut, tamarind, ber, cashewnut, banana, citrus, neem and soapnut are also the source of nector. Availability of fresh water and formation of Drone congregation centres (5-6) for queen mating may also play an important role in success of bee keeping. Mites infesting the colonies can be controlled by dusting sulphur @ 1.5 g per frame on the top bar.
