

*a compendium by NARS,  
State Department(s) of Agriculture and Agro-Industries*

# **Districtwise Promising Technologies for Rainfed Groundnut based Production System in India**



**All India Coordinated Research Project for Dryland Agriculture  
Central Research Institute for Dryland Agriculture**

Santoshnagar, Hyderabad 500 059

**Citation:** KPR Vittal, MS Basu, G Ravindra Chary, GR Maruthi Sankar, T Srijaya, Y.S.Ramakrishna, JS Samra and Gurbachan Singh. Eds. (2004). Districtwise Promising Technologies for Rainfed Groundnut based Production System in India. All India Co-ordinated Research Project for Dryland Agriculture, Central Research Institute for Dryland Agriculture, Indian Council of Agricultural Research, Hyderabad 500 059. Pages : 92

*About this compendium*

Crop based recommendations are available from several sources for location specific conditions. However, in rainfed region there are several crops grown in combination or individually at most of the places. Hence, a ready reckoner should provide information not only for growing a healthy crop but also to meet the aberrant weather conditions in that region. At present, districts which contribute to 85% of rainfed groundnut region were identified. Their agro ecological setting, soil and water conservation, crop management including nutrient management, pest management etc., suitable cropping systems, alternate farming systems and contingency plans were described in the background of crop yield gap and runoff of the district. The technologies encompass not only that from All India Coordinated Research Project for Dryland Agriculture (AICRPDA) and National Research Centre for Groundnut (NRCG), but also others from National Agricultural Research System (NARS), State Department(s) of Agriculture and Agro-industries.

*a compendium of AICRPDA, CRIDA, NRCG, SAUs,  
State Department(s) of Agriculture and Agro-Industries*

# **Districtwise Promising Technologies for Rainfed Groundnut based Production System in India**

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**2004**

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# GROUNDNUT BASED PRODUCTION SYSTEM

Groundnut (*Arachis hypogea* L.), an unpredictable legume, may continue to be an important commercial crop in rainfed areas. The crop contributes about 40 percent to the total oilseeds production in the country. At this level of contribution, the projected demand for groundnut by 2020 AD will be about 14 mt. The present production level is around 8.2 mt. Therefore, a gap of about 5.8 m t has to be bridged. This calls for a growth rate of about 2.2 percent per annum, in production. This growth has to come mainly from the increase in productivity. Productivity of groundnut has been showing a positive growth since eighties. At present, average yield in the *kharif* is around 900 kg/ha and that of in the *rabi*/summer is around 1500 kg/ha. A fair projection for enhanced productivity with sustainability by 2020 AD will be about 1100 kg/ha (about 22 % increase) for *kharif* groundnut and 2000 kg/ha (about 25 per cent increase) for *rabi*/ summer groundnut. But both production and productivity especially of *kharif* groundnut have shown highly fluctuating trends. The erratic trend in productivity, relatively high cost of cultivation, the associated financial risk and non-availability of quality seed in sufficient quantities, have led to a decline in area and production in some traditional groundnut belts including the Saurashtra region of Gujarat, the groundnut bowl of India. This erratic trend in production has affected the groundnut export also. Thus, the high growth rate of 2.35% obtained during the first few years of oilseed mission will be difficult to sustain in the long run especially when contribution from other oilseeds like rapeseed mustard, sunflower and soybean and other oil sources is already a reality. Rain dependent cropping systems have been and may continue to be the mainstay of the future of groundnut agriculture in India. Not more than 20 per cent of the total groundnut area is expected to be under irrigation by 2020 AD, from the existing 17 per cent.

Groundnut is grown in 8.46 mha in 316 districts in 16 selected states. Fifty districts cover 85% of rainfed groundnut of 5.43 mha. The details are -

Selection criteria	No. of Districts	Area under Groundnut ('000 ha)	Area under Rainfed Groundnut ('000 ha)	Gross Cropped Area ('000 ha)	Yield (kg/ha)
States (16)	316	8461	6840	154249	807
Agro eco Region **	243	7929	6416	125192	876
85% Rainfed Groundnut Area	50	6448	5429	35066	1040

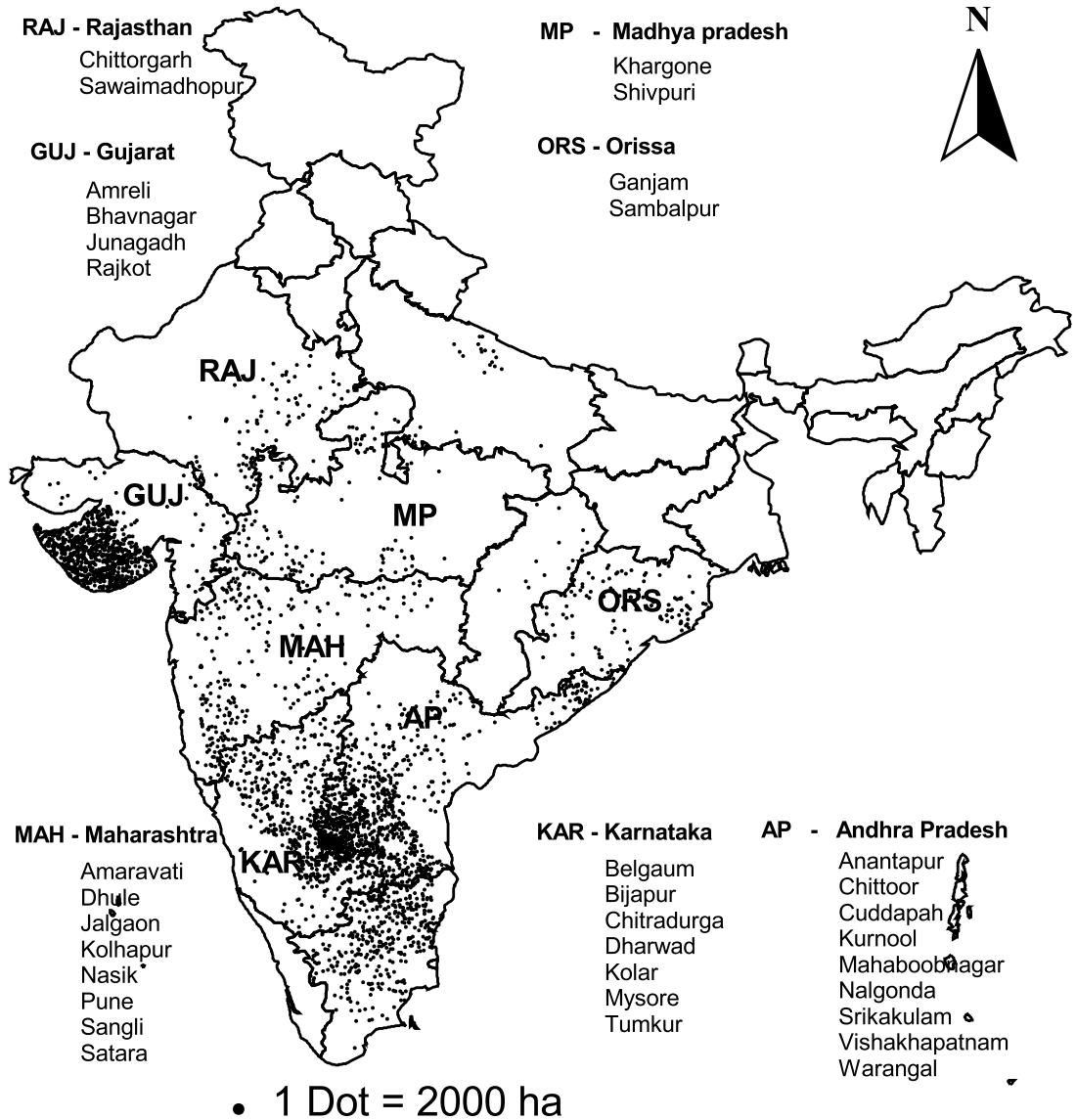
\*\* Arid, sub-humid and dry sub humid areas

*Kharif* rainfed groundnut area covers 34 districts. These are – Shivpuri, Khargone, Srikakulam, Vishakhapatnam, Kurnool, Anantapur, Cuddapah, Chittoor, Mahaboobnagar, Nalgonda, Warangal, Kolar, Tumkur, Mysore, Chitradurga, Dharwad, Belgaum, Bijapur, Nasik, Dhule, Jalgaon, Pune, Satara, Sangli, Kolhapur, Amaravati, Amreli, Bhavnagar, Junagadh, Rajkot, Chittorgarh, Sawaimadhopur, Ganjam and Sambalpur. The nine districts under *rabi* are Cuddalore (South Arcot), North Arcot, Salem, Tiruchirapalli, Dharmapuri, Erode (Periyar), Pudukottai, Thiruvannamalai (T.Sambuvariyar), and Cuttack. The districts covering both *kharif* and *rabi* are Bellary, Raichur, Gulbarga, Prakasam and Dhenkenal. Two districts with significant *rabi* and summer area are Coimbatore and Villupuram.

The trends in area and yield growth rates of groundnut for different districts are given below:

Area	Yield	State	Districts
Stagnant	Increasing	Andhra Pradesh	Anantapur, Kurnool, Chittoor, Cuddapah, Warangal, Nalgonda, Srikakulam, Vishakhapatnam
		Karnataka	Tumkur, Chitradurga, Dharwad, Kolar
		Madhya Pradesh	Shivpuri
		Maharastra	Kolhapur, Pune
		Orissa	Sambalpur
		Rajastan	Chittorgarh

# RAINFED GROUNDNUT REGION Priority Districts



Area	Yield	State	Districts
Stagnant	Stagnant	Andhra Pradesh	Mahaboobnagar
		Gujarat	Rajkot, Junagadh, Amreli, Bhavnagar Belgaum, Bijapur, Mysore
		Karnataka	Khargone
		Madhya Pradesh	Dhule, Satara, Nasik, Sangli
		Maharastra	Ganjam
		Orissa	Sawaimadhapur
		Rajasthan	
Decreasing	Stagnant	Maharastra	Jalgaon, Amaravati

Details on associated crops and dominant livestock are presented below:

Crops	Animals	Districts
Sorghum	She Cattle	Shivpuri, Khargone, Srikakulam, Vishakhapatnam, Mahaboobnagar, Nalgonda, Warangal,
Groundnut	She Buffalo	Mysore, Chitradurga, Dharwad, Belgaum, Bijapur, Nasik, Dhule, Jalgaon, Pune,
Greengram	Goat	Satara, Sangli, Kolhapur, Amaravati, Bhavnagar, Chittorgarh, Sawaimadhapur, Ganjam,
Fruits	Sheep	Sambalpur
Groundnut	Sheep	Kurnool, Anantapur, Cuddapah, Chittoor, Kolar, Tumkur,
Fruits	Goat	Amreli, Junagadh, Rajkot, Vizianagaram
	She Cattle	
	He Buffalo	

The popular groundnut based production systems in the agroeco-regions covering the prioritized districts are:

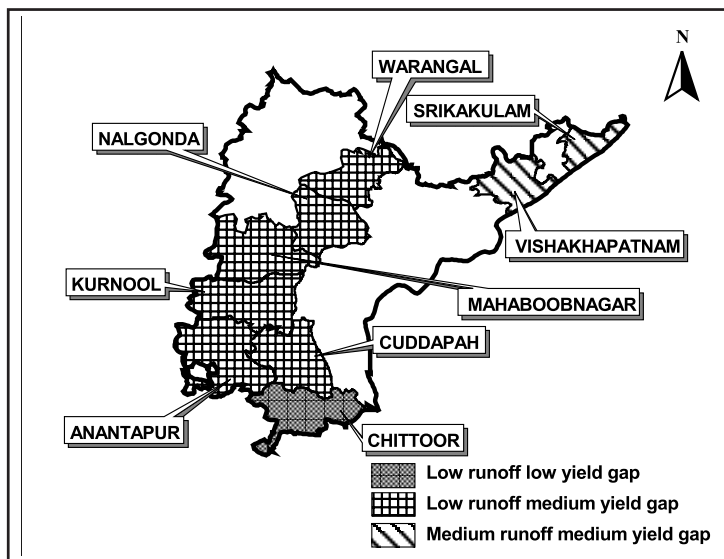
Agroecoregion	Production System
Hot Arid Karnataka Plateau	Groundnut-fallow/ horsegram
Hot Semi-arid Northern Plains	Groundnut-wheat/ fallow
Semi-arid Central Highlands	Groundnut-fallow
	Groundnut-sorghum-cotton
	Sorghum-groundnut/ wheat
Hot Semi-arid Deccan Plateau	Groundnut-wheat/ fallow
Hot Semi-arid Deccan Plateau and Eastern Ghats	Groundnut-fallow
Hot Semi-arid Eastern Ghats, Tamilnadu Uplands etc.	Groundnut-fingermillet/ pearl millet/ sorghum
Hot Sub-humid Eastern Plateau	Groundnut-niger
	Rice-groundnut

The recommendations on groundnut based production system are given below state and district-wise (except Shivpuri and Srikakulam) in alphabetical order for the regions with low (<12%), medium (12–25%) and high (>25%) surplus index, and low (<33%), medium (33–66%) and high (>66%) yield gap of *kharif* groundnut. The recommendation are given for 34 districts in 7 states where *kharif* rainfed groundnut is predominant.



## ANDHRA PRADESH

In Andhra Pradesh there is one district viz. Chittoor under low runoff and low yield gap region, six districts viz. Nalgonda, Cuddapah, Kurnool, Anantapur, Mahaboobnagar and Warangal are under low runoff and medium yield gap region, and one district viz. Srikakulam, Vishakhapatnam are under medium runoff and medium yield gap region.



District	Region
Chittoor	Low run off and Low yield gap

### Agroecological setting

- **Climate:** Hot moist semi arid
- **Physiography:** Rayalaseema region
- **Soils:** Deep red loamy soils (Alfisols 80%; Aridisols– 20%)
- **Annual rainfall:** 697 mm
- **Potential evapotranspiration:** 1556 mm
- **Moisture availability period:** 120-150 days

### Soil and water conservation:

- Contour bunding with a cross section of 0.63 m<sup>2</sup> and with horizontal spacing of 25 m to 125 m is recommended for red soils. The other soil conservation measures like compartment bunds of 15 m length and 10 m width or conservation furrow at 3.6 m interval or intercropping with mixed pulses like cowpea and horsegram can be adopted.
- Integrated watershed management (manage in a < 10 ha watershed)
- Water harvesting inlined with Cuddapah slabs to avoid seepage losses in dug out ponds
- Increasing catchment area and design of pond size for catchment size
- Interplot water harvesting of 1:1 cropped to uncropped area

- Use of life saving irrigation
- Indigenous water harvesting structures to be restored

### Crop management

- **Varieties:** TMV-2, Vemana, TPT-4, TPT-2, TPT-1 and JL-24
  - For scarce rainfall in *kharif* – Vemana (K-134), Tirupati-2, TMV-2, JCG-88, Tirupati-1, Tirupati-4
  - For delayed onset of monsoon – Kadiri-4 (K-150)
- **Seed rate:** 100 kg/ha
- **Seed treatment:** Seed treatment with Mancozeb (3g)/ Carbendazim (2g) for one kg of kernels
- **Sowing time:** *kharif* – July
- **Planting pattern:** 30x10 cm
- **Nutrient management:** 20 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> + 40 kg K<sub>2</sub>O/ha. Reduce to 50% of recommendation if soil test value is medium
  - In Zn deficient soils – apply ZnSO<sub>4</sub> at 25 kg/ha once in three years
- **Pest management:**
  - Root grub: Apply Thimmet or Phorate granules at 10 kg/ha to soil before sowing or treat the seed with chlorpyrifos @ 6 ml/kg seed.
  - Aphids, leaf miner: Spray 0.05% Endosulfan or Dimethoate or Monocrotophos
  - Red hairy caterpillar:
    - Arrange bonfires 2 days after soaking rain from 8.00 PM to 10.00 PM
    - Make a furrow around the field, and apply Carbaryl dust in the furrow
    - For second and third instar larvae spray dimethoate @ 2 ml/l or Monocrotophos @1.6 ml/l
    - Poison bait with 10 kg rice bran + 1 kg jaggery + 500 ml Quinolphos can be applied for effective control.

### Weed management

- Preplant application of Fluchloralin @3-3.5 l/ha
- Pre-emergence application of (within three days after sowing) Butachlor @4-5 l/ha or Pendimethalin @3.5-5 l/ha
- Mulching with groundnut shells @5 t/ha, 15-20 days after crop emergence.
- Application of antitranspirants like Kaoline or Lime water @ 50 g during drought conditions.
- To recover from drought effect spraying of urea @20 g/l of water
- **Some other important practices**
  - Deep ploughing once in three years, where soil depth is 20 cm or more.
  - Preparatory cultivation with country plough or “*Chekkala guntaka*”, a traditional implement increases the yield of groundnut.
  - Sand application @ 40 t/ha applied during summer increases the yield of groundnut
  - Drought management practices like application of groundnut shells @ 5 t/ha at 10 days after sowing
  - Drought tolerant varieties – Girnar -1
  - Deep tillage is done for reducing soil borne pests
  - Pearl millet act as a barrier for thrips and leaf miner

- Castor act as barrier for *Spodoptera litura*, *Achoea janata*
- Groundnut + soybean for trapping leaf miner and thrips
- Seed treatment: Carbendazim (Bavistin) 2 g/kg of seeds for seed borne fungi viz., collar rot and stem rot.

### Suitable cropping systems

- Monocropping of groundnut: In 50% of the rainfed cultivated area
- Groundnut + pigeonpea (7: 1 or 11:1)
- Groundnut + castor (7:1 or 11:1)

### Farm implements/ tools:

- Eenatigorry (bullock drawn, four row): Useful for sowing, seed and fertilizer placement. Suitable for those who have light draft animals (Rs.1500 per unit)
- Seed drill/planter (tractor drawn, nine row): It is a mechanical seed drill. More area can be covered in a day and intra row spacing is maintained (Rs.16000 per unit)
- Ashaguntaka (tractor drawn, seven row): Useful for harvesting of groundnut crop. More field capacity and labour saving (Rs.20000 per unit)
- Groundnut thresher cum decorticator: Useful for separating groundnut pods from haulms. It was found advantageous to thresh groundnut after 3-5 days after harvest. The cost of operation was Rs. 224/ha. It can also be used as decorticator with minor modifications. Perform timely operation and labour saving (Rs.45000 per unit)

### Alternate farming systems

- Crop + livestock (sheep @ 10/ha) system of farming will give 80% more income than crop system alone.
- **Fodder/ green biomass:** *Dalbergia sissoo*, *Gliricidia*, *Albizia lebbeck*, *Cassia siamea*, *Azadirachta indica*/ stylo, Marvel-8 grass
- **Fruit:** Ber, Custard apple, Pomegranate, Amla + *kharif* spreading crops
- **Medicinal and aromatic plants:** *Cassia angustifolia*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, *Rose*, *Geranium*
- **Vegetables:** Onion, Brinjal, Chillies, Cowpea, Cucumber, Cluster bean, Drumstick.

### Contingent crop planning

- **Early onset of monsoon**  
Sorghum, greengram, pigeonpea, castor (May – June)
- **Normal onset of monsoon**  
Groundnut, pigeonpea, groundnut + pigeonpea (July)
- **Late onset of monsoon**  
Pearlmillet, sorghum, greengram (after August 15<sup>th</sup>)
- **Very late onset of monsoon**  
Pearlmillet, cowpea, horsegram (early September)

District	Region
Anantapur Cuddapah Kurnool Mahaboobnagar Nalgonda Warangal	Low run off and medium yield gap

## Agroecological setting

### Anantapur

- **Climate:** Hot arid
- **Physiography:** Rayalaseema region
- **Soils:** Deep loamy and clayey mixed red and black soils( Alfisols- 80%)
- **Annual rainfall:** 497 mm
- **Potential evapotranspiration:** 1858 mm
- **Moisture availability period:** 60-90 days

### Cuddapah

- **Climate:** Hot dry semi arid
- **Physiography:** Rayalaseema
- **Soils:** Deep loamy, clayey mixed red and black soils (Alfisols - 60%, Vestic Inceptisols - 40%)
- **Annual rainfall:** 748 mm
- **Potential evapotranspiration:** 1835 mm
- **Moisture availability period:** 80-120 days

### Kurnool

- **Climate:** Hot dry semi arid
- **Physiography:** Rayalaseema region
- **Soils:** Deep loamy, clayey mixed red and black soils (Alfisols - 60%; Vertic Inceptisols - 40%)
- **Annual rainfall:** 605 mm
- **Potential evapotranspiration:** 1828 mm
- **Moisture availability period:** 80-120 days

### Mahaboobnagar

- **Climate:** Hot moist semi arid
- **Physiography:** North Telangana
- **Soils:** Deep loamy, clayey mixed red and black soils (Vertisols–40%; Vertic Inceptisols–20%; Alfisols–40%)
- **Annual rainfall:** 792 mm
- **Potential evapotranspiration:** 1678 mm
- **Moisture availability period:** 120-150 days

## **Nalgonda**

- **Climate:** Hot moist semi arid
- **Physiography:** North Telangana
- **Soils:** Deep loamy, clayey mixed red and black soils (Alfisols 100%)
- **Annual rainfall:** 763 mm
- **Potential evapotranspiration:** 1761 mm
- **Moisture availability period:** 120-150 days

## **Warangal**

- **Climate:** Hot moist semi arid
- **Physiography:** North Telangana
- **Soils:** Deep loamy, clayey mixed red and black soils (Alfisols–40%; Vertic Inceptisols–35%; Orthids–25%)
- **Annual rainfall:** 925 mm
- **Potential evapotranspiration:** 1790 mm
- **Moisture availability period:** 120-150 days

## **Soil and water conservation:**

### **Anantapur, Cuddapah, Kurnool**

- Contour bunds, graded bunds
- Contour bunding with a cross section of 0.63 m<sup>2</sup> and with horizontal spacing of 25 to 125 m is recommended for red soils. The other soil conservation measures like compartment bunds of 15 m length and 10 m width or conservation furrow at 3.6m interval or intercropping with mixed pulses like cowpea and horsegram can be adopted.
- Integrated watershed management (manage in a <10 ha watershed)
- Water harvesting inlined with cuddapah slabs to avoid seepage losses in dug out ponds
- Increasing catchment area and design of pond size for catchment size
- Interplot water harvesting of 1:1 cropped to uncropped area
- Use of life saving irrigation
- Indigenous water harvesting structures

### **Mahaboobnagar, Warangal**

- Inter-plot water harvesting of 1:1 cropped to uncropped land

## **Nalgonda**

- Ridges and furrows

## **Crop management**

### **Anantapur, Cuddapah, Kurnool**

- **Varieties:** TMV-2, Vedanta, and TPT-4, TPT-2, TPT-1 and JL-24
  - For scarce rainfall in *kharif* – Vemana (K-134), Tirupati-2, TMV-2, JCG-88, Tirupati-1, Tirupati-4
  - For delayed onset of monsoon – Kadiri-4 (K-150)

- **Seed rate:** 100 kg/ha
- **Sowing time:** *kharif* – July
- **Seed treatment:** Seed treatment with Mancozeb (3g)/ Carbendazim (2 g) for one kg of kernals
- **Panting pattern:** 30x10 cm
- **Nutrient management:**
- 20 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> + 40 kg K<sub>2</sub>O/ha. Reduce to 50% of recommendation if soil test value is medium
  - 20 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> + 50 kg K<sub>2</sub>O + 500 kg gypsum + 25 kg ZnSO<sub>4</sub> (for Zn deficient soils) for every three years of groundnut crop + farm yard manure @ 10-12 t/ha. N, P and K as basal. Apply gypsum in rows near to base of the plants after weeding at first flowering. Gypsum application should be completed before 45 DAS / before second weeding.
  - In Zn deficient soils – apply ZnSO<sub>4</sub> 25 kg/ha once in three years
- Pest Management:
  - Weed control: Hand weeding at 20 and 40 days after sowing + pendimethalin at 50 days after sowing as post emergence @ 0.5 kg a.i/ha
  - Root grub: Apply Thimmet or Phorate granules at 10 kg/ha to soil before sowing or treat the seed with chlorpyrifos @ 6 ml/kg seed.
  - Aphids, leaf miner: Spray 0.05% Endosulfan or Dimethoate or Monocrotophos
- Red hairy caterpillar:
  - Arrange bonfires 2 days after soaking rain from 8.00 PM to 10.00 PM
  - Make a furrow around the field, and apply Carbaryl dust in the furrow
  - For second and third instar larvae, spray dimethoate @ 2 ml/l or Monocrotophos @ 1.6 ml/l
  - Poison bait with 10 kg rice bran + 1 kg jaggery + 500 ml Quinolphos can be applied for effective control.

## Weed management

### Anantapur, Cuddapah, Kurnool

- Preplant application of Fluchloralin @3-3.5 l/ha
- Pre-emergence application of (within three days after sowing) Butachlor @4-5 l/ha or Pendimethalin @3.5-5 l/ha
- Mulching with groundnut shells @5 t/ha, 15-20 days after crop emergence.
- Application of antitranspirants like Kaoline or Lime water @ 50 g during drought conditions.
- To recover from drought effect spraying of urea @20 g/l of water
- **Some other important practices**
  - Deep ploughing once in three years, where soil depth is 40 cm or more.
  - Preparatory cultivation with country plough or “*Chekkala guntaka*”, a traditional implement increases the yield of groundnut.
  - Sand application @ 40 t/ha applied during summer increases the yield of groundnut
  - In Alfisols – 100 % RDF (50% organic + 50% inorganic), 50% recommended N (40 kg/ha glyricidia as half basal + half top dressing)
  - In groundnut–castor rotation – 25% N (compost) + 75% N (inorganic)
  - LCC VI – custard apple (4.5x4.5 m), Ber (6x6 m), Soapnut (6x6 m), Tamarind (9x9 m)
  - For breaking seed dormancy treat with 0.05 % (5 ml/10l water) Etheryl (plant hormone). Soak kernals in Etheryl solution for 12 hrs and shade dry before sowing.

- Crop substitution – groundnut substituted with pigeonpea, castor, pearl millet and sorghum
- Crop rotation – *kharif* groundnut – greengram/ horsegram where Northeast monsoon is assured.
- Drought tolerant varieties – Girnar-1
- Deep tillage is done for reducing soil borne pest
- Pearl millet acts as a barrier for thrips and leaf miner
- Castor acts as a barrier for *spodoptera litura*, *Achoea janata*
- Groundnut + soybean for trapping leaf miner, thrips
- Seed treatment: Carbendazim (Bavistin) 2 kg of seeds for seed borne fungi viz., collar rot and stem rot.
- Seed treatment with Mancozeb (3 g)/ Carbendazim (2 g) for 1 kg of kernels
- **Cultural practices**
  - Soil amendment with castor cake @ 500 kg/ha (preferably 15 days before sowing) for soil borne diseases like stem rot and collar rot.
  - Intercropping of groundnut with pigeonpea/ pearl millet/ sorghum (3:1) depending upon the locally recommended intercrops against foliar fungal diseases (early and late leaf spots, rust) and insect pests (leaf miner and thrips)
  - Use of trap crops such as cowpea/ soybean (leaf miner and leaf hoppers)/ castor (Spodoptera and leaf hoppers) as border crops for sucking/ defoliating insects.
  - One hand weeding at 30-35 days after sowing after the application of pre-emergence weedicide Fluchloralin @ 1.5 kg a.i./ha

### **Mahaboobnagar, Nalgonda, Warangal**

- **Varieties:** JL-24
- **Seed rate:** 100 kg/ ha
- **Seed treatment:** Seed treatment with Mancozeb (4 g)/ Carbendazim (2 g) for one kg of kernels
- **Planting pattern:** 30x10 cm
- **Nutrient management:** 20 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>+ 40 kg K<sub>2</sub>O/ha.
  - In Zn deficient soils – apply ZnSO<sub>4</sub> 25 kg/ha once in three years
  - 50% recommended dose of fertilizer + Farm yard manure 5 t/ha in sequence crops
- **Pest management:**
  - Root grub: Apply Thimmet or Phorate granules at 10 kg/ha to soil before sowing or treat the seed with Chlorpyrifos @ 6 ml/kg seed.
  - Aphids, leaf miner: Spray 0.05% Endosulfan or Dimethoate or monocrotophos
  - Red hairy caterpillar:
    - Arrange bonfires 2 days after soaking rain from 8.00 PM to 10.00 PM
    - Make a furrow around the field, and apply carbaryl dust in the furrow
    - For second and third instar larvae, spray Dimethoate @ 2 ml/l or Monocrotophos @ 1.6 ml/l
    - Poison bait with 10 kg rice bran + 1 kg jaggery + 500 ml Quinolphos can be applied for effective control.
  - Late leaf spot: Spray Mancozeb 2 g + Carbendazim 1 g/l or Hexaconazole @ 2 ml/l. Spraying can be taken up based on leaf wetness at 70 days after sowing. There is no need to spray for July sown crop.
  - Stem necrosis: Removal of weeds particularly Parthenium on the bunds and in the field

## **Weed management:**

### **Mahaboobnagar, Nalgonda, Warangal**

- Preplant application of Fluchloralin @3-3.5 l/ha
- Pre-emergence application of (within three days after sowing) Butachlor @4-5 l/ha or Pendimethalin @3.5-5 l/ha
- Mulching with groundnut shells @5 t/ha, 15-20 days after crop emergence.
- Application of antitranspirants like Kaoline or Lime water @ 50 g during drought conditions.
- To recover from drought effect spraying of urea @20 g/l of water
- **Some other important practices**
  - Drought tolerant varieties – Girnar-1
  - Deep tillage is done for reducing soil borne pest
  - Pearl millet acts as a barrier for thrips and leaf miner
  - Castor acts as a barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips
  - Seed treatment: Carbendazim (Bavistin) 2 g/kg of seeds for seed borne fungi viz., collar rot and stem rot.
  - Seed treatment with Mancozeb (3 g)/ Carbendazim (2 g) for 1 kg of kernels

## **Suitable cropping systems**

### **Anantapur, Cuddapah, Kurnool**

- Monocropping of groundnut: In 50% of the area.
- Groundnut + pigeonpea (7:1 or 11:1)
- Groundnut + castor (7:1 or 11:1)
- Groundnut + pearl millet (6:2)

### **Mahaboobnagar, Nalgonda, Warangal**

- Groundnut + pigeonpea (7: 1)
- Groundnut + castor (7:1 or 11:1)

## **Farm implements/ tools:**

### **Anantapur, Cuddapah, Kurnool**

- Eeatigorry (bullock drawn, four row): Useful for sowing, seed and fertilizer placement. Suitable for those who have light draft animals: (Rs.1500 per unit)
- Seed drill/planter (tractor drawn, nine row): It is a mechanical seed drill. More area can be covered in a day and intra row spacing is maintained (Rs.16000 per unit)
- Ashaguntaka (tractor drawn, seven row): Useful for harvesting of groundnut crop. More field capacity and labour saving (Rs.20000 per unit)
- Groundnut thresher cum decorticator: Useful for separating groundnut pods from haulms. It was found advantageous to thresh groundnut after 3-5 days after harvest. The cost of operation was Rs. 224/ha. It can also be used as decorticator with minor modifications. Perform timely operation and labour saving (Rs.45000 per unit)



- APAU groundnut seed cum fertilizer drill (three row – animal drawn)
- CRIDA seed cum fertilizer drill (four row – animal drawn)
- Groundnut thresher

### **Mahaboobnagar, Nalgonda, Warangal**

- Bullock drawn two-row sweep cultivator
- Modified two-row blade harrow
- Bullock drawn country plough attached with Pora tube

### **Alternate farming systems**

#### **Anantapur, Cuddapah, Kurnool**

- **Fodder/ green biomass:** *Dalbergia sissoo*, *Gliricidia*, *Albizzia lebbeck*, *Cassia siamea*, *Azadirachta indica*/ stylo, Marvel-8 grass
- **Fruit:** Ber, Custard apple, Pomegranate, Amla + *kharif* spreading crops
- **Medicinal and aromatic plants:** *Cassia angustifolia*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, Rose, Geranium
- **Vegetables:** Onion, Brinjal, Chillies, Cowpea, Cucumber, Cluster bean, Drumstick.
- Crop + livestock (sheep @ 10/ha) system of farming will give 80% more income than crop system alone.

#### **Mahaboobnagar, Nalgonda, Warangal**

- **Parkland systems:** *Azadirachta indica*, *Acacia nilotica*, *Tamarindus indica*
- **Trees on bunds:** *Tectona grandis*, *Leucaena leucocephala*, *Borassus flabellifera*, *Cocos nucifera*, *Acacia nilotica* var. *cupressiformis*
- **Silvipastoral system:** *Leucaena leucocephala* + *Stylosanthes hamata*, *Leucaena leucocephala* + *Cenchrus + ciliaris*
- **Alley cropping:** *Leucaena leucocephala* + sorghum/ pearl millet, *Gliricidia sepium* + sorghum/ pearl millet
- **Agrohorti system:** Mango + short duration pulses
- **Fruit:** Mango, Ber, Custard apple, Guava, Pomegranate, Amla
- **Fodder/green biomass:** *Leucaena leucocephala*, *Azadirachta indica*, *Albizzia lebbeck*, *Bauhinia purpurea*, *A. procera*, *B.monosperma*, *A.amara*, *Dalbergia sissoo*
- **Medicinal and aromatic plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Aloe barbadensis*, *Withia somnifera*, *Cymbopogon martini*, *Cymbopogon flexuosus*, *P rosalea*, *Palma rosa*, *Vetiveria zizanioides*
- **Dye yielding plants:** *Lawsonia inermis*, *Hibiscus sabdariffa*, *Tagetes erecta*, *Indigofera tinctoria*, *Annato*
- **Other economic shrubs:** Curry leaf, Jatropha, Soapnut
- **Animal component:** Female cattle, Female buffaloes, Male cattle, Sheep and Goat
- **Other enterprises:** Sericulture, Poultry

## **Contingent crop planning**

### **Anantapur, Cuddapah, Kurnool**

- Early onset of monsoon (last week of May or June): Sorghum (CSH-5), greengram, pigeonpea (PDM-1), castor (Aruna, GAUCH-1), mesta (AMV-1)
- Normal onset of monsoon (July): Groundnut, pigeonpea (TMV-2,J-11), groundnut + pigeonpea, castor (Aruna, GAUCH-1), mesta (AMV-1), setaria, pearl millet (MBH-110, MH-88), greengram
- Late onset of monsoon (August): Sorghum, greengram (after August 15<sup>th</sup>), pearl millet (MBH-110), setaria, groundnut (TMV-2)
- Very late onset of monsoon (September): Cowpea, horsegram (early September), pearl millet (MBH-110), horsegram (Anantapur local, BGM)

### **Mahaboobnagar, Nalgonda**

- **June: Normal onset of monsoon**
  - **Sole crop:** Sorghum (CSH 5, CSH-6, CSH-9), pearl millet (MBH 110)
  - Intercrop:
    - Sorghum - pigeonpea (2:1)
    - Pearl millet + pigeonpea (2:1) in 45 cm row spacing. Pigeonpea duration of 150-180 days may be used.
- **July: Late onset of monsoon**
  - Sow castor (Aruna, GAUCH-1)
  - Sole crop: Pearl millet (MBH-100), Bunch variety of groundnut (TMV-2, JL-24)
  - Intercrop: Maize (DHM-101, Ganga-5)
    - Maize + pigeonpea (2:1) at 50 cm spacing. Pigeonpea duration of 180-200 days
- **August: Very late onset of monsoon**
  - Sole crop: Setaria (H-1, Arjuna) for grain to poultry feed and straw for fodder
  - Castor (Aruna, GAUCH-1) with increased seed rate (15 kg/ ha)

### **Warangal**

#### **For Red soils**

- **June: Normal onset of monsoon**
  - Sole crop: Sorghum (CSH 5, CSH-6, CSH-9), pearl millet (MBH 110)
  - Intercrop:
    - Sorghum - pigeonpea (2:1)
    - Pearl millet + pigeonpea (2:1) in 45 cm row spacing. Pigeonpea duration of 150-180 days may be used.
- **July: Late onset of monsoon**
  - Sow castor (Aruna, GAUCH-1)
  - Sole crop: Pearl millet (MBH-100), (Bunch variety of groundnut (TMV-2, JL-24)
  - Intercrop: Maize (DHM-101, Ganga-5)
  - Maize + pigeonpea (2:1) at 50 cm spacing. Pigeonpea duration of 180-200 days
- **August: Very late onset of monsoon**
  - Sole crop: Setaria (H-1, Arjuna) for grain to poultry feed and straw for fodder
  - Castor (Aruna, GAUCH-1) with increased seed rate (15 kg/ ha)

## For Black soils

### First crop

- **June:**
  - Sorghum (CSH-5, CSH-6)
  - Maize: (Ganga 5, DHM-101)
  - Greengram (PS-16, HB-45, LRG-30)
- **July:**
  - Maize (Ganga 5, DHM-101)
  - Greengram (PS-16, HB-45, LRG-30)

### Second crop

- **September:**
  - *Maghi* sorghum (Moti, CSH-6)
  - Safflower: (Manjira)
- **October:**
  - Safflower: (Manjira)
  - Chickpea (Jyothi)

District	Region
Srikakulam Vishakhapatnam	Medium run off and Medium yield gap

## Agroecological setting

### Srikakulam

- **Climate:** Hot dry subhumid
- **Physiography:** Eastern coastal plain / Eastern ghats
- **Soils:** Medium to deep loamy red and lateritic soils/deep loamy to clayey coastal and deltaic alluvium derived soils
- **Annual rainfall:** 1104 mm
- **Potential evapotranspiration:** 1560 mm
- **Moisture availability period:** 180-210 days

### Vishakhapatnam

- **Climate:** Hot (moist/ dry) sub humid
- **Physiography:** Eastern ghats
- **Soils:** Medium to deep loamy red and lateritic, deep loamy to clayey coastal and deltaic alluvium derived soils (Aridisols – 50%; Alfisols – 50%)
- **Annual rainfall:** 975 mm
- **Potential evapotranspiration:** 1480 mm
- **Moisture availability period:** 180-210 days

## Soil and water conservation:

### Srikakulam, Vishakhapatnam

- Sowing across the slope and ridging later
- Contour farming
- Graded border strips

- Water harvesting structures
- Life saving irrigation

## Crop management

### Srikakulam, Vishakhapatnam

- **Varieties:** JL-24
- **Seed rate:** 100 kg/ha
- **Sowing time:** *kharif* – July
- **Seed treatment:** Seed treatment with Mancozeb (3 g)/ Carbendazim (2 g) for one kg of kernels
- **Planting pattern:** 30 X 10 cm
- **Nutrient management:** 20 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>+ 40 kg K<sub>2</sub>O/ ha.
  - In Zn deficient soils – apply ZnSO<sub>4</sub> 25 kg/ha once in three years
- **Pest management:**
  - Root grub: Apply Thimmet or Phorate granules at 10 kg/ha to soil before sowing or treat the seed with Chlorpyrifos @ 6 ml/kg seed.
  - Aphids, leaf miner: Spray 0.05% Endosulfan or Dimethoate or Monocrotophos
  - Red hairy caterpillar:
    - Arrange bonfires 2 days after soaking rain from 8.00 PM to 10.00 PM
    - Make a furrow around the field, and apply Carbaryl dust in the furrow
    - For second and third instar larvae spray Dimethoate @ 2 ml/l or Monocrotophos @ 1.6 ml/l
    - Poison bait with 10 kg rice bran + 1 kg jaggery + 500 ml Quinolphos can be applied for effective control.

## Weed management:

### Srikakulam, Vishakhapatnam

- Preplant application of Fluchloralin @3-3.5 l/ha
- Pre-emergence application of (within three days after sowing) Butachlor @4-5 l/ha or Pendimethalin @3.5-5 l/ha
- Mulching with groundnut shells @5 t/ha, 15-20 days after crop emergence.
- Application of antitranspirants like Kaoline or Lime water @ 50 g during drought conditions.
- To recover from drought effect spraying of urea @20 g/l of water
- **Some other important practices**
  - Drought tolerant varieties – Girnar-1
  - Deep tillage is done for reducing soil borne pest
  - Pearl millet act as a barrier for thrips and leaf miner
  - Castor act as barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips
  - Seed treatment with Mancozeb (3 g)/ Carbendazim (1 g) for 1kg of kernels

## Suitable cropping systems

### Srikakulam, Vishakhapatnam

- Groundnut + pigeonpea (7: 1)
- Groundnut + castor (7:1 or 11:1)

## **Farm implements/ tools:**

### **Srikakulam, Vishakhapatnam**

- CRIDA groundnut planter (four row)
- Bullock drawn two-row sweep cultivator
- Modified two-row blade harrow
- Bullock drawn country plough attached with Pora tube

## **Alternate farming systems**

### **Srikakulam, Vishakhapatnam**

- **Fodder/ green biomass:** *Albizia lebbbeck*, *Dalbergia sissoo*, *Subabul*, *Azadirachta indica*, *Hardwickia binata*, *Acacia albida*
- **Fruit:** Custard apple, Tamarind, Jamun, Mango, Ber
- **Medicinal/ Aromatic Plants:** *Cassia angustifolia*, *Catharanthus roseus*, *Plantago ovata*, *Palma rosa*, *Vetiveria zizanooides*
- **Vegetables:** Cluster bean, Drumstick, Cucumber, Cowpea, Ridge gourd, Round melon, Okra, Watermelon
- **Animal Component:** Male/ Female cattle, Female buffaloes, Sheep, Goat, Poultry

# GUJARAT

In Gujarat there is one district viz. Rajkot under low runoff and high yield gap region and three districts viz. Junagadh, Bhavnagar and Amreli under low runoff and medium yield gap region.



District	Region
Amreli Bhavnagar Junagadh	Low runoff and Medium Yield gap

## Agroecological setting

### Amreli

- **Climate:** Hot dry/moist semi arid
- **Physiography:** Kathiawad
- **Soils:** Shallow and medium loamy to clayey black soils, deep black soils, deep loamy coastal alluvium derived soils (Aridisols–100%)
- **Annual rainfall:** 607 mm
- **Potential evapotranspiration:** 1877 mm
- **Moisture availability period:** 90-150 days

### Bhavnagar

- **Climate:** Hot moist/dry semi arid
- **Physiography:** Coastal Kathiawad peninsula
- **Soils:** Deep loamy grey brown and alluvium - derived soils, shallow and medium loamy to clayey black soils, deep black soils, deep loamy coastal alluvium - derived soils (Aridisols–75%; Vertic Inceptisols–25%)

- **Annual rainfall:** 602 mm
- **Potential evapotranspiration:** 1814 mm
- **Moisture availability period:** 90-150 days

### **Junagadh**

- **Climate:** Hot dry/ moist semi arid
- **Physiography:** Central Kathiawad peninsula
- **Soils:** Shallow and medium loamy to clayey black soils, deep black soils and deep loamy coastal alluvium - derived soils (Aridisols-50%; Vertic Inceptisols-50%)
- **Annual rainfall:** 702 mm
- **Potential evapotranspiration:** 1684 mm
- **Moisture availability period:** 90-150 days

### **Soil and water conservation**

#### **Amreli, Bhavnagar, Junagadh**

- Shallow ploughing before sowing and ridging
- Furrowing 25 days after sowing
- *In situ* moisture conservation measures like mulching, tillage, conservation furrows etc.
- Indigenous water harvesting structures wherever topography permits

### **Crop management**

#### **Amreli, Bhavnagar, Junagadh**

- **Varieties:**
  - Bunch- GG-5, GG-7, GG-2 – are suitable for inter cropping systems
  - Semi spreading: GG-20
  - Spreading: GAUG-10, GG-11, and GG-13
- **Seed rate:**
  - Bunch- 100 kg/ha
  - Semi spreading: 100 kg/ha
  - Spreading: 80-100 kg/ha
- **Planting pattern:** Bunch- 45x10 cm
  - Semi spreading: 60x10 cm
  - Spreading: 75x10 cm
- **Nutrient management**
  - 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha
  - All nutrients to be applied as basal
  - In Zn deficient soils – apply ZnSO<sub>4</sub> 25 kg/ha once in three years
- **Pest management**
  - White grub:
    - Soil application of Lindane 0.65% dust @ 12.5 kg/ha before sowing

- Spray of Carbaryl 0.2% should be applied on trees located around the field and arrange the light trap for attraction of adults
- Ploughing of field for exposure of white grubs to predatory birds
- Seed treatment with Quinolphos 25 EC or Chlorpyrifos 25 EC @ 20 ml/kg seeds. The treated seed should be dried
- *Helicoverpa*:
  - For spray of HNPV suspension @ 250 LE/ha at five days interval, starting from initiation of the pest
- Aphids, Jassids, Thrips and *Helicoverpa*:
  - First spray: Phosphamidon 0.03%, two weeks after first notice of winged aphid on stick traps
  - Second spray: Dimethoate 0.03% one month after first spray
  - Third spray: Endosulfan 0.07% after 15 days of second spray if *Helicoverpa* infestation is high
- Groundnut pod borer, *Penthicoides seriatoporus*: control measures
  - Soil application of the granular insecticide, Cartap hydrochloride 4g @ 10 kg/ha at 55 to 65 days after sowing is recommended for effective and economic control for pod borer *Penthicoides seriatoporus* familiar in groundnut crop grown under rainfed conditions of North Saurashtra agroclimatic zone

## Weed management:

### Amreli, Bhavnagar, Junagadh

- Pre emergence application of Fluchloralin @1.0 kg (a.i)/ha or pendimethalin @1.0kg (a.i)/ha or Alachlor @1.0kg a.i./ha or Metachlor @1.0 kg a.i./ha
  - **Disease control in groundnut**
    - Collar rot: Seed treatment with Carbendazim @ 2 g/kg seed
    - Tikka: Spray Carbendazim (0.025%) @ 150 g ai/ha
    - Rust: Spray Mancozeb (0.2%) @ 1.2 kg ai/ha
- **Some other important practices**
  - Application of life saving irrigation at pegging and pod-development stages of groundnut
  - Apply borax @ 2 kg/ha as soil application at the time of sowing where soils are deficient in boron
  - Deep tillage is done for reducing soil borne pest
  - Pearl millet act as a barrier for thrips and leaf miner
  - Castor acts as barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips
  - Cultural practices
    - Soil amendment with castor cake @ 500 kg/ha (preferably 15 days before sowing) for soil borne diseases like stem rot and collar rot
    - Intercropping of groundnut with pigeonpea/ pearl millet/ sorghum (3:1) depending upon the locally recommended intercrops against foliar fungal diseases (early and late leaf spots, rust) and insect pests (leaf miner and thrips)
    - Use of trap crops such as cowpea/ soybean (leaf miner and leaf hoppers)/ castor (*Spodoptera* and leaf hoppers) as border crops for sucking/ defoliating insects
    - One hand weeding at 30-35 days after sowing after the application of pre-emergence weedicide Fluchloralin @ 1.5 kg a.i./ha

## Suitable cropping systems

- Groundnut + castor (GCH-4) (3:1)
- Groundnut + pigeonpea (BDN-2) (3:1)



- Groundnut + sesame (AHT-C/ Guj. Til-1)
- Perennial pigeonpea (alleys) + groundnut (GG-2)

### **Farm implements/ tools:**

#### **Amreli, Bhavnagar, Junagadh**

- Seed cum fertilizer drilling attachment (Bullock drawn): Three operations i.e. fertiliser drilling, seed drilling and covering at time. Rs. 3500/-
- Seed cum fertilizer drilling attachment (Tractor drawn): Three operations i.e. fertiliser drilling, seed drilling and covering at time. Rs.13, 680/-
- Tractor mounted power sprayer: Uniform and efficient spraying to cover large area. Of 1.8 ha./hours. Rs.50,000/-
- Bullock drawn multipurpose tool bar: Sowing, interculturing, Earthing up and harvesting. Rs.1800/-
- Groundnut thresher: Threshing of Groundnut. Rs.15000/-
- Sub soiler: For deep ploughing and moisture conservation. Rs.8000/- .
- M.B.Plough: To pulverize the soil and for deep ploughing. Rs.10,000/-

### **Alternate farming systems:**

#### **Amreli, Bhavnagar, Junagadh**

- **Fodder/ green biomass:** *Dichrostachys cinerea*, *Albizia lebbeck*, *Leucaena leucocephala* and *Pongamia pinnata*
- On slopy fallow lands with shallow soils – *Dicanthium annulatum*; rows of groundnut (GG-2) in alleys of perennial pigeonpea (ICPL-185); 16 rows of groundnut (GG-2) in alleys of subabul (Hawai gaint)
- **Fruit:** Custard apple, Mango, Pomegranate, Phalsa, Fig, Jamun, Tamarind
- **Medicinal and aromatic plants:** *Plantago ovata*, *Cassia angustifolia*, *Liquorice*.
- **Vegetables:** Cowpea, Cluster bean, Brinjal, Okra, Long melon, Drumstick.
- **Animal component:** Female/ Male cattle, Female buffaloes, Sheep, Goat

### **Contingent planning**

#### **Amreli, Bhavnagar, Junagadh**

##### **Delay in monsoon by**

- 15<sup>th</sup> July to 31<sup>st</sup> July:
  - Grow erect groundnut (GG-2, GG-5, GG-7), sesame (G-Sesame-1, G.Sesame-2), castor (GAUCH-1), Hybrid pearl millet (GHB-235, GHB-316, GHB-558), greengram (K-851, GM-4), blackgram (T-9, TPU-4), pigeonpea (ICPL-87, BDN2, GT-100)
- 1<sup>st</sup> August to 14<sup>th</sup> August:
  - Grow pulses blackgram (T-9, TPU-4), forage maize/ sorghum (Gundri, GFS-5), castor (GAUCH-1, GC-2) and sesame (Purva-1)
- 15<sup>th</sup> August to 31<sup>st</sup> August:
  - Grow forage maize/ sorghum (Gundri, GFS-5), sesame (Purva-1)

##### **Drought spell after normal sowing**

- 1-2 weeks after sowing:

- Resowing of early duration varieties or alternate crops should be recommended as under, if sufficient rainfall is received. Hybrid pearl millet (GHB-235, GHB-316, GHB-558), sorghum (GJ-39, J-41), sesame (G.Sesame-1, G-Sesame-2), castor (GAUCH-1, GC-2), blackgram (T-9, TPU-4)
- 3-5 weeks after sowing:
  - Agricultural operations like interculturing, weeding, hoeing and mulching may be taken up, if drought spell prolongs for two weeks or more weeks.

#### Early withdrawal of monsoon

- Give life saving irrigation
- Minimize moisture losses through complete removal of weeds
- Perform interculturing to conserve soil moisture
- Harvest the crop according to maturity of crop duration
- Thin the plant population

#### Satisfactory late rains during September - October

- Relay cropping of castor, sunflower, sesame (Purva-1) and fodder sorghum
- Second crops like rapeseed mustard and chickpea could be taken
- Ratooning of sorghum

District	Region
Rajkot	Low runoff and High yield gap

#### Agroecological setting

- **Climate:** Hot arid/ Hot dry semi arid
- **Physiography:** North Kathiawad
- **Soils:** Deep loamy saline and alkaline soils, deep loamy grey brown and alluvium - derived soils, shallow and medium loamy to clayey black soils, deep black soils (Vertic Inceptisols-80%; Vertisols-20%)
- **Annual rainfall:** 674 mm
- **Potential evapotranspiration:** 2144 mm
- **Moisture availability period:** 60-120 days

#### Soil and water conservation

- Shallow ploughing before sowing and ridging
- Furrowing 25 days after sowing
- *In situ* moisture conservation measures like mulching, tillage conservation furrows etc.
- Indigenous water harvesting structures wherever topography permits

#### Crop management

- **Varieties:**
  - Bunch- GG-5, GG-7, GG-2
  - Semi spreading: GG-20
  - Spreading: GAUG-10, GG-11, GG-13

- **Seed rate:**
  - Bunch- 100 kg/ha
  - Semi spreading: 100 kg/ha
  - Spreading: 80-100 kg/ha
- **Planting pattern:**
  - Bunch- 45x10 cm
  - Semi spreading: 65x10 cm
  - Spreading: 75x10 cm
- **Nutrient management**
  - 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha. All nutrients to be applied as basal
  - 50% recommended dose of fertilizer (6.25 kg N + 12.5 kg P<sub>2</sub>O<sub>5</sub>/ha) + rhizobium and phosphorus solubilising microorganisms in Arid vertisols
  - Subabul loppings 5t/ha/ farm yard manure 6t/ha + recommended dose of fertilizer (12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>)
  - In Zn deficient soils – apply ZnSO<sub>4</sub> 25 kg/ha once in three years
- **Pest management**
  - White grub:
    - Soil application of Lindane 0.65% dust @ 12.5 kg/ha before sowing
    - Spray of Carbaryl 0.2% should be applied on trees located around the field and arrange the light trap for attraction of adults
    - Ploughing of field for exposure of white grubs to predatory birds
    - Seed treatments with Quinolphos 25 EC or Chlorpyrifos 25 EC @ 20 ml/kg seeds. The treated seed should be dried
  - *Helicoverpa*: For spray of HNPV suspension @ 250 LE/ha at five days interval, starting from initiation of the pest
  - Aphid, Jassid, Thrips and *Helicoverpa*:
    - First spray: Phosphamidon 0.03%, two weeks after first notice of winged aphid on stick traps
    - Second spray: Dimethoate 0.03% one month after first spray
    - Third spray: Endosulfan 0.07% after 15 days of second spray if *Helicoverpa* infestation is high
  - Groundnut pod borer (*Penthicoides seriatoporus*):
    - Soil application of the granular insecticide, Cartap hydrochloride 4 g @ 10 kg/ha at 55 to 65 days after sowing is recommended for effective and economic control for pod borer *Penthicoides seriatoporus* familiar in groundnut crop grown under rainfed conditions of North Saurashtra agroclimatic zone

### Weed management:

- Pre emergence application of Fluchloralin @1.0 kg (a.i)/ha or pendimethalin @1.0kg (a.i)/ha or Alachlor @1.0kg a.i./ha or Metachlor @1.0 kg a.i./ha
- **Some other important practices**
  - Application of life saving irrigation at pegging and pod-development stages of groundnut
  - Apply borax @ 2 kg/ha as soil application at the time of sowing when soils are deficient in boron
  - Amla in dryland horticulture

- Leaf spot resistant varieties – NRCG-10121, NRCG-10123, NRCG-10125
- Deep tillage is done for reducing soil borne pest
- Pearl millet act as a barrier for thrips and leaf miner
- Castor act as barrier for *Spodoptera litura*, *Achoea janata*
- Groundnut + soybean for trapping leaf miner, thrips

### Suitable cropping systems

- Groundnut + castor (3:1)
- Groundnut + pigeonpea (3:1)
- Groundnut + sesame (AHT-C/ Guj. Til-1)
- Perennial pigeonpea (alleys) + groundnut (GG-2)

### Farm implements/ tools

- Seed cum fertilizer drilling attachment (Bullock drawn): Three operations i.e. fertilizer drilling, seed drilling and covering at time. Rs. 3500/-
- Seed cum fertilizer drilling attachment (Tractor drawn): Three operations i.e. fertilizer drilling, seed drilling and covering at time. Rs.13, 680/-
- Tractor mounted power sprayer: Uniform and efficient spraying to cover large area. Of 1.8 ha./hours. Rs.50,000/-
- Bullock drawn multipurpose tool bar: Sowing, interculturing, Earthing up and Harvesting. Rs.1800/-
- Groundnut thresher: Threshing of Groundnut. Rs.15000/-
- Sub soiler: For deep ploughing and moisture conservation. Rs.8000/- .
- M.B.Plough: To pulverize the soil and for deep ploughing. Rs.10,000/-

### Alternate farming systems

- **Alley cropping:** Subabul (paired row) + sorghum (5-6), subabul + groundnut, perennial pigeonpea (alleys) + groundnut (GG-2)
- **Fodder/ green biomass:** On sloppy fallow lands, grow *Dicanthium annulatum*, *Dichrostachys cinerea*, *Albizzia lebbek*, *Leucaena leucocephala*, *Pongamia pinnata*
- **Fruit:** Custard apple, Mango, Pomegranate, Phalsa, Fig, Jamun, Tamarind
- **Medicinal/ Aromatic Plants:** *Plantago ovata*, *Cassia angustifolia*, *Liquorice*.
- **Vegetables:** Cowpea, Clusterbean, Brinjal, Okra, Long melon, Drumstick.
- **Animal component:** Female buffaloes, Cows, Male cattle, Sheep, Goat and Poultry

### Contingent planning

#### Delay in monsoon by

- 15<sup>th</sup> July to 31<sup>st</sup> July:
  - Grow erect groundnut (GG-2, GG-5, GG-7), sesame (G-Sesame-1, G-Sesame-2), castor (GAUCH-1), hybrid pearl millet (GHB-235, GHB-316, GHB-558), greengram (K-851, GM-4), blackgram (T-9, TPU-4), pigeonpea (ICPL-87, GT-100)

- 1<sup>st</sup> August to 14<sup>th</sup> August:
  - Grow pulses blackgram (T-9, TPU-4), forage maize/ sorghum (Gundri, GFS-5), castor (GAUCH-1, GC-2) and sesame (Purva-1)
- 15<sup>th</sup> August to 31<sup>st</sup> August:
  - Grow forage maize/ sorghum (Gundri, GFS-5), sesame (Purva-1)

### **Drought spell after normal sowing**

- 1-2 weeks after sowing:
  - Resowing of early duration varieties or alternate crops should be recommended as under, if sufficient rainfall is received. Hybrid pearmillet (GHB-235, GHB-316, GHB-558), sorghum (GJ-39, J-41), sesame (G-Sesame-1, G-Sesame-2), castor (GAUCH-1, GC-2), blackgram (T-9, TPU-4)
- 3-5 weeks after sowing:
  - Agricultural operations like interculturing, weeding, hoeing and mulching may be taken up, if drought spell prolongs for two weeks or more weeks. The ratooning of sorghum may be done and top dressing of fertilizer should be suggested if sufficient rainfall after 3-5 weeks dry spell

### **Early withdrawal of monsoon**

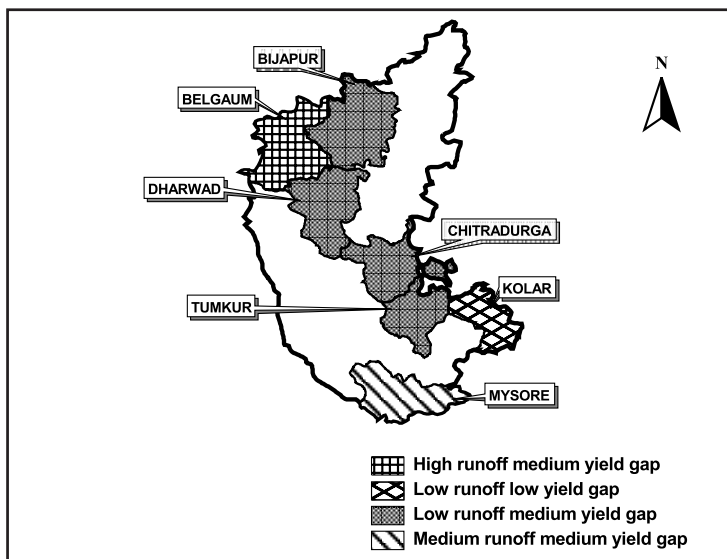
- Give life saving irrigation
- Minimize moisture losses through complete removal of weeds
- Perform interculturing to conserve soil moisture
- Harvest the crop according to maturity of crop duration
- Thin the plant population

### **Satisfactory late rains during September - October**

- Relay cropping of castor, sunflower, sesame (Purva-1) and fodder sorghum
- Second crops like rapeseed mustard and chickpea could be taken
- Ratooning of sorghum

## KARNATAKA

In Karnataka there is one district viz. Kolar under low runoff and low yield gap region, four districts viz. Tumkur, Chitradurga, Bijapur and Dharwad under low runoff and medium yield gap region, one district viz. Mysore under medium runoff and medium yield gap region and one district viz. Belgaum under high runoff and medium yield gap region.



District	Region
Belgaum	High runoff and Medium yield gap

### Agroecological setting

- **Climate:** Hot dry sub humid
- **Physiography:** North Sahyadris of Karnataka
- **Soils:** Shallow and medium loamy and clayey black soils and deep clayey black soils (Vertic Inceptisols– 70%; Vertisols – 30%)
- **Annual rainfall:** 1551 mm
- **Potential evapotranspiration:** 1482 mm
- **Moisture availability period:** 150-180 days

### Soil and water conservation

- Graded bunds
- Zingg terraces
- Compartment bunding
- Broad bed and furrows for black soils
- Ridges and furrows
- Supplemental irrigation
- Suitable surface drainage measures to avoid water logging

## Crop management

- **Varieties:** R-8808
- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x10 cm
- **Nutrient management**
  - 25 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> + 25 kg K<sub>2</sub>O/ha
  - 50% organics + 50% inorganics
- **Pest management**
  - Root grub: Apply Thimmet or Phorate granules at 10 kg/ha to soil before sowing or treat the seed with chlorpyrifos @ 6 ml/kg seed.
  - Aphids, leaf miner: Spray 0.05% Endosulfan or Dimethoate or Monocrotophos
  - Red hairy caterpillar:
    - Arrange bonfires 2 days after soaking rain from 8.00 PM to 10.00 PM
    - Make a furrow around the field, and apply Carbaryl dust in the furrow
    - For second and third instar larvae spray dimethoate @ 2 ml/l or Monocrotophos @ 1.6 ml/l
    - Poison bait with 10 kg rice bran + 1 kg jaggery + 500 ml Quinolphos can be applied for effective control.

## Weed management:

- Pre-emergence application of Nitrofen 25 EC @ 1.2 l a.i./ ha or Alcohol 50 EC @ 4.0 l a.i./ ha or Fluchloratin 45 EC a.i./ ha
- **Some other important practices**
  - Shallow ploughing before sowing and ridging and furrowing 25 days after sowing
  - Apply borax @ 2 kg/ha as soil application at the time of sowing when soils are deficient in boron
  - Deep tillage is done for reducing soil borne pest
  - Pearl millet acts as a barrier for thrips and leaf miner
  - Castor acts as a barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips
  - Cultural practices
    - Soil amendment with castor cake @ 500 kg/ha (preferably 15 days before sowing) for soil borne diseases like stem rot and collar rot
    - Intercropping of groundnut with pigeonpea/ pearl millet/ sorghum (3:1) depending upon the locally recommended intercrops against foliar fungal diseases (early and late leaf spots, rust) and insect pests (leaf miner and thrips)
    - Use of trap crops such as cowpea/ soybean (leaf miner and leaf hoppers)/ castor (*Spodoptera* and leaf hoppers) as border crops for sucking/ defoliating insects
    - One hand weeding at 30-35 days after sowing after the application of pre-emergence weedicide Fluchloralin @ 1.5 kg a.i./ha

## Suitable cropping systems

- Pigeonpea + groundnut (1:3 or 1:2)
- Groundnut + cotton (2:1)

## Farm implements/ tools

- Wooden plough (Bullock drawn): Shallow ploughing to a depth of 10 cm. Rs.2000/-
- MB plough (Bullock drawn): Deep ploughing. Rs.4000/-
- MB plough (Tractor drawn): Deep ploughing. Rs.15000/-
- Blade harrow (Bullock drawn): Harrowing. Rs.1000/-
- Blade harrow (Tractor drawn): For harrowing. Rs.10000/-
- Seed cum fertilizer drill (Bullock drawn): For sowing and fertilizer application. Rs.2500/-
- Seed cum fertilizer drill (Bullock drawn – adjustable): Sowing and fertilizer application simultaneously. Rs.4500/-
- Seed cum fertilizer drill (Tractor drawn): For sowing and fertilizer application. Rs.26000/-
- Ridger: Ridges and furrows. Rs.1000/-
- Bund former: Compartment bund. Rs.700/-
- Slit hoe: Hoeing operation. Rs.500/-
- Blade hoe: Intercultivation operations. Rs.500/-
- Wooden float: Clod breaking. Rs.600/-
- Buck scraper: For leveling. Rs.2500/-
- Scooper: For scooping. Rs.500/-
- Multi furrow opener (Tractor drawn): For opening of furrows. Rs.15000/-
- Cultivator (Tractor drawn): For cultivating. Rs.15000/-
- Rotovator (tractor drawn) : For incorporation of residues and green manures. Rs.45000/-

## Alternate Farming systems

- *Agave (Agave sisolana* with 10,000 plants/ha) intercropped with subabul. Cutting of agave leaves once in a year for fibre extraction with retaining top ten leaves
- **Silviculture:** Shallow black soils: *Casuarina, Dalbergia sissoo, Hardwickia binata, Acacia nilotica, Prosopis cineraria*, Marginal land: *Dalbergia sissoo, Neem, Acacia nilotica, Subabul*
- **Alley cropping:** Subabul/ casuarina + *Kharif* crops
- **Agro horti system:** Ber (umran) + curry leaf, Ber (umran) – safflower + chickpea, Ber/ Custard apple/ Pomegranate/ Amla + *kharif* (spreading) crops
- **Horticulture:** Mango plants in levelled portion of zingg conservation terrace
- **Fodder/ green biomass:** *Dalbergia sissoo, Gliricidia, Albizzia lebbbeck, Hardwickia binata, Cassia siama, Azadirachta indica*
- **Fruit:** Mango, Pomegranate, Sapota, Ber, Jamun, and Tamarind
- **Medicinal and aromatic plants:** *Cassia angustifolia, Catharanthus roseus, Palma rosa, Vetiveria zizanioides, Rose, Geranium*
- **Vegetables:** Onion, Brinjal, Chillies, Cowpea, Cucumber, Clusterbean, Drumstick, Curry leaf
- **Animal Component:** Male/ Female cattle, Female buffaloes, Sheep, Goat, Poultry



## **Contingent planning:**

### **Normal onset of monsoon favourable for *kharif* crops:**

- Take up sowing of the following crops in June in light soils. Groundnut (erect and spreading), pearl millet, pigeonpea, *kharif* sorghum, setaria, hybrid sorghum and other crop mixtures like *kharif* sorghum + pigeonpea (2:1), groundnut + pigeonpea (4:2), setaria + pigeonpea (2:1) and pearl millet + pigeonpea (2:1). Similarly, pulse crops in light and retentive soils may be taken up
- In *rabi* areas, i.e., medium deep black soils, sow greengram, blackgram, cucumber as a first crop to be followed by *rabi* sorghum/ sunflower/ chickpea/ safflower/ wheat
- When the land is kept fallow (deep black soils) for *rabi* crops, have compartment bunds having 1% slope, scooping where the land slope is 1 to 2%, ridges and furrows or tied ridges for better soil and moisture conservation. Take up harrowings after each rain, which helps in controlling weeds and conserving soil moisture
- Sow sunhemp as green manuring crop in medium to deep black soils prior to *rabi* crops

### **Normal onset of monsoon but dry spells soon after germination:**

- Give protective irrigation for the crops sown wherever possible
- Ratoon pearl millet, sorghum for rejuvenation after rains
- For crops like groundnut, take up urea spray (2% solution) immediately after rains for quick revival
- When the sown crops completely wither, plant setaria, dolichos, horsegram, matki, cowpea and sunflower soon after revival of rains

### **No normal rains in June but onset of rains in July:**

- Sow groundnut (bunch), hybrid pearl millet, sunflower and setaria in *kharif* areas
- Sow pure pigeonpea/ cowpea/ horsegram in light soils
- In *rabi* areas don't sow greengram since it will delay *rabi* sowing
- Have repeated harrowings to remove weeds in *rabi* areas

### **Normal rains in July/ August:**

- Complete sowing dryland cotton before middle of August. Grow Herbaceous cottons in place of Hirsutams. Early sowing of cotton is advantageous.
- Sunflower, pigeonpea, and setaria should be sown in light soils and pigeonpea in medium to deep black soils.
- In light textured soils in Hadagali, Koppal, Muddebihal, Raibag, and Athani castor may be sown. Plant castor on contour bunds also. In medium to deep black soils also take up castor sowing.
- Relay cotton in groundnut in medium black soils.

### **Normal rains in September:**

- Complete sowing of *rabi* sorghum by middle of September in medium black soils of northern taluks of Bijapur district. In the remaining taluks viz., Bagalkot, Hungund, and Mudhol, complete *rabi* sorghum sowing by first week of October. Early sowing of *rabi* sorghum in other districts is preferred. Maximum yields of *rabi* sorghum are obtained by sowing in September only.
- Sow sunflower before 10<sup>th</sup> September.
- Sow safflower as a sole crop before the end of September. Early sowing is more beneficial.

- Complete sowing of Bhagya/ Laxmi cotton before 15<sup>th</sup> September.
- If normal rains are not received during September take up dry seeding of sunflower, *rabi* sorghum, chickpea with 1 times the normal seed rate relatively at depth without applying chemical fertilizer . Fertilizer may be applied at appropriate growth stage having optimum moisture condition.

### Sowing in October:

- Continue sowing of *rabi* sorghum and sesame upto October 15<sup>th</sup> with 50 % recommended level of fertilizer
- Follow mixed cropping of *rabi* sorghum + chickpea in 2:1 row proportion
- Sow *rabi* sorghum and chickpea as mixed crops (random mixing)
- Increase the area under safflower
- Sow chickpea and safflower in 4:2 or 3:1 row proportions for higher returns
- Top dress *rabi* sorghum with 10-15 kg N/ha if adequate moisture is available in the soil

### Early stoppage of rains towards the end of season:

- Thin out the population of *rabi* sorghum by blading every third row or alternate row within 40 days of sowing.
- In mixed crops of *rabi* sorghum and safflower, uproot *rabi* sorghum component.
- Close soil cracks by repeated interculturing.
- Provide supplemental irrigation through farm ponds or other sources. By providing one or two supplemental irrigation(s) to *rabi* sorghum, safflower and chickpea, yields could be increased by 50 to 60%
- Use surface mulches of mixed trash or farm waste wherever possible. Where farm waste is not available, use a blade to form a thin layer of soil mulch to avoid cracks.

District	Region
Bijapur Chitradurga Dharwad Tumkur	Low run off and Medium yield gap

### Agroecological setting

#### Bijapur

- **Climate:** Hot arid
- **Physiography:** North Karnataka plateau
- **Soils:** Deep loamy and clayey mixed red and black soils (Vertisols–50%; Vertic Inceptisols–50%)
- **Annual rainfall:** 573 mm
- **Potential evapotranspiration:** 1649 mm
- **Moisture availability period:** 60-120 days

#### Chitradurga

- **Climate:** Hot moist semi arid
- **Physiography:** Central Karnataka plateau
- **Soils:** Medium to deep red loamy soils (Alfisols–85%; Vertisols–15%)
- **Annual rainfall:** 654 mm

- **Potential evapotranspiration:** 1606 mm
- **Moisture availability period:** 120-150 days

### **Dharwad**

- **Climate:** Hot dry sub humid
- **Physiography:** Western Karnataka plateau
- **Soils:** Shallow and medium loamy and clayey black soils, deep clayey black soils (Vertic Inceptisols–70%; Vertisols–30%)
- **Annual rainfall:** 813 mm
- **Potential evapotranspiration:** 1665 mm
- **Moisture availability period:** 150-180 days

### **Tumkur**

- **Climate:** Hot moist semi arid
- **Physiography:** Central Karnataka plateau
- **Soils:** Medium to deep red loamy soils (Alfisols–100%)
- **Annual rainfall:** 654 mm
- **Potential evapotranspiration:** 1606 mm
- **Moisture availability period:** 120-150 days

### **Soil and water conservation:**

#### **Bijapur**

- Rubbles at 0.3 m vertical interval on contour key lines
- Compartement bunding, ridges and furrows, contour cultivation
- Planting Khus grass and subabul in paired rows at vertical interval of 0.3 m.
- A farm pond of 150 m<sup>3</sup> capacity for every one hectare catchment area to harvest excess runoff in medium to deep black soils
- *In situ* moisture conservation practices like compartement bunding, ridges and furrows contour cultivation and fall ploughing helped to conserve more moisture in deep black soils

#### **Chitradurga, Tumkur**

- Construction of contour bunds with a cross section of 0.54 m<sup>2</sup> to control and conserve runoff.
- Graded border strips with a gradient of 0.1 to 0.5% to fit into the local topography and hydrographic features.
- Broad based bunds of 1.5 m<sup>2</sup> cross section on contour with 1 m vertical interval for better rainwater conservation.

#### ***In situ* conservation practices:**

- Summer ploughing to a depth of 15-30 cm for better infiltration of rainwater during onset of rains.
- Crop cultivation across the slope with Vetiver/ Pennisetum grass as live barrier at 0.5 m vertical interval to check the velocity of runoff and better moisture conservation and availability for a longer period for finger millet/ groundnut/ maize/ sunflower crops.

- Plastered both sides and bottom with cement + sandy clay soils (1:8)
- Conservation furrow at 3 to 6 mm interval
- Opening furrows on 0.2 to 0.4 slope
- Summer tillage

### **Dharwad**

- Rubbles at 0.3 m vertical interval on contour key lines
- Compartment bunding, ridges and furrows, contour cultivation
- Planting Khus grass and subabul in paired rows at vertical interval of 0.3 m
- Bund stabilization through *Stylosanthes* Spp
- A farm pond of 150 m<sup>3</sup> capacity for every one hectare catchment area to harvest excess runoff in medium to deep black soils

## **Crop management**

### **Bijapur, Dharwad**

- **Varieties:** R-8808
- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x10 cm
- **Nutrient management**
  - 25 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> + 25 kg K<sub>2</sub>O/ha.
  - 50% organics + 50% in organics
- **Pest management**
  - Root grub: Apply Thimmet or Phorate granules at 10 kg/ha to soil before sowing or treat the seed with chlorpyrifos @ 6 ml/kg seed.
  - Aphids, leaf miner: Spray 0.05% Endosulfan or Dimethoate or Monocrotophos
  - Red hairy caterpillar:
    - Arrange bonfires 2 days after soaking rain from 8.00 PM to 10.00 PM
    - Make a furrow around the field, and apply Carbaryl dust in the furrow
    - For second and third instar larvae spray Dimethoate @ 2 ml/l or Monocrotophos @ 1.6 ml/l
    - Poison bait with 10 kg rice bran + 1 kg jaggery + 500 ml Quinolphos can be applied for effective control.

## **Weed management**

### **Bijapur, Dharwad**

- Pre-emergence application of Nitrofen 25 EC @ 1.2 l a.i./ ha or Alcohol 50 EC @ 4.0 l a.i./ ha or Fluchloratin 45 EC a.i./ ha
- **Some other important practices:**
  - Drought tolerant varieties – Girnar-1
  - Deep tillage is done for reducing soil borne pest

### **Chitradurga, Tumkur**

- **Varieties:** JL-24, K-134, and VRI-2

- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x10 cm
- **Integrated nutrient management**
  - 25 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> + 25 kg K<sub>2</sub>O + 7.5 t farm yard manure/ ha.
  - Apply all nutrients as basal
  - Apply 1.0 t/ha lime and also 10 Kg/ha sulphur into the soil
- **Integrated pest management**
  - For weed control: Alachlor 50 EC or 2.5 l, Pendimethalin 30 EC or 3.25 l, Fluchloralin 45 EC or 2.0 l, Metolachlor 50 EC 2.1 l in 750 l water, to be sprayed within 3 days after sowing.

## Weed management

### Chitradurga, Tumkur

- Pre-emergence application of Alachlor 50 EC @ 2.5 l/ kg a.i./ ha (spray volume 750 l of water/ ha) or Pendimethalin 30 EC @ 3.25 l/ kg a.i./ ha or Fluchloralin 45 EC @ 2.0 l/ kg a.i./ ha or Metolachlor 50 EC @ 2.0 l/ kg a.i./ ha is to be sprayed within 3 days after sowing
- Pre-emergence application of Alachlor 50 EC @ 2.5 l/ kg a.i./ ha (spray volume 750 l of water/ ha) is to be sprayed after 3 days after sowing
- **Some other important practices:**
  - Dry sowing of groundnut when monsoon is delayed
  - Apply borax @ 2 kg/ha as soil application at the time of sowing in boron deficient soils

## Suitable cropping systems

### Bijapur, Dharwad

- Pigeonpea + groundnut (1:3 or 1:2)
- Groundnut + cotton (2:1)

### Chitradurga, Tumkur

- Pigeonpea paired rows – groundnut (2:10)
- Groundnut – castor (8:1)

## Farm implements/ tools:

### Bijapur, Dharwad

- Wooden plough (Bullock drawn): Shallow ploughing to a depth of 10 cm. Rs.2000/-
- MB plough (Bullock drawn): Deep ploughing. Rs.4000/-
- MB plough (Tractor drawn): Deep ploughing. Rs.15000/-
- Blade harrow (Bullock drawn): Harrowing. Rs.1000/-
- Blade harrow (Tractor drawn): For harrowing. Rs.10000/-
- Seed cum fertilizer drill (Bullock drawn): For sowing and fertilizer application. Rs.2500/-
- Seed cum fertilizer drill (Bullock drawn – adjustable): Sowing and fertilizer application simultaneously. Rs.4500/
- Seed cum fertilizer drill (Tractor drawn): For sowing and fertilizer application. Rs.26000/-
- Ridger: Ridges and furrows. Rs.1000/-

- Bund former: Compartment bund. Rs.700/-
- Slit hoe: Hoeing operation. Rs.500/-
- Blade hoe: Intercultivation operations. Rs.500/-
- Wooden float: Clod breaking. Rs.600/-
- Buck scraper: For leveling. Rs.2500/-
- Scooper: For scooping. Rs.500/-
- Multi furrow opener (Tractor drawn): For opening of furrows. Rs.15000/-
- Cultivator (Tractor drawn): For cultivating. Rs.15000/-
- Rotovator (tractor drawn) : For incorporation of residues and green manures. Rs.45000/-

### **Chitradurga, Tumkur**

- Bullock drawn seed-cum-fertilizer drill (fingermillet): Bullock drawn manual operation for fingermillet seeding and fertilizer application (hand metered) (Rs.1500/- per unit)
- Bullock drawn seed-cum-fertilizer drill (groundnut): Groundnut seeding with fertilizer application (Rs.1500/- per unit)
- Multifurrow opener: Opening furrows for hand seeding of different crops (Rs.1300/- per unit)
- Bent tyne hoe: Intercultural operation for fingermillet (Rs.350/- per unit)
- Duck foot hoe: Intercultural operation for fingermillet and groundnut for moisture conservation (Hand metered) (Rs.350/- per unit)
- Crust braker: For breaking the crust to facilitate smooth emergence of the seedling in fingermillet and groundnut (Rs.500/- per unit)

### **Alternate Farming systems**

#### **Bijapur, Dharwad**

- Agave (*Agave sisolana* with 10,000 plants/ha) intercropped with subabul. Cutting of agave leaves once in a year for fibre extraction with retaining top ten leaves
- Silviculture
- Shallow black soils: *Casuarina*, *Dalbergia sissoo*, *Hardwickia binata*, *Acacia nilotica*, *Prosopis cineraria*
- Marginal land: *Dalbergia sissoo*, Neem, *Acacia nilotica*, Subabul
- Alley cropping: Subabul/ casuarina + *kharif* crops
- Agro horti system: Ber (Umran) + curry leaf, ber (Umran) – safflower + chickpea, ber/ custard apple/ pomegranate/ amla + *kharif* (spreading) crops
- Horticulture: Mango plants in levelled portion of zingg conservation terrace
- Fodder/green biomass: *Dalbergia sissoo*, *Gliricidia*, *Albizia lebbbeck*, *Hardwickia binata*, *Cassia siamea*, *Azadirachta indica*
- Fruit: Mango, pomegranate, sapota, ber, jamun, tamarind
- Medicinal & Aromatic Plants: *Cassia angustifolia*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, Rose, *Geranium*
- Vegetables: Onion, brinjal, chillies, cowpea, cucumber, cluster bean, drumstick.
- Animal component: Female and male cattle, female buffaloes, goat, sheep, poultry

## Chitradurga, Tumkur

- **Fodder/ green biomass:** *Casuarina*, *Silveroak*, *Gliricidia*, *Calliandra*, *Faidherbia albida* on bunds Gravelly shallow soils – *Stylosanthes scabra*
- High gradient non-arable lands with shallow soils – Amla in catch pits with deep soils – neem, pongamia, and *Albizzia lebbeck*
- Forage crops – *Pennisetum*, *Pedicalatum*/ *Cenchrus ciliaris*, *Microtalium axillaris*
- Wastelands – Jackfruit, Custard apple, Tamarind
- **Fruit:** Mango, Pomegranate, Sapota, Guava, Custard apple, Jamun
- **Medicinal and aromatic plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Salanum viarum*, *Dioscorea*, Geranium, *Pogostemon patchouli*, Jasmine
- **Vegetables:** Tomato, Chillies, Okra, Watermelon, Bitter gourd, Drumstick, Brinjal.
- **Animal Component:** Male/ female cattle, Female buffaloes, Poultry, Sheep, Goat,
- **Other enterprises:** Muhsroom cultivation, sericulture, piggery, apiary, rabbit rearing

## Contingent planning

### Bijapur, Dharwad

#### Normal onset of monsoon favourable for *kharif* crops:

- Take up sowing of the following crops in June in light soils. Groundnut (erect and spreading), pearl millet, pigeonpea, *kharif* sorghum, setaria, hybrid sorghum and other crop mixtures like *kharif* sorghum + pigeonpea (2:1), groundnut + pigeonpea (4:2), setaria + pigeonpea (2:1) and pearl millet + pigeonpea (2:1). Similarly, pulse crops in light and retentive soils may be taken up.
- In *rabi* areas, i.e., medium deep black soils, sow greengram, blackgram, cucumber as a first crop to be followed by *rabi* sorghum/ sunflower/ chickpea/ safflower/ wheat.
- When the land is kept fallow (deep black soils) for *rabi* crops, have compartment bunds having 1% slope, scooping where the land slope is 1 to 2%, ridges and furrows or tied ridges for better soil and moisture conservation. Take up harrowings after each rain which helps in controlling weeds and conserving soil moisture.
- Sow sunhemp as green manuring crop in medium to deep black soils prior to *rabi* crops.

#### Normal onset of monsoon but dry spells soon after germination

- Give protective irrigation for the crops sown wherever possible.
- Ratoon pearl millet, sorghum for refuvenation after rains.
- For crops like groundnut, take up urea spray (2% solution) immediately after rains for quick revival.
- When the sown crops completely wither, plant setaria, dolichos, horsegram, matki, cowpea and sunflower soon after revival of rains.

#### No normal rains in June but onset of rains in July

- Sow groundnut (munch), hybrid pearl millet, sunflower and setaria in *kharif* areas.
- Sow pure pigeonpea/ cowpea/ horsegram in light soils.
- In *rabi* areas don't sow greengram since it will delay *rabi* sowing.
- Have repeated harrowings to remove weeds in *rabi* areas.

### **Normal rains in July/ August:**

- Complete sowing dryland cotton before the middle of August. Grow Herbaceous cottons in place of Hirsutam. Early sowing of cotton is advantageous.
- Sunflower, pigeonpea, and setaria should be sown in light soils and pigeonpea in medium to deep black soils.
- In light textured soils in Hadagali, Koppal, Muddebihal, Raibag, and Athani castor may be sown. Plant castor on contour bunds also. In medium to deep black soils also take up castor sowing.
- Relay cotton in groundnut in medium black soils.

### **Normal rains in September**

- Complete sowing of *rabi* sorghum by middle of September in medium black soils of northern taluks of Bijapur district. In the remaining taluks viz., Bagalkot, Hungund, and Mudhol, complete *rabi* sorghum sowing by first week of October. Early sowing of *rabi* sorghum in other districts is preferred. Maximum yields of *rabi* sorghum are obtained by sowing in September only.
- Sow sunflower before 10<sup>th</sup> September.
- Sow safflower as a sole crop before the end of September. Early sowing is more beneficial.
- Complete sowing of Bhagya/ Laxmi cotton before 15<sup>th</sup> September.
- If normal rains are not received during September take up dry seeding of sunflower, *Rabi* sorghum, Chickpea with 1<sup>1/2</sup> times the normal seed rate relatively at depth without applying chemical fertilizers. Fertilizers may be applied at appropriate growth stage having optimum moisture condition.

### **Sowing in October**

- Continue the sowing *rabi* sorghum sesame October 15<sup>th</sup> with 50% recommended level of fertilizer
- Follow mixed cropping of *rabi* sorghum + chickpea in 2:1 row proportion
- Sow *rabi* sorghum and chickpea as mixed crops (random mixing)
- Increase the area under safflower
- Sow chickpea and safflower in 4:2 or 3:1 row proportions for higher returns
- Top dress *rabi* sorghum with 10-15 kg N/ha if adequate moisture is available in the soil

### **Early stoppage of rains towards the end of season**

- Thin out the population of *rabi* sorghum by blading every third row or alternate row within 40 days of sowing
- In mixed crops of *rabi* sorghum and safflower, uproot *rabi* sorghum component.
- Close soil cracks by repeated interculturing
- Provide supplemental irrigation through farm ponds or other sources. By providing one or two supplemental irrigation(s) to *rabi* sorghum, safflower and chickpea, yields could be increased by 50 to 60 percent
- Use surface mulches of mixed trash or farm waste wherever possible-Where farm waste is not available, use a blade to form a thin layer of soil mulch to avoid cracks

### **Chitradurga, Tumkur**

- **Second fortnight of April**
  - Double cropping: Sesame or greengram



- **First fortnight of May**
  - Monocropping: Pigeonpea
  - Sequence cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum.
- **Second fortnight of May**
  - Monocropping: Pigeonpea
  - Sequence cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum.
- **First fortnight of June**
  - Monocropping: Long duration finger millet, pigeonpea, maize, groundnut
  - Sequence cropping: Fodder maize, fodder sorghum, fodder pearl millet, cowpea
- **Second fortnight of June**
  - Monocropping: Long duration finger millet, pigeonpea, maize and groundnut
  - Sequence cropping: Sowing of chilli nursery
- **First fortnight of July**
  - Monocropping: Groundnut, long duration finger millet
  - Sequence cropping: Sowing of chilli nursery
- **Second fortnight of July**
  - Monocropping: Groundnut, long/ medium duration finger millet
  - Sequence cropping: Sowing of chilli nursery
- **First fortnight of August**
  - Monocropping: Cowpea, horsegram, short duration finger millet, transplanting chilli
  - Sequence cropping: Cowpea, horsegram, short duration finger millet, transplanting chilli. Sowing of chilli nursery and short duration finger millet.
- **Second fortnight of August**
  - Monocropping: Short duration finger millet, transplanting of medium and long duration finger millet.
  - Transplanting chilli, cowpea, horsegram
  - Sequence cropping: Short duration finger millet, transplanting of medium and long duration finger millet, transplanting chilli, cowpea, horsegram. Also, fodder crops (maize-pearl millet, sorghum)
- **First fortnight of September**
  - Monocropping: Horsegram, transplanting of short duration finger millet and chilli (with protective irrigation)
  - Sequence cropping: Horsegram, transplanting of short duration finger millet and chilli (with protective irrigation)

District	Region
Kolar	Low run off and Low yield gap

### Agroecological setting

- **Climate:** Hot moist semi arid
- **Physiography:** Central South Karnataka

- **Soils:** Medium to deep red loamy soils (Alfisols–100%)
- **Annual rainfall:** 734 mm
- **Potential evapotranspiration:** 1562 mm
- **Moisture availability period:** 120-150 days

### **Soil and water conservation:**

- Construction of contour bunds with a cross section of 0.54 m<sup>2</sup> to control and conserve runoff.
- Graded border strips with a gradient of 0.1 to 0.5% to fit into the local topography and hydrographic features.
- Broad based bunds of 1.5 m<sup>2</sup> cross-section on contour with 1 m vertical interval for better rainwater conservation.

### **In situ conservation practices:**

- Summer ploughing to a depth of 15-30 cm for better infiltration of rainwater during onset of rains.
- Crop cultivation across the slope with Vetiver/ Pennisetum grass as live barrier at 0.5 m vertical interval to check the velocity of runoff and better moisture conservation and availability for a longer period for finger millet/ groundnut/ maize/ sunflower crops.
- Plastered both sides and bottom with cement + sandy clay soils (1:8)
- Conservation furrow at 3 to 6 m interval
- Opening furrows on 0.2 to 0.4 slope
- Summer tillage

### **Crop management**

- **Varieties:** JL-24, K-134, and VRI-2
- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x10 cm
- Nutrient management
  - 25 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> + 25 kg K<sub>2</sub>O+ 7.5 t farm yard manure/ha.
  - Apply all nutrients as basal
  - Apply 1.0 t/ha lime and also 10 kg/ha sulphur into the soil
- **Pest management**
  - For weed control: Alachlor 50 EC 2.5 l, Pendimethalin 30 EC or 3.25 l, Fluchloralin 45 EC or 2.0 l or Metolachlor 50 EC 2.0 l, 750 l water to be sprayed within 3 days after sowing.

### **Weed management:**

- Pre-emergence application of Alachlor 50 EC @ 2.5 l/ kg a.i./ ha (spray volume 750 l of water/ ha) or Pendimethalin 30 EC @ 3.25 l/ kg a.i./ ha or Fluchloralin 45 EC @ 2.0 l/ kg a.i./ ha or Metolachlor 50 EC @ 2.0 l/ kg a.i./ ha is to be sprayed within 3 days after sowing
- Pre-emergence application of Alachlor 50 EC @ 2.5 l/ kg a.i./ ha (spray volume 750 l of water/ ha) is to be sprayed after 3 days after sowing
- Some other important practices
- Dry sowing of groundnut when monsoon is delayed
- Apply borax @ 2 kg/ha as soil application at the time of sowing in boron deficient soils

## Suitable cropping systems

- Pigeonpea paired rows – groundnut (2:10)
- Groundnut – castor (8:1)

## Farm implements/ tools

- Bullock drawn seed-cum-fertilizer drill (finger millet): Bullock drawn manual operation for finger millet seeding and fertilizer application (hand metered) (Rs.1500/- per unit)
- Bullock drawn seed-cum-fertilizer drill (groundnut): Groundnut seeding with fertilizer application (Rs.1500/- per unit)
- Multifurrow opener: Opening furrows for hand seeding of different crops (Rs.1300/- per unit)
- Bent tyne hoe: Intercultural operation for finger millet (Rs.350/- per unit)
- Duck foot hoe: Intercultural operation for finger millet and groundnut for moisture conservation (Hand metered) (Rs.350/- per unit)
- Crust breaker: For breaking the crust to facilitate smooth emergence of the seedling in finger millet and groundnut (Rs.500/- per unit)

## Alternate farming systems

- **Fodder/ green biomass:** *Cassuarina*, Silver oak, *Gliricidia*, *Calliandra*, *Faidherbia albida* on bunds Gravelly shallow soils – *Stylosanthes scabra*
- High gradient non-arable lands with shallow soils – Amla in catch pits with deep soils – neem, pongamia, and *Albizia lebbek*
- **Forage crops** – *Pennisetum, pedicellatum / Cenchrus ciliaris, Microtaliem axillaris*
- **Wastelands** – Jackfruit, Custard apple, Tamarind
- **Fruit:** Mango, Pomegranate, Sapota, Guava, Custard apple, Jamun
- **Medicinal and aromatic plants:** *Catharanthus roseus, Cassia angustifolia, Solanum viarum, Dioscorea, Geranium, Pogostemon patchouli, Jasmine*
- **Vegetables:** Tomato, Chillies, Okra, Watermelon, Bitter gourd, Drumstick, Brinjal
- Animal Component: Male/ female cattle, Buffaloes, Poultry, Sheep, Goat
- Other enterprises: Mushroom cultivation, Sericulture, Piggery, Apiary, Rabbit rearing

## Contingent crop planning

- **Second fortnight of April**
  - Double cropping: Sesame or greengram
- **First fortnight of May**
  - Monocropping: Pigeonpea
  - Sequence cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum
- **Second fortnight of May**
  - Monocropping: Pigeonpea
  - Sequence cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum

- **First fortnight of June**
  - Monocropping: Long duration fingermillet, pigeonpea, maize, groundnut
  - Sequence cropping: Fodder maize, fodder sorghum, fodder pearl millet, cowpea
- **Second fortnight of June**
  - Monocropping: Long duration fingermillet, pigeonpea, maize and groundnut
  - Sequence cropping: Sowing of chilli nursery
- **First fortnight of July**

Monocropping: Groundnut, long duration fingermillet

Sequence cropping: Sowing of chilli nursery
- **Second fortnight of July**
  - Monocropping: Groundnut, long/ medium duration fingermillet
  - Sequence cropping: Sowing of chilli nursery
- **First fortnight of August**
  - Monocropping: Cowpea, horsegram, short duration fingermillet, transplanting chilli
  - Sequence cropping: Cowpea, horsegram, short duration fingermillet, transplanting chilli. Sowing of chilli nursery and short duration fingermillet.
- **Second fortnight of August**
  - Monocropping: Short duration fingermillet, transplanting of medium and long duration fingermillet. Transplanting chilli, cowpea, horsegram
  - Sequence cropping: Short duration fingermillet, transplanting of medium and long duration fingermillet, transplanting chilli, cowpea, horsegram, also fodder crops (maize-pearl millet, sorghum)
- **First fortnight of September**
  - Monocropping: Horsegram, transplanting of short duration fingermillet and chilli (with protective irrigation)
  - Sequence cropping: Horsegram, transplanting of short duration fingermillet and chilli (with protective irrigation)

District	Region
Mysore	Medium run off and Medium yield gap

### Agroecological setting

- **Climate:** Hot moist semi arid
- **Physiography:** Central South Karnataka
- **Soils:** Medium to deep red loamy soils (Alfisols – 100%)
- **Annual rainfall:** 920 mm
- **Potential evapotranspiration:** 1535 mm
- **Moisture availability period:** 120-150 days

### Soil and water conservation:

#### Longterm conservation practices:

- Construction of contour bunds with a cross section of 0.54 m<sup>2</sup> to control and conserve runoff.

- Construction of graded bunds by providing 0.2 to 0.4% grade with a cross section of 0.36 m<sup>2</sup> for safe disposal of excess runoff.
- Graded border strips with a gradient of 0.1 to 0.5% to fit into the local topography and hydrographic features.
- Broad based bunds of 1.5 m<sup>2</sup> cross sections on contour with 1 m vertical interval for better rainwater conservation.
- Reduced contour bunds (0.36 m<sup>2</sup>) in combination with vegetative live barriers for effective conservation of rainwater in low rainfall areas (< 600 mm)

#### ***In situ* conservation practices:**

- Opening a dead furrow in between the paired rows in pigeonpea and maize for better moisture conservation.
- Graded ridge and furrows are made on 0.2 to 0.4% grade for better conservation of moisture as well as safe disposal for cultivation of maize.
- Fall ploughing to a depth of 15-30 cm for better infiltration of rainwater during onset of rains.
- Deep ploughing to a depth of 25-30 cm using mould board plough to reduce the weed incidence and increase soil moisture storage for sunflower and maize crops.
- Crop cultivation across the slope with vetiver/ pennisetum grass as live barrier at 0.5 m vertical interval to check the velocity of runoff and better moisture conservation and availability for a longer period for finger millet/ groundnut/ maize/ sunflower crops.
  - More emphasis on *in situ* water conservation
  - Reducing soil crusting problem
  - Dead furrows at 3.6 m interval
  - Farm pond size of 250 m<sup>3</sup> plastered both sides and bottom with cement + sandy clay soils (1:8)
  - Opening furrows on 0.2 to 0.4 slope
  - Summer tillage

#### **Crop management**

- **Varieties:** JL-24, K-134, and VRI-2
- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x10 cm
- Nutrient management
  - 25 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> + 25 kg K<sub>2</sub>O + 7.5 t farm yard manure/ha.
  - Apply all nutrients as basal
  - Apply 1.0 t/ha lime and also 10 kg/ha sulphur into the soil
- **Pest management**
  - For weed control: Alachlor 50 EC 2.5 l, Pendimethalin 30 EC or 3.25 l, Fluchloralin 45 EC or 2.0 l or Metolachlor 50 EC 2.0 l, 750 l water, to be sprayed within 3 days after sowing.

#### **Weed management:**

- Pre-emergence application of Alachlor 50 EC @ 2.5 l/ kg a.i./ ha (spray volume 750 l of water/ ha) or Pendimethalin 30 EC @ 3.25 l/ kg a.i./ ha or Fluchloralin 45 EC @ 2.0 l/ kg a.i./ ha or Metolachlor 50 EC @ 2.0 l/ kg a.i./ ha is to be sprayed within 3 days after sowing

- Pre-emergence application of Alachlor 50 EC @ 2.5 l/ kg a.i./ ha (spray volume 750 l of water/ ha) is to be sprayed after 3 days after sowing
- Some other important practices
- Dry sowing of groundnut when monsoon is delayed
- Apply borax @ 2 kg/ha as soil application at the time of sowing in boron deficient soils

### Suitable cropping systems

- Pigeonpea paired rows – Groundnut (2:10)
- Groundnut-castor (8:1)

### Farm implements/ tools

- Bullock drawn seed-cum- fertilizer drill (fingermillet): Bullock drawn manual operation for fingermillet seeding and fertilizer application (hand metered) (Rs.1500/- per unit)
- Bullock drawn seed-cum-fertilizer drill (groundnut): Groundnut seeding with fertilizer application (Rs.1500/- per unit)
- Multifurrow opener: Opening furrows for hand seeding of different crops (Rs.1300/- per unit)
- Bent tyne hoe: Intercultural operation for fingermillet (Rs.350/- per unit)
- Duck foot hoe: Intercultural operation for fingermillet and groundnut for moisture conservation (Hand metered) (Rs.350/- per unit)
- Crust braker: For breaking the crust to facilitate smooth emergence of the seedling in fingermillet and groundnut (Rs.500/- per unit)

### Alternate farming systems

- **Fodder/ green biomass:** Casuarina, Silver oak, Gliricidia, Calliandra, *Faidherbia albida* on bund Gravelly shallow soils – *Stylosanthes scabra*; High gradient non-arable lands with shallow soils – Amla In catch pits with deep soils – neem, pongamia, *Albizzia lebbek*
- **Forage crops** – *Pennisetum pedicellatum*/ *Cenchrus ciliaris*, *Microtalium axillaris*
- Wastelands – Jackfruit, Custard apple, Tamarind
- **Fruit:** Mango, Pomegranate, Sapota, Guava, Custard apple, Jamun
- **Medicinal and aromatic plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Salanum viarum*, *Dioscorea*, *Geranium*, *Pogostemon patchouli*, Jasmine
- **Vegetables:** Tomato, Chillies, Okra, Watermelon, Bitter gourd, Drumstick, Brinjal.
- **Animal Component:** Male/ female cattle, Male buffaloes, Poultry, Sheep, Goat,
- **Other enterprises:** Muhsroom cultivation, Sericulture, Piggery, Apiary, Rabbit rearing

### Contingent planning

- **Second fortnight of April**
  - Double cropping: Sesame or greengram

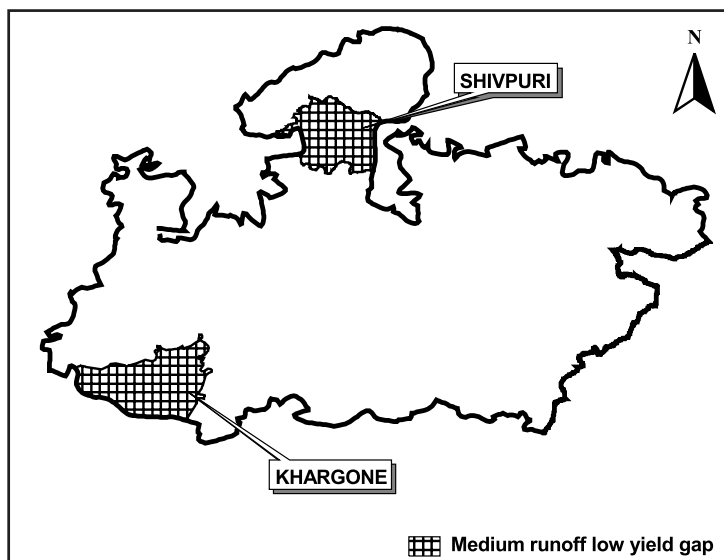
#### First fortnight of May

- Monocropping: Pigeonpea
- Sequence cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum.

- **Second fortnight of May**
  - Monocropping: Pigeonpea
  - Sequence cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum.
- **First fortnight of June**
  - Monocropping: Long duration finger millet, pigeonpea, maize, groundnut
  - Sequence cropping: Fodder maize, fodder sorghum, fodder pearl millet, cowpea
- **Second fortnight of June**
  - Monocropping: Long duration finger millet, pigeonpea, maize and groundnut
  - Sequence cropping: Sowing of chilli nursery
- **First fortnight of July**
  - Monocropping: Groundnut, long duration finger millet
  - Sequence cropping: Sowing of chilli nursery
- **Second fortnight of July**
  - Monocropping: Groundnut, long/ medium duration finger millet
  - Sequence cropping: Sowing of chilli nursery
- **First fortnight of August**
  - Monocropping: Cowpea, horsegram, short duration finger millet, transplanting chilli
  - Sequence cropping: Cowpea, horsegram, short duration finger millet, transplanting chilli. Sowing of chilli nursery and short duration finger millet.
- **Second fortnight of August**
  - Monocropping: Short duration finger millet, transplanting of medium and long duration finger millet. Transplanting chilli, cowpea, horsegram
  - Sequence cropping: Short duration finger millet, transplanting of medium and long duration finger millet, transplanting chilli, cowpea, horsegram. Also, fodder crops (maize-pearl millet, sorghum)
- **First fortnight of September**
  - Monocropping: Horsegram, transplanting of short duration finger millet and chilli (with protective irrigation)
  - Sequence cropping: Horsegram, transplanting of short duration finger millet and chilli (with protective irrigation)

## MADHYA PRADESH

In Madhya Pradesh there are two districts viz. Khargone and Shivapuri under medium runoff and low yield gap region.



District	Region
Khargone Shivpuri	Medium runoff and Low yield gap

### Agroecological setting

#### Khargone

- **Climate:** Hot moist semi-arid
- **Physiography:** Western Malwa Plateau
- **Soils:** Deep clayey black soils and shallow black soils, medium and deep clayey black soils, shallow loamy black soils (Vertic Inceptisols-80%)
- **Annual rainfall:** 888 mm
- **Potential evapotranspiration:** 1792 mm
- **Moisture availability period:** 120-180 days

#### Shivpuri

- **Climate:** Hot moist semi arid
- **Physiography:** Madhya Bharat Plateau
- **Soils:** Deep loamy and clayey mixed red and black soils (Vertic Inceptisols-100%)
- **Annual rainfall:** 1179 mm
- **Potential evapotranspiration:** 1498 mm
- **Moisture availability period:** 120-150 days



## Soil and water conservation

### Khargone

- Straighten the gullied portion in the farmers' fields through earth moving machinery to reduce the length of gully allowing safe passage for the run off water. It brings additional area under cultivation through reclamation process.
- Construct percolation tank for increasing ground water recharge and enhancing ground water storage to provide extra irrigation to the crops.
- Use gabion as an inlet and outlet of water harvesting tank without any structural failure to trap silt on the upstream sit to increase life of water storage bodies.
- Construct water harvesting tank to retain the excess run off from the water shed area to use stored water for irrigation purpose.
- Silpaulin (a plastic material) of 90 – 120 gsm has been found effective lining material for farm ponds used for water harvesting purposes.
- Use vegetative barriers to strengthen the mechanical bunds at suitable vertical intervals in order to reduce run off in associated soil losses from the cultivated fields.
- Develop a sort of terracing break the continuity of undulating slope to reduce the chances of degrading cultivated fields into gullied one.
- Ensure drainage line treatment for providing safe disposal of excess run off and providing more opportunity time in order to reduce erosive velocity.
- Mould board plough, used for deep tillage to increase the productivity of *kharif* crops and enhance sowing of *rabi* crops through better moisture conservation and eradication of infested weeds.
- Graded bunds alone and / or along with vegetative barriers at vertical intervals of 50 cm are most effective in controlling soil erosion and nutrient losses on soils having slope up to 2 per cent.
- Off-season shallow tillage is important not only in controlling weeds but also in helping entry of rain water.
- Provide *insitu soil* mulch by operating bullock drawn dora to fill up the cracks, to conserve soil moisture and to achieve weed control. Straw mulch @ 4-5 t/ha in between the rows of crop plants to minimize evaporative losses, moisture conservation and to increase moisture efficiency in *rabi* crops.

### Shivpuri

- Compartment bunding after seeding emergence
- Contour farming
- Graded border strips
- Sowing across the slope and ridging later
- To mitigate early season drought, one extra inter cultivation along with straw mulch @ 5 t/ha is effective
- One protective irrigation is only solution to control late season drought effect during summer

## Crop management

### Khargone

- **Varieties:** JL-24, JGN-3
- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x15 cm

- **Nutrient management**
  - 25 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>/ha
  - 30 kg N+ 60kg P<sub>2</sub>O<sub>5</sub> + 20 kg K<sub>2</sub>O + 30 kg S/ha
  - Integrated nutrient management (50% organic + 50% inorganic). Crop planning according to land suitability
- **Pest management:** For sucking pests, Phosphomidon or Dimethoate spray
- Some other important practices
  - Leaf spot resistant varieties - NRCG-10121, NRCG-10123, NRCG-10125
  - Deep tillage is done for reducing soil borne pest
  - Pearl millet acts as a barrier for thrips and leaf miner
  - Castor acts as a barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips
  - Seed treatment: Carbendazim (Bavistin) 2 g/kg of seeds for seed borne fungi viz., collar rot and stem rot.
- **Cultural practices**
  - Soil amendment with castor cake @ 500 kg/ha (preferably 15 days before sowing) for soil borne diseases like stem rot and collar rot.
  - Intercropping of groundnut with pigeonpea/ pearl millet/ sorghum (3:1) depending upon the locally recommended intercrops against foliar fungal diseases (early and late leaf spots, rust) and insect pests (leaf miner and thrips)
  - Use of trap crops such as cowpea/ soybean (leaf miner and leaf hoppers)/ castor (*Spodoptera* and leaf hoppers) as border crops for sucking/ defoliating insects.

### Shivpuri

- **Varieties:** JL-24
- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x15 cm
- **Nutrient management:** 25 kg N + 40 kg/ha
  - 30 kg N+ 60 kg P<sub>2</sub>O<sub>5</sub> + 20 kg K + 30 kg S/ha
- **Pest management:** For sucking pests phosphamidon or dimethoate spray

### Suitable cropping systems

#### Khargone, Shivpuri

- Groundnut + soybean
- Groundnut + maize (3:1)

### Farm implements/ tools

#### Khargone

- Suitable implements for seedbed preparations:
  - Meston Plough
  - Iron Bakhar

- Suitable implements for sowing operations
  - Mahakal Dufan
  - Mahakal Tifan and
  - Sarta attachment for intercropping
- Suitable implements/ tools for intercultural operations
  - Hand dora (small blade harrow)
  - Bullock drawn dora (small blade harrow with wooden beam)
  - Indore ridger

### Shivpuri

- Fertilizer cum Seed drill

## Alternate farming systems

### Khargone

- **Fodder/green biomass:** *Dichrostachys cineraria*, *Albizia amara*, *Faidherbia albida*, *Hardwickia binata*, *Cassia*, *Leucaena leucocephala* and *Albizia lebbeck*.
- **Fruit:** Ber, Pomegranate, Mango, Fig, Tamarind
- **Medicinal and aromatic plants:** *Withamnia somnifera*, *Rauvolfia serpentina*, *Vetiver zizanioides*, *Palma rosa*.
- **Vegetables:** Chillies, Okra, Watermelon, Cowpea, Clusterbean, Amaranthus, Round melon.
- **Animal Component:** Male/ female cattle, Female buffaloes, Sheep, Goat

### Shivpuri

- **Agro – hortisystem:** Mango + Pea/ Berseem (green fodder)/ wheat/ chickpea/ soybean
- **Silvi – pastoral system:** Teak + Sudan grass
- **Fodder/ green biomass:** *Leucaena*, *Melia azadirach*, *Dichrostachys cineraria*, *Albizia amara*, *A.lebbeck*, *Hardwickia binata*, *A.nilotica*
- Ley farming – Four years continuous raising of *Stylosanthes hamata* followed by sorghum
- **Fruit:** *Emblia officinalis* (amla), Guava, Ber, Mango
- **Medicinal and aromatic plants:** *Rauvolfia serpentina*, *Vetivera zizanioides*, *Palma rosa*, *Safed musli*, *Aswagandha*
- **Vegetables:** Bottle gourd, Brinjal, Tomato, Chillies, Cowpea, Okra
- Alternate crops in place of Greengram, blackgram/ soybean/ sunflower in place of kakun, kodan and filkar (small millets)
- **Animal component:** Female Cattle, Male Cattle, Female Buffaloes, Goat and Poultry

## Contingent planning

### Khargone

If monsoon is delayed or there is a failure of timely sown crops due to intermittent droughts, then for delayed sowing improved crops and their varieties may be chosen for planting, as given below:

### 15<sup>th</sup> to 31<sup>st</sup> July

- Maize – (short duration varieties like Navjot, Sathi)
- Pigeonpea – (under deep soils, preferred varieties are ICPL 151, T-21, Kh-2, ICPL 87, ICPL 88039)
- Sunflower – Morden, Surya, Manjira
- Sesame – Bhadeli, TKG 22, TKG 37
- Cowpea – Pusa Komal and Pusa Baisakhi
- Castor – GCH4, Kranthi

#### **1<sup>st</sup> to 15<sup>th</sup> August**

- Fodder crops – *Sorghum sudanensis*, maize- African tall, Dinanath grass and pearl millet
- Sunflower – Morden, Surya, Manjira and any of the hybrids

#### **15<sup>th</sup> to 31<sup>st</sup> August**

- Sesame – Bhadeli, TKG 22, TKG 37.
- Cowa Komal and Pusa Baisakhi
- Rajgira – (Amaranthus) – Co-1, Co-2
- Castor – GCH4, Kranthi
- Fodder crops – *Sorghum sudanensis*, Maize- African tall, Dinanath grass and pearl millet
- Safflower – JSF-1, JSF- 7 (spineless), JSF-73, Sharda
- Sunflower – Morden, Surya and Manjira
- Sesame – Bhadeli, TKG 22, and RT-46
- Rajgira –Co-1 and Co-2
- Fodder crops – Barley, Oats, Maize – African tall

### **Shivpuri**

#### **Kharif**

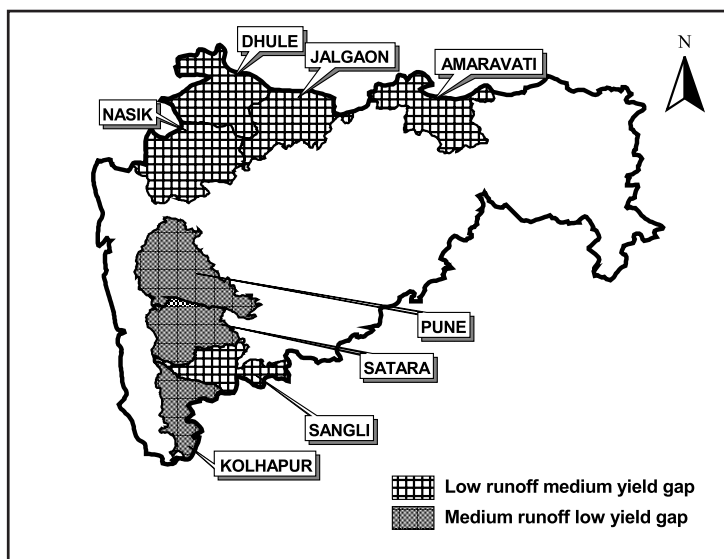
- Under normal rainfall
- Pearl millet (ProAgro 9402), pigeonpea (UPAS 120), greengram (K 851), clusterbean (RGC 197)
- Rainfall upto end of July
  - Cereals and pulses: Pearl millet (Proagro 9402) intercropped with pigeonpea (UPAS 120, IPCL 87) blackgram (T-9) and greengram (K 851). Pure crop of clusterbean, blackgram and greengram.
  - Oilseeds: Groundnut (Chandra) and sesame (Pratap) upto the end of third week of July
- Rainfall upto third week of August
  - Cereals and pulses: Clusterbean (RGC 197) and transplanting of pearl millet (MBH 163)
- Rainfall upto end of August
  - Clusterbean as pure crop (RGC 197)
  - Castor with a seed rate of 15 kg/ha.

#### **Rabi :**

- Rapeseed mustard (Pusa Jaikisan), barley (Ratna), chickpea (K 850), lentil (L 9-12), and rapeseed mustard (TMH 1) and safflower in the order.

# MAHARASHTRA

In Maharashtra there are five districts viz. Sangli, Dhule, Nasik, Jalgaon and Amaravati under low runoff and medium yield gap region and two districts viz. Kolhapur and Pune under medium runoff and low yield gap region.



District	Region
Amaravati	Low runoff and Medium yield gap
Dhule	
Jalgaon	
Nasik	
Sangli	
Kolhapur	Medium runoff and Low yield gap
Pune	
Satara	

## Agroecological setting

### Amaravati

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Maharashtra Plateau
- **Soils:** Medium and deep clayey black soils, shallow loamy to clayey black soils (Vertic Inceptisols–85%; Vertisols–15%)
- **Annual rainfall:** 976 mm
- **Potential evapotranspiration:** 1770 mm
- **Moisture availability period:** 120-150 days

### Dhule

- **Climate:** Hot semi arid
- **Physiography:** Western Maharashtra plateau
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils (Vertic Inceptisols–65%; Vertisols–35%)

- **Annual rainfall:** 738 mm
- **Potential evapotranspiration:** 1713 mm
- **Moisture availability period:** 120-150 days

### **Jalgaon**

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Maharashtra Plateau check
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils, shallow loamy to clayey black soils (Vertic Inceptisols–65%; Vertisols–35%)
- **Annual rainfall:** 841 mm
- **Potential evapotranspiration:** 1912 mm
- **Moisture availability period:** 120-150 days

### **Nasik**

- **Climate:** Hot semi arid
- **Physiography:** South Western Maharashtra
- **Soils:** Shallow and Medium loamy, medium and deep clayey black soils (Vertic Inceptisols–85%; Vertisols–15%)
- **Annual rainfall:** 591 mm
- **Potential evapotranspiration:** 1659 mm
- **Moisture availability period:** 120-150 days

### **Sangli**

- **Climate:** Hot semi arid/ Hot dry sub humid
- **Physiography:** South Western Maharashtra
- **Soils:** Shallow and Medium loamy, medium and deep clayey black soils, Shallow and medium loamy and clayey black soils, deep clayey black soils. (Vertic Inceptisols–75%; Vertisols–25%)
- **Annual rainfall:** 571 mm
- **Potential evapotranspiration:** 1620 mm
- **Moisture availability period:** 90-180 days

## **Soil and water conservation**

### **Amaravati, Jalgaon**

- Compartment bunding
- Ridges and furrows
- Graded bunds on clayey soil to drain off excess water
- *In situ* conservation measures like tillage, mulching, conservation furrows, ridging
- Contour farming

### **Nasik**

- Compartment bunding
- Graded bunds on clayey soil to drain off excess water.

- *In situ* conservation measures like tillage, mulching, conservation furrows, ridging
- Contour farming

### Dhule

- Compartment bunding
- Ridges and furrows prior to sowing
- Marvel-8 grass on bunds for protection of bunds
- Contour live bunds of Marvel-8 or *Leucaena*
- *Leucaena* lopping mulch at 3.5 t/ha

### Sangli

- Compartment bunding
- Contour bunds
- *In situ* conservation measures like conservation furrows, mulching and deep tillage.
- Indigenous water harvesting structures

## Crop management

### Amaravati

- **Varieties:** JL- 24, JL-220
- **Seed rate:** 100 kg/ha
- **Planting pattern:** 30x10/15 cm
- Pest management
  - White grub: Only in case of late sowing, soil application of phorate 10 G granules @ 10 kg/ha.
  - Pre and post emergence mortality: Treat seeds with Thiram @ 1.5 g + 1.5 g Carbendazim/ kg seed
- Some other important practices
  - Deep tillage is done for reducing soil borne pest
  - Pearlmillet act as a barrier for thrips and leaf miner
  - Castor act as barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips

### Dhule, Nasik, Sangli, Jalgaon

- **Varieties:** ICGS-11, JL-220, TAG-24, and TG-26
- **Seed rate:** 100 kg/ha
- **Planting pattern:**
  - Erect : 30x10cm
  - Semi spreading : 30x15 cm
  - Spreading : 45x15 cm
- **Nutrient management:** 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha
- Apply well developed FYM or compost @ 10-15 t/ha along with 10-30 kg N/ha as a starter dose.

- **Pest management**

- White grub:
  - Hand collection of white grub adults from white grub affected fields immediately after onset of summer rains.
  - Seed treatment with Chlorpyrifos @ 2 ml/kg of seed.
  - Soil application of 5% Heptachlor @ 80 Kg/ha before sowing
- Leaf roller:
  - Spraying of Monocrotophos 0.05% as soon as incidence starts
  - Dusting of 10% Carbaryl dust @ 20 kg/ha
  - Keep weed free *kharif* crops by one hoeing and weeding up to 30 days from sowing

- **Weed management:**

- Dhule, Nasik, Sangli Jalgaon
- Hand weeding upto 30 days after sowing with weeding hook
- Two hoeing and upto 40 days after sowing with hoe
- **Some other important practices**
  - Deep tillage is done for reducing soil borne pest
  - Pearl millet acts as a barrier for thrips and leaf miner
  - Castor acts as a barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips
  - Apply borax @ 2 kg/ha as soil application at the time of sowing in boron deficient soils

- **Suitable cropping systems**

- **Amaravati, Jalgaon**

- Pigeonpea + groundnut (1:2 or 1:3)

- **Farm implements/ tools**

- **Amaravati**

- Manually operated fertilizer drill: Simple two row tool for top dressing (hand metered)
- Bullock drawn serrated blade for interculture: Two rows, improved blades for intercultivation

- **Dhule, Nasik, Sangli, Jalgaon**

- Tractor multicrop planter: Sowing of *rabi* sorghum was done on farmer's field. Minor modifications made in the original design for adoption of the machine in dryland region. Awareness was created amongst the farmers by conducting demonstrations on farmer's field. The farmers were satisfied with operation of this machine. (Rs.22800/-)
- Bullock drawn Jyoti Planter: The field trials were conducted and the machine is recommended for sowing the crops of dryland region. (Rs.7500/-)
- Weeders developed by Maharashtra Agro Industries Development Corporation Ltd. (MAIDC): These weeders were tested on farmer's field and identified for weeding and interculturing in row crops. (Rs.410/-)
- Tractor drawn single bottom reversible plough: Tested on farmers' field for ploughing and identified for ploughing operations in dryland region, as the field operation was effective and economical. (Rs.18500/-)



- Tractor drawn double bottom reversible plough: Tested on farmers' field for ploughing and identified for ploughing operations in dryland region as the field operation was effective and economical. (Rs.23600/-)
- Bund formers were tested and found suitable for compartment bund (Rs.1050/-)
- Baliram plough: Identified for moisture conservation practices like ridges and furrows and compartment bund (Rs.2500/-)
- Kopergaon bullock drawn two bowl seed drill: The local made seed drill named "Kopergaon seed drill" is operated on the field for sowing crops like sorghum, pearl millet, pigeonpea etc. and identified for sowing of the crops of dryland region (Rs.9000/-)

## Alternate farming systems

### Amaravati, Jalgaon

- **Fodder/ Green biomass:** *Leucaena Leucocephala*, *Albizia lebeck*, *Dalbergia sissoo*, *A. indica*, *A. procera*, *Gliricidia*
- **Fruit:** Pomegranate, Ber, Mango, Sapota, Guava, Tamarind
- **Medicinal and aromatic plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, *Ocimum viride*
- **Vegetables:** Onion, Chilli, Brinjal, Okra, Amaranthus, Bottlegourd.
- **Animal Component:** Male/ Female cattle, Female buffaloes, Sheep, Goat, Poultry

### Dhule, Nasik

- **Silvipasture:** *Leucaena* + Marvel-8
- **Alley cropping:** Ber (20 m alleys) + pearl millet + pigeonpea for shallow soils
- **Fodder:** Maize (African Tall), Oats (Kent), *Stylo hamata*
- **Fodder/ Green biomass:** *Dalbergia sissoo*, *Albizia lebeck*, *Anogeissus latifolia*, *Sesbania*, *Stylo Marvel-8 grass*
- **Fruit:** Ber, Custard apple, Pomegranate, Amla + *kharif* spreading crops
- **Medicinal and aromatic plants:** *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, Rose, Geranium
- **Vegetables:** Onion, Tomato, Okra, Cowpea, Cluster bean, Drumstick
- **Animal Component:**
  - Cow breeds: Gir, Jersey
  - Poultry: White Leghorn
  - Rams
  - Male/ Female cattle, Female buffaloes, Sheep, Goat

## Alternate land use system:

### Dhule, Nasik, Sangli

- Lands < 22.5 cm depth of soil should be cultivated with Agroforestry and dryland horticulture including Ber, Custard apple, Amla, Wood apple, Jambhul etc.
- On light soils Ber cultivation at 20x5 m spatial arrangement associated with pearl millet + pigeonpea (2:1) intercropping within two rows of Ber plantation was recommended.
- Silvipastoral system of Subabul + Marvel-8 with cutting of alternate trees at 7<sup>th</sup> year onwards for fuel is also recommended.

## Contingent planning

### Amaravati, Jalgaon

#### Regular Monsoon

- The regular monsoon starts by 24<sup>th</sup> meteorological week. For regular monsoon, the following recommendations stand.
- Light soils (depth 20 to 30-35 cm)
  - Graded bunding of lands
  - Growing of strips of erosion resistant crops (Greengram Kopergaon/ blackgram T-9) in the upper half of the plot and sorghum (CSH-9) in the lower half of the plot.
- Medium deep soils (35-40 cm to 75 cm depth)
  - Cotton (AKH 84635) with greengram (Kopergaon) as an intercrop in 1:1 row ratio.
  - Sorghum (CSH-9) with intercrop of greengram/ blackgram in 1:1 row ratio.
  - Groundnut intercropped with sunflower in the row ratio of 6:2 (Groundnut: JL-24, Sunflower-Morden)
- Deep soils (75 cm depth)
  - Alternate crops like *hirsutum* cotton, Sorghum (CSH-9/ CSH-5) intercropped with Pigeonpea (C-11) in 6:2 row ratio

#### Delayed onset of monsoon by 15 days

- If the rains start by end of June, the sowing may start in the first week of July. The following changes should be made in the cropping plans.
  - Area under cotton be reduced and replaced by sorghum.
  - Sowing of sorghum should be completed before 10<sup>th</sup> July. Sorghum CSH-1 variety is sown instead of CSH-5/ CSH-9.
  - Area under greengram/ blackgram should be replaced by early pigeonpea varieties such as ICPL 8863 or ICPL 87119
  - Area under groundnut be reduced and replaced by sunflower (EC 68414)

#### Regular monsoon followed by long gaps

- Wherever possible, life-saving irrigation be given.
- Cotton can sustain some stress, but sorghum, groundnut, chickpea are not able to sustain such stress. Therefore, use of some conditioner such as spray of urea, not exceeding to 2 % concentration, may be useful.
- If there is a total failure of crop, sowing of photo-insensitive crops such as pearl millet (BJ-104) or sunflower (EC-68414) may be attempted.
- In deep soils, the land may be tilled properly. In case, *kharif* crop fails, to follow *rabi* safflower (N.7), pigeonpea (C.11) in September.

#### Extended monsoon

- Advantage of this situation is exploited for double cropping with safflower and chickpea. Safflower (No.7) may be sown after sorghum till 15<sup>th</sup> October. Beyond 15<sup>th</sup> October chickpea may be sown.

### Dhule, Nasik, Sangli

Mid season correction during *kharif* with soil having a depth upto 45 cm for the scarcity zone.

- Second fortnight of June: All *kharif* crops
- **First fortnight of July:**

- Pearl millet, setaria, groundnut, castor, pigeonpea, horsegram
- Intercropping of Pearl millet + pigeonpea (2:1)
- Cluster bean + pigeonpea (2:1)
- Cluster bean + castor (2:1)
- Sunflower + pigeonpea (2:1)
- **Second fortnight of July:**
  - Sunflower, pigeonpea, horsegram, setaria
  - Castor, pearl millet (ergot resistant)
  - Intercropping of sunflower + pigeonpea (2:1)
- **First fortnight of August:**
  - Sunflower, pigeonpea, castor, horsegram
  - Sunflower + pigeonpea (2:1)
- **Second fortnight of August:**
  - Sunflower, pigeonpea, castor
  - Sunflower + pigeonpea (2:1)
- **First fortnight of September:**
  - Sorghum for fodder
- **Second fortnight of September:**
  - *Rabi* Sorghum, safflower, sunflower
- **First fortnight of October:**
  - *Rabi* Sorghum, safflower, chickpea, sunflower
- **Second fortnight of October:**
  - Chickpea, sunflower, *rabi* sorghum
- **First fortnight of November:**
  - Chickpea, sunflower

District	Region
Kolhapur Pune Satara	Medium runoff and Low yield gap

## Agroecological setting

### Kolhapur

- **Climate:** Hot dry sub humid/ Hot moist sub humid to humid (transitional)
- **Physiography:** North Sahyadris
- **Soils:** Shallow and medium loamy and clayey black soils, deep clayey black soils, deep loamy to clayey red and lateritic soils (Vertisols-50%; Vertic Inceptisols-50%)
- **Annual rainfall:** 1137 mm
- **Potential evapotranspiration:** 1636 mm
- **Length of growing period (LGP)/ (Moisture availability period):** 150-270 days

## Pune

- **Climate:** Hot dry sub humid
- **Physiography:** North Sahyadris
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils, medium to deep loamy to clayey mixed red and black soils (Vertic Inceptisols–65%; Vertisols – 35%)
- **Annual rainfall:** 715 mm
- **Potential evapotranspiration:** 1476 mm
- **Moisture availability period:** 90-240 days

## Satara

- **Climate:** Hot semi arid/ Hot dry sub humid
- **Physiography:** North Sahyadris, Maharashtra state
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils, shallow and medium loamy and clayey black soils, deep clayey black soils (Udupts/ Udalfs – 60%; Vertisols – 40%)
- **Annual rainfall:** 1119 mm
- **Potential evapotranspiration:** 1618 mm
- **Moisture availability period:** 90-180 days

## Soil and water conservation

### Kolhapur, Pune & Satara

- Conservation furrows
- Compartment bunding
- Broad bed furrows
- Gabion structures in waterways
- More emphasis could be given on permanent structures in Kolhapur
- Semi permanent and *insitu* conservation measures may be encouraged in Pune district

## Crop management

### Kolhapur, Pune & Satara

- **Varieties:** ICGS-11, JL-220, TAG-24, and TG-26
- **Seed rate:** 100 kg/ha
- Planting Pattern:
  - Erect : 30x10 cm
  - Semi spreading : 30x15 cm
  - Spreading : 45x15 cm
- **Nutrient management:** 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha
- **Pest management**
  - White grub:
    - Hand collection of white grub adults from white grub affected fields immediately after onset of summer rains.

- Seed treatment with Chlorpyrifos @ 2 ml/kg of seed.
- Soil application of 5% Heptachlor @ 80 kg/ha before sowing
- Leaf roller:
  - Spraying of Monocrotophos 0.05% as soon as incidence starts
  - Dusting of 10% Carbaryl dust @ 20 kg/ha
  - Keep weed free *kharif* crops by one hoeing and weeding up to 30 days from sowing

## Weed management:

### Kolhapur, Pune, Satara

- Hand weeding upto 30 days after sowing with weeding hook
- Two hoeing and upto 40 days after sowing with hoe
- **Some other important practices**
  - Deep tillage is done for reducing soil borne pest
  - Pearlmillet act as a barrier for thrips and leaf miner
  - Castor act as barrier for *Spodoptera litura*, *Achoea janata*
  - Groundnut + soybean for trapping leaf miner, thrips

## Farm implements/ tools

### Kolhapur, Pune & Satara

- Tractor multicrop planter: Sowing of *rabi* sorghum was done on farmer's field. Minor modifications made in the original design for adoption of the machine in dryland region. Awareness was created amongst the farmers by conducting demonstrations on farmer's field. The farmers were satisfied with operation of this machine. Rs.22800/-
- Bullock drawn Jyoti Planter: The field trials were conducted and the machine is recommended for sowing the crops of dryland region. Rs.7500/-
- Weeders developed by Maharashtra Agro Industries Development Corporation Ltd. (MAIDC): These weeders were tested on farmer's field and identified for weeding and interculturing in row crops. Rs.410/-
- Tractor drawn single bottom reversible plough: Tested on farmers' field for ploughing and identified for ploughing operations in dryland region as the field operation was effective and economical. Rs.18500/-
- Tractor drawn double bottom reversible plough: Tested on farmers' field for ploughing and identified for ploughing operations in dryland region as the field operation was effective and economical. Rs.23600/-
- Bund former: Bund formers were tested and found suitable for compartment bund Rs.1050/-
- Baliram plough: Identified for moisture conservation practices like ridges and furrows and compartment bunding Rs.2500/-
- Kopergaon bullock drawn two bowl seed drill: The local made seed drill named "Kopergaon seed drill" is operated on the field for sowing crops like sorghum, pearlmillet, pigeonpea etc. and identified for sowing of the crops of dryland region Rs.9000/-

## Alternate farming systems

### Kolhapur and Satara

- **Silvipasture:** Leucana + Marvel-8

- **Alley cropping:** Ber (20 m alleys) + pearl millet + pigeonpea for shallow soils
- **Fodder:** Maize (African Tall) Oats (Kent), *Stylosanthes hamata*
- **Fodder/ Green biomass:** *Dalbergia sissoo*, *Albizia lebbbeck*, *Anogeissus laticolia*, *Sesbania*, Stylo, Marvel-8 grass
- **Fruit:** Ber, Custard apple, Pomegranate, Amla + *kharif* spreading crops
- **Medicinal/ Aromatic Plants:** *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, Rose, Geranium
- **Vegetables:** Onion, Tomato, Okra, Cowpea, Cluster bean, Drumstick
- **Animal Component:**
  - Cow breeds: Gir, Jersey
  - Poultry: White Leghorn
  - Rams
  - Male/ female cattle, Female buffaloes, Sheep, Goat

## Pune

- **Agri-Horticultural system** - Ber (5x5 m) + mothbean (8 lines) (30x10 cm)
- **Silvipasture:** Leucaena + Marvel-8
- **Alley cropping:** Ber (20 m alleys) + pearl millet + pigeonpea for shallow soils
- **Fodder:** Maize (African Tall) Oats (Kent), *Stylosanthes hamata*
- **Fodder/ Green biomass:** *Alianthus excelsa*, *Albizia lebbbeck*, *Dalbergia sissoo*, *Neem*, *Prosopis cineraria*
- **Fruit:** Ber, Date palm, Jamun, Fig, Phalsa, Karonola
- **Medicinal / Aromatic plants:** *Plantago ovata*, *Cassia angustifolia*, *Safed musli*, *Papaver somniferum*
- **Vegetables:** Clusterbean, Cowpea, Amaranthus, Round melon
- **Animal Component:** Female buffalo/ Sheep, Goat

## Alternate land use system

### Kolhapur, Pune & Satara

- Lands < 22.5 cm depth of soil should be cultivated with Agroforestry and dryland horticulture including Ber, Custard apple, Amla, Wood apple, Jambhul etc.
- On light soils Ber cultivation at 20x5 m spatial arrangement associated with pearl millet + pigeonpea (2:1) intercropping within two rows of Ber plantation was recommended.
- Silvopastoral system of Subabul + Marvel-8 with cutting of the alternate trees at 7<sup>th</sup> year onwards for fuel is also recommended.
- For productivity increment in scarcity area the pearl millet + pigeonpea (2:1) intercropping or ber (5x5 m) + mothbean (8 lines) is advocated.

## Contingent planning

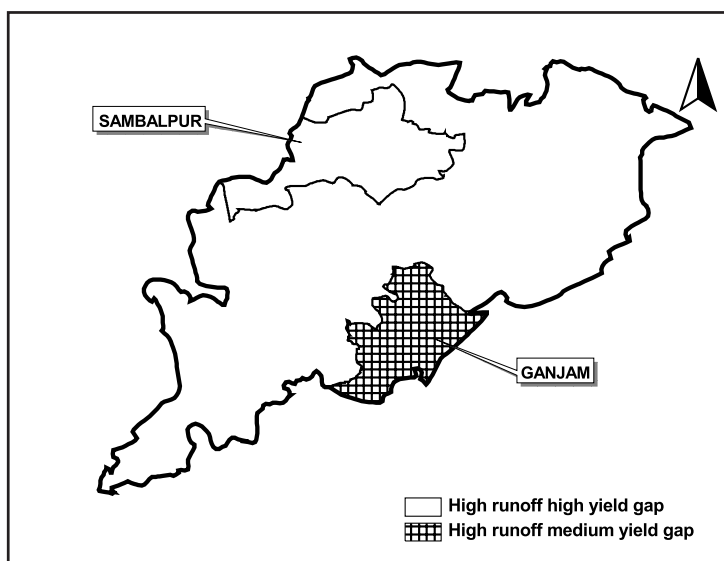
### Kolhapur, Pune & Satara

Mid season corrections during *kharif* with soil having depth upto 45 cm for the scarcity zone.

- **Second Fortnight of June:**
  - All *kharif* crops
- **First fortnight of July:**
  - Pearl millet, setaria, groundnut, castor, pigeonpea, horsegram
  - Intercropping of pearl millet + pigeonpea (2:1)
  - Cluster bean + pigeonpea (2:1)
  - Cluster bean + castor (2:1)
  - Sunflower + pigeonpea (2:1)
- **Second fortnight of July:**
  - Sunflower, pigeonpea, horsegram, setaria
  - Castor, pearl millet (ergot resistant)
  - Intercropping of sunflower + pigeonpea (2:1)
- **First fortnight of August:**
  - Sunflower, pigeonpea, castor, horsegram
  - Sunflower + pigeonpea (2:1)
- **Second fortnight of August:**
  - Sunflower, pigeonpea, castor
  - Sunflower + pigeonpea (2:1)
- **First fortnight of September:**
  - Sorghum for fodder
- **Second fortnight of September:**
  - *Rabi* Sorghum, Safflower, Sunflower
- **First fortnight of October:**
  - *Rabi* Sorghum, Safflower, Chickpea, Sunflower
- **Second fortnight of October:**
  - Chickpea, Sunflower, *rabi* sorghum.
- **First fortnight of November:**
  - Chickpea, Sunflower

## ORISSA

In Orissa there is one districts viz. Ganjam under high runoff and medium yield gap region and one district viz. Sambalpur under high runoff and high yield gap region.



District	Region
Ganjam	High runoff and Medium yield gap

### Agroecological setting

- **Climate:** Hot (moist / dry) sub humid
- **Physiography:** Eastern ghats
- **Soils:** Medium to deep loamy red and lateritic, deep loamy to clayey coastal and deltaic alluvium - derived soils (Aridisols–40%; Alfisols–60%)
- **Annual rainfall:** 1311 mm
- **Potential evapotranspiration:** 1662 mm
- **Moisture availability period:** 180-210 days

### Soil and water conservation

- Ridges and furrows
- Emphasis on permanent soil and water conservation measures
- Water harvesting structures, ponds etc. need to be created for storage of runoff for supplemental utilization and missing a second crop successful
- *In situ* conservation measures in uplands and midlands.
- Suitable drainage measures for low lands.



## Crop management

- **Varieties:** JL-24, TAG-26, ICGS-11, and Smruthi
- **Seed rate:** 100 kg/ha
- **Spreading:** 80-100 kg/ha
- **Erect and semi erect:** 125 kg/ha, Gap filling at 7-10 days after sowing
- **Planting Pattern:** 30x10/15 cm, erect and semi erect type: 30x10 cm
- **Spreading:** 30x15 cm
- **Nutrient management**
  - 20 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> + 20 kg K<sub>2</sub>O kg/ha + gypsum 250-500 kg/ha
  - All nutrients to be applied as basal.
  - Lime should be applied basing on the pH value for correction of soil acidity
- **Pest management:**
  - **Weed management**
    - First hoeing and weeding at 2-3 weeks after sowing/ 15–21 days after sowing
    - Earthing up for erect and semi erect types
    - Second weeding in spreading types 30 days after sowing is necessary

## Weed management:

- Pre-planting application of herbicides viz., Fluchloralin @ 1.0 kg (a.i.)/ ha or Metolachlor @ 0.75 kg (a.i.)/ ha or Pendimethalin @ 1.0 kg (a.i.) /ha or Oxadiazon @ 1.0 kg (a.i.)/ ha or Thiobencarb @ 1.0 kg (a.i.)/ ha or Butachlor @ 1.0 kg (a.i.)/ ha in moist soil at 1 day before sowing by mixing with 1000 l/ ha of water. Light hoeing should be given for incorporation of herbicide in the soil to avoid loss through volatilization and photo decomposition
- **Some other important practices**
- Depth of sowing–5 cm
  - Use seed drill and seed rate for erect type in *kharif*
  - Application of gypsum in sulphur and calcium deficient soils @ 250 kg/ha close to the base of the plants at 20-25 days after sowing on either side and incorporated in the soil so that it remains in top 3 cm of soil

## Suitable cropping systems

- Groundnut + maize (3:1 or 2:1)
- Alternate crops
  - Mesta–AMV–1, AS–7
  - Pearl millet – BPC-39, IP-417
  - Soybean – JS–1, Punjab–1
  - Turmeric – Sudarshan
  - Ginger – Nadia

## Farm implements/ tools:

- Bishu mould board plough for preparatory tillage
- Gujarat state fertilizer corporation seed drill for seeding in finger millet

- Implement factory seed – cum fertilizer drill for line sowing of upland rice
- Mould board plough: Suitable for primary tillage (1<sup>st</sup> and 2<sup>nd</sup> ploughing). Requires a Pair of bullock and covers 0.3 ha/ day. Rs.252/-
- Heavy soil plough: Suitable for black cotton soil. Requires a Pair of bullock and covers 0.24 ha/ day. Rs.324/-
- Cast iron plough : Suitable for ploughing and puddling in fields free from roots of trees and pebbles. Requires a pair of bullock and covers 1.0 ha/ day. Rs.266/-
- Zig-zag puddler: Puddling. Requires a pair of bullock and covers 1.0 ha/ day. Rs.1788/-
- IADP Pubbler: Pulverizing light sandy loamy soil, puddling, suitable for heavy soils of western Orissa. Requires a Pair of bullock and covers 1.0 ha/ day. Rs1700/-
- Puddler 99: Pulverising all soils,Puddling. Requires a pair of bullock and covers a 1.0 ha/ day. Rs.1232/-
- One row seed drill: Seed sowing in rice, maize and groundnut. Requires a pair of bullock and covers 0.3 ha/ day. Rs.246/-
- Two row multicrop seed drill : Seed sowing in rice, wheat, groundnut and bengalgram. Requires one man and covers 0.5 ha/ day. Rs.1164/-
- Two row mustard seed drill: Mustard sowing. Requires one man and covers 0.5 ha/ day. Rs.827/-
- Three row multicrop seed drill: Seed sowing in rice, wheat, bengalgram and groundnut. Requires one man and covers 0.8 ha/ day. Rs.1570/-
- Paddy transplanter (Manual): Transplanting paddy with proper spacing. Requires two men and covers 0.20 ha/ day. Rs.4000/-
- Pedal paddy thresher : Threshing of paddy. Requires two men and covers 2.5 q/ day. Rs.2754/-
- Power paddy thresher: Threshing of paddy. Requires Electric motor (1 HP) and covers 10-12 q/ day. Rs.8778/- (With motor and starter)
- Groundnut digger : Digging groundnut. Requires pair of bullock and covers 0.3 ha/ day. Rs.548/-
- Pedal groundnut thresher: Separating groundnut pods from the plants . Requires two men and completes 2.2 q pods/ day. Rs.2818/-
- Groundnut decorticator : Spreading seeds from groundnut pods. Requires One men and completes 50 kg/ hour. Rs.764/-
- Maize sheller: Spreading seeds from maize cobs. Requires one man and completes 1.0 q/day Rs. 25/

### Alternate farming systems

- **Agro-horti system:** Sweet potato + maize/ castor (spacing 80x25 cm)
  - Yam (100x60 cm) + maize/ castor
  - Tapioca (100x100 cm) + maize/ castor
  - Colocassia (80x25 cm) + maize/ castor
- **Alley cropping:** Subabul (4 m interval) + groundnut/ sesame/ cowpea (grain)
- **Fodder/ Green biomass:** *Dalbergia sissoo*, *Albizia lebbek*, *Anogeissus latifolia*, *Sesbania*, *Stylo*, *Marvel* – 8 grass
- **Fruit:** Ber, Custard apple, Pomegranate, Amla + *kharif* spreading crops.
- **Medicinal and aromatic plants:** *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, Rose, Geranium
- **Vegetables:** Onion, Tomato, Okra, Cowpea, Cluster bean, Drumstick
- **Non-arable wastelands**
  - Tree farming (Sal, Teak)

- Silvipastoral (*Shisham/ Subabul/ Gambar + Stylo/ Cenchrus/ Mixture*)
- **Arable wastelands**
  - Agri-horticulture: Fruit crops (mango/ citrus/ sapota/ pomegranate/ custard apple/ amla/ litchi/ jackfruit/ phalsa) + field crops (pulses/ oilseeds). Hybrid mango varieties viz. Pusa Amrapalli and Pusa Mallika are becoming increasingly popular in the zone.
  - Alley cropping: *Leucaena + turmeric/ ginger*

## Contingent planning

### Normal season:

- **Rice:**
  - Very early group (less than 95 days): Heera, Rudra, ZHU 11-26, Vandana
  - Early group (95 to 115 days): Pathara, Kandagiri, Udayagiri, Ghanteswari and Parijat
  - Early medium (115 to 120 days): Sarathi and Bhoi
  - Medium duration (125 to 145 days): Lalat, IR-64, Konark, Gajapati, Surendra, Jajati, Swarna, MTU-1001 and Padmini
  - Late duration: Utkalaprava, Gayatri, Savitri, Prachi, Ramachani, Mahanadi and Indrabati
- **Fingermillet:** Dibyasingha, Nilachala, Bhairabi and Subhra
- **Maize:** Navjot, Vijaya, DHM-103 and Ganga-5
- **Greengram:** PDM-54, K- 851, Dhauri and TARM-2
- **Blackgram:** Pant U-30, T-9 and Sarala
- **Pigeonpea:** UPAS-120, R-60, T-21 and S-5
- **Cowpea:** SEB-2, SGL-1 and Arka Kamal
- **Horsegram:** Urmi and Local
- **Groundnut:** Smruti (OG 52-1), JL-24, ICGS-11 and AK 12-24
- **Castor:** Aruna, DCH-177 and DCH-30
- **Rapeseed mustard:** PT- 303, M-27, Parvati and Anuradha
- **Sesame:** Vinayak, Uma, Usha and Prachi
- **Niger:** Deomali (GA-10), IGP-76 and Phulbani Local
- **Linseed:** Kiran, Laxmi-27, Pusa-3 and Padmini
- **Sunflower:** Morden
- **Cotton:** MCU-5, NHH-44, Somanath, Savita and Bunny
- **Ginger:** Vardhan, China and Nadia
- **Turmeric:** Sudarsan, Suguna, Subarna and Rajendra Horti-5.
- **Yam:** Hatikhoja, Srikirti and Srirupa

### Aberrant weather: Upland

#### Early season drought/Delay in onset of monsoon:

When upland rice is completely damaged, the crop may be cut down for supplying straw to the cattle. Non-paddy crops viz. fingermillet (Subhra, Bhairabi, Dibyasingha and Godavari), greengram (K 851, PDM-11 and PDM-54), blackgram (T-9, Sarala and Pant U-30), cowpea (SEB-2, SGL-1, Arka Kamal), horsegram

(Urmi), ricebean (RBL 6), sesame (Usha, Uma), castor (Aruna, DCS-9), niger (IGP-76 and Deomali) or sunflower (Morden) should be taken. Drought tolerant varieties of crop(s)/cropping system(s) should be taken up. The crop /variety should be selected based on available effective growing season.

**Mid-season drought:**

Weeding and hoeing should be done in all the crops except groundnut in flowering stage. Weeds in groundnut should be cut or uprooted not to interfere in pegging and pod formation. Hoeing creates soil mulch and decreases moisture loss from the soil. Uprooted weeds should be used as mulch between crop rows.

- Foliar spraying of 2% urea in upland rice and finger millet gives good results. For this, 200 g of urea is mixed with 10 l of water and sprayed on the foliage of the crop. Plant protection chemicals may be mixed with urea solution to minimize the cost of spraying. In a single spray 10 kg/ha of urea is applied through 500 l solution.
- Excess plants in the crop row should be thinned to reduce moisture loss from the soil.
- Use of tender twigs of *Leucaena*, *Gliricidia sepium*, *Cassia siamea* and *Mimosa invisa* and plants of sunhemp as mulch-cum-manure reduces evaporation loss from the soil.
- Spraying of planofix 10 ppm at 45 days after sowing and 20 ppm at flowering in cotton to prevent fruit drop.

**Late season drought:**

- Harvested rain water should be recycled as life saving irrigation.

**Medium and low land:**

**Direct sown rice:**

- Re-sowing of rice is needed if plant population is less than 50%. Line sowing of pre-germinated seeds of rice (125 days duration) should be done. Nursery for comparatively shorter duration rice varieties may be done.
- If plant population is more than 50% and 'beushaning' is not possible, weeds are uprooted by manual means. Even distribution of plants (*Khelua*) should be taken up immediately by using local tools. tillers with roots may be detached from hills with profuse tillering for planting in gappy areas. Urea solution (2%) may be sprayed to improve crop growth.

**Transplanted rice:**

- If puddling and transplanting is not possible, seedlings should not be uprooted. Weeds are removed to keep the nursery beds clean. Adequate plant protection measures are taken to protect the seedlings from disease and pest attack.
- When rainfall occurs, puddling is done by tractor drawn power tiller or rotovator for better puddling. Close planting of 45-day old seedlings in case of medium duration varieties and 60-70 day old seedlings in late varieties should be done. There should be 60-65 hills/m<sup>2</sup>. Instead of 2 to 3 seedlings, 4 to 5 seedlings/hill should be planted. Adequate fertilizer should be applied at transplanting.
- When seedlings are insufficient, seedlings may be raised by dapog method.

District	Region
Sambalpur	High runoff and High yield gap

**Agroecological setting**

- **Climate:** Hot moist sub humid
- **Physiography:** Northern Orissa

- **Soils:** Deep laomy red and lateritic soils (Alfisols/ Ustolls–100%)
- **Annual rainfall:** 1764 mm
- **Potential evapotranspiration:** 1452 mm
- **Moisture availability period:** 180-210 days

### Soil and water conservation

- Ridges and furrows
- Emphasis on permanent soil and water conservation measures
- Water harvesting structures, ponds etc. need to be created for storage of runoff for supplemental utilization and missing a second crop successful
- *In situ* conservation measures in uplands and midlands.
- Suitable drainage measures for low lands.

### Crop management

- **Varieties:** JL-24, TAG-26, ICGS-11, and Smruthi
- **Seed rate:** 100 kg/ha
  - Spreading: 80-100 kg/ha
  - Erect and semi erect: 125 kg/ha
  - Gap filling at 7-10 days after sowing
- **Planting Pattern:** 30x10/ 15 cm
  - Erect and semi erect type: 30X10 cm
  - Spreading: 30X15 cm
- **Nutrient management**

20 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> + 20 K<sub>2</sub>O kg/ ha + gypsum 250 kg/ha  
All nutrients to be applied as basal.  
Lime should be applied basing on the pH value for correction of soil acidity
- **Pest management:** For sucking pests phosphamidon or dimethoate spray
- **Weed management**
  - First hoeing and weeding at 2-3 weeks after sowing/ 15–21 days after sowing
  - Earthing up for erect and semi erect types
  - Second weeding in spreading types 30 days after sowing is necessary
  - Pre-planting application of herbicides viz., Fluchloralin @ 1.0 kg (a.i.)/ ha or Metolachlor @ 0.75 kg (a.i.)/ ha or Pendimethalin @ 1.0 kg (a.i.) /ha or Oxadiazon @ 1.0 kg (a.i.)/ ha or Thiobencarb @ 1.0 kg (a.i.)/ ha or Butachlor @ 1.0 kg (a.i.)/ ha in moist soil at 1 day before sowing by mixing with 1000 l/ ha of water. Light hoeing should be given for incorporation of herbicide in the soil to avoid loss through volatilization and photo decomposition
- **Some other important practices:**
  - Depth of sowing–5 cm
  - Use seed drill and seed rate for erect type in *kharif*
  - Application of gypsum @ 250 kg/ha close to the base of the plants at 20-25 days after sowing on either side and incorporated in the soil so that it remains in top 3 cm of soil

## **Suitable cropping systems**

- Groundnut + maize (3:1 or 2:1)
- Alternate crops – Mesta-AMV-1, AS-7
- Pearlmillet – BPC-39, IP-417
- Soybean – JS – 1, Punjab –1
- Turmeric – Sudarshan
- Ginger – Nadia

## **Farm implements/ tools:**

- Bishu mould board plough for preparatory tillage
- Gujarat state fertilizer corporation seed drill for seeding in finger millet
- Implement factory seed – cum fertilizer drill for line sowing of upland rice
- Mould board plough: Suitable for primary tillage (1<sup>st</sup> and 2<sup>nd</sup> ploughing). Requires a Pair of bullock and covers 0.3 ha/ day. Rs.252/-
- Heavy soil plough: Suitable for black cotton soil. Requires a Pair of bullock and covers 0.24 ha/ day. Rs.324/-
- Cast iron plough : Suitable for ploughing and puddling in fields free from roots of trees and pebbles. Requires a pair of bullock and covers 1.0 ha/ day. Rs.266/-
- Zig-zag puddler: Puddling. Requires a pair of bullock and covers 1.0 ha/ day. Rs.1788/-
- IADP Pubbler: Pulverizing light sandy loamy soil, puddling, suitable for heavy soils of western Orissa. Requires a Pair of bullock and covers 1.0 ha/ day. Rs1700/-
- Puddler 99: Pulverising all soils, puddling. Requires a pair of bullock and covers a 1.0 ha/ day. Rs.1232/-
- One row seed drill: Seed sowing in rice, maize and groundnut. Requires a pair of bullock and covers 0.3 ha/ day. Rs.246/-
- Two row multicrop seed drill : Seed sowing in rice, wheat, groundnut and bengalgram. Requires one man and covers 0.5 ha/ day. Rs.1164/-
- Two row mustard seed drill: Mustard sowing. Requires one man and covers 0.5 ha/ day. Rs.827/-
- Three row multicrop seed drill: Seed sowing in rice, wheat, bengalgram and groundnut. Requires one man and covers 0.8 ha/ day. Rs.1570/-
- Paddy transplanter (Manual): Transplanting paddy with proper spacing. Requires two men and covers 0.20 ha/ day. Rs.4000/-
- Pedal paddy thresher : Threshing of paddy. Requires two men and covers 2.5 q/ day. Rs.2754/-
- Power paddy thresher: Threshing of paddy. Requires Electric motor (1 HP) and covers 10-12 q/ day. Rs.8778/- (With motor and starter)
- Groundnut digger : Digging groundnut. Requires pair of bullock and covers 0.3 ha/ day. Rs.548/-
- Pedal groundnut thresher: Separating groundnut pods from the plants. Requires two men and completes 2.2 q pods/ day. Rs.2818/-
- Groundnut decorticator : Spreading seeds from groundnut pods. Requires One men and completes 50 kg/ hour. Rs.764/-
- Maize sheller: Spreading seeds from maize cobs. Requires one man and completes 1.0 q/ day Rs. 25/-

## Alternate farming systems

- **Agro-horti system:** Sweet potato + maize/ castor (spacing 80 x 25 cm)
  - Yam (100x60 cm) + maize/ castor
  - Tapioca (100x100 cm) + maize/ castor
  - Colocassia (80x25 cm) + maize/ castor
- **Alley cropping:** Subabul (4 m interval) + groundnut/ sesame/ cowpea (grain)
- **Fodder/ Green biomass:** *Dalbergia sissoo*, *Albizia lebbeck*, *Anogeissus latifolia*, *Sesbania*, *Stylo*, *Marvel* – 8 grass
- **Fruit:** Ber, Custard apple, Pomegranate, Amla + *kharif* spreading crops.
- **Medicinal and aromatic plants:** *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, Rose, Geranium
- **Vegetables:** Onion, Tomato, Okra, Cowpea, Cluster bean, Drumstick

## Non – arable wastelands:

- Tree farming (*Sal*, *Teak*)
- Silvopastoral system (*Shisham/ Subabul/ Gambar* + *Stylo/ Cenchrus/ mixture*)

## Arable wastelands:

- **Agri-horticulture:** Fruit crops (mango/ citrus/ sapota/ pomegranate/ custard apple/ amla/ litchi/ jackfruit/ phalsa) + field crops (pulses/ oilseeds). Hybrid mango varieties viz. Pusa Amrapalli and Pusa Mallika are becoming increasingly popular in the zone.
- **Alley cropping:** *Leucaena* + turmeric/ ginger

## Contingent planning

### Normal season

- **Rice:**
  - Very early group (less than 95 days): Heera, Rudra, ZHU 11-26, Vandana
  - Early group (95 to 115 days): Pathara, Kandagiri, Udayagiri, Ghanteswari and Parijat
  - Early medium (115 to 120 days): Sarathi and Bhoi
  - Medium duration (125 to 145 days): Lalat, IR-64, Konark, Gajapati, Surendra, Jajati, Swarna, MTU-1001 and Padmini
  - Late duration: Utkalaprava, Gayatri, Savitri, Prachi, Ramachani, Mahanadi and Indrabati
- **Fingermillet:** Dibyasinha, Nilachala, Bhairabi and Subhra
- **Maize:** Navjot, Vijaya, DHM-103 and Ganga-5
- **Greengram:** PDM-54, K- 851, Dhauri and TARM-2
- **Blackgram:** Pant U-30, T-9 and Sarala
- **Pigeonpea:** UPAS-120, R-60, T-21 and S-5
- **Cowpea:** SEB-2, SGL-1 and Arka Kamal
- **Horsegram:** Urmi and Local
- **Groundnut:** Smruti (OG 52-1), JL-24, ICGS-11 and AK 12-24
- **Castor:** Aruna, DCH-177 and DCH-30

- **Rapeseed mustard:** PT- 303, M-27, Parvati and Anuradha
- **Sesame:** Vinayak, Uma, Usha and Prachi
- **Niger:** Deomali (GA-10), IGP-76 and Phulbani Local
- **Linseed:** Kiran, Laxmi-27, Pusa-3 and Padmini
- **Sunflower:** Morden
- **Cotton:** MCU-5, NHH-44, Somanath, Savita and Bunny
- **Ginger:** Vardhan, China and Nadia
- **Turmeric:** Sudarsan, Suguna, Subarna and Rajendra Horti-5.
- **Yam:** Hatikhoja, Srikirti and Srirupa

### **Aberrant weather: Upland**

#### **Early season drought/Delay in onset of monsoon:**

When upland rice is completely damaged, the crop may be cut down for supplying straw to the cattle. Non-paddy crops viz. finger millet (Subhra, Bhairabi, Dibyasingha and Godavari), greengram (K 851, PDM-11 and PDM-54), blackgram (T-9, Sarala and Pant U-30), cowpea (SEB-2, SGL-1, Arka Kamal), horsegram (Urmi), ricebean (RBL 6), sesame (Usha, Uma), castor (Aruna, DCS-9), niger (IGP-76 and Deomali) or sunflower (Morden) should be taken. Drought tolerant varieties of crop(s)/cropping system(s) should be taken up. The crop /variety should be selected based on available effective growing season.

#### **Mid-season drought:**

Weeding and hoeing should be done in all the crops except groundnut in flowering stage. Weeds in groundnut should be cut or uprooted not to interfere in pegging and pod formation. Hoeing creates soil mulch and decreases moisture loss from the soil. Uprooted weeds should be used as mulch between crop rows.

- Foliar spraying of 2% urea in upland rice and finger millet gives good results. For this, 200 g of urea is mixed with 10 l of water and sprayed on the foliage of the crop. Plant protection chemicals may be mixed with urea solution to minimize the cost of spraying. In a single spray 10 kg/ha of urea is applied through 500 l solution.
- Excess plants in the crop row should be thinned to reduce moisture loss from the soil.
- Use of tender twigs of *Leucaena*, *Gliricidia sepium*, *Cassia siamea* and *Mimosa invisa* and plants of sunhemp as mulch-cum-manure reduces evaporation loss from the soil.
- Spraying of planofix 10 ppm at 45 days after sowing and 20 ppm at flowering in cotton to prevent fruit drop.

#### **Late season drought:**

- Harvested rain water should be recycled as life saving irrigation.

### **Medium lands and low land:**

#### **Direct sown rice:**

- Re-sowing of rice is needed if plant population is less than 50%. Line sowing of pre-germinated seeds of rice (125 days duration) should be done. Nursery for comparatively shorter duration rice varieties may be done.
- If plant population is more than 50% and 'beushaning' is not possible, weeds are uprooted by manual means. Even distribution of plants (*Khelua*) should be taken up immediately by using local tools. tillers with roots may be detached from hills with profuse tillering for planting in gappy areas. Urea solution (2%) may be sprayed to improve crop growth.

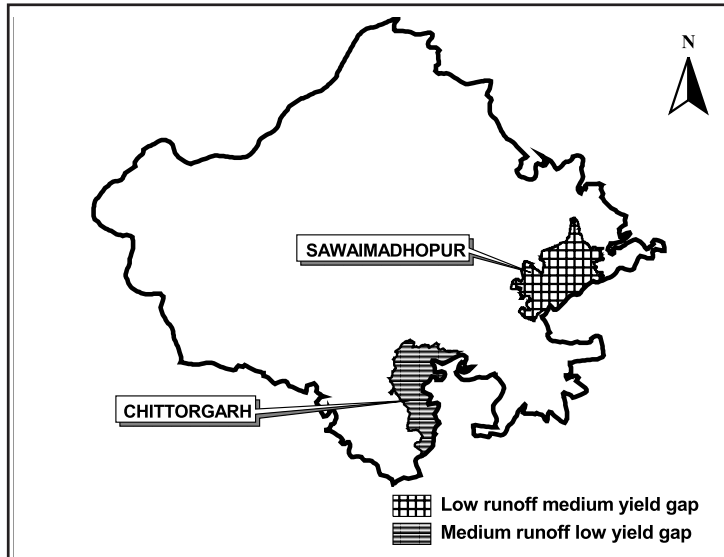


**Transplanted rice:**

- If puddling and transplanting is not possible, seedlings should not be uprooted. Weeds are removed to keep the nursery beds clean. Adequate plant protection measures are taken to protect the seedlings from disease and pest attack.
- When rainfall occurs, puddling is done by tractor drawn power tiller or rotovator for better puddling. Close planting of 45-day old seedlings in case of medium duration varieties and 60-70 day old seedlings in late varieties should be done. There should be 60-65 hills/m<sup>2</sup>. Instead of 2 to 3 seedlings, 4 to 5 seedlings/hill should be planted. Adequate fertilizer should be applied at transplanting.
- When seedlings are insufficient, seedlings may be raised by dapog method.

## RAJASTHAN

In Rajasthan there is one district viz. Sawaimadhampur under low runoff and medium yield gap region and one district viz. Chittorgarh under medium runoff and low yield gap region.



District	Region
Chittorgarh	Medium runoff and Low yield gap

### Agroecological setting

- **Climate:** Hot moist / dry semi arid
- **Physiography:** East Rajasthan uplands
- **Soils:** Deep loamy grey brown and alluvium - derived soils, deep clayey black soils, shallow black soils (Vertic Inceptisols-100%)
- **Annual rainfall:** 885 mm
- **Potential evapotranspiration:** 1556 mm
- **Moisture availability period:** 90-150 days

### Soil and water conservation

- More emphasis on *insitu* water conservation
- Increasing soil infiltration capacity and reducing soil crusting problem
- Contour furrowing
- Absorption terracing
- Contour trenches
- Inter-row water harvesting
- Inter-plot water harvesting of 1:1 cropped to un -cropped land
- Dead furrows at 3.6 m intervals

## Crop management

- **Varieties:**
  - Spreading- RS-1, M-13
  - Bunch: JL-24, HNG - 10
  - Semispreading- RSB-87
- **Seed rate:** 100 kg/ha
  - Bunch –100 kg/ha
  - Spreading – 80-100 kg/ha
- **Sowing** – first week of June to second week of June
- **Planting pattern:** 30x15 cm
  - Bunch – 30x10-15 cm
  - Spreading – 40-45X15 cm
- **Nutrient management:** 6 t FYM/ha + 25 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>/ha + gypsum 250 kg/ha
- **Pest management:**
  - For sucking pests Phosphamidon or Dimethoate spray
  - For termites Chlorpyrifos 20 EC @ 6 ml/kg of kernels or Acephate 75 SP @ 6 g/kg of kernels
  - For white grub – treat with chlorpyrifos 20 EC 1l/40 kg seed kernel.

## Weed management:

- Pre-emergence application of Pendimethalin @ 0.5 kg a.i./ ha

## Suitable cropping systems

- Groundnut + sesame (6:2 row ratio at 30 cm apart)
- Groundnut (J-11) + castor (GAUCH-1) (3:1 or 6:1 ratio)
- Cotton (G.cot-10) + groundnut (J-11)
- Groundnut + pigeonpea (3:1)

## Farm implements/ tools

- Arjia Pora : Placement of seed and fertilizer at proper depth. Rs.100/-
- Multipurpose tool bar : Ridge making, interculture, blade harrowing and seed and fertilizer drilling. Rs.2000/-
- Seeding attachment for ridge sowing : Ridge sowing of maize. Rs.300/-
- Dryland weeder : Intercultural operations. Rs.500/-
- Rotavator-L-Series: The operations like ploughing, harrowing, clod crushing, leveling are done simultaneously. Rs.60000/-
- Two Row Seed Drill : Two row sowing at a time. Rs.1500/-
- Plough Planter: Placement of seed. Rs. 1500/-
- Post hold digger: Digging of pits for planting tree species. Rs. 40000/-

## Alternate farming systems

### Marginal lands

- **Silviculture:** *Acacia tortilis*
- **Land capability class III:** Alley cropping (*Jatropha* spp + Greengram)
- **Land capability class IV:** Silvipastoral system (*Prosopis cineraria* + *cenchrus*)
- **Horti – Pastoral system:** Ber + *Cenchrus setigerus*
- **Fodder/ Green biomass:** *Alianthus excelsa*, *Albizzia lebbeck*, *Dalbergia sissoo*, *Azadirachta indica*, *Prosopis cineraria*, *Dichrostachys*
- **Fruit:** Ber, Date palm, Jamun, Fig, Phalsa, Koronda
- **Medicinal / Aromatic plants:** *Plantago ovata*, *Cassia angustifolia*, *Safed musli*, *Papaver somniferum*
- **Vegetables:** Clusterbean, Cowpea, Amaranthus, Round melon, Long melon
- **Animal Component:** Male/ Female cattle, Female buffaloes, Sheep, Goat

## Contingent Planning

### Good and normal rainfall

- Grow large areas under improved varieties of cereals, pulses and oilseeds during *kharif* on heavy soils, conserve soil moisture during *kharif* and take a early *rabi* crop of rapeseed mustard or chickpea.

### Normal onset followed by long gaps in rainfall

- Drought hardy crops with deep root system and low water requirement like sorghum, castor, pigeonpea and sesame should be preferred over maize.

### Delayed onset of monsoon:

- Grow early maturing pulses (greengram, blackgram), oilseeds (sesame) and fodder crops (sorghum + cowpea). Intercropping of maize + blackgram/ pigeonpea, groundnut + sesame is recommended

### Early withdrawal of monsoon:

- Conserve soil moisture received during last season and grow early *rabi* crops like rapeseed mustard, chickpea, safflower etc.

District	Region
Sawaimadhopur	Low runoff and Medium yield gap

## Agroecological setting

- **Climate:** Hot semi arid
- **Physiography:** Uplands Rajasthan
- **Soils:** Deep loamy alluvium - derived soils (Vertisols–85%; Inceptisols– 15%)
- **Annual rainfall:** 753 mm
- **Potential evapotranspiration:** 1569 mm
- **Moisture availability period:** 90-120 days

## Soil and water conservation

- More emphasis on *insitu* water conservation
- Increasing soil infiltration capacity and reducing soil crusting problem
- Contour furrowing
- Absorption terracing
- Contour trenches
- Inter-row water harvesting
- Inter-plot water harvesting of 1:1 cropped to un-cropped land
- Dead furrows at 3.6 m interval

## Crop management

- **Varieties:**
  - Spreading- M 13, RSB 87
  - Bunch: HNG-10
- **Seed rate:** 100 kg/ha
- **Planting Pattern:** 30x15 cm
- **Nutrient management:** 6 t farm yard manure/ha + 25 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> kg/ha + gypsum 250 kg/ha
- **Pest management:** For sucking pests Phosphamidon or Dimethoate spray

## Weed management:

- Pre-emergence application of Pendimethalin @ 0.5 kg a.i./ ha
- **Some other important practices**
  - Deep tillage is done for reducing soil borne pest

## Suitable cropping systems

- Groundnut + sesame (6:2 row ratio at 30 cm apart)
- Groundnut (J-11) + castor (GAUCH-1) (3:1) or (6:1) ratio
- Cotton (G.cot-10) + groundnut (J-11)
- Groundnut + pigeonpea (3:1)

## Farm implements/ tools

- Arjia Pora : Placement of seed and fertilizer at proper depth. Rs.100/-
- Multipurpose tool bar : Ridge making, interculture, blade harrowing and seed and fertilizer drilling. Rs.2000/-
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- Two Row Seed Drill : Two row sowing at a time. Rs.1500/-
- Plough Planter: Placement of seed. Rs.1500/-
- Post hold digger: Digging of pits for planting tree species. Rs.40000/-

## **Alternate farming systems**

### **Marginal lands:**

- Silviculture: *Acacia tortilis*
- LCC III: Alley cropping (*Jatropha* spp + Greengram)
- LCC IV: Silvipastoral system (*Prosopis cineraria* + *Cenchrus*)
- Horti – Pastoral system: Ber + *Cenchrus setigerus*
- Fodder/ green biomass: *Alianthus excelsa*, *Albizzia lebbeck*, *Dalbergia sissoo*, neem, *Prosopis cineraria*
- Fruit: Ber, date palm, jamun, fig, phalsa, karonda
- Medicinal/ Aromatic plants: *Plantago ovata*, *Cassia angustifolia*, Safed musli, *Papaver somniferum*
- Vegetables: Clusterbean, cowpea, amaranthus, round melon, loup melon
- Animal component: Female buffalo/ sheep, goat

## **Contingent planning**

### **Good and normal rainfall**

- Grow large areas under improved varieties of cereals, pulses and oilseeds during *kharif* on heavy soils, conserve soil moisture during *kharif* and take a early *rabi* crop of rapeseed mustard or chickpea.

### **Normal onset followed by long gaps in rainfall**

- Drought hardy crops with deep root system and low water requirement like sorghum, castor, pigeonpea, sesame should be preferred over maize

### **Delayed onset of monsoon:**

- Grow early maturing pulses (greengram, blackgram), oilseeds (sesame) and fodder crops (sorghum + cowpea). Intercropping of maize + blackgram/ pigeonpea, groundnut + sesame is recommended

### **Early withdrawal of monsoon:**

- Conserve the soil moisture received during last season and grow early *rabi* crops like rapeseed mustard, chickpea, safflower etc.

## SUMMARY

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop and oil content of the seed varies from 44-50%, depending on the varieties and agronomic conditions. It is also used in soap making, and in manufacturing cosmetics and lubricants, olein, stearin and their salts. Kernels are also eaten raw, roasted or sweetened. They are rich in protein and vitamins A, B and members of the B<sub>2</sub> group. The cake can be used for manufacturing artificial fibre. The haulms are fed (green, dried or silaged) to livestock. Groundnut shell is used as fuel for manufacturing coarse boards, cork substitutes etc. Groundnut is also of value as a rotation crop. The production is concentrated in the four states of Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka.

The crop can be grown successfully in places receiving a minimum rainfall of 500 mm and a maximum rainfall of 1,250 mm. The rainfall should be distributed well during the flowering and pegging of the crop. The groundnut cannot stand frost, long and severe drought or water stagnation. The crop does best on sandy loam and loamy soils and in black soils with good drainage. Heavy and stiff clays are unsuitable for groundnut cultivation as the pod development is hampered in these soils. Popular varieties are-Bunch type: 'Junagadh-II', 'TMV-2', 'Pol-2', 'AK 12-24', 'Kopergaon-3', 'KG-61-240' (Jyothi). Semi-spreading type: 'TMV-6', 'TMV-8', 'Kopergaon-1', 'C-501'. Spreading type: 'Punjab-1', 'GAUG-10', 'Kadiri-71.1', 'TMV-1', 'TMV-3', 'S-230', 'Karad-11'. The information on varieties and hybrids released after 1996 was extracted from "Improved Groundnut varieties of India": M.S.Basu, A.L.Rathnakumar and Chuni Lal, AICRP on Groundnut, NRC on Groundnut, Junagadh, Gujarat (2002),-" Oilseeds Situation: A Statistical Compendium – 2002, Directorate of Oilseeds Research, Hyderabad T. Damodaram and D.M. Hegde. (2002)", DARE Reports and information from SAUs is summarized. The cultivars suit for rainfed and partially irrigated conditions. The details follow.

Variety/ Hybrid	Year of release	Yield (t/ha)	Oil Content (%)	Area of Adaptability and Salient Features
ALR-2(ACG-56)	1997	1.74		Tamil Nadu
ALR 3 (ALG 63)	2000	1.94	50	Tamil Nadu
BSR-1 (ICGV-86143)	1997	2.84		Tamil Nadu
Co.3 (TNAU-56)	1998	1.75-201	49	Tamil Nadu
Co-4 (TNAU 269)	2001	1.50	52	Tamil Nadu
DSR-1	1997	1.50		Tamil Nadu
GG-5	1999	49		Gujarat
GG-7 (J 38)	2001	2.15	49	Gujarat, Southern Rajasthan
JCG 88 (JAGTIYAL-88)	1998	1.39		Andhra Pradesh ( <i>Kharif</i> )
JGN-3 (Jawahar Groundnut-3)	1999	1.50	50	Madhya Pradesh
JL-220 (Phule Vyas)	1997	2.00-2.40		Maharashtra
Kadiri-4	1997	2.26	48	Andhra Pradesh
M-522	1996	2.52		Punjab
Phule Vyas (JL 220)	2000	2.20		Maharashtra
R 9251	1998	2.00-2.50	45-49	Karnataka
SMRUTI (OG-2-1)	1996	1.98-3.62		Orissa ( <i>Kharif</i> )
TAG-19-A	1996	2.26	46	Konkarn Region of Maharashtra
TG-26	1996	1.59-2.42	49	Gujarat, Maharashtra, Madhya Pradesh( <i>Kharif</i> )
irupati-4(TCGS-30)	2000	2.49		Andhra Pradesh
VG 9521	2001			Tamil Nadu, Andhra Pradesh, Karnataka, Kerala and Southern Maharashtra
VRI-4	1997	2.17	47	Tamil Nadu
VRI-5	2001	2.13	51	Tamil Nadu

Variety/ Hybrid	Year of release	Yield (t/ha)	Oil Content (%)	Area of Adaptability and Salient Features
VRI Gn 6 (VG9521)	2001	2.32	52	Tamil Nadu
Kadiri 4	1997	2259	58	Andhra Pradesh; 100-110 days to maturity; 74% shelling; Suitable for <i>rabi</i> /summer season, tolerant to rust, late leaf spot and PBND
JCC 88	1998	1396	48	Andhra Pradesh; 105-110 days to maturity; 74% shelling; Tolerant to <i>A. flavus</i> , <i>A. niger</i> and PBND
GG 5	1996	1270	49.2	Gujarat; 100 days to maturity; 73.7% shelling; Early maturity, high shelling (%)
GG 6	1999	2.78	50.3	Gujarat; 115-120 days to maturity; 73% shelling; High shelling and oil
GG 7	2001	2.79	50	Gujarat; 100 days to maturity; 69% shelling; Tolerant to rust, LLS and PBND
R 9251	1997	2.0-2.5	49	Karnataka; 95-105 days to maturity; 72% shelling; Early maturity and tolerant to PBND
R 8808	1997	2.43	48.5	Karnataka; 110-120 days to maturity; 69% shelling; Suitable for both <i>Kharif</i> and <i>rabi</i> /summer seasons, tolerant to late leaf spot and PBND
TKG 19 A	1996	2.26	46	Maharashtra; 120-125 days to maturity; 63% shelling; Large seeded, HPS grade, suitable for both <i>kharif</i> and <i>rabi</i> /summer seasons
JL 200	1999	1.80-2.00	48	Maharashtra; 90-95 days to maturity; 68% shelling; Early maturity, pod rarely 3-4 seeded
LGN 2	2000	1.50-2.00	1500-2000	Maharashtra; 115-120 days to maturity; 67.5% shelling; Suitable for early sown rainfed situations
JGN 3	1997	1.81	50	Madhya Pradesh; 105 days to maturity; 70% shelling; High yield and drought tolerant
OG 52-1 (Smruti)	1997	1.98	48	Orissa; 105-110 days to maturity; 70% shelling; Suitable for rice fallows in <i>rabi</i> /summer season tolerant to rust, leaf spots, jassids and leaf miner
HNG 10	1998	1.92	51	Rajasthan; 125-130 days to maturity; 71% shelling; High shelling and oil content
ALR 2	1997	1.74	52	Tamil Nadu; 105-110 days to maturity; 70% shelling; Resistant to rust tolerant to late leaf spot
ALR 3	1999	1.94	50	Tamil Nadu; 110-115 days to maturity; 69% shelling; Suitable for early sowing of South West monsoon. Resistant to leaf hopper and thrips.
Co 3	1999	1.75 in <i>kharif</i> 2.15 in <i>rabi</i> / summer	49.2	Moderately resistant to LLS and resistant to rust Tamil Nadu; 105-110 days to maturity; 71.4% shelling; Bold kernel, suitable for <i>kharif</i> and <i>rabi</i> /summer seasons, tolerant to PBND
Co 4	2001	1.50 in <i>khari</i> 1.90 in <i>rabi</i> / summer	52.4	Tamil Nadu; 105-110 days to maturity; 69% shelling; Early maturity, high yield R/S and oil content
VRI (Gn) 5	2001	1.72	48	Tamil Nadu; 105-110 days to maturity; 73-75% shelling; Resistant to rust, late leaf spot



New generation situation specific released varieties through AICRP-Groundnut are -

Variety	Salient features	Recommended States/Area
BAU 13, B 95, Somnath, TKG 19A, GG 20	Large seeded HPS type for export promotion	Gujarat, Maharashtra, Jharkhand
ALR 1, ALR 2, ALR 3	Multiple foliar disease resistant for rainfed <i>Kharif</i>	Pollachi tract of Tamil Nadu
ICGV 86590	Resistant to Rust and LLS	Andhra Pradesh, Tamil Nadu, Karnataka
ICGS 11, ICGS 44	Field tolerance to PBNB under <i>Rabi</i> /Summer situation	Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh
K 134, BSR 1, VRI 2, VRI 3, VRI 4, Co 4, AK 159, GG 7	High yielding Spanish bunch varieties with medium maturity	Andhra Pradesh, Tamil Nadu, Maharashtra, Gujarat
CSMG 884, CSMG 84-1, HNG 10, LGN 2	High yielding Virginia varieties with medium maturity	Uttar Pradesh, Rajasthan, Punjab, Maharashtra, Madhya Pradesh
TG 17, TG 26, VRI 1, BSR 1, Dh 40, TAG 24	Fresh Seed dormancy for 2-3 weeks in Spanish group	Maharashtra, Tamil Nadu, Karnataka, Orissa, Gujarat
TG 3, TG 22, TG 26	Tolerant to acid soils suitable for <i>rabi</i> /summer season	Gujarat, Orissa, Maharastra, Kerala, Goa and N.E. States
ICGS 37, ICGS 76, CSMG 84-1, CSMG 884, TAG 24, K 134	Tolerant to drought	Chattishgadh, Rajasthan, Punjab, Maharashtra, Andhra Pradesh
RSHY 1, OG 52-1, Dh 40, VRI 3, ICGS 44, TAG 24	Suitable for Paddy fallow/ residual moisture situations	Orissa, Coastal Andhra Pradesh, Tamil Nadu, Karnataka, West Bengal during post-rainy season
ICGS 1, SG 84	For spring situations in Potato/ Toria fallow	Punjab, Uttar Pradesh

For *kharif* crop, with the onset of rains in May-June, the field is given two ploughings and the soil is pulverized well to obtain a good tilth. Harrows or tiller can be used for cultivation. It is sown as late as August or early September. If a field is infested with white grubs, chemicals, such as Heptachlor or Chlordane, are drilled at the rate of 25 kg/ha before final harrowing.

Well-filled kernels should be selected and treated with 5 g of Carbendazium or 3 g of Mancozeb per kg of kernels. The quantity of well-developed seeds required per hectare is about 100 kg for semi spreading and spreading varieties and 100-120 kg for the bunch varieties. The *kharif* crop is sown with a seed drill or with a suitable planter at a depth of 8-10 cm. for semi spreading and spreading varieties, the spacing between the adjacent rows varies from 30-60 cm and within the row from 10-15 cm. For rainfed bunch groundnut, the inter-row spacing vary between 20 and 30 cm and the intra-row spacing between 10 and 20 cm.

Fertilizer recommended for rainfed crop is 6.25 tonnes farmyard manure and 10-25 kg nitrogen (N), 20-40 kg phosphorus (P<sub>2</sub>O<sub>5</sub>) and 20-40 kg potash (K<sub>2</sub>O) per ha. The application of N should be made in two equal split doses, one before sowing and the other 30 days after sowing. The application of a culture of Rhizobium as seed treatment is beneficial in increasing nodulation and nitrogen fixation. Application of gypsum at 500 kg/ha at the pegging stage will enhance pod formation.

The Integrated Pest Management (IPM) Module in Groundnut developed by National Research Centre on Groundnut, Junagadh is given below.

### Integrated Pest Management Module:

- Seed treatment with Carbendazim (2 g/kg of seeds) for controlling seed borne fungi)
- Soil amendments with castor or mustard or neem cake @ 500 kg/ha (15 days before sowing) for controlling soil borne diseases like stem rot and collar rot.

- Intercropping of groundnut with pigeonpea/ pearl millet/ sorghum (3:1) for management of foliar fungal diseases
- Use of trap crops such as cowpea, soybean, or castor as border crop for sucking/ defoliating insects. Single hand weeding after the application of pre-emergence weedicide Fluchloralin @ 1.5 kg a.i./ha is effective for weeds management.
- Biocontrol by using of commercially available preparations of *Trichoderma* sp. For seed treatment @ 4 g/kg seed or soil application @ 25 to 62.5 kg/ha (for controlling stem rot and seed rot and application of Bt (*Bacillus thuringiensis* @ 300-500 g/ha) between 45 and 60 days of sowing for controlling Spodoptera and *Helicoverpa*; use of pheromone traps for *Spodoptera* (10 traps/ha), *Helicoverpa* (10 traps/ha) and leaf miner (25 traps/ha). Need based foliar spray of crude neem oil @ 2% in Teepol (for both foliar fungal and sucking pests), fungicides (0.05% Carbendazim + Mancozeb 0.2%) at 45 and 60 days after sowing for major foliar fungal diseases like early and late leaf spots and rust.
- **Late leaf spot:** Spray Mancozeb 2 g + Carbendazim 1g/l or hexaconazole @ 2 ml/l. Spraying can be taken up based on leaf wetness at 70 days after sowing. There is no need to spray for July sown crop.
- **Stem necrosis:** Removal of weeds particularly *Parthenium* on the bunds and in the field.
- Varieties for rust tolerance – Vemana (K-134), Tirupati-4

The Integrated Disease Management (IDM) Module in Groundnut was suitably integrated in the integrated pest management package developed at National Research Centre on Groundnut, Junagadh for the holistic management of diseases, insect-pests and weeds.

#### **Integrated Disease Management Module:**

One spray each of 2% aqueous neem leaf extracts, a mixture of Carbendazim (0.02%) and Mancozeb (0.2%) and culture filtrate of *Penicillium islandicum* was effective in reducing intensity of late leaf spot and rust.

#### **Cultural practices**

- Soil amendment with castor cake @ 500 kg/ha (preferably 15 days before sowing) for soil borne diseases like stem rot and collar rot.
- Intercropping of groundnut with pigeonpea/ pearl millet/ sorghum (3:1) depending upon the locally recommended intercrops against foliar fungal diseases (early and late leaf spots, rust) and insect pests (leaf miner and thrips)
- Use of trap crops such as cowpea/ soybean (leaf miner and leaf hoppers)/ castor (*Spodoptera* and leaf hoppers) as border crops for sucking/ defoliating insects.
- One hand weeding at 30-35 days after sowing after the application of pre-emergence weedicide Fluchloralin @ 1.5 kg a.i./ha

#### **Biological control**

- One foliar spray of culture filtrate of *Penicillium islandicum* (50%) at 70 days after sowing.
- Nuclear polyhedrosis virus for the management of *Spodoptera* and *Helicoverpa* @ 250 LE/ha)
- Spray of aqueous neem leaf extract (2-5%) for the management of leaf spots and rust.
- Spray of neem seed kernel extract (5%), or crude neem oil (2%) against defoliators, sucking pest and foliar pathogens.
- Release of *Trichogramma cheloris* @ 50000/ha, two times at 7-10 days interval followed by release of *Bracon hebetor* @ 5000/ha, two times at 7-10 days against leaf miner and defoliators.
- Pheromone traps @ 10 traps/ha for *Spodoptera* and *Helicoverpa* and 25 traps/ha for leaf miner.

- Spray of Bt (*Bacillus thuringiensis*) @ 300-500 g/ha against red hairy caterpillars.
- Seed treatment with *Trichoderma viridae*/ *T.harzianum* @ 25-62.5 kg/ha, preferably in conjunction with organic amendments such as castor cake or farm yard manure

For controlling weeds, and also to keep the soil in a friable condition, the crop should generally receive a hand-weeding and one or two hoeings, with bullock-drawn implements, the first about three weeks after sowing and the second and the third about a fortnight and a month later. No interculture would be done after the pegs have commenced going underground. Earthing up can be done in the case of bunch and semi-spreading types to facilitate maximum penetration of pegs into the soil. Weeds can also be controlled effectively with Fluchloclalin or Pendimethalin @ 1.5 kg ai k/ha weedicide at the rate of 5 l in 500 l of water per hectare as a pre-emergence soil spray within two days of sowing groundnut.

### Some important pests are:

#### Leaf-miner

- Caterpillars mine the tender leaves and later fold the adjacent leaves to feed within. Pest active during July to December; drought, with occasional showers favourable.
- Dust 4% Carbaryl

#### Groundnut aphid

- Vector of a virus disease (rosette), dry and warm weather, favourable.
- Spray 0.03% Dimethoate or Phosphamidon, Monocroptophos or Methyl-demeton

#### White grub

- The adults emerge immediately after the monsoon; grubs feed on roots and kill the plants.
- Application of 10% Phorate granules is effective to kill grubs.

#### Diseases

##### Root rot

- Reddish brown discolouration on the stem, spreading and the plant collapsing, tissues blackened and numerous tiny black sclerotia are formed
- Practise crop rotation, treat seed with Carbendazim @ 2 g/kg

##### Tikka disease or leaf spot

- Dark spots surrounded by a bright-yellow ring on the leaves and sometimes on the petiole and the stem; premature leaf shedding is characteristic.
- Spray with Brestan or with 4:4:50 Bordeaux mixture or with 0.2% Ziram or Zineb or Maneb.

##### Bunchy top

- Leaves reduced in size and malformed; suppression of the internodes; partial sterility.
- Use well-developed disease free seeds, rogue out diseased plants.

If the *kharif* crop is caught in a long spell of drought, especially at the pod-formation stage, supplemental irrigation is given. The peg-formation stage is critical.

#### Harvesting

Harvesting of groundnut should be done at appropriate maturity. Blackening of inner shell and development of testa colour are the common indicators of maturity. Over maturity affects the quality of groundnut. So harvesting should be done at 80% pod maturity.

#### Drying

At the time of harvesting, groundnut pods usually have moisture content around 40% at physiological maturity. Therefore, proper drying is necessary to bring the moisture level to 10%. Generally small farmers strip off the pods soon after harvest and carry home the produce for drying. Where holdings are large, plants are kept in the field in small heaps for sun drying before stripping off pods with mechanical threshers.

Farmers usually dispose of their groundnut pods within 3-4 weeks after harvest, although rich farmers store the pods for 3-4 months.

### Storage

Rapid loss of seed viability is a perpetual problem in post rainy season groundnut. Farmers are not able to carry over seed from one post rainy season to another unless the following low cost technology is implemented.

- Delay of harvest after giving the last irrigation to bring down the pod moisture to a desirable level.
- Harvesting the crop at physiological maturity
- The pod should give a rattling sound at the time of stripping.
- Slow drying of plants in the shade with their pods intact
- Bringing down the pod moisture to the level of 8-9% by regular drying
- Following of NRCG storage method where dried pods are stored in polythene-lined gunny bags along with calcium chloride at 250 g for a 30 kg bag. The calcium chloride should be placed in a wide-mouthed plastic bottle with pores in the upper portion. This method keeps up to 80% of seed viable for a period of 8-10 months. This technology has solved the farmers' problem in the areas where groundnut is only grown in rice-fallows during the post rainy season.

In India, machines available for shelling, threshing and digging are popular with groundnut farmers. Particularly in Saurashtra region of Gujarat equipment like planters, which can maintain plant-to-plant spacing within a row, wet threshers, and graders are in demand. The groundnut planter developed by CRIDA, Hyderabad is reported to be ideally suited for sowing groundnut in sandy loam soils and can regulate spacing both between rows and between plants within the row.

### Prioritized cultural options are -

State	District	Yield gap (%)	Prioritised Options	Average yield (kg/ha)	Expected yield (kg/ha)
Andhra Pradesh	Anantapur, Cuddapah, Kurnool, Nalgonda	49	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	740	850 to 890
	Chittoor	26	<i>In situ</i> water management techniques and crop management strategies	1025	1125 to 1180
	Mahaboobnagar	65	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	510	585 to 610
	Srikakulam, Vishakaptnam	37	Proper utilization of runoff water and long duration crops	935	1075 to 1125
Gujarat	Warangal	55	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	685	785 to 820
	Amreli	65	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	510	585 to 610
	Bhavnagar, Junagadh	49	by adopting improved cultivars, pest & disease management techniques	740	850 to 890
	Rajkot	81	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques. <i>In situ</i> water management techniques and crop management strategies	280	335 to 350

	Belgaum	40	Suitable water management techniques to reduce the difference in attainable and actual yields. Long duration varieties	900	1035 to 1080
	Bijapur	65	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention	510	585 to 610
	Dharwad	55	by adopting improved cultivars, pest & disease management techniques	685	785 to 820
Karnataka	Chitradurga, Tumkur	49	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	740	850 to 890
	Kolar	26	<i>In situ</i> water management techniques and crop management strategies	1025	1125 to 1180
	Mysore	37	Proper utilization of runoff water and long duration crops	935	1075 to 1125
Madhya Pradesh	Khargone	55	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	685	785 to 820
	Shivpuri	37	Proper utilization of runoff water and long duration crops	935	1075 to 1125
	Amravati, Jalgaon	55	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	685	785 to 820
	Dhule, Nasik	49	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention	740	850 to 890
Maharashtra	Sangli	41	by adopting improved cultivars, pest & disease management techniques	870	1000 to 1045
	Kolhapur	10	Proper utilization of runoff water through critical irrigation	1760	1940 to 2025
	Pune	16	Proper utilization of runoff water through critical irrigation	1265	1385 to 1450
	Satara	19	Proper utilization of runoff water through critical irrigation	1215	1335 to 1397
Orissa	Ganjam	40	Suitable water management techniques to reduce the difference in attainable and actual yields. Long duration varieties	900	1035 to 1080
	Sambalpur	13	Utilizing the surplus water, through efficient water resource management, a second crop may also be raised	1305	1435 to 1500
Rajasthan	Chittorgarh	16	Proper utilization of runoff water through critical irrigation	1265	1390 to 1450
	Sawai Madhopur	49	<i>In situ</i> moisture conservation techniques along with suitable mechanical structures. Suitable crop management intervention by adopting improved cultivars, pest & disease management techniques	740	850 to 890

Issues and strategies in groundnut in different agro ecoregions are as follows:

**Issue:** Characterization of the production system

**Focus:** Non-realization of existing yield potential/attainable yield in majority of the traditional groundnut areas.

**Strategies:**

- The rainfed traditional system being basically risk prone, especially because of the relatively high cultivation cost of groundnut, the crop management strategy to be developed should be efficient, low input demanding and less risk prone.

- In the rainfed system, the economic- and ecological-sustainability are at stake and so a major attention has to be paid on integrated pest-nutrient- and water- management systems.
- With the efforts made under Technology Mission on Oilseeds by the GOI, two things have occurred. The farmers have better minimum support price. Consequently, they started using more external inputs for obtaining better yields.

**Issue:** To increase crop yield ceilings

**Focus:** Stagnation of overall groundnut productivity within a narrow range, instability of production and productivity.

**Strategies:**

Strengthening the breeder seed production system by addressing the weak links in the present system

- In all 85 improved varieties have so far been identified, of which 17 are runners and 40 are Spanish bunch.
- The stagnation of yield level due to non-exploitation of yield potential of available varieties is an issue to be solved by optimum management.
- Enhancing yield potential itself will have to be achieved by two strategies. One will be to sustain the yield potential by introducing resistance to various stresses and the other will be to enhance the yield potential itself. Substantial amount of work has been done with the first strategy but the success obtained so far is a moot question.
- Some of the problems like high vegetative growth, and high incidence of foliar diseases which are peculiar to these areas, need special attention.

**Issue:** To improve crop management for higher Productivity

**Focus:** Boosting groundnut farming in the non-traditional areas. Diversification in cropping systems

**Strategies:**

- A large chunk of groundnut needed for diversification of domestic food industry (still at its infancy) and export has to come from a specialised cultivation system with assured inputs and management to maintain quality and returns. Cultivation has to be a commercial venture with high inputs and high returns in specially identified areas. Thus, the technology to be developed will need an approach substantially different from that needed for low-input rain-dependent system.
- The farmers in western India (Gujarat) prefer runner types at the start of the season and move to bunch varieties with delay in sowing. The farmers in south shifted to bunch varieties. The Gujarat Agricultural University argues that semi-spreading varieties with slightly extended season over the bunch varieties could be a solution.
- An important way to minimize the risk and enhance the efficiency in resource utilization is to develop well defined and economically viable intercropping systems, one based on groundnut and the other based on the wide-spaced crops like cotton. Such intercropping systems will stem the decline in groundnut areas and offer a possibility of expanding the area under groundnut.
- Relay intercropping is a practice evolved by the farmers of Saurashtra. It is very enterprising. The farmers sow groundnut as a rainfed crop and take up either pigeonpea or castor after 6-7 weeks as an intercrop. After the harvest of groundnut, these intercrops are provided with supplemental irrigations, number being less for pigeonpea.
- We need to optimise the system. Among others, the inputs include nutrient management, irrigation management, from harvested, water pest management, implements etc.

**Issue:** To increase seed availability

**Focus:** Production of quality and quantity seed as endogenous input

**Strategies:**

- While all have shown that improved variety is the key for higher productivity still the farmers do not have adequate access to these improved varieties. They largely call the varieties under two different categories, namely, runner type and bunch type. So there should be a deliberate effort of the Universities and the State Seed Corporations to generate more of the improved seed for further enhancing the productivity of the groundnut crop. These efforts should continue.
- Quality seeds of these varieties can be directly produced in the farmers' fields under the coordination and supervision of the NRCG, the oilseed cooperatives, NDDB, State Seed Agencies under an already formulated Crash Program.

**Issue:** To manage soil for sustainable higher productivity

**Focus:** Improving soil fertility with endogenous inputs

**Strategies:**

- The research has not addressed a very important problem of research, i.e., monitoring soil health with continuous cropping of groundnut over years like low pH, Al-toxicity etc.
- At the same time, the secondary problems like other nutrient deficiencies like calcium in alfisols need attention.
- Participatory Technology Development (PTD) is on utilization of FYM + Mussouriephos + Phosphoacteria; Gypsum; Magnesite etc.

**Issue:** To reduce losses due to pests and diseases

**Focus:** Integrated Pest Management

**Strategies:**

- Participatory IPM package development: ODA/IFID (UK) for Mysore (AESR 8.2) through NGO (Agriculture Mankind Ecology, AME) by Participatory Technology Development (PTD) is as follows:
- Seed + Trichoderma
- Install ICRISAT light meter
- If value exceeds 312 Spray M-45
- Pheromone traps
- Watch ET >10 moths/night/trap
- Place egg parasitoid cards @ 13/ha
- Repeat 15 days later

**Issue:** Post harvest value addition

**Focus:** Divesification of uses

**Strategies:**

- Diversified value added products of groundnut with a special emphasis on export
- The problem of aflatoxin and poor quality haulms for fodder.

**Issue:** Field efficient implements

**Focus:** Improved implements are not within the reach of majority of the farmers

**Strategies:**

- The seed cum ferti planters, diggers, decorticators etc. need improvements to become farmer friendly and for repairs by local mechanics, artisans etc.

**Issue:** To improve productivity of livestock by integrating with alternate land use

**Focus:** Integrating livestock and alternate land use system

**Strategies:**

- A good opportunity to use vegetatively propagated perennial wild relatives of groundnut, as fodder and forage crop also exists. Their cultivation in degraded lands can be explored.

**Issue:** Socio-Economic Policies

**Focus:** The availability of seed is the most important constraint identified in the region.

**Strategies:**

- Hence a seed production net work, specially involving the eastern and north-eastern states has to be developed.
- The farmers also need to be encouraged to grow the seed in the off-season to meet the requirements of the village.



## POPULAR AND BOTANICAL NAMES OF SOME RAINFED CROPS

Arhar (Redgram)	<i>Cajanus cajan</i> (L.) Millsp.
Bajra (Pearlmillet)	<i>Pennisetum americanum</i> (L.) Leeke
Barley	<i>Hordeum vulgare</i> L.
Bengalgram (Gram; Chickpea)	<i>Cicer arietinum</i> L.
Blackgram (Urd)	<i>Vigna mungs</i> (L.) Hepper
Blue panic	<i>Panicum antidotale</i>
Castor	<i>Ricinus communis</i> L.
Chilli	<i>Capsicum frutescens</i> L.
Clusterbean (Guar)	<i>Cyamopsis tetragonolobus</i> (L.) Taub
Coriander	<i>Coriandrum sativum</i> L.
Cowpea	<i>Vigna unguiculata</i> (L.) Walp
Fingermillet (Ragi)	<i>Eleusine coracana</i> (L.) Gaertn
Foxtail millet ( <i>Setaria</i> , Italian millet)	<i>Setaria italica</i> Beauv
Gingelly (Sesamum, Sesame, Til)	<i>Sesamum indicum</i> L.
	<i>Sesamum orientale</i> L.
	<i>Cicer arietinum</i> L.
Gram (Bengalgram)	<i>Vigna radiata</i> (L.) Wilczek
Greengram (Moong)	<i>Arachis hypogaea</i> L.
Groundnut (Peanut)	<i>Cyamopsis tetragonolobus</i> (L.) Tabu
Guar (Cluster bean)	<i>Macrotyloma uniflorum</i> (Lam.) Verdc
Horsegram	( <i>Pennisetum purpureum</i> x <i>P. typhoides</i> )
Hybrid Napier	<i>Lablab purpureus</i> (L.) Sweet
Indian bean (Lablab)	<i>Brassica campestris</i> L.
Indian rape (Toria)	<i>Citrus fistulosus</i>
Indian squash melon (Tinda)	<i>Setaria italica</i> Beauv
Italian millet (Foxtail millet, <i>Setaria</i> )	<i>Sorghum bicolor</i> (L.) Moench
Jowar (Sorghum)	<i>Corchorus capsularis</i> L.
Jute	<i>Cicer arietinum</i> L.
Kabuli gram	<i>Lens culinaris</i> Medic
Lentil (Masoor)	<i>Zea mays</i> L.
Maize	<i>Hibiscus Sabdariffa</i> L.
Mesta (Rozella)	<i>Vigna aconitifolia</i> (Jacq.) Marechal
Moth (dew gram)	<i>Brassica juncea</i> Coss.
Mustard (Raya)	<i>Pennisetum purpureum</i>
Napier Grass	<i>Guizotia abyssinica</i> (L.f.) Cass
Niger	<i>Oryza sativa</i> L.
Paddy (Rice)	<i>Arachis hypogaea</i> L.
Peanut (Groundnut)	<i>Pennisetum americanum</i> (L.) Leeke
Pearlmillet (Bajra)	<i>Pisum sativum</i> L.
Peas	<i>Cajanus cajan</i> (L.) Millsp.
Pigeonpea (Arhar, Redgram, Tur)	<i>Solanum tuberosum</i> L.
Potato	<i>Panicum milliaceum</i> L.
Proso millet	<i>Eleusine coracana</i> (L.) Gaertn
Ragi	<i>Brassica campestris</i> L.var. Sarson Prain
Rapeseed (Sarson)	<i>Brassica juncea</i> (L.) Czern. & Coss
Raya (Mustard)	<i>Cajanus cajan</i> (L.) Millsp
Redgram (Pigeonpea, Arhar, Tur)	<i>Oryza sativa</i> L.
Rice (Paddy)	<i>Hibiscus sabdariffa</i> L.
Rozella (Mesta)	<i>Carthamus tinctorius</i> L.
Safflower	<i>Brassica campestris</i> L. var. Sarson Prain
Sarson (Rapeseed)	<i>Sesamum indicum</i> L.
Sesame (Sesamum, Gingelly, Til)	

Setaria (Foxtail millet, Italian millet)	<i>Setaria italica</i> Beauv
Siratro	<i>Macroptilium purpureum</i> L.
Sorghum	<i>Sorghum bicolor</i> (L.) Moench
Soyabean or Soybean	<i>Glycine max</i> (L.) Merr
Sunflower	<i>Helianthus annuus</i> L.
Sweet Potato	<i>Ipomea batatas</i> (L.) Lam
Taramira (Rocket salad)	<i>Eruca sativa</i> Mill
Til (Gingelly, Sesamum, Sesame)	<i>Sesamum indicum</i> L.
	<i>Sesamum orientale</i> L.
Tinda (Indian Squash Melon)	<i>Citrulus fistulosus</i>
Tobacco	<i>Nicotiana tabacum</i> L.
Toria (Indian rape)	<i>Brassica campestris</i> var toria Duthie & Fuller
Tur (Redgram, Pigeonpea, Arhar)	<i>Cajanus cajan</i> (L.) Millsp.
Triticale	<i>Triticale officinale</i>
Urd (Blackgram)	<i>Vigna mungo</i> (L.) Hepper

## GENERIC AND BRAND NAMES OF SOME PESTICIDES

### Herbicides/ Weedicides

ALACHLOR 10G, 50% EC: Lasso (Monsanto), Alataf (Rallis)

ANILOPHOS 30% EC: Aerozin (Agr. Evo), Sumo (Dupont), Glyphotox (AIMCO), Ricil (De'Nocil), Anilostar (Shaw Wallance), Aniloguard (Gharda)

ATRAZINE 50% W.P.: Atrataf (Rallis), Solaro (Pesticides Inida), Dhanusine (Dhanuka)

BENTHIOCARB/ THIOBENCARB 50% EC & 10% Gr: Saturn (Pesticides India), Thiobencarb (Tropical Agro)

BUTACHLOR 50 EC, 5 GR.: Machete (Monsanto), Teer (Rallis), Milchlor (Montari), Wid Kil (Sudarshan Chemicals), Aimchlor (AMICO), Nirmool (Lupin), Starchlor (Shaw Wallace), Dhanuchlor (Dhanuka), Speclor (Southern Pesticides), Hiltaklor (Hindustan Insecticides), Trapp (Searle India), Delchlor (Coromandel Indag), Bilchlor (Bayer)

DIURON 80%: Karmex (Agromore), Mermer, Hexuron (Parry Chemicals)

FLUCHLORALIN 45%: Basalin (BASF)

ISOPROTURON 75%, 50% W.P.: Nocilon (De'Nocil), Rakshak (Lupin), Milron (Montari), Dhanuron (Dhanuka), Hilproturan (Hindustan Insecticides), Arelon (Agr Evo), Graminon (Novartis), Bilron (Bayer)

METALACHLOR 50% EC: Duel (Novartis)

NITROFEN 8 G, 25%, 24%: Tok-E-25 (Indofil)

OXADIAZON 25% EC: Ronstar (Rhone-Poulenc)

OXYFLOURFEN 23.5%, 0.35 Gr: Goal (Bayer), Oxygold (Indofil)

PENDIMETHALIN 20 & 30% EC, 5% Gr: Stomp (Cyanamid Agro), Panida (Rallis)

SIMAZINE 50%: Tafazine (Rallis), Gesatop, Hexazine (Parry Chemicals)

TRIFLURALIN 48%: Treflan (De'Nocil), Triflurex (Parry Chemicals)

### Insecticides

ALDICARB: Temic 10 G (Rhone Poulenc)

CARBARYL: 5% DUST; 10% DUST; 4 G; 50% WP: Parryvin 50 WP (E.I.D. Parry), Dhanuvin 50 WP (Dhanuka), Killex Carbaryl (Paushak), Hexavin (Parry Chemicals), Kildiryl (Kilpest), Agroryl (Gujarat Agro), Sevin Flo 42%, Sevin 50% WP, Sevin D, Sevidol 4:4G, Sevin 4G (Rhone Poulenc)

CARBOFURAN 3 G, 50% SP: Furadan 3G (Rallis), Furacarb (AIMCO), Carbocil 3G (De'Nocil), Diafuran 3G (Pesticides India), Fury (NFCL), Hexafuran (Parry Chemicals), Furatox (AIMCO), Agroduran (Gujarat Agro)

CARBOSULPHAN 25% DS: Marshal (Rallis)

CHLORPYRIPHOS 20 EC, 10 G, 1.5 DP: Coroban (Coromandal Indag), Blaze (Indofil), Dursban, Ruban (De'Nocil), Sulban (Sulphur Mill), Specphos 20 (Southern Pesticides), Hyban (Hyderabad Chemicals), Radar (Searle India), Nuklor 20EC (Dupont), Corocin (IOCL), Scout (AIMCO), Dhanwan 20 (Dhanuka), Durmet 20EC (Cyanamid Agro), Classic (Lupin), Starban (Shaw Wallace), Doomer (Bhaskar Agro), Hilban (Hindustan Insecticides), Tagban 20 EC (Tropical Agro), Cyphos (ICI-Zeneca), Tarkash (BASF), Force (NFCL), Pyrivol (Voltas), Hexaban (Parry Chemicals), Agro-Chlore (Gujarat Agro), Chlorguard (Gharda), Tafaban (Rallis), Strike (Wockhardt), Robust (Sabero)

CYPERMETHRIN 10 EC: Ralothrin (Rallis), Ankush (BASF), Simper (ICI-Zeneca), Hi-Power (Sulphur Mills), Spec Cyperin (Southern Pesticides), Hycyper (Hyderabad Chemicals), Cyper Top (Thakar Chemicals), Lacer (Searle India), Agro-Cyper (Gujarat Agro), Jawa (Dupont), Cypercine (IOCL), Super Killer (Dhanuka), Cypermil (Montari), Polytrin (Novartis), Cyproid (AIMCO), Challenger (Tropical Agro), Cilcord, (De'Nocil), Starcip (Shaw Wallace), Volcyper (Voltas), Cypermar (Parry Chemicals), Hilcyperin (Hindustan Insecticides),

CYPERMETHRIN 25 EC: Cymbush (ICI-Zeneca), Ralothrin (Rallis), Cypersul (Sulphur Mills) Spec Cyperin (SPEC), Angel (Hyderabad Chemicals), Cyper Top (Thakar Chemicals), Trofy 25 EC (Searle India), Cypercine (IOCL), Challenger (Tropical Agro), Cypermil (Montari), Cyperguard (Gharda Chemicals), Polytrin (Novartis), Cyproid (AIMCO), Clicord (De'Nocil), Colt-25 (Pesticides India), Volcyper (Voltas), Shakti (Lupin), Basathrin (BASF),

Hilcyperin (Hindustan Insecticides), Cybil (Bayer), Cyrex (United Phosphorus), White Gold (Newchemi), Panther (Bhaskar Agro Chemicals), Blaze (Indofil), Super Killer (Parry Chemicals), Starcip (Shaw Wallace), Super Killer (Dhanuka), Baadha (Sabero)

DIAZINON 20 EC, 10% Gr: Basudin (Novartis), Tik-20 (Rallis)

DICHLOROVOS 76 EC: Nuvan (Novartis), Vapona (De'Nocil), Suchlor (Sudarshan Chemicals), Specvos (SPEC), Dicotop (Thakar Chemicals), Amidos (AIMCO), Doom (United Phosphorus), Luvon (Lupin), Hilfol (Hindustan Insecticides), Divap 100 (Pesticides India), Marvex Super (Parry Chemicals), Agro-DDVP (Gujarat Agro), Vantaf (Rallis)

DICOFOL 18.5 EC: Kelthane (Bayer), Difol (Sulphur Mills), Hi Might (SPEC), Dilop (Thakar Chemicals), Tik-Tok (United Phosphorus), Hilfol (Hindustan Insecticides), Hycofol (Hyderabad Chemicals), Hexakil (Parry Chemicals), Dhanuka Dicofol (Dhanuka), Colonels (Indofil)

DIMETHOATE 30 EC: Tafgor (Rallis), Tara-909 (Shaw Wallace), Specgor (Southern Pesticides), Hygro (Hyderabad Chemicals), Tophoate (Thakar Chemicals), Parrydimate (EID Parry) Diadhan (Dhanuka), Milgor (Montari), Dimetox (AIMCO), Nugor (United Phosphorus), Primer (Bhaskar Agro), Tagor (Tropical Agro), Teeka (NFCL), Champ (Searle India), Hexagor (Parry Chemicals), Hiltzoate (Hindustan Insecticides)

ENDOSULFAN 35 EC & 4% D, 2% D: Thiodan (Agro Evo), Endocel (Excel), Endosul (Sulphur Mills), Endostar (Shaw Wallace), Dawn (Southern Pesticides), Hysulfan (Hyderabad Chemicals), Top Sulfan (Thakar Chemicals), Endocin (IOCL), Parry Sulfan (E.I.D. Parry), Endodhan (Dhanuka), Endonil (Montari), Endosol (AIMCO), Thiokill (United Phosphorus), Lusulfan (Lupin), Agro Sulfan (Gujarat Agro), Hildan (Hindustan Insecticides), Tagsulfan (Tropical Agro), Hexasulfan (Parry Chemicals), Endotaf (Rallis), Speed (NFCL), Devigor (Devi Dayal)

FENITROTHION: Sumithion (Rallis), Folithion (Bayer), Hexafen (Parry Chemicals)

FENVALERATE 20 EC 0.4% DUST: Fenval (Searle Inida), Bilfen (Bayer), Starfen (Shaw Wallace), Fen-Fen (Parry Chemicals), Topfen (Thakar Chemicals), Tagfen (Tropical Agro), Trump Card (Dhanuka), Hilfen (Hindustan Insecticides), Fencron (Novartis), Sumitox (AIMCO), Fenkill (United Phosphorus), Lufen (Lupin), Starfen (Shaw Wallace), Agrofen (Gujarat Agro), Bhaskarfen (Bhaskar Agro), Newfen (Gharda), Fenkem (New Chemi), Anchor (ICI-Zeneca), Fenny (NFCL), Viper (SPEC), Milfen (Montari), Tatafen (Rallis), Fennock 20 (De'Nocil), Bhasma (Wockhardt)

FIPRONIL 0.3% Gr, 5% SC: Regent (Rhouné – Poulneq), Tempo (Agr Evo)

FORMOTHION 25%: Anthio (Novartis)

LINDANE (GAMMA-B.H.C.) 1.3%, 20% EC: Higama (SPEC), Lintox (AIMCO), Lindstar (Shaw Wallace), Lintaf (Rallis)

MALATHION 50 EC: Dhanuka Malathion (Dhanuka), Cythion (Cyanamid Agro), Sulmathion (Sulphur Mills), Specmal (SPEC), Agromala (Gujarat Agro), Malatop (Thakar Chemicals), Himala (Hindustan Insecticides), Malamar (Parry Chemicals), Luthion (Lupin), Malataf (Rallis), Maltax (AIMCO)

MONOCROTOPHOS 36% SL: Nuvacron (Novartis), Monocil (De'Nocil), Monovol (Voltas), Atom (Indofil), Sufos (Sudarshan Chemicals), Monostar (Shaw Wallace), Specron (Southern Pesticides), Hycrophos (Hyderabad Chemicals), Topcil (Thakar Chemicals), Monocin (IOCL), Monochem (New Chemi), Parryphos (EID Parry), Milphos (Montari), Monodhan (Dhanuka), Phoskill (United Phosphorus), Luphos (Lupin), Kadett (Pesticides India), Agromonark (Gujarat Agro), Moncar (Bhaskar Agro), Azodrin (Cyanamid Inida), Hilcron (Hindustan Insecticides), Macrophos (Tropical Agro), Croton (Searle India), Balwan (Rallis), Monophos (Parry Chemicals), Monocron (NFCL), Corophos (Coromandel Indag), Bilphos (Bayer), Monosect (Agr Evo)

METHYL-PARATHION 50 EC: Metacid (Bayer), Parataf (Thakar Chemicals), Dhanumar (Dhanuka), Milion (Montari), Paratox (AIMCO), Luthion (Lupin), Devithion (Devidayal), Tagpar (Tropical Agro System), Paramar M. (Parry Chemicals), Agro-Para (Gujarat Agro), Parataf (Rallis)

METHYL-PARATHION DUST 2%: Folidol (Bayer), Parataf (Sulphur Mills), Dhanudol (Dhanuka), Paratox (AIMCO)

OXY-DEMETON METHYL 25 EC: Metasystox (Bayer), Hexasystox (Parry Chemicals), Dhanusystox (Dhanuka), Mode (Agr Evo)

PHORATE 10 G: Thimet (Cyanamid Agro), Foratox (Pesticides India), Volphor (Volrho), Starphor (Shaw Wallace), Specphor (SPEC), Forcin (IOCL), Dhan 100 (Dhanuka), Milate (Montari), Granutox (AIMCO), Umet (United Phosphorous), Luphate (Lupin), Agro-Phorate (Gujarat Agro), Helmet (Tropical Agro Chemicals), Warrant (Searle India), Hilphorate (Hindustan Insecticides), Grenades

PHOSALONE 35% EC & 4% Dust: Zolone (Rhone-Poulenc), Voltas Phosalone (Voltas)

PHOSPHAMIDON 85 S.L.: Dimecron (Novartis), Cildon (De'Nocil), Sumidon (Sudershan Chemicals), Hydan (Hyderabad Chemicals), Topcron (Thakar Chemicals), Aimphon (AIMCO), Umeson (United Phosphorous), Phamidon (Lupin), Agromidon (Gujarat Agro), Hawk (Hindustan Insecticides), Specmidon (SPEC), Rilon (Rallis)

QUINALPHOS 25 EC: Ekalux AF (Novartis), Quinaltaf (Rallis), Flash (Indofil), Quinal (Sulphur Mills), Suquin (Sudershan Chemicals), Quinguard (Gharda), Starlux (Shaw Wallace), Knock (Southern Pesticides), Hyquin (Hyderabad Chemicals), Ekator (Thakar Chemicals), Smash (Searle India), Chemlux (New Chemi), Shakti (E.I.D. Parry), Dhanulux (Dhanuka), Quinatox (AIMCO), Kinalux (United Phosphorous), Vazra (Lupin), Agroquin (Gujarat Agro), Basquin (Bhaskar Chemicals), Hilquin (Hindustan Insecticides), Tagquin (Tropical Agro), Quick (NFCL), Volquin (Voltas), Bayrusil (Bayer), Krush (Wockhardt)

TRIAZOPHOS 40% EC: Hostathion, Trelka (Agr Evo)

THIODICARB 75% WP: Larvin (Rhone-Poulenc)

## Fungicides

AUREOFUNGIN 46.15% SP: Aureofungin Sol (Hindustan Antibiotics)

CAPTAFOL 80%: Foltaf (Rallis)

CAPTAN 50%, 75% SP: Hexacap (Parry Chemicals), Captaf (Rallis), Dhanutan (Dhanuka), Deltan (Coromandel Indag)

CARBENDAZIM 50 WP, 5 Gr: Barvistin, Subeej (BASF), Zoom (United Phosphorous), Agni (EID Parry), Dhanusten (Dhanuka), Derosal (Agr Evo), Aimcozim (AIMCO), Bengard (De'Nocil), Hycarb (Hyderabad Chemicals), Calzin (Lupin), Benzin (Bhaskar Agro), Benfin (Indofil), Carzim (Lupin), Nirmool (Shaw Wallace), Diafuran (Pesticides India), Stare (Parry Chemicals), Zen (NFCL), Volzim (Voltas), Agrozim (Gujarat Agro), Arrest (Searle)

EDIFENPHOS 50 EC: Hinosan (Bayer)

HEXCONAZOLE 5% EC: Contaf (Rallis)

MANCOZEB 75%: Dithane M-45 (Bayer), Uthane M-45 (United Phosphorous), Luzen (Lupin), Dhauka M-45 (Dhanuka), Hilthane (Hindustan Insecticides), Shield (Pesticides India), Spic Mancozeb (Spic), Zeb (NFCL), Manzate (Dapal), Zebthane (Rallis), Luzim (Lupin), Abic M45 (Novartis), Aimcozeb (AIMCO), Agromanco (Gujarat Agro), Indofil M-45 (Indofil), Sparsh (Wockhardt), Saviour (De'Nocil)

PROPICONAZOLE: Radar (Rallis), Tilt (Navartis)

STREPTOCYCLINE: Streptomycin (Hindustan Antibiotics), Plantomycin (Aries Agrovet)

SULPHUR 85 W.P. & DUST: Sultaf (Rallis), Insulf (United Phosphorous), Dhanusulf (Dhanuka), Sulphosan (AIMCO), Thiovit (Novartis), Farmasulf (Shaw Wallace), Microsulf (Parry Chemicals), Sulfin M-20 (Gujarat Agro), Hexasul (Parry Chemicals), Sulcol, Wet-Sulf (Excel)

TRIDEMORPH 80% EC: Calixin (BASF)

THIRAM 75%: Hexathane (Parry Chemicals), Thiride (IEL), Vegfru thiram (Pesticides India)

ZINEB 75% W.D.P.: Hexathane (Parry Chemicals), Discon-Z (AIMCO), Devizeb (Devidayal)

ZIRAM 80% WP, 27% CS: Cuman L. (Novartis), Hexazir (Parry Chemicals), Ziride (IEL), Vegfru Zitox (Pesticides India), Tagziron (Tropical Agro)

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