

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

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



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

Santoshnagar, Hyderabad 500 059



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### *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 sesame region, were identified. Their agro ecological setting, soil and water conservation, crop management including nutrient management, pest management etc., suitable cropping systems, contingency plans, alternate farming systems 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 All India Coordinated Research Project on Sesame & Niger (AICRPSN) but also others from National Agricultural Research System (NARS), Agro-industries and State Department(s) of Agriculture.

*a compendium by AICRPDA, CRIDA, AICRPS&N, SAUs  
State Department(s) of Agriculture and Agro-Industries*

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

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**2004**

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Implements • Seeds • Fertilizers  
Pesticides

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# RAINFED SESAME BASED PRODUCTION SYSTEM

Sesame or gingelly (*Sesame indicum*) commonly known as til (Hindi), tal (Gujarati), tili (Punjabi), nuvvulu (Telugu), ellu (Tamil), and ragi (Oriya) in different parts of India, is an ancient oilseed crop. India, China, Sudan, Mexico, Turkey, Burma and Pakistan are the important sesame producing countries. India ranks first, both in the area and production of sesame in the world. The annual area put under it in India is about 2-5 mha (45 % of the world hectareage) and the total production is nearly 52 thousand tonnes. Sesame is grown mostly in Uttar Pradesh, Rajasthan, Madhya Pradesh, Andhra Pradesh, Maharashtra, Gujarat, Tamil Nadu and Orissa and Karnataka under sesame.

The sesame seed is a rich source of edible oil. Its oil content generally varies from 46 to 52%. Its grains may be eaten fried, mixed with sugar or in the form of sweetmeats. Sesame oil is used as a cooking-oil in southern India. It is also used for anointing the body, for manufacturing perfumed oils and for medicinal purposes. Sesame- cake is a rich source of protein, carbohydrates and mineral nutrients, such as calcium and phosphorus. The cake is edible and is eaten avidly by working classes. It is also a valuable and nutritious feed for milch cattle.

Sesame is grown in India in *Kharif*, semi-arid, *rabi* and summer season or more than one season in some states, as in case of *kharif* and *rabi* in parts of Maharashtra, Madhya Pradesh, Chattisgarh, Gujarat, and Orissa, summer crop after late paddy or potato in Orissa and in all the seasons in parts of Southern India. Normally the crop is grown in plains but it also comes up successfully upto 1200m above mean sea level.

The crop has not only earned foreign exchange through export but also augmented the oil production in the country. More varieties of sesame are available with oil content of more than 50%. White bold seeds are exportable for using in confectionary and oil extraction. It is mandatory to use sesame oil in *Vanaspathi* manufacturing because of its quality. To augment production, development of production technologies for newer areas is also needed.

Sesame is grown in 2.23 mha in 316 districts in 16 states (Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Gujarat, Rajasthan, Punjab, Uttaranchal, Uttar Pradesh, Madhya Pradesh, Haryana, Jharkhand, Bihar, Chattisgarh, Orissa, West Bengal) of which 2.13 mha is under rainfed. An area of 1.37 mha (85%) out of 1.41 mha is in 83 districts.

Selection criteria	No. of districts	Area under sesame ('000 ha)	Area under Rainfed sesame ('000 ha)	Gross Cropped Area ('000 ha)	Yield (kg/ha)
States (16)	316	2226	2132	154249	245
Agroecoregion**	239	1701	1612	122169	253
Cumulative 85% Rainfed Sesame Area	83	1413	1368	54062	281

\*\* Arid, semi arid and dry subhumid

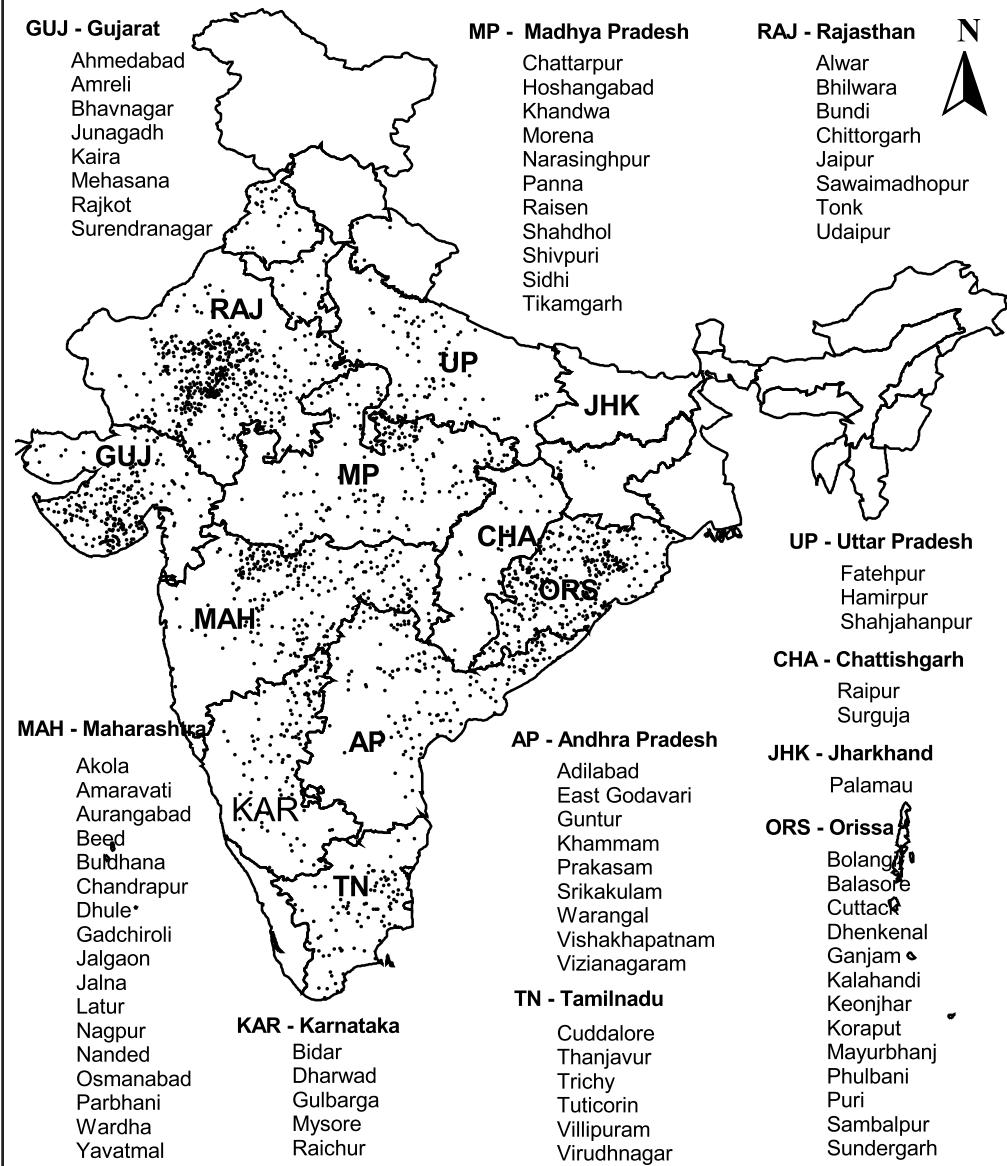
The 83 districts covering 86% of rainfed sesame growing area are given in figure.

The trends in area and yield growth rates for different districts are given in the following table.

Area	Yield	State	Districts
Stagnant	Increasing	Chattisgarh Karnataka Madhya Pradesh Orissa Rajasthan Uttar Pradesh	Surguja, Raipur Dharwad, Mysore Narsinghpur Balasore Bundi, Sawaimadhopur, Alwar Hamirpur

# RAINFED SESAME REGION

## Priority Districts



<b>Area</b>	<b>Yield</b>	<b>State</b>	<b>Districts</b>
Stagnant	Stagnant	Andhra Pradesh	Adilabad, Guntur
		Bihar	Palamu
		Gujarat	Kaira, Mehasana, Ahmednagar
		Karnataka	Gulbarga
		Madhya Pradesh	Chatarpur, Shivpuri, Panna
		Maharashtra	Chandrapur, Nanded, Wardha, Amaravati
		Orissa	Puri, Cuttack
		Rajasthan	Bhilwara, Tonk, Chittorgarh, Jaipur, Udaipur
		Tamil Nadu	Tiruchirapalli, Thanjavur
Decreasing	Stagnant	Andhra Pradesh	East Godavari
		Karnataka	Bidar
		Madhya Pradesh	Sidhi, Shahdol
		Maharashtra	Nagpur
Increasing	Increasing	Maharashtra	Dhule
		Orissa	Sambalpur
		Uttar Pradesh	Fatehpur
		Andhra Pradesh	Khammam
		Madhya Pradesh	Khandwa
Decreasing	Increasing	Madhya Pradesh	Hoshangabad, Raisen
Stagnant	Decreasing	Orissa	Phulbani
Increasing	Stagnant	Andhra Pradesh	Warangal, Vishakhapatnam, Srikakulam
		Gujarat	Bhavnagar, Amreli, Surendranagar, Rajkot, Junagadh
		Karnataka	Raichur
		Madhya Pradesh	Tikamgarh, Morena
		Maharashtra	Jalgaon, Buldhana, Akola, Aurangabad, Yavatmal, Parbhani, Beed, Osmanabad
		Orissa	Dhenkenal, Bolangir, Koraput, Kalahandi, Ganjam, Sundergarh, Keonjhar, Mayurbhanj
		Tamil Nadu	South Arcot
		Uttar Pradesh	Shahjahanpur

The popular sesame production system existing in various AERs is presented below:

<b>Agro-ecoregion</b>	<b>Production System</b>
Hot arid Karnataka plateau	Finger millet/ pearl millet/ groundnut- sesame
Hot semi-arid Northern plains	Sesame-Fallow
Hot semi-arid Deccan plateau	Pigeonpea + sesame (1:2)
Hot semi-arid Eastern ghats, Tamil Nadu uplands	Sesame- castor- horsegram Pearl millet/ finger millet/ groundnut- sesame
Hot moist/ dry subhumid Chattisgarh/ Mahanandi basin	Sesame- chickpea/ rapeseed mustard/ barley
Hot sub-humid Eastern plateau	Sesame- fallow Maize/ cowpea- sesame
Hot sub-humid Eastern plains	Sesame- maize/ wheat

Details on clusters of associated crops and dominant livestock are presented below:

<b>Crops</b>	<b>Animals</b>	<b>Districts</b>
Sorghum	Female Buffalo	Narsinghpur, Tikamgarh, Chattarpur, Morena, Khandwa, Raisen, Hoshangabad,
Cotton	Female Cattle	Srikakulam, Vishakhapatnam, East Godavari, Guntur, Warangal, Khammam,
Pearl millet	Male Cattle	Adilabad, Mysore, Dharwad, Bidar, Raichur, Gulbarga, Dhule, Jalgaon,
Pigeonpea	Sheep	Aurangabad, Parbhani, Beed, Nanded, Osmanabad, Buldhana, Akola, Amaravati
Balckgram	Goat	Yavatmal, Wardha, Nagpur, Chandrapur, Ahmedabad, Kaira, Mehasana,



Crops	Animals	Districts
Chickpea Groundnut Rice Sesame Vegetables		Surendranagar, Hamirpur, Prakasam, Jalna, Latur
Pearlmillet Maize Sorghum Rapeseed mustard Groundnut	Female Buffalo Female Cattle Male Cattle Sheep Goat	Shivpuri, South Arcot, Tiruchirapalli, Thanjavur, Alwar, Bhundi, Chittorgarh, Jaipur, Sawaimadhapur, Tonk, Udaipur, Shahjahanpur, Kamarajar, V.O.Chidambaram
Blackgram Chickpea Rice Cotton Sesame Vegetables		
Maize Chickpea Sorghum Pigeonpea Sesame Vegetables	Female Buffalo Female Cattle Male Cattle Sheep Goat	Bhilwara, Fatehpur
Rice Vegetables Horsegram Sesame	Female Buffalo Female Cattle Male Cattle Sheep Goat	Raipur, Surguja, Panna, Sidhi, Shadhol, Gadchiroli, Balasore, Bolangir, Cuttack, Dhenkenal, Ganjam, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Phulbani, Puri, Sambalpur, Sundergarh, Palamau
Groundnut Pearlmillet Sesame Onion Sorghum	Female Buffalo Female Cattle Male Cattle Sheep Goat	Amreli, Bhavnagar, Junagadh, Rajkot, Vizianagaram, Villipuram

The districts in a crop region vary in productivity, annual normal rainfall and length of growing period. The later two identifies with an agroecoregion, while the former with a crop based production system. By taking these three attributes, a cluster analysis is made and optimum number of clusters were identified. The districts under each of the crops were taken as a group. For these groups of districts, the runoff and surplus index (ratio of runoff to average annual normal rainfall) was calculated (Thornthwaite and Mather method). The surplus index was divided into three groups – low (less than 12%), medium (12-25%) and high (more than 25%). Necessary soil and water conservation methods were identified. The details follow:

Rainfall Surplus Index	Possible Options
<12	<i>In situ</i> conservation
12-25	<i>In situ</i> conservation and water harvesting
>25	Drainage, <i>in situ</i> conservation and water harvesting

The productivity (average yield 1990-91 to 1994-95) and annual rainfall (mean of past 30 years) were used for yield gap analysis, which is 0.7 of achievable yield based on water requirement satisfaction index. The yield gap was grouped as low (< 33%), Medium (33-66 %) and high (>66%). The possible options are–

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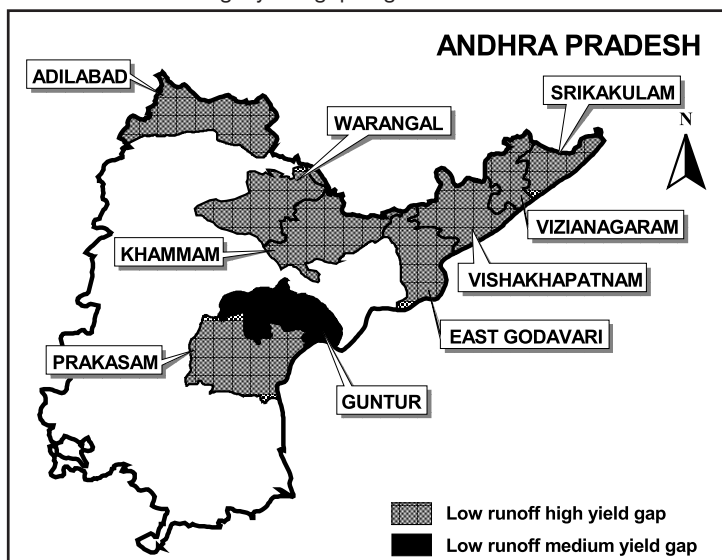
<b>Yield Gap</b>	<b>Possible Options</b>
<33	Non monetary inputs and improved varieties
33-66	Non monetary inputs, fertilizer management and improved varieties
>66	Improved varieties, fertilizer management, plant protection measures, non monetary inputs or shifting alternate land uses

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The available recommendations from network of research of National Agricultural Research System (NARS) were linked to the matrix of yield gap and surplus index. Recommendations are given for crop based production system, state-wise and group (s) of districts. These consist of integrated soil conservation and management, crop management (varieties, seed rate, planting pattern, integrated nutrient management, integrated pest management, suitable cropping systems, implements, suggested integrated farming systems, contingent planning, etc. A region was described in terms of agro-ecological setting, soils, climate, annual rainfall, PET and length of growing period. The identified priorities for increasing the productivity in short term are also included. The recommendations on this crop based production system are given state and district-wise in alphabetical order in following pages.

## ANDHRA PRADESH

In Andhra Pradesh there is one district viz. Guntur under low runoff and medium yield gap region and eight districts viz. Vishakhapatnam, Warangal, Adilabad, Prakasam, East Godavari, Srikakulam, Khammam and Vizianagaram under low runoff and high yield gap region.



The recommendation details follow:

District	Region
Adilabad	Low runoff and High yield gap
East Godavari	
Khammam	
Prakasam	
Srikakulam	
Vishakhapatnam	
Vizianagaram	
Warangal	

### Agro-ecological setting

#### Adilabad

- **Climate:** Hot moist semi arid
- **Physiography:** North western telangana plateau
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils (Vertic Inceptisols – 50%; Alfisols– 50%)
- **Annual rainfall:** 992 mm
- **Potential evapotranspiration:** 1689 mm
- **Moisture availability period:** 178 days

#### East Godavari

- **Climate:** Hot sub humid/ Hot dry sub humid
- **Physiography:** Eastern ghats

- **Soils:** Deep loamy red and lateritic soils, deep loamy to clayey coastal and deltaic alluvium soils deep loamy to clayey coastal and deltaic alluvium - derived soils (Aridisols – 65%; Alfisols – 35%)
- **Annual rainfall:** 1088 mm
- **Potential evapotranspiration:** 1689 mm
- **Moisture availability period:** 180-210 days

#### **Khammam**

- **Climate:** Hot moist semi arid
- **Physiography:** Northern Telangana Plateau
- **Soils:** Deep loamy, clayey mixed red and black soils (Vertisols – 60%; Alfisols – 40%)
- **Annual rainfall:** 1148 mm
- **Potential evapotranspiration:** 1677 mm
- **Moisture availability period:** 120–150 days

#### **Prakasam**

- **Climate:** Hot moist semi arid/ dry sub humid
- **Physiography:** Eastern ghats
- **Soils:** Medium deep loamy, clayey mix red and black soils, deep clayey coastal and deltaic alluvium derived soils (Vertic inceptisols – 70%; Aridisols – 30%)
- **Annual rainfall:** 848 mm
- **Potential evapotranspiration:** 1951 mm
- **Moisture availability period:** 150–180 days

#### **Srikakulam**

- **Climate:** Hot (moist/ dry) sub humid
- **Physiography:** Eastern plains (High altitude zone)
- **Soils:** Medium to deep loamy red and lateritic, deep loamy to clayey coastal and deltaic alluvium derived soils (Aridisols – 100%)
- **Annual rainfall:** 1104 mm
- **Potential evapotranspiration:** 1560 mm
- **Moisture availability period:** 180–210 days

#### **Warangal**

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

### **Vishakhapatnam**

- **Climate:** Hot (moist/ dry) sub humid
- **Physiography:** Eastern ghats (High altitude zone)
- **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

### **Vizianagaram**

- **Climate:** Hot (moist/ dry) sub humid
- **Physiography:** Eastern Ghats (High altitude zone)
- **Soils:** Medium to deep loamy red and lateritic, deep loamy to clayey coastal and deltaic alluvium derived soils (Aridisols – 50%; Alfisols – 50%)
- **Annual rainfall:** 1174 mm
- **Potential evapotranspiration:** 1542 mm
- **Moisture availability period:** 180–210 days

## **Soil and water conservation**

### **Adilabad, Khammam**

- More emphasis on *insitu* water conservation
- Increasing soil infiltration capacity and reducing soil crusting problem

### **Warangal**

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

### **Vishakhapatnam**

- Sowing across the slope and ridging later
- Contour farming
- Graded border strips
- Water harvesting structures
- Life saving irrigation

### **East Godavari, Srikakulam, Vizianagaram**

- Bench terracing
- Compartment bunding
- Graded border strips
- Sowing across the slope and ridging later
- *Insitu* conservation of soil moisture



## Prakasam

- More emphasis on insitu water conservation like mulching, deep tillage, conservation furrows
- Increasing soil infiltration capacity and reducing soil crusting problem
- Supplemental irrigation wherever possible
- Field bunds for smaller areas may be encouraged for wider adoption

## Crop management

### Adilabad, Khammam, Warangal

- **Varieties:** Gowri, Madhavi, T-85, RT-54, RT-103, Yellamanchali, Varaha, Gautam, Rajeshwari
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30x15 cm
- **Nutrient management:** *Kharif:* Farm yard manure 10 t/ ha+ 20 kg N (within 2-3 weeks)+20 kg P<sub>2</sub>O<sub>5</sub> +20 kg K<sub>2</sub>O/ha
- **Pest management:**
  - Intercropping of sesame with greengram and groundnut reduces damage due to gall fly and leaf roller /capsule borer
  - Weed free condition upto three weeks after sowing
  - **Resistant /tolerant varieties**
    - Gallfly: RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - **Leaf roller/ capsule borer**
    - RT-46, RT-54, Swetha Til, Krishna and N-32.
    - Apply Phorate 10 G granules @10 kg/ha as basal application.
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra.
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing.
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, Pre-emergence application of Pendimethalin @ 1.25 kg/ha
- **Some other important practices**
  - Sowing in July for *kharif*
  - Seed treatment: 3g Thiram or Captan per 1 kg of seed
  - Sowing: *Kharif*-May, *Rabi*- December last week to January second week
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment.
  - Sesame + Mothbean/ Blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch.
  - For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting.

- Phyllody - sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon.
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+1 g) before planting.
- Tetracycline 500 ppm spray at flower initiation stage against phyllody.
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties.
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests.
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after sowing
- For interculture, use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

### **East Godavari, Prakasam, Srikakulam, Vishakhapatnam, Vizianagaram**

- **Varieties:** Madhavi, Gauri, Yellamanchali-1, Varaha, Gautam, Rajeshwari
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30x15 cm
- **Nutrient management**
  - *Kharif:* Farm yard manure 10 t/ ha + 20 kg N (with in 2-3 weeks) + 20 kg P<sub>2</sub>O<sub>5</sub> + 20 kg K<sub>2</sub>O/ha
  - *Rabi:* Farm yard manure 10 t/ha + 20-30 kg N (in two splits) + 20 kg P<sub>2</sub>O<sub>5</sub> + 20 kg K<sub>2</sub>O/ha
- **Pest management**
  - Inter cropping of sesame with greengram and groundnut reduces damage due to gall fly and leafroller/ capsule borer
  - Weed free condition upto three weeks after sowing
  - **Resistant/ tolerant varieties**
    - Gallfly: RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - **Leaf roller/ capsule borer**
    - RT-46, RT-54, Swetha Til, Krishna and N-32.
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application.
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra.
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing.
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
- **Some other important practices**
  - Seed treatment: 3g Thiram or Captan per 1 kg of seed
  - Sowing: *Kharif*-May, *Rabi*- December last week to January second week
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment.
  - Sesame + mothbean/ blackgram

- Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch.
- For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting.
- Phyllody - sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon.
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+1 g) before planting.
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- Early sowing in the first week of July and use of early varieties.
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests.
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after sowing
- For interculture, use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

### Suitable cropping systems

#### Adilabad, East Godavari, Khammam, Prakasam, Srikakulam, Warangal, Vishakhapatnam

- Sesame + blackgram

### Farm implements/ tools

#### Adilabad, Khammam, Prakasam, Warangal

- Ferti cum seed drill
- Bullock drawn two-row sweep cultivator
- Modified/ Two-row blade harrow
- Bullock drawn country plough attached with pore tub

#### East Godavari, Srikakulam, Vizianagaram

- Hand hoe

### Alternate farming systems

#### Adilabad, Khammam, 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*, *Albizia lebbbeck*, *Bauhinia purpurea*, *A. procera*, *Butea monosperma*, *A.amara*, *Dalbergia sissoo*

- **Medicinal & Aromatic Plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Aloe barbadensis*, *Withia somnifera*, *Cymbopogon martini*, *Cymbopogon flexuosus*, *Vetiveria zizanioides*, *Prosalea*, *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

### East Godavari, Srikakulam, Vizianagaram

- **Fodder/ green biomass:** *Pinnata*, *Albizia sp*, *Cassia siamea*, *Grevillea robusta*, *Dalbergia sissoo*, *Azadirachta indica*
- **Fruit:** Mango, Jack fruit, Guava, Lime
- **Medicinal and Aromatic Plants:** *Vetiveria zizanioides*, *Cymbopogon flexuosus*, *Palma rosa*, *Solanum viarum*, *Cinnamon*, *Citronella java*.
- **Vegetables:** Bottle gourd, Brinjal, Ridge gourd, Water melon, Long melon, Bitter gourd, Tomato
- **Animal Component:** Female cattle, Male cattle, Goat

### Vishakhapatnam

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

### Prakasam

- **Fodder/ green biomass:** *Albizia lebbbeck*, *Dalbergia sissoo*, *Leucaena leucocephala*, *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 zizanioides*
- **Vegetables:** Cluster bean, Drumstick, Cucumber, Cowpea, Ridge gourd, Round melon, Okra, Watermelon.

### Contingent planning

#### Adilabad, Khammam, Warangal

##### For Red soils

- **June:**
  - **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:**
  - Sow castor (Aruna, GAUCH-1)
  - **Sole crop:**
    - Fingermillet
    - Bunch variety of Groundnut (MV-2, JL-24)
  - **Intercrop:**
    - Maize (DHM-101, Ganga-5) + pigeonpea (2:1) at 50 cm spacing. Pigeonpea duration of 180-200 days
- **August**
  - **Sole crop:**
    - Setaria (H-1, Arjuna) for grain to poultry feed and straw for fodder
    - Castor (GCH-4, Kranthi) 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
Guntur	Low runoff and medium yield gap

### Agro-ecological setting

- **Climate:** Hot moist semi arid/ dry sub humid
- **Physiography:** Eastern ghats (South)
- **Soils:** Medium deep loamy, clayey mix red and black soils, deep clayey coastal and Deltaic Aluvium derived soils (Aridisols – 40%; Vertisols – 30%; Alfisols – 30%)
- **Annual rainfall:** 704 mm



- **Potential evapotranspiration:** 1777 mm
- **Moisture availability period:** 150–180 days

### Soil and water conservation

- More emphasis on *insitu* water conservation like mulching, deep tillage, conservation furrows
- Increasing soil infiltration capacity and reducing soil crusting problem
- Supplemental irrigation wherever feasible
- Field bunds for smaller areas may be encouraged for wider adoption

### Crop management

- **Varieties:** Gowri, Madhavi, Yellamanchali, Varaha, Gautam, Rajeshwari
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30x15 cm
- **Nutrient management:**
  - *Kharif:* Farm yard manure 10 t/ha+ 20 kg N (with in 2-3 weeks)+ 20 kg P<sub>2</sub>O<sub>5</sub> +20 kg K<sub>2</sub>O/ha
  - *Rabi:* Farm yard manure 10 t/ha + 20-30 kg N (in two splits)+ 20 kg P<sub>2</sub>O<sub>5</sub> + 20 kg K<sub>2</sub>O/ha
- **Pest management**
  - Intercropping of sesame with greengram and groundnut reduces damage due to gall fly and leaf roller/ capsule borer
  - Weed free condition upto three weeks after sowing
  - **Resistant/ tolerant varieties**
    - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - **Leaf roller/ capsule borer**
    - RT-46, RT-54, Swetha Til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @1.25 kg/ha
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Sowing: *Kharif*-May, *Rabi*- December last week to January second week
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram

- Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
- Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

### Suitable cropping systems

- Sesame + blackgram

### Farm implements/ tools

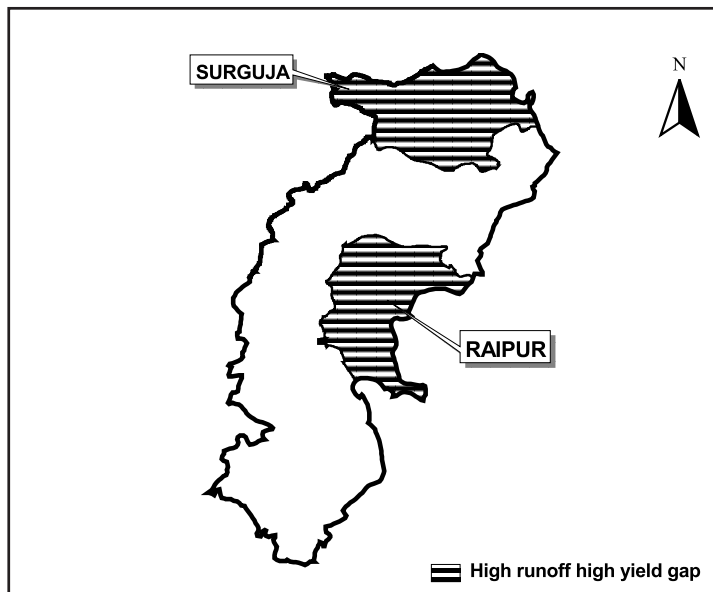
- Bullock drawn two-row sweep cultivator
- Modified two-row blade harrow
- Bullock drawn country plough attached with Pore tube

### Alternate farming systems

- **Fodder/ green biomass:** *Albizia lebbbeck*, *Dalbergia sissoo*, *Leucaena leucocephala*, *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 zizanioides*
- **Vegetables:** Cluster bean, Drumstick, Cucumber, Cowpea, Ridge gourd, Round melon, Okra, Watermelon.

# CHATTISGARH

In Chattisgarh there are two districts viz. Raipur and Surguja under high runoff and high yield gap region.



The recommendation details follow:

District	Region
Raipur Surguja	High runoff and high yield gap

## Agro-ecological setting

### Raipur

- **Climate:** Hot moist/ dry sub humid
- **Physiography:** Chattisgarh / Mahanadi basin
- **Soils:** Deep loamy to clayey red and yellow soils (Alfisols/ Ustolls – 50%; Alfisols – 25%; Vertisols – 15%)
- **Annual rainfall:** 1388 mm
- **Potential evapotranspiration:** 1723 mm
- **Moisture availability period:** 201 days

### Surguja

- **Climate:** Hot moist sub humid
- **Physiography:** Chattisgarh / Mahanadi basin
- **Soils:** Deep loamy to clayey red and yellow soils (Alfisols/ Ustolls – 100%)
- **Annual rainfall:** 1406 mm
- **Potential evapotranspiration:** 1471 mm
- **Moisture availability period:** 150-180 days

## **Soil and water conservation**

### **Raipur**

- Sowing across the slope
- Contour farming

### **Surguja**

- Soil and Water Conservation
- Graded trenches (16-33%) terrous with dry rubble gravel or enteritic pitched wall
- Gabion structures in water ways

## **Crop management**

### **Raipur, Surguja**

- **Varieties** : TKG-21, TKG-22, TKG-55, Rama,JTS-8, JT-7, N-32
- **Seed rate**: 5 kg/ha for pure crop
- **Planting pattern**: 30x15 cm
- **Nutrient management**: 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha as basal + 12.5 kg N at 30-35 days after sowing
- **Pest management**:
  - Weed free condition upto three weeks after sowing
  - Resistant/ tolerant varieties
  - Gallfly: RT-46, RT – 103, RT – 108 and RT – 125
  - Gallfly and Mites: RT – 127
  - **Leaf roller/ capsule borer**
    - RT-46, RT-54, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
- **Some other important practices**
- Seed treatment: 3 g Thiram or Captan per kg of seed
  - Line sowing through seed drill
  - Normal rainfall - Last week of June and in the first week of July
  - Late onset of monsoon - Second week of July
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment.
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought

- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
- Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g + 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## Suitable cropping systems

### Raipur, Surguja

- Sesame + rapeseed mustard

### Farm implements/ tools

#### Raipur, Surguja

- Dryland weeder

## Alternate farming systems

### Raipur

- **Agro – hortisystem:** Mango + Pea/ Berseem (green fodder)/ Wheat/ Chickpea/ Soybean
- **Silvi – pastoral system:** Teak + Sudan grass
- **Fodder/ green biomass:** *Leucaena leucocephala*, *Albizia amara*, *Dichrostachys cinerea*, *Melia azadirach*, *Hardwickia binata*, *Albizia lebbeck*
- **Fruit:** Mango, Ber, Guava, Tamarind, Karonda
- **Medicinal and Aromatic Plants:** *Safed musli*, *Palma rosa*, *Withania somnifera*, *Papaver somniferum*, *Vetiveria zizanooides*
- **Vegetables:** Brinjal, Chilli, Cowpea, Okra, Bottle gourd, Round melon
- **Animal component:** Female cattle, Male cattle, Female buffaloes, Goats

### Surguja

- **Fodder/ green biomass:** Neem, subabul, *Hardwickia binata*, pongamia, *Cassia siamea*, bauhinia
- **Fruit:** Mango, guava, amla, phalsa, jamun and karonda
- **Medicinal/ Aromatic plants:** *Papaver somniferum*, *Palma rosa*, *Cymbopogan flexous*, *Vetiveria zyzanooides*.
- **Vegetables:** Tomato, chillies, brinjal, okra, bottle gourd, cowpea
- **Animal component:** Female buffalo/ sheep, goat



## **Contingent planning**

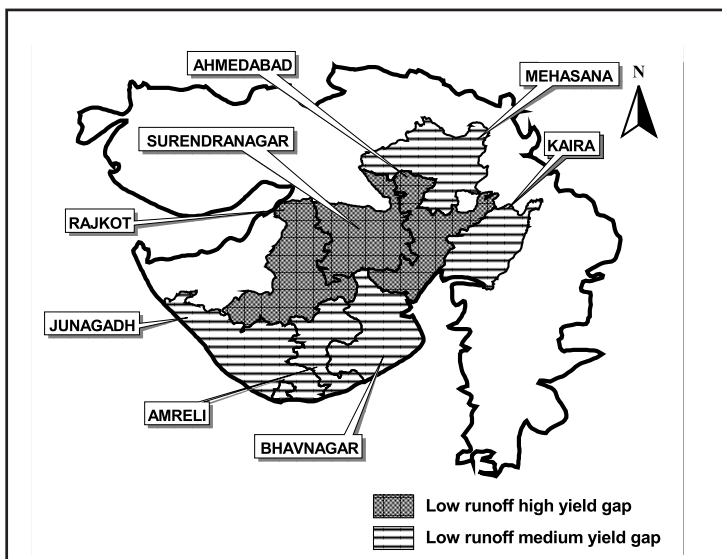
### **Raipur, Surguja**

Cropping systems under drylands

- **June**
  - **Sole crop**
    - Sorghum (CSH 5, JS 1041)
    - Greengram (K 850)
    - Blackgram (JU 2, PDU 4)
    - Groundnut (Jawahar Jyoti, M 13)
  - **Inter crop**
    - Sorghum + pigeonpea (2:1)
    - Soybean + pigeonpea (2:1)
- **July**
  - **Sole crop**
    - Rice (IR 50, JR 345)
    - Kodo (JK 155, JK 76, JK 136)
    - Sorghum (CSH 5)
    - Pigeonpea (NPWR -15, JA4, Asha)
    - Groundnut (Jyoti, M 12, Exotic 1-1)
  - **Inter crop**
    - Sorghum + pigeonpea (2:1)
    - Soybean + pigeonpea (2:1)
- **August**
  - Castor (Aruna)
  - Pigeonpea (No.148)
- **October**
  - Wheat (JW 17, C 306)
  - Chickpea (JG 321, JG 315)
  - Linseed (JL 23, R 552)
  - Barley (Karan 4, Jyoti)
  - Lentil (JL 1, Malika)

# GUJARAT

In Gujarat there are five districts viz. Amreli, Junagadh, Bhavnagar, Mehasana and Kaira under low runoff and medium yield gap region, and three districts viz. Ahmedabad, Rajkot and Surendra Nagar under low runoff and high yield gap region.



The recommendation details follow:

District	Region
Amreli Bhavnagar Junagadh Kaira Mehasana	Low runoff and medium yield gap

## Agro-ecological setting

### Amreli

- **Climate:** Hot dry/ moist semi arid
- **Physiography:** Central Kathiawad peninsula
- **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:** Central 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 semi arid / hot moist semi arid
- **Physiography:** Central Kathiawad Peninsula
- **Soils:** Shallow and medium loamy to clayey black soils, deep black soils, 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

### **Kaira**

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Gujarat Plains
- **Soils:** Deep clayey black soils, shallow black soils (Alfisols/ Ustolls – 60%, Vertic Inceptisols – 40%)
- **Annual rainfall:** 929 mm
- **Potential evapotranspiration:** 1596 mm
- **Moisture availability period:** 120–150 days

### **Mehasana**

- **Climate:** Hot arid/ hot dry semi arid
- **Physiography:** North Gujarat Plains
- **Soils:** Deep loamy desert soils, deep loamy grey brown and alluvium - derived soils (Alfisols/ Ustolls – 100%)
- **Annual rainfall:** 507 mm
- **Potential evapotranspiration:** 1988 mm
- **Moisture availability period:** 60–120 days

## **Soil and water conservation**

### **Kaira**

- Shallow ploughing before sowing and ridging and furrowing 25 days after sowing
- Increasing soil infiltration capacity and reducing soil crusting problem

### **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, Kaira, Mehasana

- **Varieties:**
  - Sole crop – GT-1, GT-2
  - Intermediate *kharif* – *rabi* season– Purva (semi *rabi*)
  - Purra – 1
- **Seed rate:** 3.5 kg/ha for pure crop
- **Planting pattern:** 45x15 cm
- **Nutrient management:**
  - 25 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha. All N and P<sub>2</sub>O<sub>5</sub> applied as basal
  - Intercropping of sesame with greengram and groundnut reduces damage due to gall fly and leaf roller/ capsule borer
  - Weed free condition upto four weeks after sowing
- **Pest management:**
  - **Resistant/ tolerant varieties**
    - Gallfly: RT-46, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - **Leaf roller/ Capsule borer**
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application.
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of *Anti Gastra*
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
- **Gallfly: Control measures**
  - For effective and economical control of sesame gall fly (*Asphondylia sesami*) in North Saurashtra agroclimatic zone, two sprays, first at initiation of flowering and second at 15 days after first spray, of any one of the following insecticides is recommended
    - Monocrotophos 0.04% (ICBR 1:9.4)
    - Dimethoate 0.03% (ICBR 1:8.2)
    - Quinolphos 0.05% (ICBR 1:6.4)
- **Leaf webber: Control measures**
  - For effective and economical control of sesame leaf webber one or two spraying/ application of Endosulfan 0.07% of dusting of Quinolphos 1.5% dust @ 25 kg/ha at 15 days interval is recommended from the commencement of the pest appearance under rainfed conditions of north Saurashtra agroclimatic zone
  - Cercospora disease - Spray Zineb (0.2%) @ 2 kg ai/ha
  - Powdery mildew disease – Spray Sulfex (80 WP) @ 2 kg ai/ha or any other sulphur containing fungicide
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed

- Thinning 21 days after sowing
- Line sowing through seed drill
- RT-46, RT-125, RT-54 and RT-127
- Sowing with onset of monsoon
- Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
- Sesame + mothbean/ blackgram
- Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting
- Phyllody - sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- Time of sowing: *Kharif* – last week of June to second fortnight of July, *Semi rabi* – mid September, *Rabi* – January- February
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after sowing
- For interculture, use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## **Bhavnagar, Junagadh**

- **Varieties:** G-Til-1, G-Til-2, Purva (*Semi rabi*)
- **Seed rate:** 3 kg/ha
- **Planting pattern:** 45x15 cm
- **Nutrient management:** 25 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha, all nutrients to be applied as basal
- **Pest management**
  - Resistant/ tolerant varieties
    - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 12
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha

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### Diseases control

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Disease	Control measures
<i>Cercospora leaf spot</i> Powdery milden	Spray Zineb (0.2%) 2 kg a.i/ha Spray Sulfex (80 wp) 2 kg/ha a.i or any other sulphur containing fungicide
Rust	Spray monocrotophos (0.2%) @ 1.2 kg ai/ha

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#### • Some other important practices

- Application of life saving irrigation at pegging and pod-development stages of groundnut

### Suitable cropping systems

#### Amreli, Kaira, Mehasana

- Sesame + blackgram
- Groundnut (AHT-60) + sesame (Guj. Sesame.1)
- Sesame + soybean (3:1)
- Sesame + millet (3:1)

#### Bhavnagar, Junagadh

- Groundnut + sesame (AHT-C/ Guj. Til – 1)

### Farm implements/ tools

#### Amreli, Kaira, Mehasana

- For multipurpose tool bar, seed-cum-fertilizer drilling attachment (manually metered) is recommended to carry out three operations i.e. fertilizer drilling, seed drilling and covering at a time for the farmers of north Saurashtra agroclimatic zone
- Two bowl seed cum fertilizer drill

### Alternate farming systems

#### Kaira, Mehasana

- 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 lebbeck*, *Leucaena leucocephala*, *Pongamia pinnata*
- Fruit: Custard apple, Mango, Pomegranate Phalsa, Fig, Jamun, Tamarind
- Medicinal/ Aromatic Plants: *Plantago ovata*, *Cassia angustifolia*, *Liquorice*
- Vegetables: Cowpea, Cluster bean, Brinjal, Okra, Long melon, Drumstick
- Animal component: Female buffaloes, Cows, Male cattle, Sheep, Goat, Poultry

#### Amreli, Bhavnagar, Junagadh

- Fodder/ green biomass: *Dichrostachys cinerea*, *Albizzia lebbeck*, *Leucaena leucocephala* and *Pongamia pinnata*
- On sloppy 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, Kaira, Mehasana**

#### **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 (Gujarat til-1, Gujarat til-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 pearl millet (GHB-235, GHB-316, GHB-558), sorghum (GJ-39, J-41), sesame (Gujarat til-1, Gujarat til-2) and 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. 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

<b>District</b>	<b>Region</b>
Ahmedabad Rajkot Surendranagar	Low runoff and high yield gap

## **Agro-ecological setting**

### **Ahmedabad**

- **Climate:** Hot dry semi arid

- **Physiography:** North Gujarat Plains
- **Soils:** Deep loamy grey brown and alluvium - derived soils, shallow and medium loamy to clayey black soils, deep black soils (Alfisols/ Ustolls – 100%)
- **Annual rainfall:** 823 mm
- **Potential evapotranspiration:** 1678 mm
- **Moisture availability period:** 90–120 days

### Rajkot

- **Climate:** Hot arid/ Hot dry semi arid
- **Physiography:** North Kathiawad peninsula
- **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

### Surendranagar

- **Climate:** Hot arid/ hot dry semi arid
- **Physiography:** North Kathiawad Peninsula
- **Soils:** Deep loamy desert soils, deep loamy saline and alkaline soils, deep loamy grey brown and alluvium - derived soils (Alfisols/ Ustolls – 60%; Vertic Inceptisols – 40%)
- **Annual rainfall:** 601 mm
- **Potential evapotranspiration:** 1970 mm
- **Moisture availability period:** 60–120 days

## Soil and water conservation

### Ahmedabad, Rajkot

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

### Surendranagar

- More emphasis on *insitu* water conservation
- Increasing soil infiltration capacity and reducing soil crusting problem
- Absorption terracing
- Inter-row water harvesting
- Dead furrows at 3.6 m interval



## Crop management

### Ahmedabad, Rajkot, Surendranagar

- **Varieties:**
  - Sole crop – G-Sesame-1, G-Sesame-2
  - Intermediate *kharif* – *rabi* season– Purva (semi *rabi*)
  - Purra – 1, Gujarat Sesame – 1, Murg – 1, Gujarat til-1, Mrug-1, Purva-1, RT-54, RT-103
- **Seed rate:** 3.5 kg/ha for pure crop
- **Planting pattern:** 45x15 cm
- **Nutrient management:**
  - 25 kg N + 25 kg /ha. All N and P<sub>2</sub>O<sub>5</sub> applied as basal
  - Intercropping of sesame with greengram and groundnut reduces damage due to gall fly and leaf roller/ capsule borer
  - Weed free condition upto four weeks after sowing
- **Pest management:**
  - **Resistant/ tolerant varieties**
    - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - **Leaf roller/ capsule borer**
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
  - Gallfly: Control measures
    - For effective and economical control of Sesame gall fly (*Asphondylia sesami*) in north Saurashtra agroclimatic zone, two spray, first at initiation of flowering and second at 15 days after first spray, of any one of the following insecticides is recommended
      - Monocrotophos 0.04% (ICBR 1:9.4)
      - Dimethoate 0.03% (ICBR 1:8.2)
      - Quinolphos 0.05% (ICBR 1:6.4)
  - Leaf webber: Control measures
    - For effective and economical control of sesame leaf webber one or two spraying/ application of Endosulfan 0.07% of dusting of Quinolphos 1.5% dust @ 25 kg/ha at 15 days interval is recommended from the commencement of the pest appearance under rainfed conditions of North Saurashtra agroclimatic zone
    - Cercospora disease - Spray Zineb (0.2%) @ 2 kg ai/ha
    - Powdery mildew disease – spray Sulfex (80 WP) @ 2 kg ai/ha or any other sulphur containing fungicide
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan/kg of seed
  - Thinning 21 days after sowing

- Line sowing through seed drill
- RT-46, T-125, RT-54 and RT-127
- Sowing with onset of monsoon
- Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
- Sesame + mothbean/ blackgram
- Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting
- Phyllody - sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- Time of sowing: *kharif* – last week of June to second fortnight of July, semi *rabi* – mid September, *rabi* – January- February
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## Suitable cropping systems

### Ahmedabad, Rajkot, Surendranagar

- Sesame + blackgram
- Groundnut (AHT-60) + sesame (Guj. Sesame.1)
- Sesame + soybean (3:1)
- Sesame + millet (3:1)

## Farm implements/ tools

### Ahmedabad, Rajkot, Surendranagar

- For multipurpose tool bar, seed-cum-fertilizer drilling attachment (manually metered) is recommended to carry out three operations i.e. fertilizer -drilling, seed drilling and covering at a time for the farmers of North Saurashtra Agroclimatic Zone

## Alternate farming systems

### Ahmedabad, Rajkot, Surendranagar

- 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 lebbeck*, *Leucaena leucocephala*, *Albizzia lebbeck*, *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, Poultry

## **Contingent planning**

### **Ahmedabad, Rajkot, Surendranagar**

#### **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 pearl millet (GHB-235, GHB-316, GHB-558), sorghum (GJ-39, J-41), sesame (G-Sesame-1, G-Sesame-2) and 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**

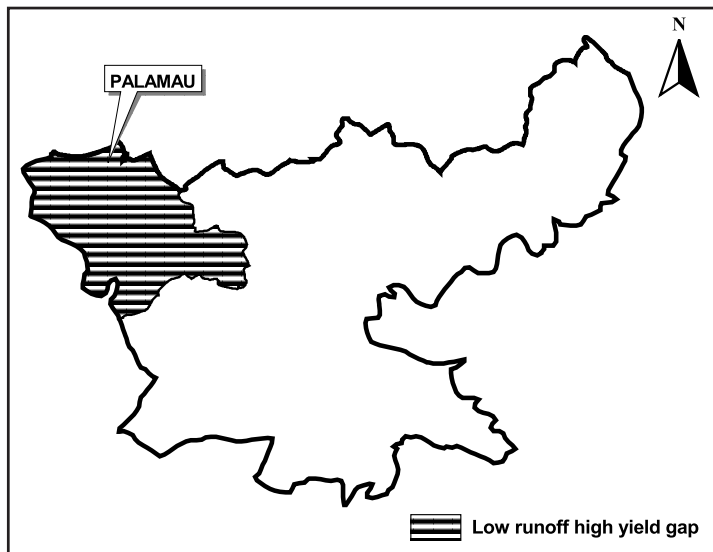
- Give life saving irrigation
- Minimize moisture losses through complete removal of weeds
- Perform interculturing to conserve soil moisture
- Harvest the crop according to maturity of crop duration
- Thin the plant population

#### **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

## JHARKHAND

In Jharkhand there is one district viz., Palamau under high runoff and high yield gap



The recommendation details follow:

District	Region
Palamau	Low runoff and high yield gap

### Agro-ecological setting

- **Climate:** Hot moist /dry sub humid
- **Physiography:** Chattisgarh / Mahanandi basin
- **Soils:** Deep loamy to clayey red and yellow soils
- **Annual rainfall:** 1237 mm
- **Potential evapotranspiration:** 1387 mm
- **Moisture availability period:** 150-180 days

### Soil and water conservation

- Sowing across the slope
- Contour farming
- The fields must be banded to conserve soil moisture in uplands
- Intercepts 1 m wide x 0.5 m deep at 20 m interval across the slope

### Crop management

- **Varieties:** Kanke white, Krishna
- **Seed rate:** 8 kg/ha
- **Planting pattern:** 30x15 cm
- **Nutrient management:** 40 kg N +40 kg P<sub>2</sub>O<sub>5</sub> +20 kg K<sub>2</sub>O/ha. All P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and 50%N should be applied as basal, remaining 50%N to be applied at 21days after sowing

## Suitable cropping systems

### Uplands

#### Mono-cropping

- Upland, finger millet, pulses, oil seeds and *khari*f vegetables like, cauliflower, capsicum, lady finger and French bean etc

#### Sequence cropping

- Rice (Brown gora 23 –19, Birsa dhan 101, and Vandana ) – Niger and Toria
- Sorghum – Linseed/ Lentil
- Cowpea – Linseed

### Intercropping

#### Pigeonpea based

- Pigeonpea (T21) + rice (Brown gora 23-19): 3 rows of rice 20 cm apart between two rows of pigeonpea two rows of pigeonpea spaced 90 cm apart
- Pigeonpea (BR 65) + Birsa dhan 101: 3 rows of rice 20 cm apart in between two rows of pigeonpea spaced 90 cm
- Pigeonpea (BR-165) + rice (Brown gora 23-19, Vandana and Birsa dhan 101): 3 rows of rice 20 cm apart in between two rows of pigeonpea spaced 90 cm
- Pigeonpea (BR 65) + Okra (Parbhani Karanti): Two rows of lady finger 25 cm apart in-between two rows of pigeonpea spaced 75 cm apart
- Pigeonpea (BR-65) + Blackgram (T9): 2 rows of blackgram 25 cm apart in between two rows of pigeonpea spaced 75 cm apart
- Pigeonpea (BR 65) + Greengram (Sunaina): 2 rows of blackgram 25 cm apart in between two rows of pigeonpea spaced 75 cm apart
- Pigeonpea (BR 65) + Soybean (Punjab – 1): Two rows of soybean 30 cm apart in between two rows of pigeonpea spaced
- Pigeonpea (BR 65) + Groundnut (AK 12-24): Two rows of groundnut 30 cm apart in between two rows of pigeonpea spaced 90 cm apart
- Pigeonpea (BR 65) + Maize Suwan composite-1: One row of maize in between two rows of maize spaced 60/75 cm apart
- Rice (Vandana) + Okra (Parbhani Karanti): 2 rows of paddy 25 cm apart, alternate two rows of lady finger 25 cm apart
- Pigeonpea (BR 65) + finger millet (direct sown): 2 rows of finger millet 25 apart in between two rows of pigeonpea 60 x 25 cm
- Sorghum (CSH 6) + blackgram (T9): Two rows of blackgram 25 cm apart in between two rows of sorghum 50 cm
- Safflower (59-2-1) + linseed (T397) : One row of linseed in between two rows of safflower 45 cm apart
- Safflower (59-2-1) + toria (BR 23): One row of toria in between two rows of safflower
- Safflower (59-2-1) + rai (BR 40): One row of toria in between two rows of safflower 45 cm
- Safflower (59-2-1) + chickpea (Pant G 14): one row of chickpea in between two rows safflower 45 cm

#### Medium lands

- Rice (IR 36, IR 64, Pant 4) linseed (T 397)/ Gram (BR 17, BR 77 and C 235)/ Safflower (A 300, 59-2-1)/ lentil (BR 25) Rai (BR 40) and Niger (N5)

#### Relay cropping

- Rice (Ladut, Swarna, IR 36 etc)- Lathers (local)

### Sequence cropping

- Rice- Linseed

### Lowland

#### Sequence cropping

- Rice (Tulegi, Pusa-44)- Late sown wheat (HPI 744)/ tomato without irrigation

### Farm Implements/ Tools

Tool / implement	Cost / unit (Rs)	Operation
Bullock drawn 2 row seed – cum – fertilizer drill	2300/-	For seeding dryland crop and fertilizer
Bullock drawn ridger – seder (single row)	480/-	For seeding when 8-10 cm topsoil gets dry, but soil Moisture is available below This depth. Seed metered by Hand
Bullock drawn potato digger	280/-	For digging potato crop
Birsa seed –cum- fertilizer drill – <i>kharif</i> crops	400/-	For interculturing operation
Dutch hoe	40/-	For interculturing operation
Grubber	40/-	For interculturing operation
Dryland weeder	80/-	For interculturing operation

### Alternate farming Systems

#### Non arable lands

- Tree farming (Sal, Teak, Shorea Robusta)
- Silvipastoral system (Shisham/ *Leucaena*/ gamhar + Stylo/ *Cenchrus*/ mixture)
- **Arable wastelands**
- Agri-horticulture: Fruit crops (Nngo/ citrus/ sapota/ pomegranate/ custardapple/ litchi/ Jack fruit, Jamun) + Field crops (Pulses/ oil seeds)
- Alley cropping: *Leucaena* + turmeric/ginger

#### Low fertility, unbunded uplands

- Transplantation of ragi, niger (Birsa niger, N5)
- Cowpea – Niger

### Contingent planning

#### Normal sowing period (15<sup>th</sup> to 30<sup>th</sup> June)

- Rice: Br.G. 23-19, Bandana, RAU. 4045 – 3
- Fingermillet: A. 404, PR. 202, IE. 723 (direct seeding as well as nursery sowing of all the 3 varieties)
- Maize: Ganga Safed, Ganga. 5, Suwan. 1
- Sorghum: CSH 5, CSH 6
- Groundnut: Ak. 12-24, Birsa Groundnut. 1, BG. 1, BG.2, Birsa bold
- Soybean : Birsa Soybean- 1, Bragg
- Pigeonpea: BR. 103, 65, Upas 120
- Greengram: Sunaina
- Blackgram: T. 9

#### Intercropping

- Pigeonpea + rice, Pigeonpea +maize, Pigeonpea + groundnut, Pigeonpea + 2 rows Pigeonpea, Pigeonpea + blackgram/greengram, (two row) Pigeonpea + 2 rows soybean

- If the onset is delayed but is expected within a week or 10 days of normal onset date – Dry seeding of all the rice and groundnut varieties mentioned above in mid June

#### **Delayed sowing period (1 – 7 July)**

- Groundnut seeding with AK. 12-24 can be extended upto first week of July. BG.1 and BG.2 should not go beyond June
- Direct seeding of finger millet: A. 404, PR. 202, IE. 723
- Pigeonpea: BR. 183, BR. 165, Upas 120, T. 21
- Blackgram: T. 9
- Maize (ridge planting): Rajendra Makka, Diara
- Pigeonpea (BR.65)+ Groundnut (AK.12-24) intercrop
- Greengram: Sunayana

#### **Much delayed sowing (2<sup>nd</sup> to 4<sup>th</sup> week of July)**

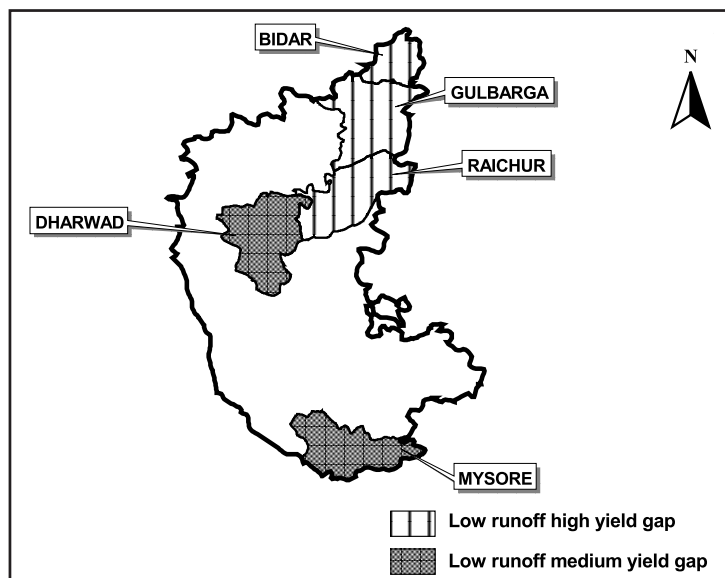
- Transplanting of finger millet (all varieties) but spacing to be reduced from 20 x 15 to 20 x 10 cm
- Greengram: Sunaina
- Blackgram: T.9
- Sesame: Kanke white (normal sowing time), Krishna
- Sweet potato: Cross 4 and Local (normal sowing time)
- Much too late for general crops (early August). Niger (N.5) and horsegram (BR 10 Madhu) are the natural choice seeding
- Transplanting of finger millet if seedlings are available could be resorted to in early August

#### **Other supportive practices**

- Apply post – monsoon pre-sowing mulching with locally available straw (10.0 t/ha) to get better plant stands of wheat
- Grow niger even as *rabi* crop if moisture is adequate for germination particularly in medium textured deep soil
- Diversify with adoption of rice, grow plant short (90-100 days), medium (120 days) and long duration (140 days) varieties of rice in tanr (upland), medium land and low (don I) land respectively on toposequence. Increase the acreage under 90-100 days varieties up to don II land to escape the damage caused due to early cessation of monsoon. Take advantage of late rains for *rabi* sowing if any
- In Finger millet – farm yard manure –(2.5 t/ha) + 40kg N (50% basal + 50% one month after transplanting) + 30kg P<sub>2</sub>O<sub>5</sub> + 20 kg K<sub>2</sub>O /ha is effective
- Chickpea – farm yard manure compost, (4 t/ha) + 30 P<sub>2</sub>O<sub>5</sub> + 20kg P<sub>2</sub>O<sub>5</sub> /ha
- Rice – early season drought (within one month after sowing) application of 5 cm minimal irrigation
- General precautions in case of delayed sowing
  - Pre-monsoon tillage will pay dividends under such a situation in keeping weeds under control
  - Crops should be spaced a little closer to compensate for loss in growing period
  - Heavier dose of basal nitrogen and less number of splits should be followed specially in short duration crops
  - Under these conditions, since there is possibility of continuous rains proper care should be taken for the drainage of upland crops that suffer from water logging at emergence state and some even at later stages

# KARNATAKA

In Karnataka there are two districts viz. Mysore and Dharwad under low runoff and medium yield gap region and three districts viz. Raichur, Gulbarga and Bidar under low runoff and high yield gap region.



The recommendation details follow:

District	Region
Bidar Gulbarga Raichur	Low runoff and high yield gap

## Agro-ecological setting

### Bidar

- **Climate:** Hot semi arid
- **Physiography:** North Karnataka Plateau (East)
- **Soils:** Shallow and Medium loamy, medium and deep clayey black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 977 mm
- **Potential evapotranspiration:** 1775 mm
- **Moisture availability period:** 120–150 days

### Gulbarga

- **Climate:** Hot semi arid
- **Physiography:** North Karnataka Plateau (North east)
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils (Vertic Inceptisols – 55%; Vertisols – 45%)
- **Annual rainfall:** 753 mm



- **Potential evapotranspiration:** 1915 mm
- **Moisture availability period:** 120–150 days

### **Raichur**

- **Climate:** Hot arid
- **Physiography:** North Karnataka Plateau (North east)
- **Soils:** Deep loamy and clayey mixed red and black soils (Vertisols – 60%; Vertic Inceptisols – 40%)
- **Annual rainfall:** 719 mm
- **Potential evapotranspiration:** 1951 mm
- **Moisture availability period:** 60–120 days

### **Soil and water conservation**

#### **Bidar**

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

#### **Gulbarga**

- 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
- Bund stabilisation through *stylosanthes spp*
- Bund planting with neem, sissoo and tamarind
- 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

#### **Raichur**

- Supplemental irrigation with harvested water
- Emphasis should be on farmer oriented soil conservation measures like *insitu* conservation measures
- Plant sunhemp in *rabi* areas
- 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*
- Bund planting with neem, sissoo and tamarind
- 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

### Bidar, Gulbarga, Raichur

- **Varieties:** TMV – 3, T-7
- **Seed rate:** 4 kg/ha for pure crop
- **Planting pattern:** 30x5 cm
- **Nutrient management:** 50 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha, apply all N and P as basal
- **Pest management**
  - Resistant/ tolerant varieties
    - Gallfly: RT-46, Swetha til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per kg of seed
  - Mix the seed with sand before sowing
  - Shallow soils: Sowing up to last week of July
  - Medium black soils: Sowing in June
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting
  - Phyllody - sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
  - Time of sowing for *kharif* is June–July

- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## **Suitable cropping systems**

### **Bidar, Gulbarga, Raichur**

- Greengram + sesame
- Sesame + pigeonpea (3:1)
- Sesame + groundnut (1:1)

## **Farm implements/ tools**

### **Bidar, Gulbarga, Raichur**

- 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 bunding. 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**

### **Bidar, Gulbarga, Raichur**

- 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:* *Cassuarina*, *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 zing conservation terrace
- **Fodder/ Green biomass:** *Dalbergia sissoo*, *Gliricidia*, *Albizia lebbeck*, *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 cattle, Male cattle, Female buffaloes, Goat, Sheep and Poultry

## Contingent crop planning

### Bidar, Gulbarga, Raichur

#### 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 and 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 compartmental 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 (spreading), 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 of dryland cotton before the middle of August. Grow Herbaceum cottons in place of Hirsutum. 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> of 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 and chickpea with 1 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%
- 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
Dharwad Mysore	Low runoff and medium yield gap

**Agro-ecological setting**

**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

### **Mysore**

- **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**

### **Dharwad**

- 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
- Bund stabilisation through *stylosanthes* spp
- Bund planting with neem, sissou and tamarind
- 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

### **Mysore**

#### **Long term 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 plough 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 *insitu* 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

### Dharwad

- **Varieties** : TMV – 3, DS1,E8
- **Seed rate**: 4 kg/ha for pure crop
- **Planting pattern**: 30x5 cm
- **Nutrient management**:
  - 50 kg N + 25 kg P<sub>2</sub>O<sub>5</sub> /ha. Apply all N, P and K as basal
- **Pest management**
  - Resistant/ tolerant varieties
    - Galfly: IS-65, RT-46, swetha til, RT – 103, RT – 108 and RT – 125
    - Galfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing.
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @1.25 kg/ha
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Mix the seed with the sand before sowing
  - Shallow soils: Sowing upto last week of July
  - Medium black soils: Sowing in June
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment

- Sesame + mothbean/ blackgram
- Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting
- Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2g+ 1g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- Time of sowing for *kharif* is June–July
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
- For interculture use hand hoe or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## Mysore

- **Varieties** : TMV – 3, DS1, E-8
- **Seed rate** : 4 kg/ha for pure crop
- **Planting pattern**: 30x5 cm
- **Nutrient management**: FYM 5 t/ha + 38 kg N + 25 kg P<sub>2</sub>O<sub>5</sub> + 25 kg K<sub>2</sub>O/ha, apply all N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as basal
- **Pest management**
  - Resistant/ tolerant varieties
    - Gallfly: IS-65, RT-46, swetha til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Intercropping of sesame with greengram and groundnut reduces damage due to gall fly and leaf roller/ capsule borer
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Mix the seed with the sand before sowing
  - Line sowing through seed drill
  - RT-46, T-125, RT-54 and RT-127



- Sowing with onset of monsoon
- Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
- Sesame + mothbean/ blackgram
- Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting
- Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- Time of sowing for *kharif* April-May
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
- For interculture, use hand hoe or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## Suitable cropping systems

### Dharwad

- Greengram + sesame
- Sesame + pigeonpea (3:1)
- Sesame + groundnut (1:1)

### Mysore

- Sesame + fingermillet
- Sesame + pigeonpea (10: 2 or 3: 1)
- Sesame + groundnut (1:1)

## Farm implements/ tools

### Dharwad

- Seed cum fertilizer drill
- Bed former
- Bullock drawn two wheeled multipurpose carrier

### Mysore

- Bullock drawn seed-cum-fertilizer drill (Fingermillet): Bullock drawn manual operation for fingermillet seeding and fertilizer application (Hand metered) Rs.1500/-
- Bullock drawn seed-cum-fertilizer drill (Groundnut): Groundnut seeding with fertilizer application Rs.1500/-
- Multifurrow opener: Opening furrows for hand seeding of different crops Rs. 1300/-

- Bent type hoe: Intercultural operation for finger millet Rs. 350/-
- Duck foot hoe: Intercultural operation for finger millet and groundnut for moisture conservation (Hand metered) Rs. 350/-
- Crust brakes: For breaking the crust to facilitate smooth emergence of the seedling in finger millet and groundnut. Rs. 500/-

## Alternate farming systems

### 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/ cassuarina + *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:** *D.sissoo*, *Gliricidia*, *A.lebbeck*, *H.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 cattle, Male cattle, Female buffaloes, Goat, Sheep, Poultry

### Mysore

- **Fodder/ Green biomass:** Casuarina, silveroak, *Gliricidia*, *Caliandra*, *Faidherbia albida* on bunds
- Gravelly shallow soils – *Stylosanthes scabra*
- High gradient non-arable lands with shallow soils – amla in catche pits with deep soils – neem, pongamia, *Albizia lebbek*
- **Forage crops** – *Pennisetum pedicellatum*/ *Cenchrus ciliaris*, *Microtalium axillaris*
- **Wastelands** – Jackfruit, Custard apple, Tamarind
- **Fruit:** Mango, Pomegranate, Sapota, Guava, Custard apple, Jamun
- **Medicinal/ Aromatic Plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Solanum viarum*, *Dioscorea*, *Geranium*, *Pogostemon patchouli*, *Jasmine*
- **Vegetables:** Tomato, Chillies, Okra, Water melon, Bitter gourd, Drumstick, Brinjal, Bitter gourd
- **Animal component:** Male / Female cattle, Female buffaloes, Poultry, Sheep, Goat
- **Other enterprises:** Mushroom cultivation, Sericulture, Piggery, Apiary, Rabbit rearing

## Contingent planning

### 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 compartmental 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 (spreading), 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 Herbaceum cottons in place of Hirsutum. 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> of 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 fertilizers. Fertilizers may be applied at appropriate growth stage having optimum moisture condition

### **Sowing in October:**

- Continue the 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

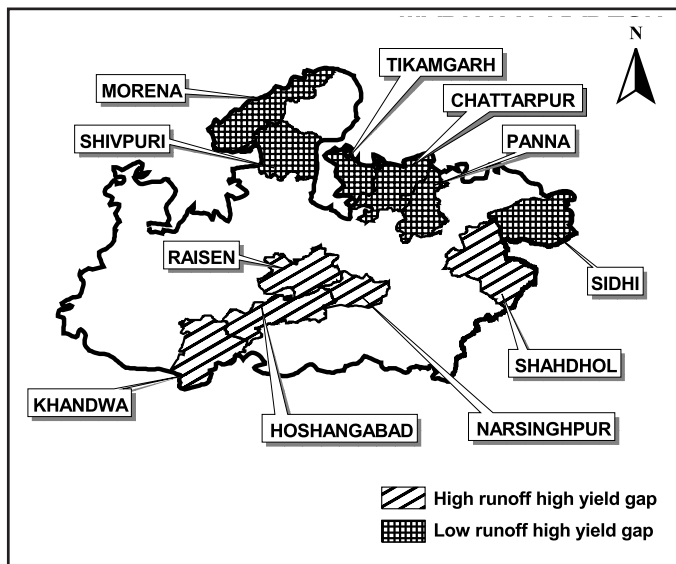
### **Mysore**

- **Second fortnight of April:**
  - Double cropping: Sesame or greengram
- **First fortnight of May:**
  - Monocropping: Pigeonpea
  - Double cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum
- **Second fortnight of May:**
  - Monocropping: Pigeonpea
  - Double cropping: Sesame, cowpea, greengram, blackgram, fodder maize, fodder pearl millet, fodder sorghum
- **First fortnight of June:**
  - Monocropping: Long duration finger millet, pigeonpea, maize, groundnut
  - Double cropping: Fodder maize, Fodder sorghum, Fodder pearl millet, cowpea
- **Second fortnight of June:**
  - Monocropping: Long duration finger millet, pigeonpea, maize and groundnut
  - Double cropping: Sowing of chilli nursery

- **First fortnight of July:**
  - Monocropping: Groundnut, long duration fingermillet
  - Double cropping: Sowing of chilli nursery
- **Second fortnight of July:**
  - Monocropping: Groundnut, long/medium duration fingermillet
  - Double cropping: Sowing of Chilli nursery
- **First fortnight of August:**
  - Monocropping: Cowpea, horsegram, short duration fingermillet, transplanting chilli
  - Double 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
  - Double cropping: Short duration fingermillet, transplanting of medium and long duration fingermillet, transplanting chilli, cowpea, horsegram. Also, Fodder crops (maize-pearlmillet, sorghum)
- **First fortnight of September:**
  - Monocropping: horsegram, transplanting of short duration fingermillet and chilli (with protective irrigation)
  - Double cropping: horsegram, transplanting of short duration fingermillet and chilli (with protective irrigation)

## MADHYA PRADESH

In Madhya Pradesh there are six districts viz. Morena, Shivpuri, Panna, Tikamgarh, Chattarpur and Sidhi under low runoff and high yield gap region and five districts viz. Shahdhol, Narsinghpur, Raisen, Khandwa and Hosanghabad under high runoff and high yield gap region.



The recommendation details follow:

District	Region
Chattarpur	Low runoff and High yield gap
Morena	
Panna	
Shivpuri	
Sidhi	
Tikamgarh	
Khandwa	High runoff high yield gap
Raisen	
Hoshangabad	
Narsinghpur	
Sidhi	

### Agro-ecological setting

#### Chattarpur

- **Climate:** Hot dry sub humid
- **Physiography:** Vindhyas scarplands
- **Soils:** Deep loamy to clayey mixed red and black soils (Vertic Inceptisols – 80%; Inceptisols – 20%)
- **Annual rainfall:** 1044 mm
- **Potential evapotranspiration:** 1429 mm
- **Moisture availability period:** 150–180 days

#### Morena

- **Climate:** Hot moist semi arid
- **Physiography:** Madhya Bharat Plateau
- **Soils:** Deep loamy and clayey mixed red and black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 927 mm

- **Potential evapotranspiration:** 1516 mm
- **Moisture availability period:** 120–150 days

#### **Panna**

- **Climate:** Hot dry sub humid
- **Physiography:** Vindhyan scraplands
- **Soils:** Deep loamy to clayey mixed red and black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1186 mm
- **Potential evapotranspiration:** 1436 mm
- **Moisture availability period:** 150–180 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

#### **Sidhi**

- **Climate:** Hot dry sub humid
- **Physiography:** Baghelkhand plateau
- **Soils:** Deep loamy to clayey mixed red and black soils (Alfisols/ Ustolls – 75%; Vertic Inceptisols – 25%)
- **Annual rainfall:** 1174 mm
- **Potential evapotranspiration:** 1468 mm
- **Moisture availability period:** 150–180 days

#### **Tikamgarh**

- **Climate:** Hot dry sub humid
- **Physiography:** Vindhyan scraplands
- **Soils:** Deep loamy to clayey mixed red and black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1100 mm
- **Potential evapotranspiration:** 1485 mm
- **Moisture availability period:** 150–180 days

### **Soil and water conservation**

#### **Chattarpur, Panna, Sidhi, Tikamgarh**

- Broadbed furrow
- Contour farming

- Inter-plot water harvesting
- Raised bed and sunken system

### **Morena, Shivpuri**

- Compartment bunding after seedling 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
- Gully plugging

### **Crop management**

#### **Chattarpur, Panna, Sidhi, Tikamgarh**

- **Varieties:** JT-7, N-32, TKG-21, TKG-22, Uma, RT-46, JTS-8,TKG-55
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30 X15 cm
- **Nutrient management:** 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha as basal
- **Pest management:**
  - Resistant/ tolerant varieties
    - Gallfly: RT-46, Swetha til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Line sowing through seed drill
  - Normal rainfall - Last week of June and in the first week of July
  - Late onset of monsoon - Second week of July
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought



- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- For Phytophthora blight and cercospora leaf spot – sesame + pearl millet (4:1) and early planting
- Phyllody - sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3g/kg) /Mancozeb/ Thiram + Bavistin (2g+ 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

### Morena, Shivpuri

- **Varieties** : T – 4, T – 12, TKG-12, TKG-22, TKG-55, JTS-8
- **Seed rate**: 5 kg/ha for pure crop
- **Planting pattern**: 30 X15 cm
- **Nutrient management**: 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha as basal
- **Pest management**:
  - Resistant /tolerant varieties
    - Gallfly: RT-46, Swetha til, RT – 103 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ Blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting

- Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g + 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
- For interculture, use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

### **Suitable cropping systems**

#### **Chattarpur, Panna, Sidhi, Tikamgarh**

- Sesame + rapeseed mustard
- Cotton – sesame
- Sesame + greengram (1:1)
- Sesame + soybean (2:1)

#### **Morena, Shivpuri**

- Sesame + groundnut (1:1)
- Groundnut + sesame (6:2 or 6:3)
- Sesame + rapeseed mustard
- Cotton – sesame
- Sesame + greengram (1:1)
- Sesame + soybean (2:1)

### **Farm implements/ tools**

#### **Chattarpur, Panna, Sidhi, Tikamgarh**

- Dryland weeder

#### **Morena, Shivpuri**

- Dryland weeder is quite effective and economic in controlling the weeds in both seasons
- Fertilizer cum seed drill

### **Alternate farming systems**

#### **Chattarpur, Panna, Sidhi, Tikamgarh**

- **Agro – hortisystem:** Mango + pea/ berseem (green fodder)/ wheat/ chickpea / soybean
- **Silvi – pastoral system:** Teak + sudan grass
- **Fodder/ Green biomass:** *Leucaena leucocephala*, *Albizia amara*, *Dichrostachys cinerea*, *Melia azadirach*, *Hardwickia binata*, *Albizia lebbeck*
- **Fruit:** Mango, Ber, Guava, Tamarind, Caronda

- **Medicinal/ Aromatic Plants:** *Safed musli, Palma rosa, Withania somnifera, Papaver somniferum, Vetiveria zizanioides*
- **Vegetables:** Brinjal, Chilli, Cowpea, Okra, Bottle gourd, Round melon
- **Animal component:** Female cattle, Male cattle, Female buffaloes, Goats

### Morena

- **Agro – hortisystem:** Mango + pea/ berseem (green fodder) / Wheat/ chickpea/ soybean
- **Silvi – pastoral system:** Teak + sudan grass
- **Fodder/ Green biomass:** *Azadirachta indica, Leucaena leucocephala, Albizzia lebbeck, Hardwickia binata, Pongamia, Cassia siamea, Bauhinia*
- **Fruit:** Mango, Gauva, Amla, Phalsa, Jamun, karonda
- **Medicinal/ Aromatic Plants:** *Papaver somniferum, Palma rosa, Cymbopogon flexuosus, Vetiveria zizanioides*
- **Vegetables:** Tomato, Chillies, Brinjal, Okra, Bottle gourd, Amaranthus, Cowpea
- **Animal Component:** Female cattle, Female buffaloes, Goat, Poultry

### Shivpuri

- **Agro – hortisystem:** Mango + Pea / Berseem (green fodder) / Wheat/ chickpea/ soybean
- **Silvi – pastoral system:** Teak + Sudan grass
- **Fodder/ Green biomass:** *Leucaena, Melia azadirach, Dichrostachys cinerea, Albizzia amara, Albizzia lebbeck, Hardwickia binata, Acacia nilotica*
- Ley farming – Four years continuous raising of *Stylosanthes hamata* followed by Sorghum
- **Fruit:** *Embllica officinalis* (amla), Guava, Ber, Mango
- **Medicinal and aromatic plants:** *Rauvolfia serpentina, Vetiveria zizanioides, Palma rosa, Safed musli, Aswagandh*
- **Vegetables:** Bottle gourd, Brinjal, Tomato, Chillies, Brinjal, 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

#### Chattarpur, Panna, Sidhi, Tikamgarh

#### Cropping systems under drylands

- June
  - Sole crop
    - Sorghum (CSH 5, JS 1041)
    - Greengram (K 850)
    - Blackgram (JU 2, PDU 4)
    - Groundnut (Jawahar Jyoti, M 13)
  - Inter crop
    - Sorghum + pigeonpea (2:1)
    - Soybean + pigeonpea (2:1)

- July
  - Sole crop
    - Rice (IR 50, JR 345)
    - Kodo (JK 155, JK 76, JK 136)
    - Sorghum (CSH 5)
    - Pigeonpea (NPWR –15, JA4, Asha)
    - Groundnut (Jyoti, M 12, Exotic 1-1)
  - Inter crop
    - Sorghum + pigeonpea (2:1)
    - Soybean + pigeonpea (2:1)
- August
  - Castor (Aruna)
  - Pigeonpea (No.148)
- October
  - Wheat (JW 17, C 306)
  - Chickpea (JG 321, JG 315)
  - Linseed (JL 23, R 552)
  - Barley (Karan 4, Jyoti)
  - Lentil (JL 1, Malika)

## Morena, Shivpuri

### Kharif

- Under normal rainfall: Pearl millet (Proagro 9402), pigeonpea (UPAS 120), greengram (K 851), clusterbean (RGC 197)
  - As the monsoon progresses
  - 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

District	Region
Hoshangabad Khandwa Narsinghpur Raisen Shahdol	High runoff and High yield gap

## **Agro-ecological setting**

### **Hoshangabad**

- **Climate:** Hot dry sub humid
- **Physiography:** Central Narmada valley
- **Soils:** Medium and deep clayey black soils, shallow loamy black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1385 mm
- **Potential evapotranspiration:** 1597 mm
- **Moisture availability period:** 150–180 days

### **Khandwa**

- **Climate:** Hot moist /dry sub humid
- **Physiography:** Malwa plateau
- **Soils:** Deep clayey black soils, shallow black soils (Vertic Inceptisols -100%)
- **Annual rainfall:** 961 mm
- **Potential evapotranspiration:** 1728 mm
- **Moisture availability period:** 120-150/150-180 days

### **Narasinghpur**

- **Climate:** Hot dry sub humid
- **Physiography:** Central Narmada Valley
- **Soils:** Medium and deep clayey black soils, shallow loamy black soils (Vertisols – 80%; Vertic Inceptisols – 20%)
- **Annual rainfall:** 1690 mm
- **Potential evapotranspiration:** 1430 mm
- **Moisture availability period:** 150–180 days

### **Raisen**

- **Climate:** Hot dry sub humid
- **Physiography:** Vindhyan Scraplands / Malwa plateau
- **Soils:** Medium and deep clayey black soils, shallow loamy black soils (Vertic Inceptisols – 80%; Vertisols- 20%)
- **Annual rainfall:** 1595 mm
- **Potential evapotranspiration:** 1527 mm
- **Moisture availability period:** 150 - 180 days

### **Shahdhol**

- **Climate:** Hot dry sub humid
- **Physiography:** Vindhyan Scraplands
- **Soils:** Deep loamy to clayey mixed red and black soils (Vertic Inceptisols – 60%; Alfisols/ Ustolls – 40%)

- **Annual rainfall:** 1335 mm
- **Potential evapotranspiration:** 1342 mm
- **Moisture availability period:** 150–180 days

## Soil and water conservation

### Hoshangabad, Khandwa, Narasinghpur, Raisen

- 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 watershed area to use stored water for irrigation purpose.
- Silpaulin (a plastic material) of 90 – 120 gsm has been found as an 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.
- Ensure drainage line treatment for providing safe disposal of excess runoff 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 proves most effective in controlling soil erosion and nutrient losses on soils having slope up to 2%.
- Off-season shallow tillage is important not only in controlling the weeds but also in helping entry of rain water.
- Develop a sort of terracing to break the continuity of undulating slope to reduce the changes of degrading cultivated fields into gullied one.
- Provide *insitu* soil mulch by operating bullock drawn dora to fill up the cracks, to conserve the 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.

### Shahdhol

- Broadbed furrow
- Contour farming
- Inter-plot water harvesting
- Raised bed and sunken system

## Crop management

### Hoshangabad, Khandwa, Narasinghpur, Raisen, Shahdhol

- **Varieties :** G-5, JT-7, N-32, TKG-21, TKG-22, Uma, JP-7, RT-46 and Rama (Shahdhol)
- **Seed rate:** 5 kg/ha for pure crop

- **Planting pattern:** 30 X 15 cm
- **Nutrient management:** 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub> /ha as basal
- **Pest management:**
  - Resistant/ tolerant varieties
    - Gallfly: IS-65, RT-46, Swetha til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 12
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting
  - Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3g/kg)/ mancozeb/ thiram + bavistin (2g+ 1 g) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
  - A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
  - For interculture, use hand hoes or bullock drawn blade harrow
  - Provide protective irrigation during *kharif* season wherever possible

## Suitable cropping systems

### Hoshangabad, Khandwa, Narasinghpur, Raisen

- Soybean – sesame
- Cotton – sesame

- Sesame + greengram (1:1)
- Sesame + soybean (2:1)

### Shahdhol

- Cotton – sesame
- Sesame + greengram (1:1)
- Sesame + soybean (2:1)

### Farm implements/ tools

#### Hoshangabad, Narasinghpur, Raisen

- Suitable implements for seed bed preparations:
  - Meston Plough
  - Iron Bakhar
- Suitable implements for sowing operations:
  - Mahakal Dufan
  - Mahakal Tifan and
  - Sarta attachment for intercropping
- Suitable implements / tools for interculture operations:
  - Hand dora (small blade harrow)
  - Bullock drawn dora (small blade harrow with wooden beam)
  - Indore ridger

### Shahdhol

- Dryland weeder

### Alternate farming systems

#### Narasinghpur

- **Fodder/ Green biomass:** *Dichrostachys cinerea*, *Albizia amara*, *Faidherbia albida*, *Harwickia binata*, *Cassia*, *Leucaena leucocephala*, *Albizia lebbeck*
- **Fruit:** Ber, Pomegranate, Mango, Fig, Tamarind
- **Medicinal/ Aromatic Plants:** *Withamnia somnifera*, *Rauvolfia serpentina*, *Vetiveria zizanoides*, *Palma rosa*
- **Vegetables:** Chillies, Okra, Watermelon, Cowpea, Cluster bean, Amaranthus, Round melon
- **Animal component:** Male/ Female cattle, Female buffaloes, Sheep, Goat

#### Hoshangabad, Khandwa, Raisen

- **Agro – hortisystem:** Mango + pea / berseem (green fodder) / wheat/ chickpea/ soybean
- **Silvi – pastoral system:** Teak + Sudan grass
- **Fodder/ Green biomass:** *Dichrostachys cinerea*, *Albizzia amara*, *Faidherbia albida*, *Hardwickia binata*, *Cassia*, *Leucaena leucocephala*, *Albizzia lebbeck*
- **Fruit:** Ber, Pomegranate, Mango, Fig, Tamarind



- **Medicinal/ Aromatic Plants:** *Withamnia somnifera*, *Rauvolfia serpentina*, *Vetiveria zizanoides*, *Palma rosa*, *Liquorice*
- **Vegetables:** Chillies, Okra, Watermelon, Cowpea, Cluster bean, Amaranthus, Round melon
- **Animal component:** Male/Female cattle, Female buffaloes, Sheep, Goat, Dairy

### Shahdhol

- **Fodder/ Green biomass:** *Leucaena leucocephala*, *Albizia amara*, *Dichrostachys cinerea*, *Melia azadirach*, *Hardwickia binata*, *Albizia lebbeck*
- **Fruit:** Mango, Ber, Guava, Tamarind, karonda
- **Medicinal/ Aromatic Plants:** *Safed musli*, *Palma rosa*, *Withania somnifera*, *Papaver somniferum*, *Vetiveria zizanoides*
- **Vegetables:** Brinjal, Chilli, Cowpea, Okra, Bottle gourd, Round melon
- **Animal component:** Female cattle, Male cattle, Female buffaloes, Goats

### Contingent planning

#### Hoshangabad, Khandwa, Narasinghpur, Raisen

If monsoon is delayed or there is 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 and ICPL 88039)
  - Sunflower – Morden, Surya, Manjira and any other hybrids
  - Sesame – Bhadeli, TKG 22 and TKG 21
  - Cowpea – Pusa Komal and Pusa Baisakhi
  - Castor – Gauch and Varuna
  - Fodder crops – *Sorghum sudanensis*, Maize- (African tall) Dinanath grass and Pearl millet
- 1<sup>st</sup> to 15<sup>th</sup> August
  - Sunflower – Morden, Surya, Manjira and any of the hybrids
  - Sesame – Bhadeli, TKG 22, TKG 37
  - Cowpea – Pusa Komal and Pusa Baisakhi
  - Rajgira (Amaranthus)- CO-1 and CO-2
  - Castor- Gauch and Varuna.
  - Fodder crops – *Sorghum Sudanensis*, Maize (African tall), Dinanath grass and Pearl millet
- 15<sup>th</sup> to 31<sup>st</sup> August
  - Safflower – JSF-1, JSF- 7 (spineless), JSF-73 and Sharda
  - Sunflower – Morden, Surya and Manjira
  - Sesame – Bhadeli, TKG 22 and RT-46
  - Rajgira – CO-1 and CO-2
  - Castor- Gauch and Varuna
  - Fodder crops – Barley, Oats, Maize (African tall), Safflower and Sunflower

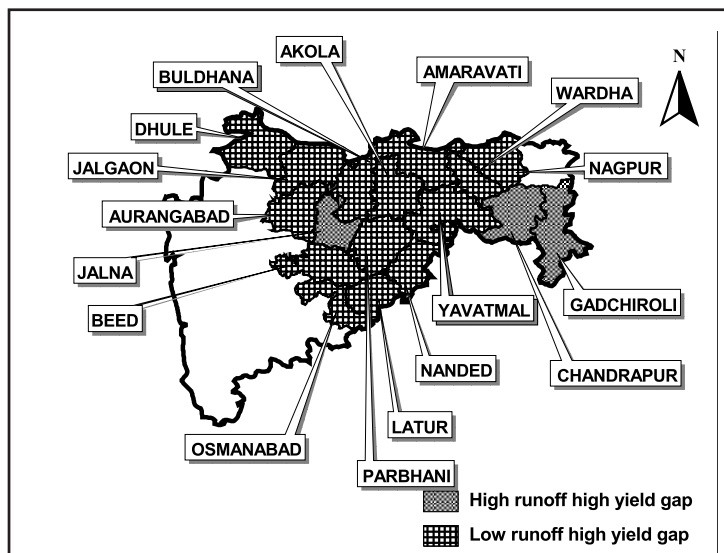
## Shahdhol

### Cropping systems under drylands

- June
  - Sole crop
    - Sorghum (CSH 5, JS 1041)
    - Greengram (K 850)
    - Blackgram (JU 2, PDU 4)
    - Groundnut (Jawahar Jyoti, M 13)
  - Inter crop
    - Sorghum + pigeonpea (2:1)
    - Soybean + pigeonpea (2:1)
- July
  - Sole crop
    - Rice (IR 50, JR 345)
    - Kodo (JK 155, JK 76, JK 136)
    - Sorghum (CSH 5)
    - Pigeonpea (NPWR -15, JA4, Asha)
    - Groundnut (Jyoti, M 12, Exotic 1-1)
  - Inter crop
    - Sorghum + pigeonpea (2:1)
    - Soybean + pigeonpea (2:1)
- August
  - Castor (Aruna)
  - Pigeonpea (No.148)
- October
  - Wheat (JW 17, C 306)
  - Chickpea (JG 321, JG 315)
  - Linseed (JL 23, R 552)
  - Barley (Karan 4, Jyoti)
  - Lentil (JL 1, Malika)

## MAHARASHTRA

In Maharashtra there are fourteen districts viz., Amaravati, Dhule, Aurangabad, Beed, Nanded, Jalgaon, Latur, Parbhani, Osmanabad, Akola, Buldhana, Nagpur, Yavatmal and Wardha under low runoff and high yield gap region and three districts viz. Chandrapur, Gadchiroli and Jalna under high runoff and high yield gap region.



The recommendation details follow:

District	Region
Akola	Low runoff and High yield gap
Amaravati	
Aurangabad	
Beed	
Buldhana	
Dhule	
Jalgaon	
Latur	
Nagpur	
Nanded	
Osmanabad	
Parbhani	
Wardha	
Yavatmal	

### Agro-ecological setting

#### Akola

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Maharashtra Plateau
- **Soils:** Medium and deep clayey black soils, shallow loamy to clayey black soils (Vertic Inceptisols – 60%)
- **Annual rainfall:** 878 mm
- **Potential evapotranspiration:** 1730 mm
- **Moisture availability period:** 120-150 days

### **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

### **Aurangabad**

- **Climate:** Hot semi arid
- **Physiography:** Central Maharashtra Plateau
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils (Vertic Inceptisols – 80%; Vertisols – 20%)
- **Annual rainfall:** 786 mm
- **Potential evapotranspiration:** 1774 mm
- **Moisture availability period:** 120-150 days

### **Beed**

- **Climate:** Hot dry semi arid
- **Physiography:** South Western Maharashtra Plateau
- **Soils:** Shallow and medium loamy black soils, deep clayey black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 685 mm
- **Potential evapotranspiration:** 1606 mm
- **Moisture availability period:** 90-120 days

### **Buldhana**

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Maharashtra Plateau
- **Soils:** Medium and deep clayey black soils, shallow loamy to clayey black soils (Vertic Inceptisols – 75%; Vertisols – 25%)
- **Annual rainfall:** 901 mm
- **Potential evapotranspiration:** 1648 mm
- **Moisture availability period:** 120-150 days

### **Dhule**

- **Climate:** Hot semi arid
- **Physiography:** Central 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

### **Jalagaon**

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

### **Latur**

- **Climate:** Hot moist semi arid
- **Physiography:** Central Maharashtra Plateau
- **Soils:** Shallow and medium loamy, black soils, medium and deep clayey black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 891 mm
- **Potential evapotranspiration:** 1861 mm
- **Moisture availability period:** 120–150 days

### **Nagpur**

- **Climate:** Hot dry sub humid
- **Physiography:** Eastern Maharashtra Plateau
- **Soils:** Shallow and medium loamy to clayey black soils, deep clayey black soils (Vertisols-60%, Inceptisols-20%, Eutisols-20%)
- **Annual rainfall:** 1242 mm
- **Potential evapotranspiration:** 2050 mm
- **Moisture availability period:** 150–180 days

### **Nanded**

- **Climate:** Hot semi arid
- **Physiography:** Central Maharashtra Plateau
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils (Vertic Inceptisols – 60%; Vertisols – 25%)
- **Annual rainfall:** 915 mm
- **Potential evapotranspiration:** 1789 mm
- **Moisture availability period:** 120–150 days

### **Osmanabad**

- **Climate:** Hot moist semi arid
- **Physiography:** South Western Maharashtra Plateau
- **Soils:** Shallow and medium loamy and deep clayey black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 809 mm

- **Potential evapotranspiration:** 1984 mm
- **Moisture availability period:** 120–150 days

#### **Parbhani**

- **Climate:** Hot semi arid
- **Physiography:** Central Maharashtra plateau
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils (Vertic Inceptisols-75%, Vertisols-25%)
- **Annual Rainfall:** 905 mm
- **Potential evapotranspiration:** 1769 mm
- **Moisture availability period:** 120-150 days

#### **Wardha**

- **Climate:** Hot dry sub humid
- **Physiography:** Eastern Maharashtra Plateau
- **Soils:** Shallow and medium loamy to clayey black soils, deep clayey black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1144 mm
- **Potential evapotranspiration:** 1788 mm
- **Moisture availability period:** 150–180 days

#### **Yavatmal**

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Maharashtra Plateau
- **Soils:** Medium and deep clayey black soils, shallow loamy to clayey black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1133 mm
- **Potential evapotranspiration:** 1775 mm
- **Moisture availability period:** 120–150 days

### **Soil and water conservation**

#### **Akola, Amaravati, Nagpur, Wardha, Yavatmal**

- On sloppy land, contour cultivation along vegetative hedge of vetiver or *Leucaena* at 0.5 m vertical interval
- Broad bed furrows
- Compartment bunding
- Sowing across the slope
- Contour farming (cultivation and sowing along contour)

#### **Buldhana**

- Importance for permanent soil conservation measures
- Water harvesting for raising a successful second crop may be encouraged
- Suitable for surface drainage measures to avoid water logging

- On sloppy land, contour cultivation along vegetative hedge of vetiver or *Leucaena* at 0.5 m vertical interval
- Broad bed furrows
- Compartment bunding
- Sowing across the slope

#### **Aurangabad, Beed, Dhule, Jalagaon, Latur, Osmanabad, Parbhani**

- 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

#### **Nanded**

- Contour bunds
- Graded bunds for high rainfall areas
- Suitable surface drainage measures in high rainfall and deep black soils to avoid water logging
- Supplemental irrigation in high rainfall areas with harvested water during dry spells
- *In situ* conservation measures like mulching, conservation furrows, deep tillage
- Compartment bunding and ridges and furrows prior to sowing
- Marvel-8 grass on bunds for protection of bunds
- Contour live bunds of Marvel-8 of *Leucaena*
- *Leucaena* cropping mulch at 3.5 t/ha

#### **Crop management**

#### **Akola, Amaravati, Aurangabad, Beed, Buldhana, Dhule, Jalagaon, Latur, Nagpur, Nanded, Osmanabad, Parbhani, Wardha, Yavatmal**

- **Varieties** : T-85, Phule Til -1, RT-54, RT-103, AKT-64, Tapi and Padma
- **Seed rate**: 5 kg/ha for pure crop
- **Planting pattern**: 30 X 5 cm
  - *Kharif* – 30 X 15 cm
  - *Rabi* – 45 X 12 cm
- **Nutrient management**: 50 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha
- **Pest management**
  - Resistant /tolerant varieties
    - Gallfly: RT-46, Swetha til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha til, Krishna and N-32.
    - Apply Phorate 10 g @ 10 kg/ha as basal application

- Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
- Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
- Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
- Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Mix the seed with the sand before sowing
  - Line sowing through seed drill
  - Thinning 21 days after sowing
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting
  - Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
  - Tetracycline 500 ppm sprays at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
  - Time of sowing – *kharif* – second fortnight of June to first week of July, semi *rabi* – early September
  - 50 kg N, half of N at 3 weeks after of sowing and remaining half 9 weeks after sowing
  - A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
  - For interculture use hand hoes or bullock drawn blade harrow
  - Provide protective irrigation during *kharif* season wherever possible

### **Suitable cropping systems**

#### **Akola, Amaravati, Buldhana, Nagpur, Wardha, Yavatmal**

- Greengram + sesame
- Sesame – safflower
- Sesame – safflower/ *rabi* sorghum
- Sesame (early)- *rabi* sorghum/ safflower

#### **Aurangabad, Beed, Dhule, Jalagaon, Latur, Nanded, Osmanabad, Parbhani**

- Greengram + sesame
- Sesame + pigeonpea



- Sesame – safflower
- Sesame –safflower/ *rabi* sorghum
- Sesame (early)- *rabi* sorghum/ safflower

### Farm implements/ tools

#### Akola, Amaravati, Nagpur, Wardha, Yavatmal

- 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

#### Beed, Dhule, Jalagaon, Latur, Nanded, Osmanabad

- 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 bunding. 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, pearl millet, pigeonpea etc. and identified for sowing of the crops of dryland region. Rs.9000/-

#### Aurangabad, Buldana, Parbhani

- Bullock drawn two row seed cum fertilizer drill
- Bullock drawn shivaji multipurpose farming machine

### Alternate farming systems

#### Akola, Amaravati, Nagpur, Wardha, Yavatmal

- **Fodder/ Green biomass:** *Leucaena Leucocephala*, *Albizia lebbeck*, *Dalbergia sissoo*, *A. procera*, *Gliricidia*
- **Fruit:** Pomegranate, Ber, Mango, Sapota, Guava, Tamarind
- **Medicinal/ Aromatic Plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, *Ocimum viride*
- **Vegetables:** Onion, Chilli, Brinjal, Okra, Amaranthus, Bottle gourd.
- **Animal component:** Male/Female cattle, Female buffaloes, Sheep, Goat, Poultry

### Dhule, Jalagaon, Osmanabad

- **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:** *Dalbergia sissoo*, *Albizia lebbbeck*, *Anogeissus latifolia*, *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

### Parbhani

- 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*, *Azadirachta indica*, *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

### Aurangabad, Buldana

- **Fodder/ Green biomass:** Stylo sole and stylo-marvel pastural system recorded higher green fodder yield than sole or combination of grasses *Leucaena leucocephala*, *A.lebbbeck*, *D.sissoo*, *A.indica*, *A.procera*, *Gliricidia*
- **Fruit:** Ber agro-horticulture system (ber + short duration legume crop) was found more remunerative than amla and custard apple horticulture system Pomegranate, Ber, Mango, Sapota, Guava, Tamarind
- **Medicinal & Aromatic Plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, *Ocimum viride*
- **Vegetables:** Onion, Chilli, Brinjal, Okra, Amaranthus, Bottle - gourd.
- **Animal Component:** Female Cattle, Male Cattle, Female Buffaloes, Goat, Poultry

### Beed, Nanded

- Agri-horti 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

### Latur, Osmanabad

- **Agri-horti 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*, *Azadirachta indica*, *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, loup melon
- **Animal component:** Female buffalo/ sheep, goat

### Crop planning as per soil depth

Soil depth (cm)	Available moisture (mm)	Crops to be taken
< 7.5	15-20	Grasses, Agroforestry, Dryland Horticulture
7.5 – 22.5	30-35	Grasses, Horsegram, Mothbean, Castor, Agroforestry, Dryland Horticulture, Pearl millet + horsegram / mothbean (2:1)
22.5 – 45	40-65	Sunflower, Pearl millet, Pigeonpea, Pearl millet + pigeonpea (2:1), Pigeonpea + clusterbean (1:2), Castor + clusterbean (1:2), Castor + ridge gourd, castor 90x45 cm line sowing of ridge gourd in the castor row at 100 cm spacing.
45 – 60	60-150	Rabi sorghum, Safflower, Sunflower & Chickpea.
> 60	> 150	Rabi sorghum, Safflower, Sunflower, Chickpea and Double cropping.

### Alternate land use system

#### Aurangabad, Beed, Nanded, Latur, Parbhani, Osmanabad

- 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 the alternate trees at 7<sup>th</sup> year onwards for fuel is also recommended.
- For productivity increment in scarcity area, pearl millet + pigeonpea (2:1) intercropping or Ber (5x5 m) + mothbean (8 lines) is advocated.

## **Contingent planning**

### **Akola, Amaravati, Buldhana, Nagpur, Wardha, Yavatmal**

#### **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)**

- Cotton – inter specific cultivation of Hirsutum cotton AKA-7 with AKH 4 cotton
- Hybrid cotton AKH 4
- 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 be 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 per cent 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 *khari*f crop fails, then follow *rabi* crop safflower (N.7), pigeonpea (C-11) in September

## Extended monsoon

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

### Aurangabad, Beed, Dhule, Jalagaon, Latur, Nanded, Osmanabad, Parbhani

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

District	Region
Chandrapur Gadchiroli Jalna	High runoff and High yield gap

## Agro-ecological setting

### Chandrapur

- **Climate:** Hot dry sub humid/ Hot moist sub humid
- **Physiography:** Eastern Maharashtra Plateau (Dandakaranya)
- **Soils:** Shallow and medium loamy to clayey black soils, deep clayey black soils, deep loamy red and lateritic soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1474 mm

- **Potential evapotranspiration:** 1579 mm
- **Moisture availability period:** 150–210 days

### **Gadchiroli**

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern Maharashtra Plateau (Dandakaranya)
- **Soils:** Deep loamy red and lateritic soils (Ustrochepts/ Alfisols – 60%; Aridisols – 40%)
- **Annual rainfall:** 1574 mm
- **Potential evapotranspiration:** 1574 mm
- **Moisture availability period:** 150–210 days

### **Jalna**

- **Climate:** Hot semi arid
- **Physiography:** Central Maharashtra Plateau
- **Soils:** Shallow and medium loamy, medium and deep clayey black soils (Vertic Inceptisols – 75%; Vertisols – 25%)
- **Annual rainfall:** 1472 mm
- **Potential evapotranspiration:** 1559 mm
- **Moisture availability period:** 120–150 days

## **Soil and water conservation**

### **Chandrapur, Gadchiroli**

- On sloppy land contour cultivation along vegetative hedge of vetiver or leucaena at 0.5 m vertical interval
- Broad bed furrows
- Compartment bunding
- Sowing across the slope
- Contour farming (cultivation and sowing along contour)

### **Jalna**

- 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

## **Crop management**

### **Chandrapur, Gadchiroli, Jalna**

- **Varieties :** T-85, Phule Sesame –1, RT-54, RT-103, Padma, Tapi, AK764 and AKT101
- **Seed rate:** 5 kg/ha for pure crop

- **Planting pattern:** 30x5 cm
  - *Kharif* – 30X15 cm
  - *Semi rabi* – 45X12 cm
- **Nutrient management:** 50 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha
- **Pest management**
  - Resistant/ tolerant varieties
    - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha Til, Krishna and N-32
    - Apply Phorate 10 gm @ 10 kg/ha as basal application
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per kg of seed
  - Mix the seed with sand before sowing
  - Line sowing through seed drill
  - Thinning at 21 days after sowing
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
  - Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 gm/kg) /Mancozeb/ Thiram + Bavistin (2 gm+ 1 gm) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with Cowpea, Pigeonpea, Pearl millet, Greengram, Blackgram, Mothbean and Sunflower is effective for minimizing the damage by insect pests
  - Time of sowing – *kharif* – second fortnight of June to first week of July, *semi rabi* – early September

- 50 kg N half of N at 3 weeks after of sowing and remaining half at 9 weeks after sowing
- A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
- For interculture, use hand hoe or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## **Suitable cropping systems**

### **Chandrapur, Gadchiroli**

- Greengram + sesame
- Sesame – safflower
- Sesame – safflower/ *rabi* sorghum
- Sesame (early)- *rabi* sorghum/ safflower

### **Jalna**

- Greengram + sesame
- Sesame + pigeonpea
- Sesame – safflower
- Sesame –safflower/ *rabi* sorghum
- Sesame (early)- *rabi* sorghum/ safflower

## **Farm implements/ tools**

### **Chandrapur, Gadchiroli**

- 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
- Manually operated fertilizer drill
- Bullock drawn serrated blade for intercultivation

### **Jalna**

- 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 compartmental bunding. Rs.1050/-
- Baliram plough: Identified for moisture conservation practices like ridges and furrows and compartmental 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, pearl millet, pigeonpea etc. and identified for sowing of the crops of dryland region. Rs.9000/-

## Alternate farming systems

### Chandrapur, Gadchiroli

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

### Jalna

- Agri-horti 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 lebbeck*, *Dalbergia sissoo*, *Azadirachta indica*, *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, Loup melon
- **Animal component:** Female buffalo/ Sheep, Goat

## Alternate land use system

### Jalna

- 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 the alternate trees at 7<sup>th</sup> year onwards for fuel is also recommended
- For productivity increment in scarcity area, pearl millet + pigeonpea (2:1) intercropping or ber (5x5 m) + mothbean (8 lines) is advocated

## Contingent planning

### Chandrapur, Gadchiroli

#### Regular Monsoon

The regular monsoon starts by 24<sup>th</sup> meteorological week. For regular monsoon, the following recommendations stand

Light soils (20 to 30-35 cm) depth

- 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)

- Cotton – inter specific cultivation of Hirsutum Cotton AKA-7 with AKH 4 cotton
- Hybrid cotton AKH 4
- 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 be 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* crop safflower (N-7), pigeonpea (C-11) in September

#### Continued 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

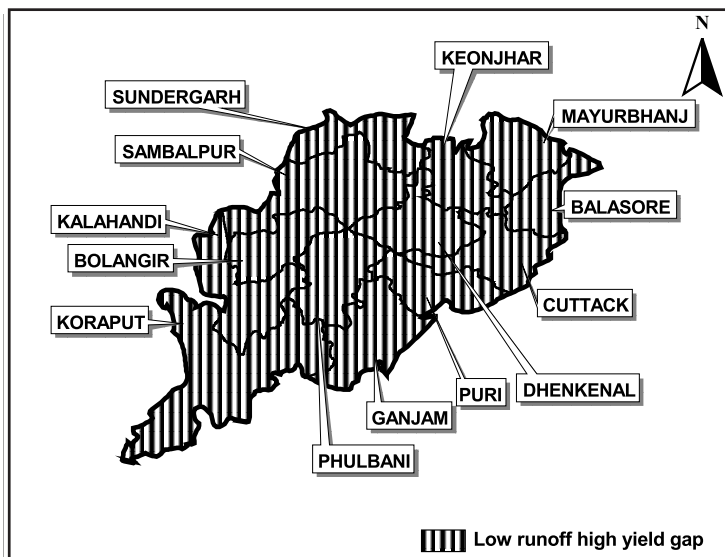
#### Jalna

- Mid season corrections during *kharif* with soil having depth upto 45cm 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 are thirteen districts viz. Cuttack, Ganjam, Puri, Kalahandi, Keonjhar, Mayurbhanj, Dhenkenal, Sambalpur, Sundergarh, Balasore, Bolangir, Koraput and Phulbani under low runoff and high yield gap region.



The recommendation details follow:

District	Region
Bolangir	Low runoff and High yield gap
Balasore	
Cuttack	
Dhenkenal	
Ganjam	
Kalahandi	
Keonjhar	
Koraput	
Mayurbhanj	
Phulbani	
Puri	
Sambalpur	
Sundergarh	

### Agro-ecological setting

#### Bolangir

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern Ghats
- **Soils:** Alfisols/ Ustolls 100%
- **Annual rainfall:** 1588 mm
- **Potential evapotranspiration:** 1497 mm
- **Moisture availability period:** 180-210 days

### **Balasore**

- **Climate:** Hot (moist/ dry) sub humid
- **Physiography:** Eastern ghats (Gangetic delta)
- **Soils:** Medium to deep loamy red and lateritic, deep loamy to clayey coastal and deltaic alluvium derived soils (Alfisols – 55%; Aridisols – 45%)
- **Annual rainfall:** 1690 mm
- **Potential evapotranspiration:** 1437 mm
- **Moisture availability period:** 180–210 days

### **Cuttack**

- **Climate:** Hot (moist / dry) sub humid
- **Physiography:** Eastern ghats / Gangetic delta
- **Soils:** Medium to deep loamy red and lateritic, deep loamy to clayey coastal and deltaic alluvium derived soils (Alfisols – 60%; Aridisols – 40%)
- **Annual rainfall:** 1559 mm
- **Potential evapotranspiration:** 1504 mm
- **Moisture availability period:** 180–210 days

### **Dhenkanal**

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern ghats
- **Soils:** Deep loamy red and lateritic soils (Alfisols – 60%; Alfisols/ Ustolls – 40%)
- **Annual rainfall:** 1552 mm
- **Potential evapotranspiration:** 1540 mm
- **Moisture availability period:** 180–210 days

### **Ganjam**

- **Climate:** Hot (moist/ dry) sub humid
- **Physiography:** Eastern ghats (Gangetic delta)
- **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

### **Kalahandi**

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern ghats and high lands
- **Soils:** Deep loamy red and lateritic soils (Alfisols/ Ustolls – 70%; Alfisols – 30%)

- **Annual rainfall:** 1511 mm
- **Potential evapotranspiration:** 1524 mm
- **Moisture availability period:** 180–210 days

### Keonjhar

- **Climate:** Hot dry sub humid
- **Physiography:** Garjat hills
- **Soils:** Moderately deep to deep loamy to clayey red and lateritic soils
- **Annual rainfall:** 1422 mm
- **Potential evapotranspiration:** 1988 mm
- **Moisture availability period:** 150 – 180 days

### Koraput

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern ghats
- **Soils:** Deep loamy red and lateritic soils (Alfisols - 100%)
- **Annual rainfall:** 1671 mm
- **Potential evapotranspiration:** 1630 mm
- **Moisture availability period:** 180–210 days

### Mayurbhanj

- **Climate:** Hot moist sub humid
- **Physiography:** Garjat hills
- **Soils:** Deep loamy red and lateritic soils (Alfisols/ Ustolls – 65%; Alfisols – 35%)
- **Annual rainfall:** 1361 mm
- **Potential evapotranspiration:** 1641 mm
- **Moisture availability period:** 180–210 days

### Phulbani

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern ghats
- **Soils:** Deep loamy red and lateritic soils (Alfisol – 50%; Alfisols/ Ustolls – 50%)
- **Annual rainfall:** 1425 mm
- **Potential evapotranspiration:** 1642 mm
- **Moisture availability period:** 180–210 days

### Puri

- **Climate:** Hot (moist/ dry) sub humid
- **Physiography:** Eastern ghats (Gangetic delta)

- **Soils:** Medium to deep loamy red and lateritic, deep loamy to clayey coastal and deltaic alluvium derived soils (Aridisols – 50%; Alfisols – 50%)
- **Annual rainfall:** 1440 mm
- **Potential evapotranspiration:** 1730 mm
- **Moisture availability period:** 180–210 days

### **Sambalpur**

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern ghats
- **Soils:** Deep loamy red and lateritic soils (Alfisols/ Ustolls – 100%)
- **Annual rainfall:** 1764 mm
- **Potential evapotranspiration:** 1452 mm
- **Moisture availability period:** 180–210 days

### **Sundargarh**

- **Climate:** Hot moist sub humid
- **Physiography:** Northern Orissa/ Northwest Orissa
- **Soils:** Deep loamy red and lateritic soils
- **Annual rainfall:** 1572 mm
- **Potential evapotranspiration:** 1624 mm
- **Moisture availability period:** 180-210 days

### **Soil and water conservation**

#### **Bolangir, Balasore, Cuttack, Dhenkenal, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Phulbani, Puri**

- Bench terracing, compartment bunding, graded border strips, sowing across the slope and ridging later, *insitu* conservation of soil moisture

#### **Sambalpur, Sundargarh, Ganjam**

- 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 for second crop
- *Insitu* conservation measures in uplands and midlands.
- Suitable drainage measures for low lands.

### **Crop management**

#### **Bolangir, Balasore, Cuttack, Dhenkenal, Ganjam, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Phulbani, Puri, Sambalpur, Sundargarh**

- **Varieties :** Usha, Uma, Vinayak, Kalika, Kanak, Nirmala and Prachi
- **Seed rate :** 7 kg/ha – in case of drilling in lines

- **Planting pattern:** 30 X10 cm, 30 X15 cm
- **Nutrient management:** 40 kg N + 20 kg P<sub>2</sub> O<sub>5</sub> + 20 kg K<sub>2</sub>O/ha, 50% N at basal and 50% N at 21 days after sowing, P<sub>2</sub> O<sub>5</sub> and K<sub>2</sub>O as basal
- **Pest management:**
  - Weed free condition upto three weeks after sowing
  - Shoot and pod borer: Spray Endosulfan 35 EC @ 1250 ml or Cabaryl 50 WP @ 2 kg/ha as first application 3 weeks after of germination and second application at flowering initiation stage
- **Some other important practices:**
  - Seed treatment: 3 g Thiram or Captan/kg of seed
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form as mulch
  - For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
  - Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g + 1 g) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
    - Alternate crops – Mesta – AMV -1, AS -7
    - Safflower – S-2-27, A-300
    - Pearl millet – BPC-39, IP-417
    - Soybean – JS – 1, Punjab -1
    - Turmeric – Sudarshan
    - Ginger – Nadia
  - Apply farm yard manure @ 5 t/ha
  - Excess water should be drained from the field
  - Sow the seeds within 2 cm depth
  - Mix the seeds with fine soil to ensure uniform sowing
  - First weeding, thinning and hoeing should be done at 15 days stage
  - Time of sowing June – July
  - A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
  - For interculture, use hand hoes or bullock drawn blade harrow
  - Provide protective irrigation during *kharif* season wherever possible



## **Suitable cropping system**

**Bolangir, Balasore, Cuttack, Dhenkenal, Ganjam, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Phulbani, Puri, Sambalpur, Sundargarh**

- Sesame + spring/ summer groundnut

## **Farm implements/ tools**

**Bolangir, Balasore, Cuttack, Dhenkenal, Ganjam, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Phulbani, Puri, Sambalpur, Sundargarh**

- Bolangir, Balasore, Cuttack, Dhenkenal, Ganjam, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Phulbani, Puri, Sambalpur and Sundergarh
- 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. Rs.1700/-
- Puddler 99: Pulverising all soils, Puddling, Requires a pair of bullock and covers 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 a one man and covers 0.5 ha/ day. Rs. 1164/-
- Two row mustard seed drill: Mustard sowing, Requires a one man and covers 0.5 ha/ day. Rs.827/-
- Three row multicrop seed drill: Seed sowing in rice, wheat, bengalgram and groundnut, Requires a one man and covers 0.8 ha/ day. Rs.1570/-
- Paddy transplanter (Manual): Transplanting paddy with proper spacing, Requires a two men and covers 20 ha/ day. Rs.4000/-
- Pedal paddy thresher: Threshing of paddy, Requires a two men and covers 2.5 q/ day. Rs.2754/-
- Power paddy thresher: Threshing of paddy, Requires a electric motor (1 HP) and covers 10-12 q/ day. Rs.8778/- (With motor and starter)
- Groundnut digger: Digging groundnut, Requires a pair of bullock and covers 0.3 ha/ day. Rs.548/-
- Pedal groundnut thresher: Separating groundnut pods from the plants, Requires a two men and covers 2.2 q pods/ day. Rs.2818/-
- Groundnut decorticator: Spreading seeds from groundnut pods, Requires a one men and covers 50 kg/ hour. Rs. 764/-
- Maize Sheller: Spreading seeds from maize cobs, Requires a one man and covers 1.0 q/ day. Rs. 25/-

## Alternate farming systems

### Bolangir, Keonjhar, Puri

- **Fodder/ Green biomass:** *Dalbergia sissoo*, *Albizia lebbeck*, *Anogeissus latifolia*, *Sesbania*, *Stylosanthes hamata*, Marvel – 8 grass
- **Fruit:** Ber, Custard apple, Pomegranate, Amla+ *kharif* spreading crops.
- **Medicinal/ Aromatic Plants:** *Catharanthus roseus*, *Palma rosa*, *Vetiveria zyzanoides*, *Rose*, *Geranium*
- **Vegetables:** Onion, Tomato, Okra, Cowpea, Cluster bean, Drumstick
- **Non – arable wastelands:**
  - Tree farming (*Sal*, *Teak*)
  - Silvi-pastoral (*Shisham/Subabul/Gambar* + *Stylo/Cenchrus*/mixture)
- **Arable wastelands:**
  - Agri-horticulture: Fruit crops (mango/citrus/sapota/pomegranate/custardapple/ amla/ litchi/ jackfruit/ phalsa) + field crops (pulses/ oilseeds). Hybrid mango varieties viz. Pusa Amrapalli and Pusa Mallika are becoming increasingly popular in the zone
  - 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)
  - *Leucaena* + turmeric/ ginger

### Sambalpur, Ganjam

- **Agro-horti system:** Sweet potato + maize/ castor (spacing 80x25 cm)
- Yam (100x60 cm) + maize/ castor
- Tapioca (100x100 cm) + maize/ castor
- Colocassia 980 x 25 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 zizanooides*, *Rose*, *Geranium*
- Vegetables: Onion, Tomato, Okra, Cowpea, Cluster bean, Drumstick

### Non – arable wastelands:

- Tree farming (*Sal*, *Teak*)
- Silvipastoral 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

### Mayurbhanj

- **Alley cropping:** Subabul (4 m interval) + groundnut/sesame/cowpea (grain)
- Silviculture/ social forestry – for denuded eroded, highly sloppy and shallow lands
- Horticulture – in uplands- Mango, Litchi, Guava, Lemon, Custard apple, Jack fruit
- **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
- **Fodder/ Green biomass:** *P.pinnata*, *Albizia sps*, *Cassia siamea*, *Grevillea robusta*, *Dalbergia sissoo*, *Azadirachta indica*
- **Fruit:** Mango, Jack fruit, Guava, Lime
- **Medicinal and Aromatic plants:** *Vetiveria zizanioides*, *Cymbopogon flexuosus*, *Palma rosa*, *Solanum viarum*, *Cinnamon*, *Citronella java*
- **Vegetables:** Bottle gourd, Brinjal, Ridge gourd, Watermelon, Long melon, Bittergourd, Tomato
- **Animal component:** Female cattle, Male cattle, Goat

### Balasore, Cuttak, Dhankenal, Phulbani, Kalahandi, Koraput

#### Non – arable wastelands:

- Tree farming (Sal, Teak)
- Silvi-pastoral (*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  
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)  
*Leucaena* + turmeric/ ginger
- **Tree on crop lands:** *Albizia spp*, *Cassia siamea*, *Gravellea robusta*, *Dalbergia sissoo*
- **Fruit:** Mango, Jackfruit, Guava, Lime
- **Medicinal/ Aromatic plants:** *Vetiveria zizanioides*, *Cymbopogon flexuosus*, *Palma rosa*, *Solanum viarum*, *Cinnamon*, *Citronella fara*
- **Vegetables:** Bottle gourd, Ridgegourd, Watermelon, Longmelon, Tomato, Brinjal
- **Animal component:** Female buffalo/ Sheep, Goat

## Contingent planning

**Bolangir, Balasore, Cuttack, Dhenkenal, Ganjam, Kalahandi, Keonjhar, Koraput, Phulbani, Puri, Sambalpur, Sundargarh**

**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. 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

### Mayurbhanj

Normal sowing period (15<sup>th</sup> to 30<sup>th</sup> June)

Monsoon sets in generally in the third week of June. Crops and varieties for normal onset of monsoon are

- Rice: Br.G. 23-19, Bandana and RAU. 4045 – 3
- Finger millet: A. 404, PR. 202, IE. 723 (direct seeding as well as nursery sowing of all the 3 varieties)
- Maize: Ganga Safed. 2, Ganga. 5 and Suwan. 1
- Sorghum: CSH. 5 and CSH. 6

- Groundnut: Ak. 12-24, Birsa groundnut. 1, BG. 1, BG.2 and Birsa bold
- Soybean: Birsa Soybean- 1, Bragg
- Pigeonpea: BR. 103, 65, Upas 120
- Greengram: Sunaina
- Blackgram: T. 9
- Intercrop: Pigeonpea + rice, pigeonpea+maize, pigeonpea + groundnut, Pigeonpea + 2 rows finger millet, pigeonpea + blackgram/greengram (two row), pigeonpea + 2 rows soybean
- If the onset is delayed but is expected within a week or 10 days of normal onset date – dry seeding of all the rice and groundnut varieties mentioned above in mid June

### **Delayed sowing period (1 – 7 July)**

- Groundnut seeding with AK- 12-24 can be extended upto first week of July. BG-1 and BG-2 should not go beyond June
- Direct seeding of finger millet: A-404, PR-202 and IE-723
- Pigeonpea: BR-183, BR-165, Upas-120 and T-21
- Blackgram: T-9
- Maize (ridge planting): Rajendra Makka, Diara
- Pigeonpea (BR-65) + groundnut (AK-12-24) intercrop
- Greengram: Sunaina

### **Very delayed sowing (2<sup>nd</sup> to 4<sup>th</sup> week of July)**

- Transplanting of finger millet (all varieties) but spacing to be reduced from 20x15 to 20x10 cm
- Greengram: Sunaina
- Blackgram: T-9
- Sesame: Kanke white (normal sowing time), Krishna
- Sweet potato: Cross 4 and Local (normal sowing time)

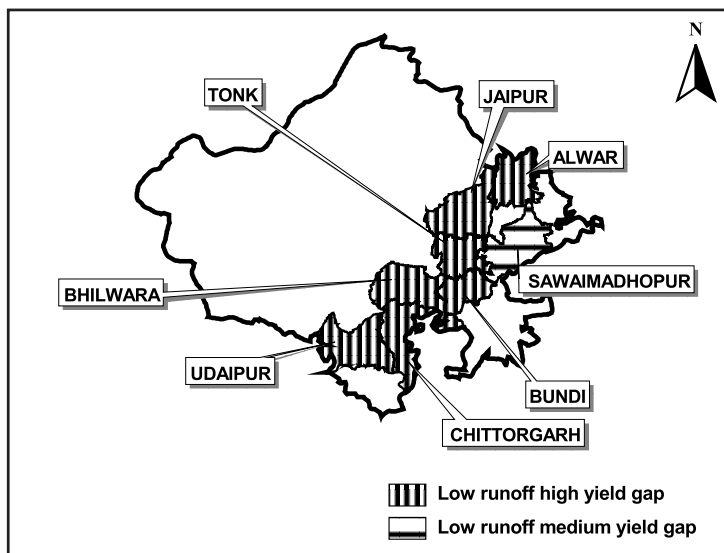
Beyond July it is much too late for general crops. However, if seedlings are available transplanting of finger millet could be resorted to in early August. Niger (N-5) and horsegram (BR-10 Madhu) are the natural choice for August seeding

- General precautions in case of delayed sowing
- Pre-monsoon tillage will pay dividends under such a situation in keeping weeds under control
- Crops should be spaced a little closer to compensate for loss in growing period
- Heavier dose of basal nitrogen and less number of splits should be followed specially in short duration crops

Under these conditions, since there is possibility of continuous rains proper care should be taken for the drainage of upland crops, which suffer from water logging at emergence state and some even at later stages.

## RAJASTHAN

In Rajasthan there is one district viz. Sawaimadhapur under low runoff and medium yield gap region and seven districts viz. Alwar, Bundi, Chittorgarh, Bhilwara, Jaipur, Tonk and Udaipur under low runoff and high yield gap region.



The recommendation details follow:

District	Region
Alwar	Low runoff and High yield gap
Bhilwara	
Bundi	
Chittorgarh	
Jaipur	
Tonk	
Udaipur	

### Agro-ecological setting

#### Alwar

- **Climate:** Hot semi arid
- **Physiography:** Rajasthan Uplands (North)
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 725 mm
- **Potential evapotranspiration:** 1595 mm
- **Moisture availability period:** 90–120 days

#### Bhilwara

- **Climate:** Hot dry semi arid
- **Physiography:** East Rajasthan Uplands (Aravelli hills)

- **Soils:** Deep loamy grey brown and alluvium - derived soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 658 mm
- **Potential evapotranspiration:** 1559 mm
- **Moisture availability period:** 90–120 days

### **Bundi**

- **Climate:** Hot dry / moist semi arid
- **Physiography:** East Rajasthan plains/uplands
- **Soils:** Deep loamy grey brown and alluvium - derived soils, deep clayey black soils, shallow black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 768 mm
- **Potential evapotranspiration:** 1554 mm
- **Moisture availability period:** 90–150 days

### **Chittorgarh**

- **Climate:** Hot dry / moist 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:** 90-120 days

### **Jaipur**

- **Climate:** Hot semi arid
- **Physiography:** Central Rajasthan Uplands
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 647 mm
- **Potential evapotranspiration:** 1745 mm
- **Moisture availability period:** 90–120 days

### **Tonk**

- **Climate:** Hot dry semi arid
- **Physiography:** East Rajasthan Uplands (Aravelli hills)
- **Soils:** Deep loamy grey brown and alluvium derived soil (Inceptisols 100%)
- **Annual rainfall:** 703 mm
- **Potential evapotranspiration:** 1597 mm
- **Moisture availability period:** 90-120 days



## Udaipur

- **Climate:** Hot dry semi arid
- **Physiography:** East Rajasthan Uplands/Plains
- **Soils:** Deep loamy grey brown and alluvium - derived soils (Pssaments – 30%; Vertic Inceptisols– 70%)
- **Annual rainfall:** 661 mm
- **Potential evapotranspiration:** 1380 mm
- **Moisture availability period:** 90–120 days

## Soil and water conservation

### Alwar

- Compartment bunding after seedling 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 @ 5t/ha is effective
- One protective irrigation is only solution to control late season drought effect during summer

### Bhilwara, Bundi, Chittorgarh, Jaipur, Tonk, Udaipur

- 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

### Alwar, Bhilwara, Bundi, Chittorgarh, Jaipur, Tonk, Udaipur

- **Varieties :** RT-125, RT-46, RT-127, RT-103
- **Seed rate:** 3 kg/ha for pure crop
- **Planting pattern:** 45 X 15 cm
- **Nutrient management:** FYM 6 t/ha + 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha as basal
  - Heavy soils 20 kgN + 20 kg P<sub>2</sub>O<sub>5</sub>/ha for areas with <350 mm rainfall
  - Light soils 40kgN + 25kg P<sub>2</sub>O<sub>5</sub> for areas with >350 mm rainfall
- **Pest management:**
  - Resistant/ tolerant varieties
    - Galfly: RT-46, Swetha Til, RT – 103 and RT – 125

- Gallfly and Mites: RT – 127
- Leaf roller/ capsule borer
  - RT-46, RT-54, Swetha Til, Krishna and N-32
  - Apply Phorate 10 G granules @ 10 kg/ha as basal application
  - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
  - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
  - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
  - Intercropping of sesame with greengram and groundnut reduces damage due to gall fly and leaf roller /capsule borer
  - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Sowing: *Kharif*-May, *Rabi*- December last week to January second week
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
  - Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
  - For branched varieties like Type –13, TC-25–apply 2- 2.5 kg of seed/ha
  - For branched varieties maintain 35 cm inter row & 15 cm intra row spacing. For non branching varieties maintain 30 cm inter row and 10 cm intra row spacing
  - Apply 20kg N + 25 kg P<sub>2</sub>O<sub>5</sub> /ha. Apply half dose of N at sowing and full dose P as basal and remaining half of N 4-5 weeks after sowing
  - Weed management with hand hoe or weeder one month after sowing
  - A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
  - For interculture use hand hoes or bullock drawn blade harrow
  - Provide productive irrigation during *kharif* season wherever possible

## Suitable cropping systems

### Alwar, Bhilwara, Bundi, Chittorgarh, Jaipur, Tonk, Udaipur

- Sesame + groundnut (1:1)
- Groundnut + sesame (6:2 or 6:3)
- Sesame + rapeseed mustard
- Greengram/ pigeonpea + sesame (1:1)
- Sesame + greengram
- Sesame + pearl millet (1:1)
- Sesame + mothbean (1:1)
- Sesame – greengram/barley

## Farm implements/ tools

### Alwar, Bhilwara, Bundi, Chittorgarh, Jaipur, Tonk, Udaipur

- 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/-

### Sawaimadhopur

- Arjia Pora: Placement of seed and fertilizer at proper depth. Rs.100/-
- Multipurpose tool bar: Reidge making, interculture, blade harrowing and seed and fertilizer drilling. Rs.2000/-
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- Plough Planter: Placement of seed. Rs.1500/-
- Post hold digger: Digging of pits for planting tree species. Rs.40000/-

## Alternate farming systems

### Alwar, Bhilwara, Bundi, Chittorgarh, Jaipur, Tonk, Udaipur

#### Marginal lands

- Silviculture (LCC): *Acacia tortilis*
- **Alley cropping:** (LCC III): *Jatropha spp* + greengram

- Silvipastoral system (LCC IV): *Prosopis cineraria* + *Cenchrus spp*
- 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, Caronda
- **Medicinal/ Aromatic Plants:** *Plantago ovata*, *Cassia angustifolia*, *Safed musli*, *Papaver somniferum*
- **Vegetables:** Clusterbean, Cowpea, Amaranthus, Round melon, Long melon
- **Animal component:** Female cattle, Male cattle, Female buffaloes, Sheep, Goat

## Contingent planning

### Alwar, Bhilwara, Bundi, Chittorgarh, Jaipur, Tonk, Udaipur

- 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 an 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, chickpea and sesame should be preferred over maize
- Delayed onset of monsoon:
  - Growing early maturing pulses (greengram and 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

District	Region
Sawaimadhapur	Low runoff and Medium yield gap

## Agro-ecological setting

- **Climate:** Hot semi arid
- **Physiography:** Uplands plains of Eastern Rajasthan
- **Soils:** Deep loamy alluvium - derived soils (Vertic Inceptisols – 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 intervals

## Crop management

- **Varieties** : RT-125, RT-46, RT-127, RT-146, RT125 and TS-25
- **Seed rate**: 3 kg/ha for pure crop
- **Planting pattern**: 45 X 15 cm
- **Nutrient management**: Farm yard manure 6 t/ha + 12.5 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha as basal
  - Heavy soils 20 kgN + 20 kg P<sub>2</sub>O<sub>5</sub> for areas with <350 mm rainfall
  - Light soils 40 kgN + 25 kg P<sub>2</sub>O<sub>5</sub>/ha for areas with >350 mm rainfall
- **Pest management**:
  - Resistant /tolerant varieties
    - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha Til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10kg/ha as basal application
    - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Intercropping of sesame with greengram and groundnut reduces damage due to gall fly and leaf roller/ capsule borer
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Sowing: *Kharif*-May, *Rabi*- December last week to January second week
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – sesame + pearl millet (4:1) and early planting

- Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g + 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- For branched varieties like Type -13, TC-25-apply 2- 2.5 kg of seed/ha
- For branching varieties maintain 35 cm inter row & 15 cm intra row spacing. For non-branching varieties maintain 30 cm inter row and 10 cm intra row spacing
- Apply 20 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha. Apply half dose of N at sowing and full dose P as basal and remaining half of N 4-5 weeks after sowing
- Weed management with hand hoe or weeder one month after sowing
- A minimum of two weedings, one at 15 days after sowing and second at 30-35 days after of sowing
- For interculture, use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

### Suitable cropping systems

- Sesame + groundnut (1:1)
- Groundnut + sesame (6:2 or 6:3)
- Sesame + rapeseed mustard
- Greengram/ pigeonpea + sesame (1:1)
- Sesame + greengram
- Sesame + pearl millet (1:1)
- Sesame + mothbean (1:1)
- Sesame – greengram/barley

### Alternate farming systems

#### Marginal lands

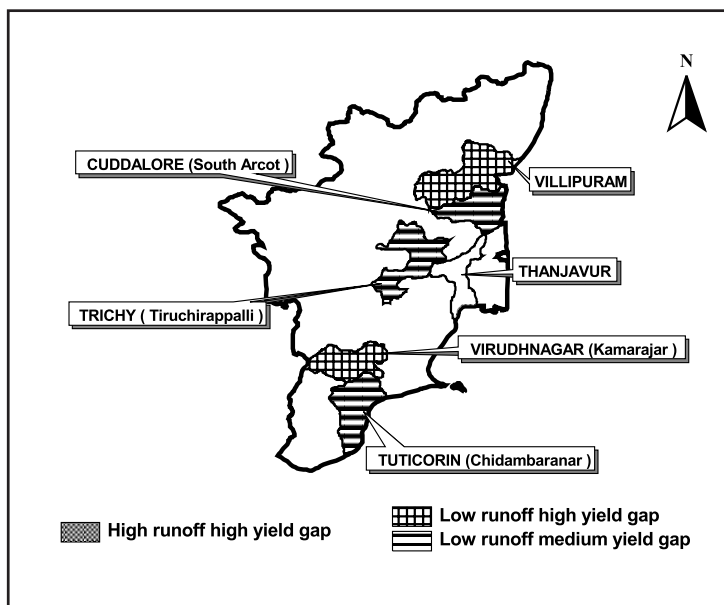
- Silviculture (Land capability class): *Acacia tortilis*
- **Alley cropping:** (Land capability class): *Jatropha spp* + greengram
- Silvicultural system (Land capability class): *Prosopis cineraria* + *Cenchrus spp*
- **Horti –pastoral system:** Ber + *cenchrus setigerus*
- **Fodder/ Green biomass:**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

## 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, chickpea and sesame should be preferred over maize
- Delayed onset of monsoon:
  - Growing early maturing pulses (greengram and 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

## TAMIL NADU

In Tamil Nadu there are three districts viz. Trichy, Cuddalore and Villipuram under low runoff and medium yield gap region, two districts viz. Virudhnagar and Tuticorin under low runoff and high yield gap region and one district viz. Thanjavur under high runoff and high yield gap region.



The recommendation details follow:

District	Region
Virudhnagar Tuticorin	Low runoff and High yield gap

### Agro-ecological setting

#### Virudhnagar

- **Climate:** Hot dry semi arid
- **Physiography:** Tamil Nadu Uplands
- **Soils:** Moderately deep to deep, loamy to clayey mixed red and black soils (Alfisol – 100%)
- **Annual rainfall:** 1158 mm
- **Potential evapotranspiration:** 1752 mm
- **Moisture availability period:** 90–120 days

#### Tuticorin

- **Climate:** Hot moist /dry semi arid
- **Physiography:** Tamil Nadu Uplands/ plains
- **Soils:** Moderately deep to deep, loamy to clayey mixed red and black soils and deep red loamy soils
- **Annual rainfall:** 821 mm
- **Potential evapotranspiration:** 1818 mm
- **Moisture availability period:** 90-150 days



## Soil and water conservation

### Tuticorin, Virudhnagar

- Soil water balance studies
- Runoff-erosion measurements
- More emphasis on *insitu* water conservation
- Increasing soil infiltration capacity and reducing soil crusting problem
- Inter-plot water harvesting of 1:1 cropped to uncropped land
- Dead furrows at 3.6 m interval
- Absorption/ drainage type terraces

## Crop management

### Tuticorin, Virudhnagar

- **Varieties:** TMV-3, TMV -6, Co-1, SVPR-1, VRI-1
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30 X 30 cm
- **Nutrient management:** 40 kg N + 20 kg P<sub>2</sub>O<sub>5</sub>/ha. All N and P<sub>2</sub>O<sub>5</sub> applied as basal and placement
  - 23 kg N + 13 kg P<sub>2</sub>O<sub>5</sub> + 13 kg K<sub>2</sub>O/ha or 17 kg N + 13 kg P<sub>2</sub>O<sub>5</sub> + 13 kg K<sub>2</sub>O/ha + 600 g azospirillum
  - Apply full dose of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O basally and add 5 kg manganese sulphate/ha
  - Open furrows to depth of 5 cm and 30 cm apart and place fertilizer mixture along the furrows and cover to depth of 3 cm with soil before sowing
  - 25% N can be substituted with 3 packets (600 g) of azospirillum by seed treatment or 10 packets (2000 g) azospirillum per hectare as soil application
- **Pest management:**
  - Weed management – weeding and hoeing on 15<sup>th</sup> and 30<sup>th</sup> day of sowing
  - Pod borer/ gallmidge/ shoot webber control:
    - Apply Quinolphos 25 EC @ 1000 ml/ha (or) 2 ounce of neem oil of 25% on the 25<sup>th</sup> and 50<sup>th</sup> day of sowing
    - Spraying of Endosulfan 35 EC @ one l/ha
  - Sesame phyllody:
    - Remove and destroy infected plants
    - Intercrop sesame with pigeonpea (6:1)
  - Root rot: Soil application of neem cake 150 kg/ha combined with *Trichoderma viridae* 4 kg/ha
  - Resistant/ tolerant varieties
    - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
- Leaf roller/ capsule borer: RT-46, RT-54, Swetha Til, Krishna and N-32
  - Apply Phorate 10 G granules @ 10 kg/ha as basal application
  - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
  - Minimum of 2 hand weeding at 15-20 days after sowing and 35-40 days after sowing

- Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
- Pre emergence application of Pendimethalin 2 l/ha on third day after sowing
- Pod borer: Spraying of Endosulfan 35 EC one l/ha
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per kg of seed
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – Sesame + Pearl millet (4:1) and early planting
  - Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g + 1 g) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
  - Chiselling the soils having hardpan formation at shallow depth with chisel plough at 0.5 m interval first in one direction and then in the direction perpendicular to the previous one once in 3 years
  - Apply 12.5 t farm yard manure/ha or composted coir pith besides chiselling
  - Azospirillum and *Trichoderma viridae* (biocontrol agent) (4 g/kg) compatible for seed treatment and hence can be applied as single treatment
  - Treat the seed with *Trichoderma* @ 4 g/kg seed just before sowing
  - Seeds should not be treated with fungicides
  - Sow the seeds in lines to a depth of 3 cm and cover with soil
  - Mix the seeds with 4 times its volume of dry sand and drop the mixture evenly along the furrow in which fertilizers were applied
  - Sowing from June –July
  - A minimum of two weedings, one after 15 days after sowing and second 30-35 days after of sowing
  - For interculture, use hand hoes or bullock drawn blade harrow
  - Provide protective irrigation during *kharif* season wherever possible

## **Suitable cropping systems**

### **Tuticorin, Virudhnagar**

- Sesame + greengram (8:2)
- Sesame + cowpea (8:2)

## Farm implements/ tools

### Tuticorin, Virudhnagar

- Tractor drawn seed drill
- Bullock drawn seed drill
- Multipurpose implement

## Alternate farming systems

### Tuticorin, Virudhnagar

- **Alley cropping:** Subabul (6 m width) + sorghum/ pearl millet/ pigeonpea
- Subabul (6 m width) + mulching with Subabul leaves in alleys + cotton/ blackgram/ sunflower
- **Agroforestry:** Tamarind/ neem + sorghum (K-8), tamarind/ neem + blackgram (C0-5)
- **Agro-horti system:** Tamarind (PKM-1) + blackgram (K-1)
- **Silvipasture:** *Alianthus excelsa* + Blackgram, *Alianthus excelsa* + Dinanath grass
- **Fodder/ green biomass:** *Alianthus excelsa*, *Albizia lebbbeck*, *Leucaena leucocephala*, *Hardwickia binata*, *Azadirachta indica*
- **Fruit:** Mango, Sapota, Fig, Jamun, Pomegranate
- **Medicinal/ Aromatic Plants:** *Cassia aungstifolia*, *Palma rosa*, *Vetiveria zizanoioides*, *Jasmine*, *Rose*, *geranium*
- **Vegetables:** Okra, Bittergourd, Ridge gourd, Chilles, Brinjal, Amaranthus
- **Animal Component:** Sheep, Goat

## Integrated farming System

In drylands, maintenance of two milch cows along with agricultural component indicated that percentage contribution of agricultural component to the total gross and net income of Integrated Farming system was 10 and 6.7% as compared to the percentage contribution of dairy component with 90 and 93.3%

## Contingent planning

### Tuticorin, Virudhnagar

- Normal monsoon conditions: With the onset of north-east monsoon in September – October, crops like sorghum, cotton, pearl millet, pulses and oilseeds can be sown. Sorghum (K.Tall or K.8) may be sown during September
- Delayed onset of monsoon: If the rains are received late in October, pearl millet (WCC75) can be sown. Pulses like blackgram, greengram and oilseeds like sunflower (K1) can be grown if the rains are received later
- Very delayed monsoon: Sunflower (K1), Sesame (TMV 3), senna and coriander can be sown upto the first week of November under very delayed monsoon conditions
- Early withdrawal of monsoon: Short duration crops like pearl millet (Co.6 and X 4) with 75 days duration and sunflower (K1) with 65 days duration are grown
- Cultural practices like shallow intercultural to eradicate weeds, maintain soil mulch to conserve soil moisture, application of surface mulch, thinning of crops by removing alternate rows as in pearl millet and recycling of stored runoff water are generally resorted to

District	Region
Thanjavur	High runoff and High yield gap

### Agro-ecological setting

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu Uplands (Kaveri delta)
- **Soils:** Deep red loamy soils, deep clayey and cracking coast and deltaic alluvium - derived soils (Aridisols – 100%)
- **Annual rainfall:** 1337 mm
- **Potential evapotranspiration:** 1775 mm
- **Moisture availability period:** 120–150 days

### Soil and water conservation

- Soil water balance studies
- Runoff-erosion measurements
- More emphasis on *insitu* water conservation
- Increasing soil infiltration capacity and reducing soil crusting problem
- Inter-plot water harvesting of 1:1 cropped to uncropped land
- Dead furrows at 3.6 m interval
- Absorption/drainage type terraces

### Crop management

- **Varieties:** TMV-3, TMV –5 and Co-1
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30X30 cm
- **Nutrient management:** 40 kg N + 20 kg P<sub>2</sub>O<sub>5</sub>/ha. All N and P<sub>2</sub>O<sub>5</sub> applied as basal and placement
  - 23 kg N +13 kg P<sub>2</sub>O<sub>5</sub> +13 kg K<sub>2</sub>O/ha or 17 kg N + 13 kg P<sub>2</sub>O<sub>5</sub> + 13 kg K<sub>2</sub>O/ha + 600 g azospirillum
  - Apply full dose of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O basally and add 5 kg manganese sulphate/ha
  - Open furrows to depth of 5 cm and 30 cm apart and place fertilizer mixture along the furrows and cover to depth of 3 cm with soil before sowing
  - 25% N can substitute 3 packets (600 g) of azospirillum by seed treatment or 10 packets (2000 g) azospirillum per hectare as soil application
- **Pest management:**
  - Weed management – weeding and hoeing on 15<sup>th</sup> and 30<sup>th</sup> day of sowing
  - Pod borer/ gallmidge/ shoot webber control:
    - Apply Quinolphos 25 EC @ 1000 ml/ha (or) 2 ounce of neem oil of 25% on the 25<sup>th</sup> and 50<sup>th</sup> day of sowing
    - Spraying of Endosulfan 35 EC @ one l/ha
    - Sesame phyllody:
      - Remove and destroy infected plants

- Intercrop sesame with pigeonpea (6:1)
- Root rot: Soil application of neem cake 150 kg/ha combined with *Trichoderma viridae* 4 kg/ha
- Resistant/tolerant varieties
  - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
  - Gallfly and Mites: RT – 12
- Leaf roller/ capsule borer
  - RT-46, RT-54, Swetha Til, Krishna and N-32
  - Apply Phorate 10 G granules @ 10 kg/ha as basal application
  - Two rounds of spraying @ 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
  - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
  - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
  - Pre emergence application of Pendimethalin 2 l/ha on third day after sowing
  - Pod borer: Spraying of Endosulfan 35 EC one l/ha
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan per 1 kg of seed
  - Line sowing through seed drill
  - RT-46, T-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
  - Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
  - Early sowing in the first week of July and use of early varieties
  - Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
  - Chiselling the soils having hardpan formation at shallow depth with chisel plough at 0.5 m interval first in one direction and then in the direction perpendicular to the previous one once in 3 years
  - Apply 12.5 t farm yard manure/ha or composted coir pith besides chiselling
  - Azospirillum and *Trichoderma viridae* (biocontrol agent) (4 g/kg) compatible for seed treatment and hence can be applied as single treatment
  - Treat the seed with *Trichoderma* @ 4 g/kg seed just before sowing
  - Seeds should not be treated with fungicides
  - Sow the seeds in lines to a depth of 3 cm and cover with soil
  - Mix the seeds with 4 times its volume of dry sand and drop the mixture evenly along the furrow in which fertilizers were applied

- Sowing from June –July
- A minimum of two weedings, one at 15 days after sowing and second 30-35 days after sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

### Suitable cropping systems

- Sesame + greengram (8:2)
- Sesame + cowpea (8:2)

### Farm implements/ tools

- Tractor drawn seed drill
- Bullock drawn seed drill
- Multipurpose implement

### Alternate farming systems

- **Alley cropping:** Subabul (6 m width) + Sorghum/ Pearl millet/ Pigeonpea
- Subabul (6 m width) + mulching with Subabul leaves in alleys + Cotton/ blackgram/ sunflower
- **Agroforestry:** Tamarind/ neem + sorghum (K-8), Tamarind/ Neem + Blackgram (C0-5)
- **Agro-horti system:** Tamarind (PKM-1) + Blackgram (K-1)
- **Silvipasture:** *Alianthus excelsa* + Blackgram, *Alianthus excelsa* + Dinanath grass
- **Fodder/ Green biomass:** *Alianthus excelsa*, *Albizia lebbek*, *Leucaena leucocephala* Hardwickia *binata*, *Azadirachta indica*
- **Fruit:** Mango, Sapota, Fig, Jamun, Pomegranate
- **Medicinal/ Aromatic Plants:** *Cassia aungstifolia*, *Palma rosa*, *Vetiveria zizanooides*, Jasmine, Rose, geranium
- **Vegetables:** Okra, Bittergourd, Ridge gourd, Chilles, Brinjal, Amaranthus
- **Animal Component:** Sheeps, Goat

### Contingent planning

- Normal monsoon conditions: With the onset of north-east monsoon in September – October, crops like sorghum, cotton, pearl millet, pulses and oilseeds can be sown. Sorghum (K-Tall or K-8) may be sown during the month of September
- Delayed onset of monsoon: If the rains are received late in October, pearl millet (WCC75) can be sown. Pulses like blackgram, greengram and oilseeds like sunflower (K1) can be grown if the rains are received later
- Very delayed monsoon: Sunflower (K1), Sesame (TMV 3), senna and coriander can be sown upto the first week of November under very delayed monsoon conditions
- Early withdrawal of monsoon: Short duration crops like pearl millet (Co-6 and X-4) with 75 days duration and sunflower (K-1) with 65 days duration are grown
- Cultural practices like shallow intercultural to eradicate weeds, maintain soil mulch to conserve soil moisture, application of surface mulch, thinning of crops by removing alternate rows as in pearl millet and recycling of stored runoff water are generally resorted to

## Integrated farming system

In dryland, maintenance of two milch cows along with agricultural component indicated that percentage contribution of agricultural component to the total gross and net income of Integrated Farming system was 10 and 6.7% as compared to the percentage contribution of dairy component with 90 and 93.3%.

District	Region
Cuddalore, Trichy, Villipuram	Low runoff and Medium yield gap

## Agro-ecological setting

### Cuddalore

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu Uplands/ plains
- **Soils:** Deep red loamy soils
- **Annual rainfall:** 923 mm
- **Potential evapotranspiration:** 1826 mm
- **Moisture availability period:** 120-150 days

### Trichy

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu plains/uplands (Kaveri delta)
- **Soils:** Deep red loamy soils (Aridisols – 25%; Alfisols – 75%)
- **Annual rainfall:** 869 mm
- **Potential evapotranspiration:** 2091 mm
- **Moisture availability period:** 120–150 days

### Villipuram

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu plains
- **Soils:** Deep red loamy soils (Aridisols – 25%; Alfisols – 75%)
- **Annual rainfall:** 869 mm
- **Potential evapotranspiration:** 1826 mm
- **Moisture availability period:** 120–150 days

## Soil and water conservation

### Cuddalore, Trichy, Villipuram

- Soil water balance studies
- Runoff-erosion measurements
- More emphasis on *insitu* water conservation
- Increasing soil infiltration capacity and reducing soil crusting problem
- Inter-plot water harvesting of 1:1 cropped to uncropped land

- Dead furrows at 3.6 m interval
- Absorption/drainage type terraces

## Crop management

### Cuddalore, Trichy, Villipuram

- **Varieties:** TMV-3, TMV -5 and Co-1
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30 X 30 cm
- **Nutrient management:** 40 kg N + 20 kg P<sub>2</sub>O<sub>5</sub>/ha. All N and P<sub>2</sub>O<sub>5</sub> applied as basal and placement
  - 23 kg N +13 kg P<sub>2</sub>O<sub>5</sub> +13 kg K<sub>2</sub>O/ha or 17 kg N + 13 kg P<sub>2</sub>O<sub>5</sub> +13 kg K<sub>2</sub>O/ha + 600 g azospirillum
  - Apply full dose of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O basally and add 5 kg manganese sulphate/ha
  - Open furrows to depth of 5 cm and 30 cm apart and place fertilizer mixture along the furrows and cover to depth of 3 cm with soil before sowing
  - 25% N can substitute 3 packets (600 g) of Azospirillum by seed treatment or 10 packets (2000 g) Azospirillum per hectare as soil application
- **Pest management:**
  - Weed management – weeding and hoeing on 15<sup>th</sup> and 30<sup>th</sup> day of sowing
  - Pre emergence application of Pendimethalin @ 2 l/ha on third day after sowing
  - Pod borer/ gallmidge/ shoot webber control:
    - Apply Quinolphos 25 EC @ 1000ml/ha (or) 2 ounce of neem oil of 25% on the 25<sup>th</sup> and 50<sup>th</sup> day of sowing
    - Spraying of Endosulfan 35 EC @ one l/ha
  - Sesame phyllody:
    - Remove and destroy infected plants
    - Intercrop sesame with pigeonpea (6:1)
  - Root rot: Soil application of neem cake 150 kg/ha combined with *Trichoderma viridae* 4 kg/ha
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan/ kg of seed
  - Line sowing through seed drill
  - RT-46, RT-125, RT-54 and RT-127
  - Sowing with onset of monsoon
  - Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
  - Sesame + mothbean/ blackgram
  - Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
  - Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
  - For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
  - Phyllody - sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
  - Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g+ 1 g) before planting
  - Tetracycline 500 ppm spray at flower initiation stage against phyllody
  - Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125



- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- Chiselling the soils having hardpan formation at shallow depth with chisel plough at 0.5 m interval first in one direction and then in the direction perpendicular to the previous one once in 3 years
- Apply 12.5 t farm yard manure/ha or composted coir pith besides chiselling
- *Azospirillum* and *Trichoderma viridae* (biocontrol agent) (4 g/kg) compatible for seed treatment and hence can be applied as single treatment
- Treat the seed with *Trichoderma* @4 g/kg seed this can be done just before sowing
- Seeds should not be treated with fungicides
- Sow the seeds in lines to a depth of 3 cm and cover with soil
- Mix the seeds with 4 times its volume of dry sand and drop the mixture evenly along the furrow in which fertilizers were applied
- Sowing from June –July
- A minimum of two weedings, one at 15 days after sowing and second 30-35 days after of sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## Suitable cropping systems

### Cuddalore, Trichy, Villipuram

- Sesame + greengram (8:2)
- Sesame + cowpea (8:2)

## Farm implements/ tools

### Cuddalore, Trichy, Villipuram

- Tractor drawn seed drill
- Bullock drawn seed drill
- Multipurpose implement

## Alternate farming systems

### Cuddalore, Trichy, Villipuram

- **Alley cropping:** Subabul (6 m width) + sorghum/ pearl millet/ pigeonpea
- Subabul (6 m width) + mulching with Subabul leaves in alleys + cotton/ blackgram/ sunflower
- **Agroforestry:** Tamarind/ Neem + sorghum (K-8), Tamarind/ Neem + blackgram (C0-5)
- **Agro-horti system:** Tamarind (PKM-1) + blackgram (K-1)
- **Silvipasture:** *Alianthus excelsa* + Blackgram, *Alianthus excelsa* + Dinanath grass
- **Fodder/ Green biomass:** *Alianthus excelsa*, *Albizia lebbeck*, *Leucaena leucocephala*, *Hardwickia binata*, *A.indica*
- **Fruit:** Mango, Sapota, Fig, Jamun, Pomegranate
- **Medicinal/ Aromatic Plants:** *Cassia aungstifolia*, *Palma rosa*, *Vetiveria zizanoides*, Jasmine, Rose, geranium
- **Vegetables:** Okra, Bittergourd, Ridge gourd, Chilles, Brinjal, Amaranthus
- **Animal Component:** Sheep, Goat

## **Contingent planning**

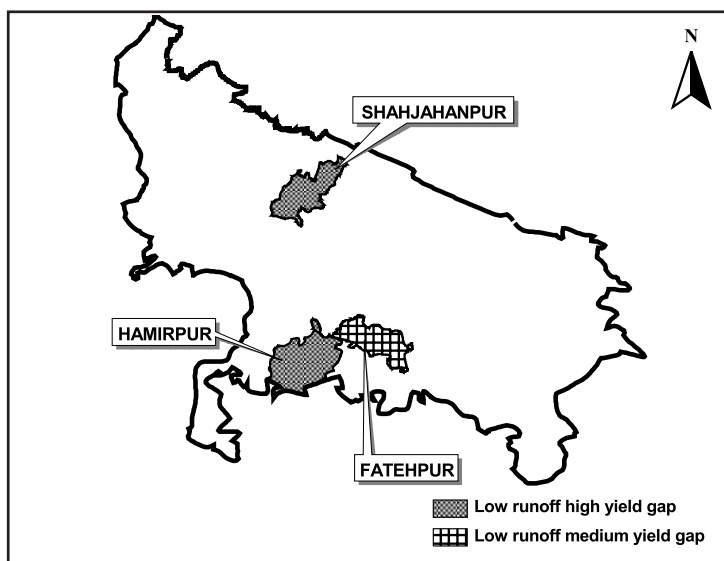
- Normal monsoon conditions: With the onset of North-East monsoon in September – October, crops like sorghum, cotton, pearl millet, pulses and oilseeds can be sown. Sorghum (K-Tall or K-8) may be sown during September
- Delayed onset of monsoon: If the rains are received late in October, pearl millet (WCC-75) can be sown. Pulses like blackgram, greengram, and oilseeds like sunflower (K-1) can be grown if the rains are received later
- Very delayed monsoon: Sunflower (K-1), Gingelly (TMV-3), Senna and Coriander can be sown up to the first week of November under very delayed monsoon conditions
- Early withdrawal of monsoon: Short duration crops like pearl millet (Co-6 and X-4) with 75 days duration and sunflower (K-1) with 65 days duration are grown
- Cultural practices like shallow interculturing to eradicate weeds, maintain soil mulch to conserve soil moisture, application of surface mulch, thinning of crops by removing alternate rows as in pearl millet and recycling of stored runoff water are generally resorted to

## **Integrated farming System**

In drylands, maintenance of two milch cows along with agricultural component indicated that percentage contribution of agricultural component to the total gross and net income of Integrated Farming system was 10 and 6.7% as compared to the percentage contribution of dairy component with 90 and 93.3%

## UTTAR PRADESH

In Uttar Pradesh there are two districts viz. Hamirpur and Shahjahanpur under low runoff and high yield gap region, one district viz. Fatehpur under low runoff and medium yield gap



The recommendation details follow:

District	Region
Fatehpur	Low runoff and
Hamirpur	High/medium yield gap
Shahjahanpur	

### Agro-ecological setting

#### Fatehpur

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga –Yamuna Doab (Northern plains)
- **Soils:** Deep loamy alluvium derived soils
- **Annual rainfall:** 885 mm
- **Potential evapotranspiration:** 1464 mm
- **Moisture availability period:** 120-150 days

#### Hamirpur

- **Climate:** Hot moist semi arid
- **Physiography:** Bundelkhand uplands
- **Soils:** Deep loamy and clayey mixed red and black soils (Inceptisols– 100%)
- **Annual rainfall:** 998 mm
- **Potential evapotranspiration:** 1481 mm

- **Moisture availability period:** 120–150 days

### Shahjahanpur

- **Climate:** Hot dry sub humid/ Hot moist semi arid
- **Physiography:** Rohilkhand plains
- **Soils:** Deep loamy aluvium derived soils, deep loamy alluvium - deveried soils (Inceptisols – 100%)
- **Annual rainfall:** 1093 mm
- **Potential evapotranspiration:** 1406 mm
- **Moisture availability period:** 120–180 days

### Soil and water conservation

#### Fatehpur, Hamirpur, Shajahanpur

- Sowing across the slope and ridging later
- Compartment bunds for raising crops on conserved soil moisture
- More emphasis on *insitu* water conservation and semi permanent structures
- Increasing soil infiltration capacity and reducing soil crusting problem
- Supplemental irrigation by harvesting runoff water at dry spells
- Field bunds for smaller areas may be encouraged for wider adoption

### Crop management

#### Fatehpur, Hamirpur, Shahjahanpur

- **Varieties:** T-13, T-12, Pragathi, Sekhar, T-78
- **Seed rate:** 5 kg/ha for pure crop
- **Planting pattern:** 30 X 5 cm
- **Nutrient management:** 50 kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha
- **Pest management:**
  - Resistant/ tolerant varieties
    - Gallfly: IS-65, RT-46, Swetha Til, RT – 103, RT – 108 and RT – 125
    - Gallfly and Mites: RT – 127
  - Leaf roller/ capsule borer
    - RT-46, RT-54, Swetha Til, Krishna and N-32
    - Apply Phorate 10 G granules @ 10 kg/ha as basal application
    - Two rounds of spraying at 30 and 45 days after sowing with neem oil or neem gold or neemycin for the control of Anti Gastra
    - Minimum of 2 hand weedings at 15-20 days after sowing and 35-40 days after sowing
    - Pre-plant incorporation of Fluchloralin @ 0.75 kg/ha, pre-emergence application of Pendimethalin @ 1.25 kg/ha
    - Weed free condition upto three weeks after sowing
- **Some other important practices**
  - Seed treatment: 3 g Thiram or Captan/kg of seed
  - Mix the seed with the sand before sowing

- Line sowing through seed drill
- Thinning 21 days after sowing
- RT-46, RT-125, RT-54 and RT-127
- Sowing with onset of monsoon
- Seed priming with soaking of seeds with water for 12 hrs followed by drying before sowing improves the crop establishment
- Sesame + mothbean/ blackgram
- Mulching with organic wastes or polythene sheets in between rows as per feasibility in the situation of prolonged drought
- Clean cultivation by weed removal by hand hoeing and leaving them on soil surface to form mulch
- For Phytophthora blight and Cercospora leaf spot – Sesame + pearl millet (4:1) and early planting
- Phyllody - Sesame + pigeonpea (1:1) and late planting about 3 weeks after onset of monsoon
- Seed treatment with Thiram (3 g/kg)/ Mancozeb/ Thiram + Bavistin (2 g + 1 g) before planting
- Tetracycline 500 ppm spray at flower initiation stage against phyllody
- Phyllody resistant varieties: RT-46, RT-54, RT-103 and RT-125
- Early sowing in the first week of July and use of early varieties
- Intercropping with cowpea, pigeonpea, pearl millet, greengram, blackgram, mothbean and sunflower is effective for minimizing the damage by insect pests
- Second fortnight of July
- A minimum of two weedings, one at 15 days after sowing and second 30-35 days after of sowing
- For interculture use hand hoes or bullock drawn blade harrow
- Provide protective irrigation during *kharif* season wherever possible

## Suitable cropping systems

### Fatehpur, Hamirpur, Shahjahanpur

- Groundnut - sesame
- Sesame (early) - chickpea/ rapeseed mustard/lentil
- Sesame + greengram (1:1)
- Sesame + pigeonpea (2:1)

## Farm implements/ tools

### Fatehpur, Hamirpur, Shahjahanpur

- Ferti – cum - seed drill

## Alternate farming systems

### Fatehpur, Hamirpur, Shahjahanpur

- **Fodder/ Green biomass:** *Leucaena*, *Melia azadirach*, *Dichrostachys cineraria*, *Albizzia amara*, *Albizzia lebbek*, *Hardwickia binata*, *Acacia nilotica*
- **Fruit:** *Embllica officinalis* (amla), Guava, Ber, Mango
- **Medicinal and Aromatic plants:** *Rauvolfia serpentina*, *Vetiveria zizanoioides*, *Palma rosa*, *Safed musli*, Aswagandh
- **Vegetables:** Bottle gourd, Brinjal, Tomato, Chillies, Brinjal, Cowpea, Okra
- **Animal component:** Female Cattle, Male Cattle, Female Buffaloes, Goat, Poultry

## SUMMARY

Sesame (*Sesamum indicum* L.), also known as sesamum, til and gingelly, is an important and ancient oil-yielding crop. Africa is considered to be the primary centre of origin of this crop because of the presence of its diverse wild species in that continent. India is the secondary centre of origin and another secondary centre is Japan. The genus belongs to the family Pedaliaceae which has a wide distribution, covering tropical Africa, Madagascar, Arabia, India, Sri Lanka, tropical Australia and a few of the eastern islands of the Malayan Archipelago.

It is an erect and annual herb. The plant is simple or branched. The leaves are opposite below and alternate above. The flowers are zygomorphic, solitary, occasionally two or three together, axillary, short-pedicelled, borne on the upper part of the stem or branches. The tube, bent downwards and is dilated above the oblique base. The calyx is small, and five sectioned, 0.5-0.6 cm long. The corolla is tubular, campanulate, approximately 3 cm long, with an applicate margin and slightly bilabiate, the upper lip is entire and the lower one is tripartite. There are four functional stamens and often one is sterile, didynamous. The antennae are sagittate. The ovary is superior, bilocular, but may be subdivided by false internal walls. The fruit is a capsule, erect and oblong. The capsule contains numerous small ovate seeds. The testa may be smooth or reticulate and may be white, yellow, reddish-brown or black. The seed is dicotyledonous, albuminous and oleaginous.

The varieties differ not only in respect of the season of growth and the time of maturity but also in the number of capsules formed in the leaf axils, the habit of growth (Single-stemmed or branched) and the size, colour and oil content of the seeds. The seeds may be white, dull white, light brown dark brown, red or black.

Information on varieties and hybrids released from 1985 was extracted from "T. Damodaram and D.M. Hegde. (2002). Oilseeds Situation: A Statistical Compendium – 2002, Directorate of Oilseeds Research, Hyderabad" and the Annual Report(s), Department of Agricultural Research and Education, Ministry of Agriculture, Government of India, and Indian Council of Agriculture Research, New Delhi summarized below. The cultivars suit for rainfed and partially irrigated conditions. The details follow.

Sesame				
Variety/ Hybrid	Year of release	Yield (t/ha)	Oil Content (%)	Area of Adaptability
AKT-64	2000	0.60-0.70	47	Maharashtra
DS-1	1997	0.40-0.50	51	Northern-Eastern lane of Karnataka
JTS 8	2001	0.63	47	Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh and Karnataka
Paiyur-1	1997	0.64	50	Coastal districts of Tamil Nadu
RT-127	1999	0.60-0.90	51	Rajasthan
Swetha Til	1999	0.60-0.70	45	Andhra Pradesh
VRI-1	1997	0.60-0.70	51	Tamil Nadu
VRISV-1	1997	0.70	51	Tamil Nadu
TKG 55	1998	-	-	Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, Jharkhand. Resistant to <i>Phytophthora</i> blight

About 2 ploughings are necessary to obtain fine tilth. It is followed by harrowing and levelling. The crop should be sown in lines. A spacing of 30 cm should be maintained between rows and 15 cm between plants. Seed should be mixed with sand in 1:3 ratio.

It is grown both as pure and mixed with other crops, whereas the semi-rabi and summer crops are taken as pure. The common component crops are pigeonpea (arhar) in Andhra Pradesh, pearl millet and pigeonpea in Gujarat, pigeonpea and sorghum in Madhya Pradesh. Cotton, groundnut and pigeonpea in Maharashtra and blackgram, greengram and horsegram in Orissa.

The preparatory cultivation for the *kharif* crop is usually not thorough. For the semi-*rabi* and summer crops, the land is ploughed and harrowed repeatedly to secure a clean and fine seedbed. Except in Maharashtra and Gujarat, where line sowing is practised, in all other states it is sown broadcast. The recommended spacings for the line-sown crop in different regions, however, range from 25 to 35 cm between the rows and 10 to 20 cm between the plants in the row. The seed being small, it is often mixed with sand to ensure its even distribution and the drill is operated rather shallow to avoid deep sowing. After sowing, the seed is covered lightly with a brush harrow. The seed-rate varies from 3 to 5 kg/ha. The seed should be treated with Captan or Thiram at the rate of 3 g/kg of seed to control seed-borne diseases.

For obtaining high yields, application of 2.5-5 t/ha farm yard manure and fertilizers of 40 kg N, 60 kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O/ha during *kharif* and 60 kg N, 60 kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O in *rabi* season is recommended. Apply half of the nitrogen and entire P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as basal dressing and remaining half of the nitrogen at 25-30 days after sowing as top dressing. The recommendation for different regions as 25-30 kg of N, 20-30 kg of P<sub>2</sub>O<sub>5</sub> and 0-20 kg of K<sub>2</sub>O/ha.

Two hand-weedings followed by one hoeing during early crop period should be done to keep the crop free from weeds. Thinning must be done 14 days after germination. The rainfed crop is weeded and hoed once or twice and the irrigated crop is weeded often. Wherever the weed control with mechanical means is a problem, chemical weed control with pre-emergence application of Lasso @ 3 l/ha is recommended

Leaf roller and pod-borer feed on the leaves and take shelter inside webs. Spraying endosulfan (35%, 2 ml/l of water) is recommended to control this pest. The larvae of gallfly eat the floral parts and affect seed setting. Dusting of 10% Carbaryl at 12 kg/ha or spraying Endosulfan or Ekalux (2 ml/l) helps in controlling the pest. Stem and root-rot, phyllody, bacterial leaf spot and leaf curl are the important diseases of sesame. Seed treatment with Captan at the rate of 3-9/ kg of seed for controlling root rot, 3 sprays of Agrimycin @ 01-100 ppm at 15-day intervals for controlling bacterial leaf spot are recommended. Both phyllody and leaf-curl can be controlled by spraying, the insecticides, such as Phosphamidon 0.05% or Dimethoate 0.05% or Dichlorovas 0.05%, which reduce the population of the insect vectors. The average grain yield of the *kharif* crop grown unmixed is 200 to 500 kg/ha and the average yields of the semi-*rabi* crop and of the irrigated summer crop are 300 to 600 kg/ha. Under moist and cool conditions, the powdery mildew develops fast covering the leaves with mycelium. The plant is defoliated before maturity. Spraying 0.2% wettable sulphur controls the disease.

The crop is harvested when the leaves, stems and capsule begin to turn yellow and the lower leaves start shedding. To prevent the shedding of grains, the crop should not be allowed to become dead ripe in the field. The ripe plants are cut, carried to the threshing-yard, stacked for a week in the sun with the cut-ends downwards and well shaken or beaten to take out the grains from the dry capsules. Winnowing and cleaning completes the process. The average grain yield of the *kharif* crop grown unmixed is 200-500 kg/ha and the average yields of the semi-*rabi* crop and of the irrigated summer crop are 300-600 kg/ha.

### Important hints for obtaining high yields

- A suitable variety must be chosen for the tract and the season.
- The crop should be sown in lines.
- The application of fertilizers, inter-cultivation and plant- protection measures must be taken up at the appropriate time.
- Harvesting should be done after the crop matures but must not be delayed upto the stage when the capsules shed seeds.

### IPM (Integrated Pest Management) module for sesame

Sesame, an important indigenous oil crop, is grown as rainfed *kharif*, semi-*rabi* and also as summer crop. The average productivity of 345 kg/ha in India is quite low with wide fluctuations from year to year. The crop is damaged by a number of insect-pests and diseases. Sesame leaf roller, pod borer and gall fly are the major pests causing up to 100% yield loss.

## Pest management

### Cultural practices

- Field should be ploughed to expose pupae and larvae of pests for predation. Sunlight radiation also kills soil pathogens.
- Fields should have a good drainage of excess rain water.
- Soon after harvesting, straw and stubbles should be burnt to avoid the carry over of the pests.
- In *kharif*, early sowing in the first week of July and use of early maturing varieties like Uma, RT-46 and JT-7 reduces the crop losses due to pests and diseases.
- Intercropping of sesame with mungbean, or moth bean, pearl millet and groundnut reduces the damage due to gall fly and leaf roller/ capsule borer.
- Early sowing (after onset of monsoon) manages *Cercospora* leaf spot and *Alternaria*. However, delayed sowings up to 3 weeks after onset monsoon is good for phyllody management.

### Crop rotation

The practice of crop rotation is effective in reducing pest populations and maintaining productivity, particularly in this crop in which significant yield reduction has been reported in growing sesame in the same field continuously for more than two years. This is because the continuous production of crop over an area increases pest species adapted to attack the crop.

### Major insect-pests and resistant varieties of sesame

Insect pest (s)	Resistant varieties
Leaf roller/ capsule borer ( <i>Antigastra catalaunalis</i> )	RT-46, RT-54, RT-103, RT-125, RT-127, JT-21, Usha, Swetha til, tapi, Krishna and N-32
Gall fly ( <i>Asphondylia sesami</i> )	N-32, RT-46, Swetha til, Rt-103, RT-108, RT-125
Leaf roller/ capsule borer and gall fly	RT-46, Rt-103, Swetha Til, RT-127, N-32
Gall fly and mites	RT-127
Hairy caterpillar ( <i>Spilosoma oblique</i> )	Tilothama and Rama
Hawk moth ( <i>Acherontia styx</i> )	-

### Mechanical control

**Collection and destruction:** Collection and destruction of caterpillars of *Acherontia styx*, egg masses and early instars of *Spilosoma oblique* caterpillars when in congregation, effectively reduce the pest population. Collection and destruction of leaf rolls, shoots, capsules and buds infested by *Antigastra* and *Asphondylia* help to check their population. Clipping of the galls and picking off and burning the shed buds are good prophylactic measures against gall fly.

**Bird perching:** Perching provide shelter to birds, which readily predate on the caterpillars of insects and thus checks the insect population.

### Chemical control:

- Soil application of phorate 10 G @ 10 kg a.i./ha effectively controls the sesame pests, particularly at early stage which is most vulnerable for pests.
- The seed treatment with (a) Thiram (0.3%) or Thiram (0.2%) + Bavistin (0.1%) or *Trichoderma viride*/*T. harzianum* (0.4%); Bavistin (0.1%) or Apron 35 SD (0.25%), (b) seed soaking in the solution of Streptomycin (500 ppm) or Agrimycin 100 (250 ppm) or Streptocycline (500 ppm) for 30 minutes and (c) hot water treatment at 52°C for 10 minutes, effectively control fungal (*Macrophomina*, *Rhizoctonia* and *Fusarium*) and bacterial root rot diseases.
- Three sprays of endosulfan 0.07% viz., first at 30 days after sowing (DAS), second at 45 DAS and third at 60 DAS effectively control of leaf roller/ capsule borer and gall fly.
- Dust with endosulfan 4% or phosalone 4% or quinalphos 4% @ 25 kg/ha for the control of hawk moth



and other leaf feeding caterpillars.

- Spraying with dimethoate 0.03%, or monocrotophos 0.04% or endosulfan 0.07% at bud initiation stage is effective against gall fly.
- Apply carbendazim 0.1% or toposin – M 0.1% thrice at 15 days intervals for the control of *Cercospora* and *Alternaria* leaf spot.
- Apply agrimycin 100 (250 ppm) or streptomycycline (500 ppm) for the control of bacterial blight.
- Apply sulfex 0.2% for the control of powdery mildew.

### Biological control

- Several bio-control agents have been reported to control pests of sesame. *Bracon gelechi* and *Trathala flavorbitalis* as the major parasitoids whereas *Cantheconidia furcellata* is the efficient predator of leaf roller/ capsule borer.

### Exclusion of the pathogen

- **Roughing:** Proper and timely uprooting and destruction of plants infected with root rot, stem rot and phyllody reduces the intensity of the diseases.
- **Destruction of collateral host:** The destruction of weed *Acanthospermum hispidum* in the sesame field significantly reduces the incidence of bacterial blight.

### Biological control of diseases

Disease	Bioagent	Dose	Time of application
Wilt (F.O.f. sp. <i>Sesami</i> ), Charcoal rot ( <i>Macrophomina phaseolina</i> )	<i>T.viride/ T.virens</i>	10 g/kg seed or soil application @ 12.5 kg/250 kg FYM/ha	-

### Prioritised cultural options

State	District	Yield gap	Prioritised Options	Average Yield (kg/ha)	Expected Yield (kg/ha)
Andhra Pradesh	Adilabad, Prakasam, Vishakapatnam, Warangal	80%	Crop management technologies ( <i>Insitu</i> conservation management)	200	235 to 245
	Khammam, Srikakulam, Vizianagaram	74%	Water harvesting for second crop to increase overall productivity	175	200 to 210
	East Godavari	73%	Water harvesting for second crop to increase overall productivity	265	320 to 330
	Guntur	59%	Crop management technologies, <i>Insitu</i> conservation management	405	465 to 485
Bihar	Aurangabad	73%	Crop management technologies, <i>Insitu</i> conservation management	265	320 to 335
Chhattisgarh	Raipur, Surguja	80%	Crop management technologies, <i>Insitu</i> conservation management	200	240 to 250
Gujarat	Rajkot, Surendranagar	79%	Crop management technologies, <i>Insitu</i> conservation management	215	255 to 265
	Ahmedabad	62%	Crop management technologies, <i>Insitu</i> conservation management	265	320 to 335
	Kaira		Crop management technologies, <i>Insitu</i> conservation management	375	435 to 450
	Amreli, Bhavnagar, Junagadh, Mehsana	59%	Crop management technologies <i>Insitu</i> conservation management	405	465 to 485

State	District	Yield gap	Prioritised Options	Average Yield (kg/ha)	Expected Yield (kg/ha)
Jharkhand	Palamu	73%	Water harvesting for second crop to increase overall productivity	265	320 to 330
Karnataka	Bidar	80%	Crop management technologies, <i>In situ</i> conservation management	200	235 to 245
	Gulbarga, Raichur	73%	Water harvesting for second crop to increase overall productivity	265	320 to 335
Madhya Pradesh	Dharwad, Mysore	62%	Crop management technologies	375	435 to 450
	Khandwa, Morena	80%	<i>In situ</i> conservation management	200	235 to 245
Maharashtra	Narsinghpur	55%	Water harvesting for second crop to increase overall productivity	450	520 to 540
	Chhattarpur, Sidhi	74%	Water harvesting for second crop to increase overall productivity	180	200 to 210
	Panna, Shivpuri, Tikamgarh	73%	Water harvesting for second crop to increase overall productivity	265	320 to 330
	Hoshangabad, Raisen, Shahdol	80%	Water harvesting for second crop to increase overall productivity	200	240 to 250
	Akola, Buldhana, Latur, Nanded, Osmanabad, Parbhani	80%	Crop management technologies ( <i>In situ</i> conservation management)	200	235 to 245
	Wardha, Yavatmal	74%	Water harvesting for second crop to increase overall productivity	175	205 to 210
	Beed, Dhule	73%	Crop management technologies ( <i>In situ</i> conservation management)	265	319 to 333
	Jalgaon	62%	Water harvesting for second crop to increase overall productivity	375	435 to 450
	Nagpur	73%	Water harvesting for second crop to increase overall productivity	218	235 to 245
	Chandrapur, Gadchiroli, Jalna	80%	Water harvesting for second crop to increase overall productivity	144	175 to 190
Orissa	Balasore, Bolangir, Cuttack, Dhenkanal, Koraput, Sambalpur	55%	Water harvesting for second crop to increase overall productivity	407	465 to 485
	Phulbani	80%	Water harvesting for second crop to increase overall productivity	144	175 to 190
Rajasthan	Ganjam, Kalahandi, Keonijhar, Mayurbhanj, Puri, Sundargarh	56%	Water harvesting for second crop to increase overall productivity	430	520 to 540
	Chittorgarh	80%	Crop management technologies ( <i>In situ</i> conservation management)	181	200 to 210
	Bhilwara, Jaipur, Tonk, Udaipur	79%	Water harvesting for second crop to increase overall productivity	190	240 to 250
	Alwar, Bundi	73%	Water harvesting for second crop to increase overall productivity	323	375 to 400
Tamilnadu	Sawai Madhopur	62%	Water harvesting for second crop to increase overall productivity	326	375 TO 400
	Tiruchirapally, Villipuram, Tuticorin	62%	Crop management technologies ( <i>In situ</i> conservation management)	326	375 TO 400
	Virudhnagar	73%	Water harvesting for second crop to increase overall productivity		
Uttar Pradesh	Tanjavur	80%		144	175 to 190
	Hamirpur	80%	Crop management technologies ( <i>In situ</i> conservation management)	181	200 to 210
	Shajahanpur	74%	Water harvesting for second crop to increase overall productivity	147	175 to 190
	Fatehpur	62%	Crop management technologies ( <i>In situ</i> conservation management)	326	375 to 400

## 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.
Bengalgarm (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.
Gram (Bengalgram)	<i>Cicer arietinum</i> L.
Greengram (Moong)	<i>Vigna radiata</i> (L.) Wilczek
Groundnut (Peanut)	<i>Arachis hypogaea</i> L.
Guar (Cluster bean)	<i>Cyamopsis tetragonolobus</i> (L.) Tabu
Horsegram	<i>Macrotyloma uniflorum</i> (Lam.) Verdc
Hybrid Napier	( <i>Pennisetum purpureum</i> x <i>P. typhoides</i> ) F1
Indian bean (Lablab)	<i>Lablab purpureus</i> (L) Sweet
Indian rape (Toria)	<i>Brassica campestris</i> L.
Indian squash melon (Tinda)	<i>Citrulus fistulosus</i>
Italian millet (Foxtail millet, <i>Setaria</i> )	<i>Setaria italica</i> Beauv
Jowar (Sorghum)	<i>Sorghum bicolor</i> (L.) Moench
Jute	<i>Corchorus capsularis</i> L.
Kabuli gram	<i>Cicer arietinum</i> L.
Lentil (Masoor)	<i>Lens culinaris</i> Medic
Maize	<i>Zea mays</i> L.
Mesta (Rozella)	<i>Hibiscus Sabdariffa</i> L.
<i>Moth</i> (dew gram)	<i>Vigna aconitifolia</i> (Jacq.) Marechal
Mustard (Raya)	<i>Brassica juncea</i> Coss.
Napier Grass	<i>Pennisetum purpureum</i>
Niger	<i>Guizotia abyssinica</i> (L.f.) Cass
Paddy (Rice)	<i>Oryza sativa</i> L.
Peanut (Groundnut)	<i>Arachis hypogaea</i> L.
Pearlmillet (Bajra)	<i>Pennisetum americanum</i> (L.) Leeke
Peas	<i>Pisum Sativum</i> L.
Pigeonpea (Arhar, Redgram, Tur)	<i>Cajanus cajan</i> (L.) Millsp.

Potato	<i>Solanum tuberosum</i> L.
Proso millet	<i>Panicum miliaceum</i> L.
Ragi	<i>Eleusine coracana</i> (L.) Gaertn
Rapeseed (Sarson)	<i>Brassica campestris</i> L.var. Sarson Prain
Raya (Mustard)	<i>Brassica juncea</i> (L.) Czern. & Coss
Redgram (Pigeonpea, Arhar, Tur)	<i>Cajanus cajan</i> (L.) Millsp
Rice (Paddy)	<i>Oryza sativa</i> L.
Rozella (Mesta)	<i>Hibiscus sabdariffa</i> L.
Safflower	<i>Carthamus tinctorius</i> L.
Sarson (Rapeseed)	<i>Brassica campestris</i> L. var. Sarson Prain
Sesame (Sesamum, Gingelly, Til)	<i>Sesamum indicum</i> L.
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 Wallace), Aniloguard (Gharda)

ATRAZINE 50% W.P.: Atrataf (Rallis), Solaro (Pesticides India), 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), Killlex 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: Furan 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), Pyrirol (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), Cilcord (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 Phosphorous), 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 Phosphorous), 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 Phosphorous), Primer (Bhaskar Agro), Tagor (Tropical Agro), Teeka (NFCL), Champ (Searle India), Hexagor (Parry Chemicals), Hiltthoate (Hindustan Insecticides)

ENDOSULFAN 35 EC & 4% D, 2% D: Thiodan (Agro Evo), Endocel (Excel), Endosul (Sulphur Mills), Endostar (Shaw Wallance), 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 Phosphorous), 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 Chemmicals)

FENVALERATE 20 EC 0.4% DUST: Fenval (Searle Inida), Bilfen (Bayer), Starfen (Shaw Wallance), Fen-Fen (Parry Chemicals), Topfen (Thakar Chemicals), Tagfen (Tropical Agro), Trump Card (Dhanuka), Hilfen (Hindustan Insecticides), Fencron (Novartis), Sumitox (AIMCO), Fenkill (United Phosphorous), Lufen (Lupin), Starfen (Shaw Wallance), Agrofен (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 (Rhoune – Poulnec), Tempo (Agr Evo)

FORMOTHION 25%: Anthio (Novartis)

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

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

MONOCROTOPHOS 36% SL: Nuvacron (Novartis), Monocil (De'Nocil), Monovol (Voltas), Atom (Indofil), Sufos (Sudarshan Chemicals), Monostar (ShawWallance), Specron (Southern Pesticides), Hycrophos (Hyderabad Chemicals), Topcil (Thakar Chemicals), Monocin (IOCL), Monochem (New Chemi), Parryphos (EID Parry), Milphos (Montari), Monodhan (Dhanuka), Phoskill (United Phosphorous), Lumphos (Lupin), Kadett (PesticidesIndia), Agromonark (Gujarat Agro), Moncar (Bhaskar Agro), Azodrin (Cyanamid Inida), Hilcron (HindustanInsecticides), Macrophos (Tropical Agro), Croton (Searle India), Balwan (Rallis), Monophos (Parry Chemicals), Monocron (NFCL), Corophos (Coromandel Indag), Bilphos (Bayer), Monosect (Arg 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), Lophate (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), Ekaton (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 (Rhoune-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 (Novartis)

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

SULPHUR 85 W.P. & DUST: Sulfat (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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## For Further Reading

- AICRPDA, (2003). Research Publications and Recommendations in Dryland Agriculture; An Annotated Bibliography of 1972-2002. An AICRPDA contribution. Compiled by KPR Vittal, H.P. Singh, G.R. Maruthi Sankar, G. Ravindra Chary, T. Sri Jaya and Vibha Srivastava. All India Coordinated Research Project, Central Research Institute for Dryland Agriculture, Hyderabad 500 059, Andhra Pradesh, India. pp.85.
- Akerele, O., Heywood, V., and Syngé, H. (Eds). (1991). Global importance of Medicinal Plants. Conservation of Medicinal Plants. Cambridge University press. U.K.
- Akthar Hussain, (1994). Essential oil plants and their cultivation. Central Institute for Medicinal and Aromatic Plants, Lucknow, Uttar Pradesh.
- ANGRAU, (2002), *Vyvasaya Panchangam (Telugu)*. Acharya N.G.Ranga Agricultural University, Hyderabad, Andhra Pradesh.
- DARE (1997-2002) Annual Reports : 1997-98, 1998-99, 1999-2000, 2000-2001 and 2001-2002. Department of Agricultural Research and Education and Indian Council of Agricultural Research, Ministry of Agriculture, Government of India, New Delhi.
- Anonymous, (1992-93). Agriculture at a Glance. pp70. Karnataka State Department of Agriculture, Bangalore, Karnataka.
- Anonymous, (1993). *Kharif crops* - Manual for Agricultural Extension Officers. pp 196. Directorate of Agriculture and Food Production, Orissa University of Agriculture and Technology. Bhubaneswar, Orissa.
- Anonymous, (2000). *Sudharitha Kotagarika Padathigalu (Kannada)*. pp 328. University of Agriculture Sciences, GKVK, Bangalore.
- Anonymous, (2001). *Kharif Fasalon ki Sasya Jalvayuvik Sadan Padhatia (Hindi)*. Zone 4. pp 91. Krishi Vibhag, Lucknow, (Uttar Pradesh).
- Anonymous, (2001). *Kharif Fasalon ki Sasya Jalvayuvik Sadan Padhatia (Hindi)*. Zone 8. pp 43. Krishi Vibhag, Lucknow, (Uttar Pradesh).
- Anonymous, (2001). Report of the Task Force on Greening India for Livelihood Security and Sustainable Development. Planning Commission, India
- Anonymous, (2002). *Bharani Krishi Kshetre se Adhik Utpadan Kaisa Len? (Hindi)*. Jawaharlal Nehru Krishi Vishwavidyala, Indore, Madhya Pradesh.
- Anonymous, (2002). *Jayad Fslzason ki Sasya Jalvayuvik Sadan Padhatian, (Hindi)* Zone 7. pp 40. Krishi Vibhag, Uttar Pradesh.
- Anonymous, (2002). *Unnat Krishi, Jal kadh Suraksha me Aham Tatv (Hindi)*. pp 47. Krishi Vistar Nirdeshalay, Krishi Vistar Bhavan, New Delhi.
- Balain, D.S. (1995). Recent advances in livestock production. *Kisan Goshthi - Agri Expo – 1995*. Division of Agricultural Extension. pp 10. ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi-110012.
- Behera, B.D., Singh, G.S. and Senapati, P.C. (1998). New vistas for Apriculture in Rainfed plateaux of Orissa. *Indian Farming*. 47 (12): 14-16.
- Chadha, K. L., and Rajendra Gupta. (1997). Advances in Horticulture: *Medicinal and Aromatic plants – Vol.11*. pp 932 + V-xxxii. Malhotra Publishing House, New Delhi.
- Damodaram, T. and Hegde, D.M. (2002). Oilseeds Situation: A Statistical compendium. pp 471. Directorate of Oilseeds Research, Hyderabad, Andhra Pradesh.
- David Norman, Malcolm Doulas. (1994). Farming Systems Development and Soil Conservation. Food and Agriculture Organization, Rome.
- Directorate of Agriculture. (1997). Land Management Techniques for Watershed Development in Karnataka. pp 98. Department of Agriculture, Bangalore, Karnataka.

- Gururaj Hunsigi and Krishna, K.R. (1998). Science of Field Crop Production. pp 433. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
- Hegde, D.M. (Ed.) (2002). Integrated Nutrient Management for Oilseed crops. (pp 10). Directorate of Oilseeds Research, Rajendranagar, Hyderabad.
- Hegde, D.M. (Ed.) (2002). IPM in Oil seed crops. pp 25. Directorate of Oilseeds Research, Rajendranagar, Hyderabad, Andhra Pradesh.
- Lakhdive, B., Nagdeve, M.B and Anita Chorey. (2000). Dryland Agriculture Technology. pp 50. Dr.Panjabrao Deshmukh Krishi Vidyaapeeth, Akola, Maharashtra.
- Mayande, V.M., Katyal, J.C. (1996). Low Cost Improved Seeding Implements for Rainfed Agriculture. pp.28. Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad, Andhra Pradesh.
- Menhi Lal, Shukla, N.P., Tripathi, S. N., Sinsinwar, B.S., Niranjana, K.P., Gupta, S.D., and Arya, R.L. (1994). Forage Production Technology. pp.72. Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh.
- More, S.M., Deshpande, S.S., Mulik, S.P. and Patil, J.D. (1993). *Sericulture – A gainful vocation in Dryland watershed. Indian Farming* 43(a) 9-10.
- Pareek, S.K. and Gupta, R. (1993). Medicinal and aromatic plants to improve profitability of cropping systems in India. pp 325-335. In Glimpses in Plant Research (Govil, J.W. et al., eds). Pub. Today and Tomorrow Printers and Pub, New Delhi. Vol. II.
- Pathak, P.S. and Roy, M.M. (1992). Fodder trees in Agro-forestry: Their selection and management. Range Management and Agro-forestry. 13: 63-87.
- Pathak, P.S., and Roy, M.M. (1994). Silvi-pastoral System of Production. A Research Bulletin. pp 55. Indian Grassland and Fodder Research Institute, Jhansi.
- Pathak, P.S., Gupta, S.K., and Punjab Singh. (1996). IGFRI. Approaches for Rehabilitation of Degraded Lands. pp 23. Indian Grassland and Fodder Research Institute. Jhansi, Uttar Pradesh.
- Prasanta Kumar Mishra, Sastry, G., Mohammed Osman, Babjee Rao, N and G. R. Maruthi Sankar. (Eds.) (2002) Indigenous Technical Knowledge on Soil and Water Conservation in Semi-Arid India, Agro – Ecosystem Directorate (Rainfed), pp. 151. National Agricultural Technology Project, Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad.
- Rama Mohan Rao, M.S., and Narayana Chowdary, P. (1994). Watershed management for sustainable development (Chinnatekur watershed-a case study). pp 69. Central soil and Water Conservation Research and Training Institute, Regional Centre, Bellary and District Rural Development Agency, Kurnool District, Andhra Pradesh.
- Roy, M.M. (1991). Some tropical fodder trees for sustained fodder and firewood availability during lean periods. *Journal of Tropical Agriculture*. 7: 196-205.
- Roy, M.M.(1996). *Hardwickia binata* for Silvicultural systems in India. *Agroforestry Today*, 8:12-13.
- Ruthenberg, H. (1971). Farming Systems in the Tropics. Oxford, Clarendon Press. UK.
- Samra, J.S. and Gurbachan Singh. (2002). Drought Management Strategies. pp. 68. Natural Resource Management Division. Indian Council of Agriculture Research, New Delhi.
- Shankar Babu, and Jagdev Singh. (2003). *Pramuk Kharif Faslon Ki Unnathi Krishi Vidya (Hindi)*. pp 90. Krishi Suchana, Krishi Vibhag, Rajasthan, Jaipur.
- Shankar, M.A., and Shivakumar, H.R. (2003). Mulberry as a component of Watershed development. pp 73. University of Agriculture Sciences, Gandhi Krishi Viganana Kendra, Bangalore, Karnataka.
- Shankar, M.A., Mannjunath, A., Somasekhara, K., Roopadevi, V.D., Nehru, S.D., and Panduranga. (2001). Potentials of Intercropping in Dryland Farming, Technical Bulletin, pp 100. All India Co-ordinated

- Research Project on Dryland Agriculture, University of Agriculture Sciences, G.K.V.K., Bangalore, Karnataka.
- Sharma, S.M. (1995) Package of Practices for increasing production of sesame. Eds. P.S. Reddy and D. Pati. Directorate of Oilseeds Research, Hyderabad, Andhra Pradesh.
- Sidharamaiah, B.N., Ranganatha Mangalavaddara, and Gokul Raj, P. (1999). *Adhika Illugvaragi Adhunika Besaya Paddathigallu – Pradesha 4, 5 mattu 6. (Kannada)*. pp 288. University of Agriculture Sciences, Bangalore, Karnataka.
- Singh, A.K., Bhatia, K.S. and Yadav, J.P. (Eds.) (1999). Waste Land Development Challenges and Opportunities. pp 357. Chandra Shekhar Azad University of Agriculture & Technology, Kanpur and State Land use Board, Department of Planning, Yojana Bhavan, Lucknow.
- Singh, Harvir and Hegde, D.M. (Eds.) (2003). Stress Management in Oilseeds for Attaining Self-Reliance in Vegetable Oils. *A Souvenir in National Seminar*. pp 165. Indian Society of Oilseeds Research, Directorate of Oilseeds Research, Rajendranagar, Hyderabad 500 030 Andhra Pradesh.
- Singh, H.P., Ramakrishna, Y.S., Sharma, K.L. and Venkateswarlu, B. (Eds.) (1999). Fifty Years of Dryland Agricultural Research in India. pp 632. Central Research Institute for Dryland Agriculture. Hyderabad, Andhra Pradesh.
- Singh, H.P., Subba Reddy, G., Venkateswaralu, B., Maheswari, M., and Sreenath Dixit. (2002). Indigenous Technical Knowledge in Rainfed Agriculture. pp 69. Agroecosystem Directorate (Rainfed). Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad-59, Andhra Pradesh.
- Singh, H.P., Venkateswaralu, B., Venkata Ramana, K., and Sanjeeva Reddy. B. (1999). Status of centre-state coordination in agricultural research education and extension in region V, Andhra Pradesh, Orissa and Eastern Madhya Pradesh. pp 247. Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad-59, Andhra Pradesh.
- Singh, R. P., Srivastava, S.N., and Khan, I.M. (2002). *Kaimore Pattar Upanchak Avam Chattisgarh, Uttar Parvathiya Shetris ke Liye Krishi Karyamala (Hindi)*. pp 66. Jawaharlal Nehru Krishi Vishwavidyala, Rewa. Madhya Pradesh.
- Velayutham, M., Mandal, D. K., Mandal, Champa and Sehgal, J. (1999). Agro-ecological Sub regions of India for Planning and Development. pp 372. NBSS Publication 35. National Bureau of Soil Survey & Land Use Planning, Nagpur, India.
- Vittal, K.P.R., Singh, H.P., Rao, K.V., Sharma, K.L., Victor, U.S., Ravindra Chary, G., Maruthi Sankar, G.R., Samra, J.S. and Gurbachan Singh. (2003). Guidelines on Drought Coping Plans for Rainfed Production Systems. pp 39. All India Coordinated Research Project for Dryland Agriculture, Central Research Institute for Dryland Agriculture, Hyderabad-500 059, Andhra Pradesh.
- Vittal, K.P.R., Maruthi Sankar, G.R., Singh, H.P. and Samra, J.S. (2003). Sustainability of Practices of Dryland Agriculture: Methodology and Assessment. pp 100. All India Coordinated Research Project for Dryland Agriculture, Central Research Institute for Dryland Agriculture, Hyderabad-500 059, Andhra Pradesh.
- Vittal, K.P.R., Singh, H.P., Prasad, J.V.N.S., Rao, K.V., Victor, U.S., Maruthi Sankar, G.R., Ravindra Chary, G., Gurbachan Singh and Samra, J.S. (2003). Bio-Diverse Farming System Models for Dryland Agriculture. pp 58. All India Coordinated Research Project Dryland Agriculture, Central Research Institute for Dryland Agriculture, Hyderabad-500 059, Andhra Pradesh.
- Vittal, K.P.R., Singh, H.P., Ravindra Chary, G., Maruthi Sankar, G.R., Prasad, Y.G., Srinivasa Rao, M., Samra, J.S. and Gurbachan Singh. (2003). Improved Agronomic Practices for Dryland Crops in India. pp 210. All India Coordinated Research Project for Dryland Agriculture, Central Research Institute for Dryland Agriculture, Hyderabad-500 059, Andhra Pradesh.



## PUBLICATIONS

1. Annual Report of AICRPDA 2000 – 01 (137 pages)
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