

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

**Districtwise
Promising Technologies
for Rainfed Pigeonpea based
Production System in India**



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

Santoshnagar, Hyderabad 500 059

2005

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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 pigeonpea region, were identified. Their agro ecological setting, soil and water conservation, crop management including nutrient management, pest management, suitable cropping systems, alternate farming systems, contingency plans etc., are 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 Indian Institute of Pulses Research (IIPR), Kanpur but also others from National Agricultural Research System (NARS), State Department(s) of Agriculture and Agro-industries.

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

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Agro-Industries

Implements
Seeds
Fertilizers
Pesticides

State Department(s) of Agriculture

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PIGEONPEA BASED PRODUCTION SYSTEM

About 96% area under pigeonpea is rain dependent. Most often these form a part of the intercropping or traditional mixed seeding systems, providing the much needed resilience to the production system. Pigeonpea, particularly due to its long duration is often intercropped with cereals, short duration pulses and oilseeds. Pulse production is also benign to long-term sustainability of natural resources.

Actual place of origin of pigeonpea is very controversial as some people believe is to originate in India while others say that pigeonpea was found in the wild estate in Africa in regions of upper Nile and the coastal districts of Angola. From Africa, it spread to other parts of the world and to India. Australian people grow it for fodder and vegetable purposes. Now it is being grown in Africa, America, Australia, Hawaii, Ceylon, Netherlands, Malaya, East and West Indies, India, Indo-China, Pakistan, etc. In India, the major pigeonpea producing states are: Maharashtra, Madhya Pradesh, Himachal Pradesh, Karnataka, Gujarat, Bihar, and Andhra Pradesh. Punjab, Haryana, West Bengal, Assam, Orissa, Rajasthan, Jammu and Kashmir, Tamil Nadu, Kerala, also grow pigeonpea.

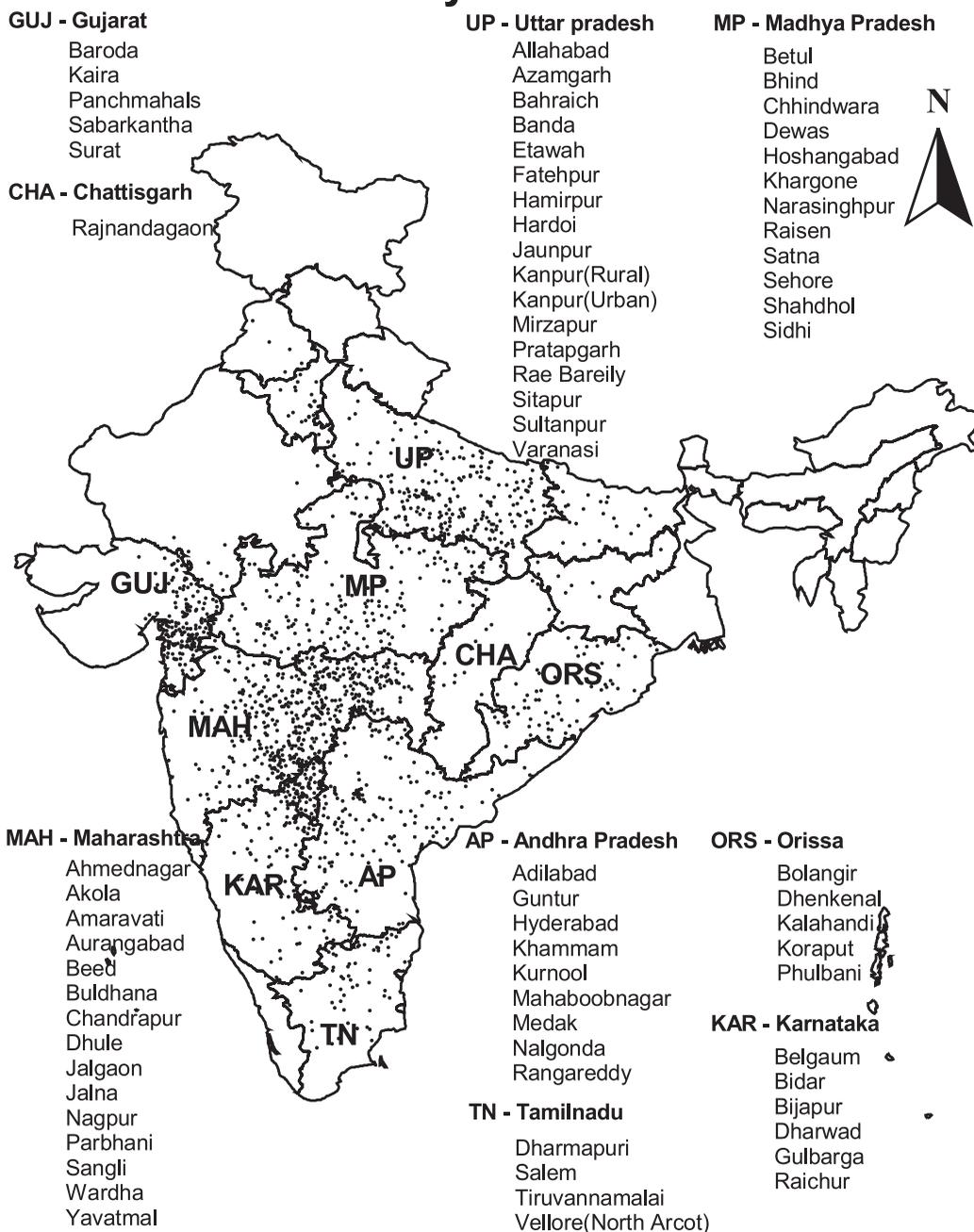
Pigeonpea is grown in 3.4 mha. in 266 districts out of which 3.26 mha is rainfed. About 85% of the rainfed area (2.62 mha.) is in 83 districts.

Selection Criteria	No. of Districts	Area under Pigeonpea ('000 ha)	Area under Rainfed Pigeonpea ('000 ha)	Gross Cropped Area ('000 ha)	Yield (kg/ha)
Rainfed states (13)	266	3396	3255	143910	664
AESR 3-13	215	3218	3080	117676	717
Cumulative 85% rainfed Pigeonpea Area	83	2697	2615	53958	698

The area and yield growth rates for different districts are given below:

Area	Yield	State	District
Stagnant	Increasing	Madhya Pradesh	Raisen
Stagnant	Stagnant	Andhra Pradesh	Mahaboobnagar, Medak
		Karnataka	Gulbarga, Bijapur, Dharwad, Belgaum
		Madhya Pradesh	Khargone, Khandwa, Satna
		Maharashtra	Solapur, Sangli
		Orissa	Ganjam, Phulbani
		Tamilnadu	Vellore, Trichy
		Uttar Pradesh	Banda, Fatehpur, Mirzapur, Balia, Hardoi, Jaunpur
Decreasing	Stagnant	Madhya Pradesh	Chhindwara, Hoshangabad, Betul, Narasinghpur, Dewas
		Uttar Pradesh	Hamirpur, Pratapgarh, Varanasi, Azamgarh, Sultanpur
Increasing	Stagnant	Andhra Pradesh	Adilabad, Hyderabad, Khammam, Kurnool, Nalgonda, Guntur
		Gujarat	Bharuch, Baroda, Sabarkantha, Surat, Kaira
		Karnataka	Bidar, Kolar
		Madhya Pradesh	Sidhi, Shahdol
		Maharashtra	Yavatmal, Osmanabad, Amaravati, Akola, Parbhani, Aurangabad, Nagpur, Buldhana, Beed, Nanded, Jalgaon, Chandrapur, Dhule, Ahmednagar, Koraput, Kalahandi
		Orissa	Bolangir
		Tamilnadu	Salem
		Uttar Pradesh	Sitapur, Etawah
Increasing	Increasing	Gujarat	Panchmahals
		Orissa	Dhenkanal
Stagnant	Decreasing	Karnataka	Raichur
		Uttar Pradesh	Allahabad
Decreasing	Increasing	Madhya Pradesh	Bhind, Sehore
Increasing	Decreasing	Maharashtra	Wardha
Decreasing	Decreasing	Uttar Pradesh	Rae Bareli

RAINFED PIGEONPEA REGION Priority Districts



Details on associated crops and livestock in these districts are presented below:

Crops	Animals	Districts
Rice	Male Cattle	Chattarpur, Narasinghpur, Sidhi, Satna, Shahdhol, Bhind,
Soybean	Goat	Dewas, Sehore, Raisen, Betul, Hoshangabad, Kaira,
Chickpea	Female Cattle	Hamirpur, Mirzapur, Rajnandagaon, Bolangir, Dhenkenal,
Wheat	Female Buffalo	Ganjam, Kalahandi, Koraput, Phulbani
Pigeonpea	Male Buffalo	
Sorghum	Sheep	
Vegetables		
Fruits		
Chickpea	Goat	Panchmahals, Etawah, Fathehpur, Allahabad, Banda,
Rice	Male cattle	Varanasi, Balia, Rae Bareli, Sitapur, Hardoi, Kanpur (Dehat)
Pigeonpea	Female Buffalo	
Maize	Female Cattle	
Sorghum	Sheep	
Vegetables	Male Buffalo	
Fruits		
Rice	Male cattle	Jaunpur, Azamgarh, Sultanpur, Pratapgarh
Maize	Goat	
Pigeonpea	Female Cattle	
Chickpea	Female Buffalo	
Vegetables	Sheep	
Fruits	Male Buffalo	
Groundnut	Sheep	Kurnool, Mahaboobnagar, Kolar, Vellore, Salem, Trichy,
Sorghum	Goat	Dharmapuri, Tiruvannamalai
Finger millet	Male Cattle	
Pigeonpea	Female Cattle	
Fruit	Female Buffalo	
Vegetables	Male buffalo	
Sorghum	Goat	Khargone, Khandwa, Guntur, Hyderabad, Medak, Nalgonda,
Cotton	Male Cattle	Khammam, Adilabad, Dharwad, Belgaum, Bijapur, Bidar,
Pigeonpea	Female Cattle	Raichur, Gulbarga, Dhule, Jalgaon, Ahmednagar, Sangli,
Fruit	Female Buffalo	Solapur, Aurangabad, Parbhani, Beed, Nanded, Osmanabad,
Vegetables	Sheep	Buldhana, Akola, Amaravati, Yavatmal, Wardha, Nagpur,
	Male Buffalo	Chandrapur, Bharuch, Baroda, Sabarkhantha, Surat,
		Prakasam, Jalna, Latur, Rangareddy

The popular production systems associated with the pigeonpea are -

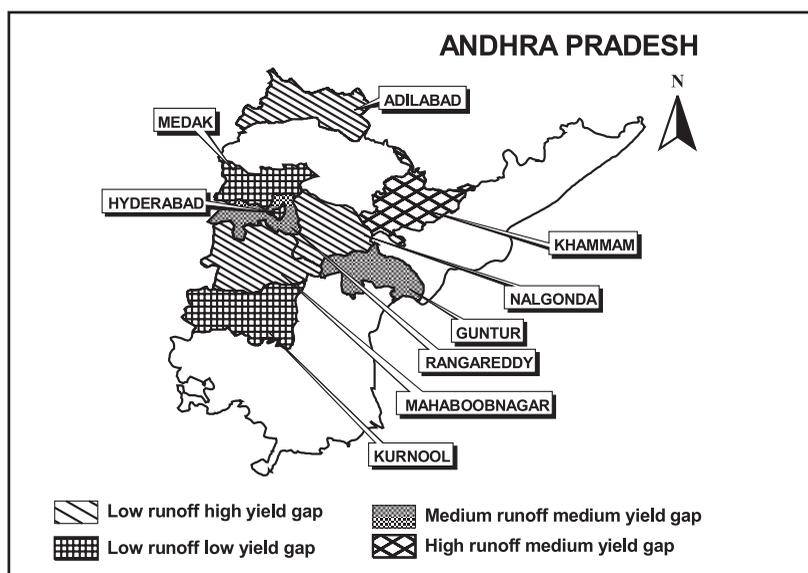
AER	Production System
Hot arid ecoregion of Karnataka plateau (Rayalseema as inclusion)	Groundnut/ setaria/ pearl millet/ sorghum+ pigeonpea
Semi-arid ecoregion of Central highlands (Malwa) and Gujarat plain Kathiawar peninsula	Sorghum+ pigeonpea
Hot Semi arid ecoregion of Deccan plateau	Pigeonpea- fallow Pearl millet/ sunflower/ cotton/ sorghum/ sesame/ greengram/ blackgram/ soybean+ pigeonpea Pigeonpea + blackgram/ greengram
Hot Semi arid ecoregion of Deccan plateau (Telangana) and Eastern ghats	Pigeonpea- fallow Sorghum+ pigeonpea
Hot semi arid ecoregion of Eastern ghats and Tamilnadu uplands and Deccan (Karnataka) plateau	Finger millet/ groundnut/ maize/ cowpea/ blackgram + pigeonpea

AER	Production System
Hot subhumid (dry) ecoregion of Central highlands (Malwa and Bundelkhand)	Sorghum+ pigeonpea
Hot moist/ dry subhumid ecoregion of Chattisgarh/ Mahanadi basin	Blackgram/ sesame + pigeonpea
Hot subhumid ecoregion of Eastern plateau (Chotta Nagpur) and Eastern ghats	Finger millet/ maize + pigeonpea
Hot subhumid (moist) ecoregion of Eastern plains	Pigeonpea - fallow

The recommendations on pigeonpea based production system are given below state and district-wise in alphabetical order for the regions with low (<12%), medium (12-25%) and high (>25%) surplus index, and low (<33%), medium (33-66%) and high (>66%) yield gap of pigeonpea. The recommendations are given for 74 districts in 9 states where rainfed pigeonpea is predominant.

ANDHRA PRADESH

In Andhra Pradesh there are three districts viz. Hyderabad, Kurnool and Medak under low runoff and low yield gap region, three districts viz. Adilabad, Mahaboobnagar and Nalgonda under low runoff and high yield gap region, two districts viz. Guntur and Rangareddy under medium runoff and medium yield gap region and one district viz. Khammam under high runoff and medium yield gap region.



The setting and recommendations follow:

District	Region
Adilabad Mahaboobnagar Nalgonda	Low runoff and High yield gap

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

Mahaboobnagar

- **Climate:** Hot moist semi arid
- **Physiography:** Northern Telangana
- **Soils:** Deep loamy, clayey mixed red and black soils (Vertisols – 40%; Vertic Inceptisols– 20%; Alfisols – 40%)

- **Annual rainfall:** 792 mm
- **Potential evapotranspiration:** 1678 mm
- **Moisture availability period:** 120-150 days

Nalgonda

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

Soil and water conservation

Adilabad

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

Mahaboobnagar

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

Nalgonda

- Ridges and furrows

Crop management

Adilabad, Mahaboobnagar, Nalgonda

- **Varieties:**
 - Maruti (ICP-8863), Abhaya (ICPL-332), Laxmi (ICPL 85063), HY3C, Asha (ICPL 87119), Durga (ICPL-84031), PRG-100, LRG-30, PGR-100
 - **Seed rate:** *kharif*: 8-10 kg/ha; *Rabi*: 15 kg/ha
- **Planting pattern:**
 - Black soils: 90 x 20 cm
 - Red soils: 60 x 20 cm
- **Nutrient management:** 5 t FYM/ ha +20 kg N + 50 kg P₂O₅ + 20 kg S /ha. Apply N and P as basal
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ ha at branching and at pod filling
- **Some important practices**
 - Sowing in June/ July as inter crop
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Adilabad, Nalgonda

- Groundnut (TMV-2) + pigeonpea (ICPL-87) (7:1)

- Pigeonpea + pearl millet (2:6/2:1)
- Pigeonpea + sorghum (1:2)
- Pigeonpea + greengram/ blackgram (1:2)
- Pigeonpea + groundnut (2: 1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)

Mahaboobnagar

- Groundnut (TMV-2) + pigeonpea (ICPL-87) (7:1)
- Pigeonpea + pearl millet (2:6/2:1)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)

Farm implements/ tools

Adilabad

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

Mahaboobnagar, Nalgonda

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

Alternate farming systems

Adilabad, Mahaboobnagar, Nalgonda

- **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 lebbek*, *Bauhinia purpurea*, *Acacia procera*, *Butea monosperma*, *Acacia samara*, *Dalbergia sissoo*
- **Medicinal & Aromatic Plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Aloe barbadensis*, *Withia somnifera*, *Cymbopogon martini*, *Cymbopogon flexuosus*, *Vetiveria zizanioides*, *Palma rosa*.
- **Dye yielding plants:** *Lawsonia inermis*, *Hibiscus sabdariffa*, *Tagetes erecta*, *Indigofera tinctoria*, *Annato*

- **Other economic shrubs:** Curry leaf, Jatropha, Soapnut
- **Animal component:** Female cattle, Female Buffaloes, Male Cattle, Sheep and Goat
- **Other enterprises:** Sericulture, Poultry

Contingent planning

Adilabad

For Red soils:

- **June:**
 - **Sole crop:**
 - Sorghum (SPV-462, CSH-13, 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:**
 - **Sole crop:**
 - Fingermillet
 - Sow castor (Aruna, GCH-4)
 - Bunch variety of Groundnut (TMV-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 (Kranthi, GCH -4) 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 (LGG 450, Warangal 2, Madhira)

Second crop

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

Mahaboobnagar, Nalgonda

- **June: Normal onset of monsoon**
 - **Sole crop:** Sorghum (CSH 5, CSH-6, CSH-9), Pearlmillet (MBH 110)
 - **Intercrop:**
 - Sorghum - pigeonpea (2:1)
 - Pearlmillet + pigeonpea (2:1) in 45 cm row spacing. Pigeonpea duration of 150 - 180 days may be used.
- **July: Late onset of monsoon**
 - Sow castor (Aruna, GCH-4)
 - **Sole crop:** Pearlmillet (MBH-110), Bunch variety of groundnut (TMV-2, JL-24)
 - **Intercrop:**
 - Pearlmillet + pigeonpea (2:1)
 - Maize + pigeonpea (2:1) at 50 cm spacing. Pigeonpea duration of 180 days may be used.
- **August: Very late onset of monsoon**
 - **Sole crop:**
 - Setaria (H-1, Arjuna) grain for poultry feed and straw for fodder
 - Castor (Aruna, GCH -4) with increased seed rate (15 kg/ha)

District	Region
Guntur Rangareddy	Medium runoff and Medium yield gap

Agro-ecological setting

Guntur

- **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 alluvium derived soils (Aridisols – 40%; Vertisols – 30%; Alfisols – 30%)
- **Annual rainfall:** 704 mm
- **Potential evapotranspiration:** 1777 mm
- **Moisture availability period:** 150 -180 days

Rangareddy

- **Climate:** Hot moist semi arid
- **Physiography:** North Telangana
- **Soils:** Deep loamy, clayey mixed red and black soils (Alfisols – 100%)
- **Annual rainfall:** 829 mm
- **Potential evapotranspiration:** 1750 mm
- **Moisture availability period:** 120 -150 days

Soil and water conservation

Guntur, Rangareddy

- More emphasis on *in situ* 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

Guntur, Rangareddy

- **Varieties:**
 - Maruti (ICP-8863), Abhaya (ICPL-332), Laxmi (ICPL 85063), HY3C, Asha (ICPL 87119), Durga (ICPL-84031), PRG-100, LRG-30, PGR-100
- **Seed rate:** *kharif*: 8-10 kg/ha, *Rabi*: 15 kg/ha
- **Planting pattern:** Black soils: 90 x 20 cm; Red soils: 60 x 20 cm
- **Nutrient management:** 5 t FYM/ha + 20 kg N + 50 kg P₂O₅ + 20 kg S/ha. Apply N, P and S as basal.
- **Pest management**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ ha at branching and at pod filling
- **Some other important practices**
 - Sowing in June/ July as inter crop
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Guntur, Rangareddy

- Groundnut (TMV-2) + pigeonpea (ICPL- 87) (7:1)
- Pigeonpea + pearl millet (2:6/2:1)
- Pigeonpea + sorghum (1:2)
- Pigeonpea + greengram/ blackgram (1:2)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)

Farm implements/ tools

Guntur, Rangareddy

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

Alternate farming systems

Guntur

- **Fodder/ green biomass:** *Albizzia lebbeck*, *Dalbergia sissoo*, *Leucaena*, *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:** Clusterbean, drumstick, cucumber, cowpea, ridge gourd, round melon, okra, watermelon.

Rangareddy

- **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.
- **Agri-horti system:** Mango + short duration pulses.
- **Fruit:** Mango, ber, custard apple, guava, pomegranate, amla.
- **Fodder/ green biomass:** *Leucaena leucocephala*, *Azadirachta indica*, *Albizia lebbek*, *Bauhinia purpurea*, *A.procera*, *B.monosperma*, *A.amara*, *D.sissoo*.
- **Medicinal and Aromatic Plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Aloe barbadensis*, *Withia somnifera*, *Cymbopogon martini*, *Cymbopogon flexuosus*, *Vetiveria zizanioides*, *Palma rosa*.
- **Dye yielding plants:** *Lawsonia inermis*, *Hibiscus subdariffa*, *Tagetes erecta*, *Indigofera tinctoria*, *Annato*.
- **Other economic shrubs:** Curry leaf, *Jatropha*, Soapnut.
- **Animal Component:** Female cattle, female buffaloes, male cattle, sheep and goat.
- **Other enterprises:** Sericulture, Poultry.

Contingent crop planning

Rangareddy

- **June: Normal onset of monsoon**
 - **Sole crop:** Sorghum (CSH 5, CSH-6, CSH-9), Pearl millet (MBH 110)
 - **Intercrop:**
 - Sorghum - pigeonpea (2:1)
 - Pearl millet + pigeonpea (2:1) in 45 cm row spacing. Pigeonpea duration of 150-180 days may be used.
 - Pigeonpea (Maruti) + Greengram (ML-267) (1:2)
- **July: Late onset of monsoon**
 - Sow castor (Aruna, GCH-4)
 - **Sole crop:** Pearl millet (MBH – 110), Bunch variety of Groundnut (TMV-2, JL-24), Pigeonpea cv. Durga
 - **Inter crop:**
 - Pearl millet + pigeonpea (2:1)
 - Maize + pigeonpea (2:1) at 50 cm spacing. Pigeonpea duration of 180 days may be used.
- **August: Very late onset of monsoon**
 - **Sole crop:**
 - *Setaria* (H-1, Arjuna) for grain to poultry feed and straw for fodder
 - Castor (Aruna, GCH-4) with increased seed rate (15 kg/ha)

District	Region
Hyderabad Kurnool Medak	Low runoff and low yield gap

Agro-ecological setting

Hyderabad

- **Climate:** Hot moist semi arid
- **Physiography:** North Telangana
- **Soils:** Deep loamy, clayey mixed red and black soils (Alfisols – 100%)
- **Annual rainfall:** 764 mm
- **Potential evapotranspiration:** 1758 mm
- **Moisture availability period:** 120-150 days

Kurnool

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

Medak

- **Climate:** Hot moist semi arid
- **Physiography:** North Telangana Plateau
- **Soils:** Deep loamy, clayey mixed red and black soils (Alfisols – 75%; Vertic Inceptisols – 25%)
- **Annual rainfall:** 835 mm
- **Potential evapotranspiration:** 1758 mm
- **Moisture availability period:** 120-150 days

Soil and water conservation

Hyderabad

- More emphasis on *in situ* 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.

Medak

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

Kurnool

- Contour bunds, graded bunds

- Contour bunding with a cross section of 0.63 m² and with horizontal spacing of 25 m to 125 m is recommended for red soils. The other soil conservation measures like compartment bunds of 15 m length and 10 m width or conservation furrow at 3.6 m interval or intercropping with mixed pulses like cowpea and horsegram can be adopted.
- Integrated watershed management (manage in a < 10 ha watershed)
- Water harvesting: Dug out ponds are lined with cuddapah slabs to avoid seepage losses
- Increasing catchment area and design of pond size for catchment size
- Interplot water harvesting of 1:1 cropped to uncropped area
- Use of life saving irrigation
- Indigenous water harvesting structures

Crop management

Hyderabad, Medak

- **Varieties:**
 - Maruti (ICP-8863), Abhaya (ICPL-332), Laxmi (ICPL 85063), HY3C, Asha (ICPL 87119), Durga (ICPL-84031), PRG-100, LRG-30, PGR-100
- **Seed rate:** *Kharif:* 8-10 kg/ha, *Rabi:* 15 kg/ha
- **Planting pattern:** Black soils: 90 x 20 cm; Red soils: 60 x 20 cm
- **Nutrient management:** 5 t FYM/ha + 20 kg N + 50 kg P₂O₅ + 20 kg S/ ha. Apply N, P and S as basal
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ha sprayed at branching and at pod filling
- **Some other important practices**
 - Sowing in June/ July as inter crop
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Kurnool

- **Varieties:** LRG-30, PGR-100, ICPL 87
- **Seed rate:** 15 kg/ha
- **Planting pattern:** 90 x 20 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 40 kg K₂O/ha
- **Pest management:**
 - For pod borers:
 - Spray Chlorpyrifos @ 2.5 l during flower initiation stage and Quinolphos @ 2 l or Acephate @ 1 kg in 750-1000 l of water during flowering stage, with hand compression sprayer.
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ha at branching and at pod filling
- **Some other important practices**
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Hyderabad, Medak

- Groundnut (TMV-2) + pigeonpea (ICPL- 87) (7:1)
- Pigeonpea + pearl millet (2:6/2:1)
- Pigeonpea + sorghum (1:2)
- Pigeonpea + greengram/ blackgram (1:2)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)

Kurnool

- Groundnut (TMV-2) + pigeonpea (ICPL-87) (7:1)
- Pigeonpea + pearl millet (2:6/2:1)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)

Farm implements/ tools

Hyderabad, Medak

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

Kurnool

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

Alternate farming systems

Hyderabad

- **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
- **Agri-Horti system:** Mango + short duration pulses
- **Fruit:** Mango, ber, custard apple, guava, pomegranate, amla
- **Fodder/ green biomass:** *Leucaena leucocephala*, *Azadirachta indica*, *Albizia lebbeck*, *Bauhinia purpurea*, *B.monosperma*, *A.amara*, *D. sissoo*
- **Medicinal & Aromatic Plants:** *Catharanthus roseus*, *Cassia angustifolia*, *Aloe barbadensis*, *Withia somnifera*, *Cymbopogon martini*, *Cymbopogon flexuosus*, *Vetiveria zizanioides*, *Palma rosa*
- **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

Kurnool

- **Fodder/ green biomass:** *Dalbergia sissoo*, *Gliricidia*, *Albizia lebbeck*, *Cassia siamea*, *Azadirachta indica*, *styro*, Marvel-8 grass
- **Fruit:** Ber, custard apple, pomegranate, amla + *kharif* spreading crops
- **Medicinal and aromatic plants:** *Cassia angustifolia*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, Rose, Geranium
- **Vegetables:** Onion, brinjal, chillies, cowpea, cucumber, clusterbean, drumstick.
- Crop + livestock (sheep @ 10/ha) system of farming will give 80% more income than crop system alone.

Medak

- **Fodder/ green biomass:** *Albizia lebbeck*, *Dalbergia sissoo*, *Subabul*, *Azadirachta indica*, *Hardwickia binata*, *Acacia albinda*.
- **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, water melon.
- **Animal component:** Male/ female cattle, female buffaloes, sheep, goat, poultry.

Contingent planning

Hyderabad, Medak

- **June: Normal onset of monsoon**
 - **Sole crop:** Sorghum (CSH 5, CSH-6, CSH-9), Pearl millet (MBH 110)
 - **Intercrop:**
 - Sorghum - pigeonpea (2:1)
 - Pearl millet + pigeonpea (2:1) in 45 cm row spacing. Pigeonpea duration of 150-180 days may be used.
- **July: Late onset of monsoon**
 - Sow castor (Aruna, GCH-4)

- **Sole crop:** Pearl millet (MBH – 110), Bunch variety of Groundnut (TMV-2, JL-24)
- **Inter crop:**
 - Pearl millet + pigeonpea (2:1)
 - Maize + pigeonpea (2:1) at 50 cm spacing. Pigeonpea duration of 180-200 days
- **August: Very late onset of monsoon**
 - **Sole crop:**
 - Setaria (H-1, Arjuna) grain for poultry feed and straw for fodder
 - Castor (Aruna, GCH-4) with increased seed rate (15 kg/ha)

Kurnool

- **Early onset of monsoon (last week of May or June):** Sorghum (CSH-5), greengram (PDM 54), pigeonpea (ICPL 87), castor (Aruna, GCH-4), mesta (AMV-1)
- **Normal onset of monsoon (July):** Groundnut, pigeonpea (TMV-2, J-11), groundnut + pigeonpea, castor (Aruna, GCH-4), mesta (AMV-1), setaria, pearl millet (MBH-110, MH-88), greengram
- **Late onset of monsoon (August):** Sorghum, greengram (after August 15th), pearl millet (MBH-110), setaria, groundnut (TMV-2)
- **Very late onset of monsoon (September):** Cowpea, horsegram (early September), pearl millet (MBH-110), horsegram (Anantapur local, BGM)

District	Region
Khammam	High runoff and Medium yield gap

Agro-ecological setting

- **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

Soil and water conservation

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

Crop management

- **Varieties:**
 - Maruti (ICP-8863), Abhaya (ICPL-332), Laxmi (ICPL 85063), HY3C, Asha (ICPL 87119), Durga (ICPL-84031), PRG-100, LRG-30, PGR-100
- **Seed rate:** *kharif*: 8-10 kg/ha; *Rabi*: 15 kg/ha
- **Planting pattern:** Black soils: 90 x 20 cm; Red soils: 60 x 20 cm
- **Nutrient management:** 5 t FYM/ha + 20 kg N + 50 kg P₂O₅ + 20 kg S/ ha. Apply N, P and S as basal.

- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ ha at branching and at pod filling
- **Some other important practices**
 - Sowing in June/ July as inter crop
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

- Groundnut (TMV-2) + pigeonpea (ICPL-87) (7:1)
- Pigeonpea + pearl millet (2:6/2:1)
- Pigeonpea + sorghum (1:2)
- Pigeonpea + greengram + blackgram (1:2)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)

Farm implements/ tools

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

Alternate farming systems

- **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
- **Agro-horti system:** Mango + short duration pulses
- **Fruit:** Mango, ber, custard apple, guava, pomegranate, amla
- **Fodder/ Green biomass:** *Leucaena leucocephala*, *Azadirachta indica*, *Albizia lebbeck*, *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*, *Prosopis juliflora*, *Palma rosa*.
- **Dye yielding plants:** *Lawsonia inermis*, *Hibiscus sabdariffa*, *Tagetes erecta*, *Indigofera tinctoria*, *Annato*
- **Other economic shrubs:** Curry leaf, Jatropha, Soapnut
- **Animal component:** Female cattle, female buffaloes, male cattle, sheep and goat
- **Other enterprises:** Sericulture, poultry

Contingent planning

For Red soils

- **June:**
 - **Sole crop:** Sorghum (CSH 5, CSH-6, CSH-9), Pearlmillet (MBH 110)
 - **Intercrop:**
 - Sorghum + pigeonpea (2:1)
 - Pearlmillet + pigeonpea (2:1) in 45 cm row spacing. Pigeonpea duration of 150- 180 days may be used.
- **July:**
 - Sow castor (Aruna, GCH-4)
 - **Sole crop:**
 - Fingermillet
 - Bunch variety of Groundnut (TMV-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) grain for poultry feed and straw for fodder
 - Castor (Kranthi, GCH -4) with increased seed rate (15 kg/ha)

For black soils

First crop

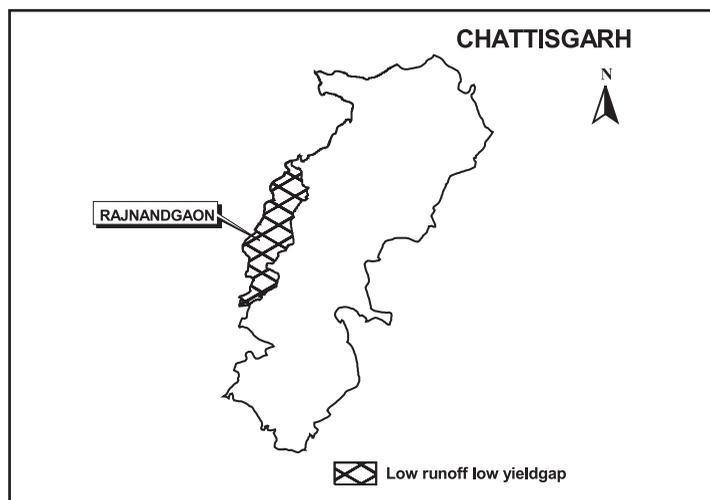
- **June:**
 - Sorghum (CSH-5, CSH-6, CSH-9)
 - Maize (Ganga 5, DHM-101)
 - Greengram (Madhira, LGG 450, HB-45, LRG -30)
- **July:**
 - Maize (Ganga 5, DHM-101)
 - Greengram (Madhira, LGG 450, HB-45, LRG -30)

Second crop

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

CHATTISGARH

In Chattisgarh there is one district viz. Rajnandagaon under low runoff and low yield gap region.



The setting and recommendations follow:

District	Region
Rajnandagaon	Low runoff and low yield gap

Agro-ecological setting

- **Climate:** Hot moist/ dry sub humid
- **Physiography:** Chattisgarh – Mahanandi Basin
- **Soils:** Deep loamy to clayey red and yellow soils (Alfisols – 50%; Ustolls – 50%)
- **Annual rainfall:** 1354 mm
- **Potential evapotranspiration:** 1577 mm
- **Moisture availability period:** 150-180 days

Soil and water conservation

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

Crop management

- **Varieties:** MA 6, KM 7, No. 148, TT 6
- **Seed rate:** 12 - 15 kg/ha

- **Planting pattern:** 60 x 30 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 kg S/ ha
- **Pest management**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ha sprayed at branching and at pod filling
- **Some other important practices**
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed
 - Suitable cropping systems
 - Pigeonpea + greengram (2:1/1:3)
 - Pigeonpea + soybean (1:3)
 - Pigeonpea (142) + groundnut (SB-11) (1:3)
 - Pigeonpea + setaria (1:3)
 - Pigeonpea + cotton (12:2)

Farm implements/ tools

- Seed cum fertilizer drill

Alternate farming systems

- **Fodder/ green biomass:** *Albizzia lebbbeck*, *Subabul*, *Dalbergia sissoo*, *Azadirachta indica*, *Sesbania*, *Pongamia*.
- **Fruit:** Ber, mango, sapota, tamarind, fig.
- **Medicinal and Aromatic Plants:** *Papaver somniferum*, *Rauvolfia liquorice*, *Safed musli*, *Palma rosa*.
- **Vegetables:** Bottlegourd, tomato, ridge gourd, amaranthus, drumstick.
- **Animal Component:** Female and male cattle, female and male buffaloes.
- **Horticulture:**
 - Promising mango varieties recommended for different purposes are as follows:
 - Langra – Banarasi, *Desheri*, Bombay Green (Table varieties)
 - Rani Pasand (Sucking)
 - Batasiya & Bitter gourd (Karela) (Pickle & *murabba*)
 - In newly planted mango orchards, intercropping with vegetables and legume crops (upto 5-7 years) found to be economical.
 - Jharberi (*Ziziphus rotundifolia*) can easily be converted by budding into improved varieties.

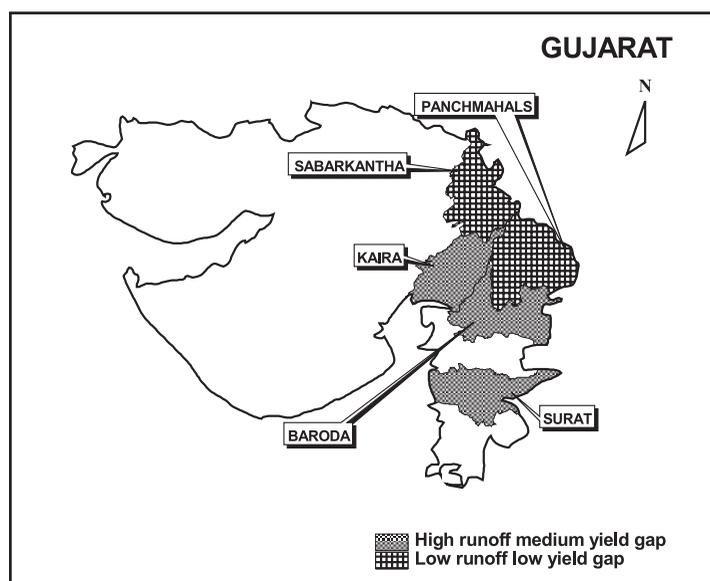
Contingent planning

- **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, JA 4, Asha)
 - Groundnut (Jyoti, M 12, Exotic 1-1)
 - **Inter crop**
 - Sorghum + pigeonpea (2:1)
 - Soybean + pigeonpea (2:1)
- **August**
 - Castor (GCH 4, Kranthi)
 - 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 two districts viz. Panchmahals and Sabarkantha under low runoff and low yield gap region and three districts viz. Baroda, Kaira and Surat under high runoff and medium yield gap region.



The setting and recommendations follow:

District	Region
Baroda Kaira Surat	High runoff and Medium yield gap

Agro-ecological setting

Baroda

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Gujarat Plains
- **Soils:** Vertic Inceptisols – 55%; Vertisols – 45%
- **Annual rainfall:** 987 mm
- **Potential evapotranspiration:** 1575 mm
- **Moisture availability period:** 60-90 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

Surat

- **Climate:** Hot moist semi arid/ Hot humid
- **Physiography:** Eastern Gujarat Plains, South East Gujarat
- **Soils:** Deep clayey black soils, shallow black soils, medium to deep loamy to clayey mixed red and black soils (Vertisols – 60%; Orthids – 20%; Vertic Inceptisols – 20%)
- **Annual rainfall:** 1207 mm
- **Potential evapotranspiration:** 1606 mm
- **Moisture availability period:** 120-240 days

Soil and water conservation

Baroda

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

Kaira

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

Surat

- Shallow ploughing before sowing and ridging and furrowing 25 days after sowing.
- Increasing soil infiltration capacity and reducing soil crusting problem
- Two to four interculturings along with deep ploughing in groundnut

Crop management

Baroda, Kaira, Surat

- **Varieties:** GT – 100, ICPL – 87, BON-2, and ICPL-87119
- **Seed rate:** 12 – 15 kg/ha
- **Planting pattern:** 60 x 30 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 kg S + 20 kg ZnSO₄/ ha. N and P to be applied as basal
- **Pest management:**
 - Pod borer complex
 - Pod borer complex of pigeonpea can be effectively controlled by three spraying of 5% neem seed kernel extract at initiation of flowering, 50% flowering and pod formation stage
 - First spray with Endosulfan 0.07% at 50% flowering and second with Monocrotophos 0.04% at 50% pod setting stage are recommended for the effective and economic control (NICBR 1:4.30) of pod borer complex (*Heliothis plume moth* and pod fly)

- NPV culture – extract of 500 caterpillars in 500 l of water/ ha
- 25 kg neem seed extract in 500 l of water/ha sprayed at branching and at pod filling
- **Some other important practices**
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Baroda, Kaira, Surat

- Pearl millet (BJ-104) should be grown in paired rows (40 cm apart with a spacing 40 x 0.5) in between two rows of pigeonpea (UPAS-120) at a spacing of 120 x 45 cm
- Groundnut + pigeonpea (3:1)
- Pearl millet + pigeonpea (2:1)
- Sorghum + pigeonpea (1:1)
- Pigeonpea + teosinte
- Pigeonpea + maize
- Soybean + pigeonpea (2:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + green gram (2:1)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + small millets (2:1)

Farm implements/ tools

Baroda

- Two bowl seed cum fertilizer drill

Kaira, Surat

- 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

Baroda, Surat

- **Fodder/ green biomass:** *Dichrostachys cineraria*, *Albizia lebbeck*, *Leucaena*, *Pongamia pinnata*
- On sloppy fallow lands with shallow soils – *Dicanthium annulatum*; 16 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/ Aromatic Plants:** *Plantago ovata*, *Cassia angustifolia*
- **Vegetables:** Cowpea, clusterbean, brinjal, okra, long melon, drumstick.
- **Animal Component:** Female/ male cattle, female buffaloes, sheep, goat

Kaira

- **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*, *Albizia lebbeck*, *Leucaena leucocephala*, *Pongamia pinnata*
- **Fruit:** Custard apple, mango, pomegranate, phalsa, fig, jamun, tamarind
- **Medicinal/ Aromatic Plants:** *Plantago ovata*, *Cassia angustifolia*, *Liquorice*.
- **Vegetables:** Cowpea, clusterbean, brinjal, okra, long melon, drumstick.
- **Animal component:** Female buffaloes, cows, male cattle, sheep, goat, poultry

Contingent planning

Baroda, Kaira, Surat

Delay in monsoon by

- 15th July to 31st July
 - Grow erect groundnut (GG-2, GG-5, GG-7), Sesame (G-Til-1, G.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)
- 1st August to 14th August
 - Grow pulses blackgram (T-9, TPU-4), forage maize/ sorghum (Gundri, GFS-5), castor (GAUCH-1, GC-2) and sesame (Purva-1)
- 15th August to 31st 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.Til-1, G-Til-2), castor (GAUCH-1, GC-2) and 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
- Foliar spray of 2% urea.

Satisfactory late rains during September - October

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

District	Region
Panchmahals Sabarkantha	Low runoff and low yield gap

Agro-ecological setting

Panchmahals

- **Climate:** Hot moist semi arid
- **Physiography:** Eastern Gujarat Plains
- **Soils:** Deep clayey black soils, shallow black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 833 mm
- **Potential evapotranspiration:** 1560 mm
- **Moisture availability period:** 120-150 days

Sabarkantha

- **Climate:** Hot dry semi arid
- **Physiography:** Gujarat Plains
- **Soils:** Deep loamy grey brown and alluvium - derived soils (Vertic Inceptisols – 50%; Ustalf/ Ustolls – 50%)
- **Annual rainfall:** 885 mm
- **Potential evapotranspiration:** 1608 mm
- **Moisture availability period:** 90-120 days

Soil and water conservation

Panchmahals, Sabarkantha

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

Crop management

Panchmahals, Sabarkantha

- **Varieties:** T-15-15, BDN-2, ICHP-8, ICPL-87 and GT 1
- **Seed rate:** 12-15 kg/ha
- **Planting pattern:** 60 x 20 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 S/ ha. All N, P and S to be applied on basal
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 2.25 kg neem seed extract in 500 l of water/ha sprayed at branching and at pod filling

Pests:

- | | |
|--------------------|------------------------------------|
| i. Pod fly | Spray Monocrotophos 40 EC @ 2 ml/l |
| ii. Tur plume moth | Spray Dimethoate 30 EC @ 1.5 ml/l |
| iii. Heliothis sp. | Spray Endosulfan 35 EC @ 2ml/l |
| iv. Tur pod bug | |

Diseases:

- | | |
|------|--|
| Wilt | Eradicate affected plants.
Use disease free seed.
Seed treatment with Thiram @ 3 g/kg seed |
|------|--|

• **Some important practices**

- Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Panchmahals, Sabarkantha

- Pigeonpea + groundnut
- Pearl millet + pigeonpea
- Pigeonpea + soybean (2:1)
- Pigeonpea + green gram (2:1)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + small millets (2:1)

Alternate farming systems

Panchmahals, Sabarkantha

- **Alley cropping:** Subabul (paired row) + sorghum (5-6), Subabul + groundnut, Perennial Pigeonpea (alleys) + groundnut (GG-2)
- **Fodder/ green biomass:** The farmers growing ber (10 x 6 m) on light textured soils are advised to take inter crop of either greengram or sorghum (fodder)
- *A.lebbeck, A. indica, A. albida, Cassia siamea, D.sissoo, Alianthus excelsa*
- **Fruit:** Mango, pomegranate, guava, ber, fig, jamun.
- **Medicinal/ Aromatic Plants:** *Plantago ovata, Cassia angustifolia, Liquorice.*
- **Vegetables:** Drumstick, clusterbean, cowpea, long melon, okra.
- **Animal Component:** Female and male cattle, female buffaloes, goats.

Contingent planning

Panchmahals, Sabarkantha

Normal sowing (Early July)

- Castor: GCH-4, GCH-5, GCH-6
- Pearl millet: GHB-235, GHB-316
- Cowpea: Guj. Cowpea-4

- Clusterbean: Guj. Clusterbean-1
- Greengram: Guj. Mung-4
- Sorghum: GSF-4
- Mothbean: Guj.1
- Karingado: Guj. Karingado-1

Delayed sowing (15th July to early August)

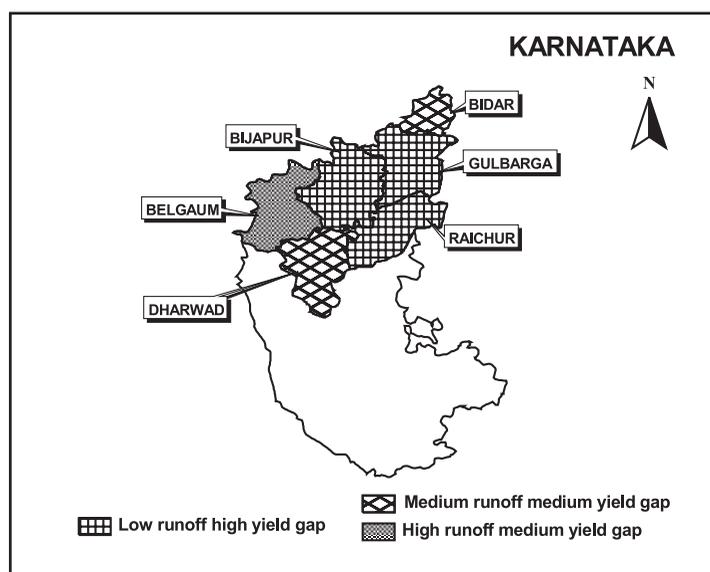
- Castor: GCH-4
- Sorghum: GSF-4
- Clusterbean: Guj. Clusterbean-1

Very delayed sowing (mid August)

- Castor: GCH-4

KARNATAKA

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



The setting and recommendations follow:

District	Region
Belgaum	High runoff and medium yield gap

Agro-ecological setting

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

Soil and water conservation

- Graded bunds
- Zingg terraces
- Compartment bunding
- Broad bed and furrows for black soils

- Ridges and furrows
- Supplemental irrigation
- Suitable surface drainage measures to avoid water logging

Crop management

- **Varieties:** C – 11, PT –221, G.S – 1, KGT 1, TTB 7, Asha
- **Seed rate:** 12-15 kg/ha
- **Planting pattern:** 90 x 20 cm
- **Nutrient management:** 20 Kg N + 50 kg P₂O₅ +20 kg S/ ha
- **Pest management:**
 - For pod borers control:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg Neem seed extract in 500 l of water per hectare sprayed at branching and pod filling
- **Some other important practices**
 - Shallow soils: sowing upto 15th July medium black soils
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

- Pigeonpea + pearl millet (1:3/2:1)
- Bunch Groundnut + pigeonpea (3:1)
- Sesame + pigeonpea (3:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1/2:4)
- Pigeonpea + sorghum (2:1)

Farm implements/ tools

- Wooden plough (Bullock drawn): Shallow ploughing to a depth of 10 cm. Rs. 2000/-
- MB plough (Bullock drawn): Deep ploughing. Rs. 4000/-
- MB plough (Tractor drawn): Deep ploughing. Rs. 15000/-
- Blade harrow (Bullock drawn): Harrowing. Rs. 1000/-
- Blade harrow (Tractor drawn): For harrowing. Rs. 10000/-
- Seed cum fertilizer drill (Bullock drawn): For sowing and fertilizer application. Rs. 2500/-
- Seed cum fertilizer drill (Bullock drawn - adjustable): Sowing and fertilizer application simultaneously. Rs. 4500/-
- Seed cum fertilizer drill (Tractor drawn): For sowing and fertilizer application. Rs. 26000/-
- Ridger: Ridges and furrows. Rs. 1000/-
- Bund former: Compartment bund. Rs. 700/-

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

Alternate farming systems

- Agave (*Agave sisolana* with 10, 000 plants/ha) intercropped with subabul. Cutting of agave leaves once in a year for fiber extraction with retaining top ten leaves
- Silviculture
- **Shallow black soils:** *Casuarina*, *Dalbergia sissoo*, *Hardwickia binata*, *Acacia nilotica*, *Prosopis cineraria*
- **Marginal land:** *Dalbergia sissoo*, neem, *Acacia nilotica*, Subabul
- **Alley cropping:** Subabul/ casuarina + *Kharif* crops
- **Agro horti system:** Ber (umran) + curry leaf, ber (umran) – safflower + chickpea, ber/ custard apple/ pomegranate/ amla + *kharif* (spreading) crops
- **Horticulture:** Mango plants in levelled portion of zingg conservation terrace
- **Fodder/ green biomass:** *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, clusterbean, drumstick, curry leaf.
- **Animal Component:** Female/ male cattle, female buffaloes, goat, sheep, poultry

Contingent planning

Normal onset of monsoon favourable for *kharif* crops

- Take up sowing of the following crops in June in light soils. Groundnut (erect and spreading), pearl millet, pigeonpea, *kharif* sorghum, setaria, hybrid sorghum and other crop mixtures like *kharif* sorghum + pigeonpea (2:1), groundnut + pigeonpea (4:2), setaria + pigeonpea (2:1) and pearl millet + pigeonpea (2:1). Similarly, pulse crops in light and retentive soils may be taken up.
- In *rabi* areas, i.e., medium deep black soils, sow greengram, blackgram, cucumber as a first crop to be followed by *rabi* sorghum/ sunflower/ chickpea/ safflower/ wheat.
- When the land is kept fallow (deep black soils) for *rabi* crops, have compartment bunds having 1 per cent slope, scooping where the land slope is 1 to 2 per cent, 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 Hirsutam. Early sowing of cotton is advantageous.
- Sunflower, pigeonpea, and setaria should be sown in light soils and pigeonpea in medium to deep black soils.
- In light textured soils in Hadagali, Koppal, Muddebihal, Raibag, and Athani castor may be sown. Plant castor on contour bunds also. In medium to deep black soils also take up castor sowing.
- Relay cotton in groundnut in medium black soils.

Normal rains in September

- Complete sowing of *rabi* sorghum by middle of September in medium black soils of northern taluks of Bijapur district. In the remaining taluks viz., Bagalkot, Hungund, and Mudhol, complete *rabi* sorghum sowing by first week of October. Early sowing of *rabi* sorghum in other districts is preferred. Maximum yields of *rabi* sorghum are obtained by sowing in September only.
- Sow sunflower before 10th 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 15th September.
- If normal rains are not received during September take up dry seeding of sunflower, *Rabi* sorghum, chickpea with $1\frac{1}{2}$ 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 sowing of *rabi* sorghum and sesame upto October 15th with 50 per cent 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 per cent.
- 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
Bidar Dharwad	Medium runoff and medium 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:** 1755 mm
- **Moisture availability period:** 120-150 days

Dharwad

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

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 @ 3.5 t/ha

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 stabilization through stylosanthes spp
- Bund planting with neem, sissoo and tamarind
- A farm pond of 150 m³ capacity for every one hectare catchment area to harvest excess runoff in medium to deep black soils

Crop management

Bidar

- **Varieties:** C 11, No. 148, BSMR 736, BSMR 175, ICPL 87, GS – 1, KGT - 1
- **Seed rate:** 12-15 kg/ha
- **Planting pattern:** 90 x 20 cm
- **Nutrient management:** 20 kg N + 50 kg P₂O₅ + 20 kg S/ ha
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha.
 - 25 kg neem seed extract in 500 l of water/ha sprayed at branching and pod filling
- **Some other important practices**
 - Shallow soils: sowing upto 15th July in shallow and medium black soils
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Dharwad

- **Varieties:** C 11, GS – 1, KGT - 1, BSMR 736, BSMR 175, ICPL 87.
- **Seed rate:** 12-15 kg/ha.
- **Planting pattern:** 90 x 20 cm.
- **Nutrient management:** 20 kg N + 50 kg P₂O₅ + 20 kg S/ ha
- **Pest management**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ha at branching and at pod filling
- **Some other important practices**
 - Shallow soils: Sowing upto 15th July in shallow and medium black soils
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Bidar, Dharwad

- Pigeonpea + pearl millet (1:3/2:1)
- Bunch groundnut + pigeonpea (3:1)

- Sesame + pigeonpea (3:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1/2:4)
- Pigeonpea + sorghum (2:1)

Farm implements/ tools

Bidar

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

Dharwad

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

Alternate farming systems

Bidar

- Agave (*Agave sisolana* with 10,000 plants/ha) intercropped with subabul. Cutting of agave leaves once in a year for fiber extraction with retaining top ten leaves
- **Silviculture:**
- **Shallow black soils:** *Casuarina*, *Dalbergia sissoo*, *Hardwickia binata*, *Acacia nilotica*, *Prosopis cineraria*

- **Marginal land:** *Dalbergia sissoo*, Neem, *Acacia nilotica*, Subabul
- **Alley cropping:** Subabul/ casuarina + *Kharif* crops
- **Agro horti system:** Ber (umran) + curry leaf, Ber (umran) – safflower + chickpea, Ber/ Custard apple/ Pomegranate/ Amla + *kharif* (spreading) crops
- **Horticulture:** Mango plants in levelled portion of zingg conservation terrace
- **Fodder/ Green biomass:** *Dalbergia sissoo*, *Gliricidia*, *Albizzia 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, clusterbean, drumstick
- **Animal Component:** Female cattle, male cattle, female buffaloes, goat, sheep and poultry

Dharwad

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

Contingent planning

Bidar, Dharwad

Normal onset of monsoon favourable for *kharif* crops

- Take up sowing of the following crops in June in light soils. Groundnut (erect and spreading), pearl millet, pigeonpea, *kharif* sorghum, setaria, hybrid sorghum and other crop mixtures like *kharif* sorghum + pigeonpea (2:1), groundnut + pigeonpea (4:2), setaria + pigeonpea (2:1) and pearl millet + pigeonpea (2:1). Similarly, pulse crops in light and retentive soils may be taken up.
- In *rabi* areas, i.e., medium deep black soils, sow greengram, blackgram, cucumber as a first crop to be followed by *rabi* sorghum/ sunflower/ chickpea/ safflower/ wheat.

- When the land is kept fallow (deep black soils) for *rabi* crops, have compartment bunds having 1 per cent slope, scooping where the land slope is 1 to 2 per cent, 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 10th 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 15th September.
- If normal rains are not received during September take up dry seeding of sunflower, *Rabi* sorghum, chickpea with 1^{1/2} 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 sowing of *rabi* sorghum till October 15th with 50 per cent 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 per cent.
- Use surface mulches of mixed trash or farm waste wherever possible. Where farm waste is not available, use a blade to form a thin layer of soil mulch to avoid cracks.

District	Region
Bijapur Gulbarga Raichur	Low runoff and High yield gap

Agro-ecological setting

Bijapur

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

Gulbarga

- **Climate:** Hot semi arid
- **Physiography:** North Karnataka Plateau
- **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
- **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

Bijapur

- Rubbles at 0.3 m vertical interval on contour key lines
- Compartement bunding, ridges and furrows, contour cultivation
- Planting Khus grass and subabul in paired rows at vertical interval of 0.3 m.
- Bund planting with neem, sissoo and tamarind
- A farm pond of 150 m³ capacity for every one hectare catchment area to harvest excess runoff in medium to deep black soils
- *In situ* moisture conservation practices like compartement bunding, ridges and furrows contour cultivation and fall ploughing helped to conserve more moisture in deep black soils

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 m³ 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 *in-situ* conservation measures
- Plant sunhemp in *rabi* areas
- 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 stabilization through *Stylosanthes spp*
- Bund planting with neem, sissoo and tamarind
- A farm pond of 150 m³ capacity for every one hectare catchment area to harvest excess runoff in medium to deep black soils

Crop management

Bijapur, Gulbarga, Raichur

- **Varieties:** C 11, Asha (ICPL-87119), Maruthi, ICPL 87, G.S – 1, KGT - 1
- **Seed rate:** 10-12 kg/ha
- **Planting pattern:** 60 x 20 cm.

- **Nutrient management:** 20 kg N + 50 kg P₂O₅ + 20 kg S/ ha
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ha
 - 25 kg Neem seed extract in 500 l of water/ha sprayed at branching and pod filling
- **Some other important practices**
 - Shallow soils: sowing upto 15th July in shallow and medium black soils
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Bijapur, Gulbarga, Raichur

- Pigeonpea + pearl millet (1:3/2:1)
- Bunch Groundnut + pigeonpea (3:1)
- Sesame + pigeonpea (3:1)
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1/2:4)
- Pigeonpea + sorghum (2:1)

Farm implements/ tools

Bijapur, Gulbarga, Raichur

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

Alternate farming systems

Bijapur, Gulbarga, Raichur

- Agave (*Agave sisolana* with 10, 000 plants/ha) intercropped with subabul. Cutting of agave leaves once in a year for fiber extraction with retaining top ten leaves
- **Silviculture**
 - **Shallow black soils:** *Casuarina*, *Dalbergia sissoo*, *Hardwickia binata*, *Acacia nilotica*, *Prosopis cineraria*
 - **Marginal land:** *Dalbergia sissoo*, neem, *Acacia nilotica*, Subabul
- **Alley cropping:** Subabul/ casuarina + *Kharif* crops
- **Agro horti system:** Ber (umran) + curry leaf, ber (umran) – safflower + chickpea, ber/ custard apple/ pomegranate/ amla + *kharif* (spreading) crops
- **Horticulture:** Mango plants in levelled portion of zingg conservation terrace
- **Fodder/ green biomass:** *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, clusterbean, drumstick.
- **Animal Component:** Female/ male cattle, female buffaloes, goat, sheep and poultry.

Contingent planning

Bijapur, 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, cucumber as a first crop to be followed by *rabi* sorghum/ sunflower/ chickpea/ safflower/ wheat.
- When the land is kept fallow (deep black soils) for *rabi* crops, have compartment bunds having 1 per cent slope, scooping where the land slope is 1 to 2 per cent, 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 Herbaceous cottons in place of Hirsutams. Early sowing of cotton is advantageous.
- Sunflower, pigeonpea, and setaria should be sown in light soils and pigeonpea in medium to deep black soils.
- In light textured soils in Hadagali, Koppal, Muddebihal, Raibag, and Athani castor may be sown. Plant castor on contour bunds also. In medium to deep black soils also take up castor sowing.
- Relay cotton in groundnut in medium black soils.

Normal rains in September

- Complete sowing of *rabi* sorghum by middle of September in medium black soils of northern taluks of Bijapur district. In the remaining taluks viz., Bagalkot, Hungund, and Mudhol, complete *rabi* sorghum sowing by first week of October. Early sowing of *rabi* sorghum in other districts is preferred. Maximum yields of *rabi* sorghum are obtained by sowing in September only.

- Sow sunflower before 10th 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 15th September.
- If normal rains are not received during September take up dry seeding of sunflower, *Rabi* sorghum, chickpea with 1½ 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

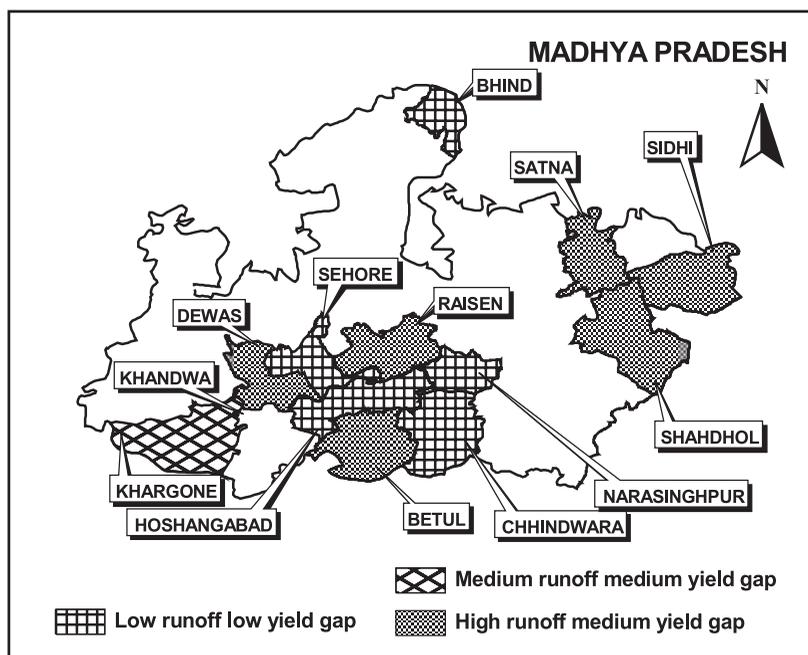
- Continue sowing of *rabi* sorghum till October 15th with 50 per cent recommended level of fertilizer.
- Follow mixed cropping of *rabi* sorghum + chickpea in 2:1 row proportion.
- Sow *rabi* sorghum and chickpea as mixedcrops (random mixing).
- Increase the area under safflower.
- Sow chickpea and 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 per cent.
- 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.

MADHYA PRADESH

In Madhya Pradesh there are five districts viz. Bhind, Chhindwara, Hoshangabad, Narasinghpur and Sehore under low runoff and low yield gap region, one district viz. Khargone under medium runoff and medium yield gap region and six districts viz. Betul, Dewas, Raisen, Satna, Shahdhol and Sidhi under high runoff and medium yield gap region.



The setting and recommendations follow:

District	Region
Bhind	Low runoff and low yield gap
Chhindwara	
Hoshangabad	
Narasinghpur	
Sehore	

Agro-ecological setting

Bhind

- **Climate:** Hot moist semi arid
- **Physiography:** Satpura ranges
- **Soils:** Deep loamy alluvium - derived soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1148 mm
- **Potential evapotranspiration:** 1484 mm
- **Moisture availability period:** 120-150 days

Chhindwara

- **Climate:** Hot moist sub humid
- **Physiography:** Satpura ranges, South Madhya Pradesh
- **Soils:** Shallow to deep loamy to clayey mixed red and black soils (Vertic Inceptisols - 85%; Vertisols – 15%)
- **Annual rainfall:** 1094 mm
- **Potential evapotranspiration:** 1427 mm
- **Moisture availability period:** 180-210 days

Hoshangabad

- **Climate:** Hot dry sub humid
- **Physiography:** 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

Narasinghpur

- **Climate:** Hot dry sub humid
- **Physiography:** Satpura ranges
- **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

Sehore

- **Climate:** Hot dry sub humid
- **Physiography:** Malwa Plateau
- **Soils:** Medium and deep clayey black soils, shallow loamy black soils (Vertic Inceptisols – 60%; Vertisols – 40%)
- **Annual rainfall:** 1169 mm
- **Potential evapotranspiration:** 1602 mm
- **Moisture availability period:** 150 -180 days

Soil and water conservation

Bhind

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

Chhindwara, Hoshangabad, Narasinghpur, Sehore

- 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 a 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 site 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 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 run off and providing more opportunity time in order to reduce erosive velocity.
- Mould board plough, used for deep tillage to increase the productivity of *kharif* crops and enhance sowing of *rabi* crops through better moisture conservation and eradication of infested weeds.
- Graded bunds alone and/ or along with vegetative barriers at vertical intervals of 50 cm proves most effective in controlling soil erosion and nutrient losses on soils having slope up to 2 per cent.
- Off-season shallow tillage is important not only in controlling 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 in to gullied one.
- Provide *in situ* soil mulch by operating bullock drawn dora to fill up the cracks, to conserve the soil moisture and to achieve weed control. Straw as 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.

Crop management

Bhind

- **Varieties:** IJPAS 120, Pusa 992, ICPL 87, ICPL 151, JA 4
- **Seed rate:** 15 kg/ha
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 kg S/ ha
- **Some other important practices:** Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Chhindwara, Hoshangabad, Narasinghpur, Sehore

- **Varieties:** ICPL-87119 (Asha), ICPL-151 (Jagrati), ICPL-87, JA-4, No.148, Khargone-7, Pusa-33, Jawahar Arhar-4, IJPAS 120
- **Seed rate:** 15-20 kg/ha for short duration and 10-12 kg/ha for long duration
- **Planting pattern:** 45 x 15 cm for short duration and 60 x 20cm for long duration
- **Nutrient management:** 20 kg N + 60 kg P₂O₅ + 20 kg K₂O + 20 kg S/ ha

• **Pest management:**

- For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ha
 - 2.25 kg neem seed extract in 500 l of water/ha sprayed at branching and pod filling

Pests:

- | | |
|---------------------|-------------------------------------|
| (i) Pod fly | Spray Monocrotophos 40 EC @ 2 ml/ l |
| (ii) Tur plume moth | Spray Dimethoate 30 EC @ 1.5 ml/ l |
| (iii) Heliothis sp. | Spray Endosulfan 35 EC @ 2ml/ l |
| (iv) Tur pod bug | |

Diseases:

- | | |
|------|--|
| Wilt | Eradicate affected plants.
Use disease free seed.
Seed treatment with Thiram @ 3 g/kg seed |
|------|--|

• **Some other important practices**

- Sowing in second week of June to third week of July
- Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Bhind

- Sorghum + pigeonpea
- Groundnut + pigeonpea (2:1)
- Sesame + pigeonpea
- Pigeonpea + sunhemp (fodder)
- Pigeonpea + forage sorghum
- Pigeonpea + sudan grass
- Pigeonpea + *Pennisetum pedicellatum*
- Pigeonpea + small millets (2:4)
- Pigeonpea + soybean (2:4/2:1)
- Pigeonpea + green gram (2:1)

Chhindwara, Hoshangabad, Narasinghpur, Sehore

- Sorghum + pigeonpea (2:2)
- Pigeonpea + small millets (2:4)
- Pigeonpea + soybean (2:4/2:1)
- Pigeonpea + green gram (2:1)

Farm implements/ tools

Bhind

- Fertilizer cum seed drill

Chhindwara, Hoshangabad, Narasinghpur, Sehore

- Suitable implements for seedbed preparations
 - Meston Plough
 - Iron Bakhar
- Suitable implements for sowing operations
 - Mostly the sowing operation is done using seed drills
 - For planting intercrops, intercrop seed drill is available
 - 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

Alternate farming systems

Bhind

- **Agro - hortisystem:** Ber + pearl millet + cowpea as fodder
- **Fodder/ green biomass:** Neem, Subabul, *Hardwickia brete*, Pongamia, *Cassia siamea*, Bauhinia
- **Fruit:** mango, guava, amla, phalsa, jamun, karonda
- **Medicinal/ Aromatic plants:** *Papaver somniferum*, *Palma rosa*, *Cymbopogon flexuosus*, *Vetiveria zizanooides*.
- **Vegetables:** Tomato, chillies, brinjal, okra, bottle gourd, cowpea.
- **Animal component:** Female buffalo/ sheep, goat

Chhindwara, Narasinghpur

- **Fodder/ green biomass:** *Dichrostachys cineria*, *Albizia amara*, *Faidherbia albida*, *Hardwickia binata*, *Cassia*, *Leucaena leucocephala*, *Albizia lebbeck*,
- **Fruit:** Ber, pomegranate, mango, fig, tamarind.
- **Medicinal/ Aromatic Plants:** *Withamnia somnifera*, *Rauwolfia serpentina*, *Vetiveria zizanooides*, *Palma rosa*, *Liquorice*.
- **Vegetables:** Chillies, okra, cowpea, clusterbean, amaranthus, round melon, water melon.
- **Animal Component:** Male/ female cattle, female buffaloes, sheep, goat.

Hoshangabad, Sehore

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

- **Fruit:** Ber, pomegranate, mango, fig, tamarind
- **Medicinal/ Aromatic Plants:** *Withamnia somnifera*, *Rauvolfia serpentina*, *Vetiveria zizanoides*, *Palma rosa*, *Liquorice*.
- **Vegetables:** Chillies, okra, watermelon, cowpea, clusterbean, amaranthus, round melon.
- **Animal component:** Male/ female cattle, female buffaloes, sheep, goat.

Contingent planning

Bhind

Kharif

Under normal rainfall

- Pearl millet (Proagro 9402), Pigeonpea (UPAS 120), Greengram (K 851), Clusterbean (RGC 197)

Rainfall upto end of July

- Cereals and pulses: Pearl millet (Proagro 9402) intercropped with pigeonpea (UPAS 120, IPCL 87), blackgram (T-9) and greengram (K 851). Pure crop of clusterbean, blackgram and greengram.
- Oilseeds: Groundnut (Chandra) and sesame (Pratap) upto the end of third week of July

Rainfall upto third week of August

- Cereals and pulses: Clusterbean (RGC 197) and transplanting of pearl millet (MBH 163)

Rainfall upto end of August

- Clusterbean as pure crop (RGC 197)
- Castor with a seed rate of 15 kg/ha.

Rabi

- Mustard (Pusa bold), barley (Ratna), chickpea (K 850), lentil (L 9-12), and rapeseed (Jawahar toria 1) and safflower in the order.

Chhindwara, Hoshangabad, Narasinghpur, Sehore

- If monsoon is delayed or there is failure of timely sown crops due to intermittent droughts then for delayed sowing of improved crops and their varieties may be chosen for planting, as given below:
- **15th to 31st July**
 - Maize – (short duration varieties like Navjot, sathi, etc)
 - Pigeonpea – (under deep soils preferred varieties ICPL 151, T-21, Kh-2, ICPL 87, ICPL 88039 etc.)
 - Sunflower – Morden, Surya, Manjira and any hybrid
 - Sesame – Bhadeli, TKG 22, TKG 37
 - Cowpea – Pusa Komal, Pusa Barsati, C 152
 - Castor – Gauch and Varuna
 - Fodder crops – Sorghum sudanensis, Maize (African tall), Dinanath grass and pearl millet etc.
- **1st to 15th August**
 - Sunflower – Morden, Surya, Manjira and any hybrid
 - Sesame – Bhadeli, TKG 22, TKG 37 etc
 - Cowpea – Pusa Komal and Pusa Baisakhi
 - Rajgira (Amaranthus) - CO-1 and CO-2
 - Fodder crops – Sorghum Sudanensis, Maize (African tall), Dinanath grass and pearl millet etc

- **15th to 31st August**
 - Safflower – JSF-1, JSF- 7 (spineless), JSF-73, Sharda
 - Sunflower – Morden, Surya and Manjira
 - Sesame – Bhadeli, TKG 22, and RT-46
 - Rajgira – Co-1 and Co – 2
 - Castor – Gauch, Varuna
 - Fodder crops – Barley, oats, Maize (African tall), safflower and sunflower

District	Region
Betul Dewas Raisen Satna Shahdol Sidhi	High runoff and Medium yield gap

Agro-ecological setting

Betul

- **Climate:** Hot dry sub humid
- **Physiography:** Satpura ranges
- **Soils:** Shallow and medium loamy to clayey black soils, deep clayey black soils (Vertic Inceptisols – 85%; Vertisols – 15%)
- **Annual rainfall:** 1129 mm
- **Potential evapotranspiration:** 1370 mm
- **Moisture availability period:** 150-180 days

Dewas

- **Climate:** Hot dry/ moist sub humid
- **Physiography:** Malwa plateau
- **Soils:** Deep clayey black soils, shallow black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1079 mm
- **Potential evapotranspiration:** 1707 mm
- **Moisture availability period:** 120 -180 days

Raisen

- **Climate:** Hot dry sub humid
- **Physiography:** 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

Satna

- **Climate:** Hot dry sub humid
- **Physiography:** Baghelkhand plateau (Central highlands)
- **Soils:** Deep loamy to clayey mixed red and black soils (Vertic Inceptisols – 100%)
- **Annual rainfall:** 1138 mm
- **Potential evapotranspiration:** 1452 mm
- **Moisture availability period:** 150 -180 days

Shahdhol

- **Climate:** Hot dry sub humid
- **Physiography:** Vindhya scarplands
- **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

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

Soil and water conservation

Betul, Dewas, 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 a 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 to increase life of water storage bodies.
- Construct a water harvesting tank to retain the excess run off from the watershed area to use stored water for irrigation purpose.
- Silpaulin (plastic material) of 90 – 120 gsm has been found to be an effective lining material for farm ponds used for water harvesting purpose.
- Use vegetative barriers to strengthen the mechanical bunds at suitable vertical intervals in order to reduce run off and associated soil losses from the cultivated fields.
- Ensure drainage line treatment for providing safe disposal of excess run off and providing more opportunity time in order to reduce erosive velocity.

- Mould board plough can be 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.

Satna, Shahdhol, Sidhi

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

Crop management

Betul, Dewas, Raisen

- **Varieties:** ICPL-87119 (Asha), ICPL-151 (Jagrati), ICPL-87, JA-4, No.148, Khargone-7, Pusa-33, Jawahar Arhar-4
- **Seed rate:** 15-20 kg/ha for short duration and 12-15 kg/ha for long duration
- **Planting pattern:** 45 x 15 cm for short duration and 60 x 20 cm for long duration
- **Nutrient management:** 20 kg N + 60 kg P₂O₅ + 20 kg K₂O + 20 kg S/ ha
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

Pests:

- | | |
|---------------------|-------------------------------------|
| (i) Pod fly | Spray Monocrotophos 40 EC @ 2 ml/ l |
| (ii) Tur plume moth | Spray Dimethoate 30 EC @ 1.5 ml/ l |
| (iii) Heliothis sp. | Spray Endosulfan 35 EC @ 2ml/ l |
| (iv) Tur pod bug | |

Diseases:

- | | |
|------|--|
| Wilt | Eradicate affected plants.
Use disease free seed.
Seed treatment with Thiram @ 3 g/kg seed |
|------|--|

Some other important practices

- Sowing in second week of June to third week of July
- Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Satna, Shahdhol, Sidhi

- **Varieties:** No. 148, ICPL-87, AS 71- 37, JA 4, Pusa 992, BSMR 736, KM 7
- **Seed rate:** 20 kg/ha
- **Planting pattern:** 45 x 15 cm
- **Nutrient management:** 20 kg N + 60 kg P₂O₅ + 20 kg K₂O + 20 kg S/ ha
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 2.25 kg neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

Pests:

- | | |
|---------------------|-------------------------------------|
| (i) Pod fly | Spray Monocrotophos 40 EC @ 2 ml/ l |
| (ii) Tur plume moth | Spray Dimethoate 30 EC @ 1.5 ml/ l |
| (iii) Heliothis sp. | Spray Endosulfan 35 EC @ 2ml/ l |
| (iv) Tur pod bug | |

Diseases:

- | | |
|------|--|
| Wilt | Eradicate affected plants.
Use disease free seed.
Seed treatment with Thiram @ 3 g/kg seed |
|------|--|

- **Some other important practices**
 - One harrowing with small blades harrow (Dora, Kulfa or Desi plough) within 30 days of sowing
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Betul, Dewas, Raisen

- Sorghum + pigeonpea (2:2)
- Pigeonpea + small millets (2:4)
- Pigeonpea + soybean (2:4/2:1)
- Pigeonpea + green gram (2:1)

Satna, Shahdhol, Sidhi

Unbunded field: Sorghum + pigeonpea

- Soybean + pigeonpea (2:1)
- Blackgram + pigeonpea
- Paddy + pigeonpea

Big Bandh: (0.4-10 ha)

- Sorghum + pigeonpea
- Pigeonpea + small millets (2:4)

- Pigeonpea + soybean (2:4/2:1)
- Pigeonpea + green gram (2:1)

Farm implements/ tools

Betul, Dewas, Raisen

- Suitable implements for seedbed preparations
 - Meston Plough
 - Iron Bakhar
- Suitable implements for sowing operations
 - Mostly the sowing operation is done using seed drills.
 - For planting intercrops, intercrop seed drill is available
 - 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

Satna, Sidhi

- Dryland weeder

Alternate farming systems

Betul, Dewas

- **Fodder/ green biomass:** *Dichrostachys cinerea*, *Albizia amara*, *Faidherbia albida*, *Hardwickia binata*, *Cassia*, *Leucaena leucocephala*, *Albizia lebbeck*,
- **Fruit:** Ber, pomegranate, mango, fig, tamarind
- **Medicinal/ Aromatic Plants:** *Withamnia somnifera*, *Rauvolfia serpentina*, *Vetiveria zizanioides*, *Palma rosa*.
- **Vegetables:** Chillies, okra, watermelon, cowpea, clusterbean, amaranthus, round melon.
- **Animal Component:** Male/ female cattle, female buffaloes, sheep, goat.

Raisen

- **Agro-horti system:** Mango + pea/ berseem (green fodder)/ wheat/ chickpea/ soybean
- **Silvi-pastoral system:** Teak + Sudan grass
- **Fodder/ green biomass:** *Dichrostachys cineria*, *Albizia amara*, *Faidherbia albida*, *Hardwickia binata*, *Cassia*, *Leucaena leucocephala*, *Albizia lebbeck*.
- **Fruit:** Ber, pomegranate, mango, fig, tamarind.
- **Medicinal/ Aromatic plants:** *Withamnia somnifera*, *Rauvolfia serpentina*, *Vetiveria zizanioides*, *Palma rosa*, *Liquorice*.
- **Vegetables:** Chillies, okra, watermelon, cowpea, cluster bean, amaranthus, round melon.
- **Animal component:** Male/ female cattle, female buffaloes, sheep, goat.

Satna, Sidhi

- **Agro – hortisystem:** Mango + pea/ berseem (green fodder)/ wheat/ chickpea/ soybean, Mango/ guava/ amla + field crops (wheat, barley, pulses and oilseeds) (for Satna district)
- **Silvi – pastoral system:** Teak + sudan grass
- **Fodder/ green biomass:** *Leucaena leucocephala*, *Albizia amara*, *Dichrostachys cineraria*, *Melia azadirachta*, *Hardwickia binata*, *A.lebbeck*.
- **Fruit:** Mango, ber, guava, tamarind, karonda.
- **Medicinal and Aromatic Plants:** *Safed musli*, *Palma rosa*, *Withania somnifera*, *Papaver somniferum*, *Vetiveria zizanoides*.
- **Vegetables:** Brinjal, chilli, cowpea, okra, bottle gourd, round melon.
- **Animal Component:** Female/ male cattle, female buffaloes, goats

Shahdhol

- **Fodder/ green biomass:** *Leucaena leucocephala*, *Albizia amara*, *Dichrostachys cineraria*, *Melia azadirachta*, *Hardwickia binata*, *A.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

Betul, Dewas, Raisen

- **15th to 31st July**
 - Maize – (short duration varieties like Navjot, sathi, etc)
 - Pigeonpea – (under deep soils preferred varieties ICPL 151, T-21, ICPL 87, ICPL 88039, Pusa 992 for early type and ICPL 87119, KM 7, BSMR 736 of late type)
 - Sunflower – Morden, Surya, Manjira and any hybrid
 - Sesame – Bhadeli, TKG 22, TKG 37
 - Cowpea – Pusa Komal and Pusa Barsati
 - Castor – Gauch and Varuna
 - Fodder crops – Sorghum sudanensis, Maize (African tall), Dinanath grass and pearl millet
- **1st to 15th August**
 - Sunflower – Morden, Surya, Manjira and any hybrid
 - Sesame – Bhadeli, TKG 22, TKG 37
 - Cowpea – Pusa Komal and Pusa Barsati, C 152
 - Rajgira (Amaranthus) - CO-1 and CO-2
 - Fodder crops – Sorghum Sudanensis, Maize (African tall), Dinanath grass and pearl millet
- **15th to 31st August**
 - Safflower – JSF-1, JSF- 7 (spineless), JSF-73, Sharda
 - Sunflower – Morden, Surya and Manjira
 - Sesame – Bhadeli, TKG 22, and RT-46

- Rajgira – Co-1 and Co – 2
- Castor – Gauch, Varuna
- Fodder crops – Barley, oats, Maize (African tall), safflower and sunflower

Satna, Shahdhol, Sidhi

- **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)

District	Region
Khargone	Medium runoff and Medium yield gap

Agro-ecological setting

- **Climate:** Hot moist semi arid
- **Physiography:** Western Malwa Plateau
- **Soils:** Deep clayey black soils and shallow black soils, medium and deep clayey black soils, shallow loamy black soils (Vertic Inceptisols – 100%)

- **Annual rainfall:** 888 mm
- **Potential evapotranspiration:** 1792 mm
- **Moisture availability period:** 120-180 days

Soil and water conservation

- 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 site 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 effective lining material for farm ponds used for water harvesting purposes.
- Use vegetative barriers to strengthen the mechanical bunds at suitable vertical intervals in order to reduce run off in associated soil losses from the cultivated fields.
- Develop a sort of terracing to break the continuity of undulating slope to reduce the chances of degrading cultivated fields into gullied one.
- Ensure drainage line treatment for providing safe disposal of excess run off and providing more opportunity time in order to reduce erosive velocity.
- Mould board plough, used for deep tillage to increase the productivity of *kharif* crops and enhance sowing of *rabi* crops through better moisture conservation and eradication of infested weeds.
- Graded bunds alone and/ or along with vegetative barriers at vertical intervals of 50 cm are most effective in controlling soil erosion and nutrient losses on soils having slope upto 2 per cent.
- Off-season shallow tillage is important not only in controlling weeds but also in helping entry of rain water.
- Provide *insitu soil* mulch by operating bullock drawn dora to fill up the cracks, to conserve soil moisture and to achieve weed control. Straw mulch @ 4-5 t/ha in between the rows of crop plants to minimize evaporative losses, moisture conservation and to increase moisture efficiency in *rabi* crops.

Crop management

- **Varieties:** ICPL-87119 (Asha), ICPL-151 (Jagrati), ICPL-87, JA-4, No.148, Khargone-7, Pusa-33, and Jawahar Arhar-4
- **Seed rate:** 15-20 kg/ha for short duration and 10-12 kg/ha for medium duration variety
- **Planting pattern:** 45 x 15 cm for short duration and 60 x 20 cm for long duration
- **Nutrient management:** 20 kg N + 60 kg P₂O₅ + 20 kg K₂O + 20 kg S/ ha
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 2.25 kg neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

Pests:

- | | |
|---------------------|-------------------------------------|
| (i) Pod fly | Spray Monocrotophos 40 EC @ 2 ml/ l |
| (ii) Tur plume moth | Spray Dimethoate 30 EC @ 1.5 ml/ l |
| (iii) Heliothis sp. | Spray Endosulfan 35 EC @ 2ml/ l |
| (iv) Tur pod bug | |

Diseases:

- | | |
|------|--|
| Wilt | Eradicate affected plants.
Use disease free seed.
Seed treatment with Thiram @ 3 g/kg seed |
|------|--|

• **Some other important practices**

- Sowing in second week of June to third week of July
- Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

- Sorghum + pigeonpea (2:2)
- Pigeonpea + small millets (2:4)
- Pigeonpea + soybean (2:4/2:1)
- Pigeonpea + green gram (2:1)

Farm implements/ tools

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

Alternate farming systems

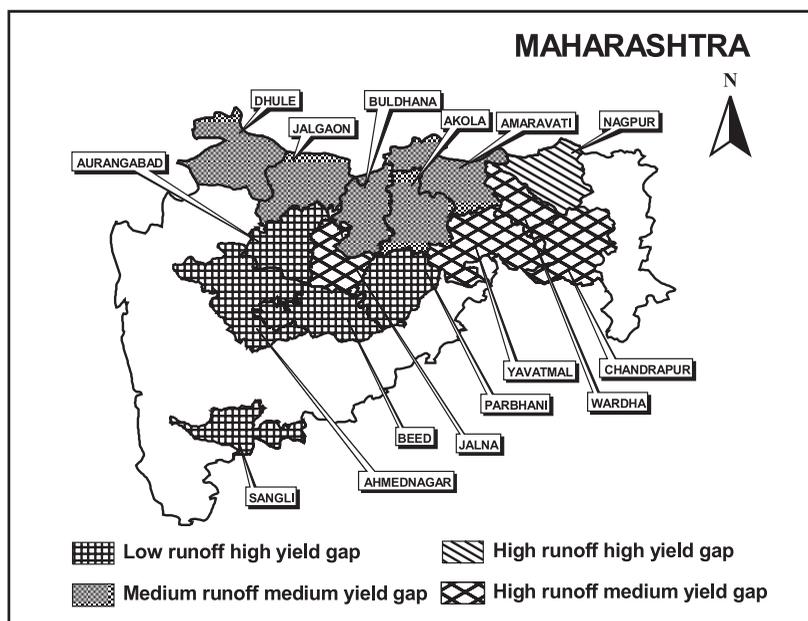
- **Fodder/ green biomass:** *Dichrostachys cineria*, *Albizia amara*, *Faidherbia albida*, *Hardwickia binata*, *Cassia*, *Leucaena leucocephala*, *Albizia lebbeck*.
- **Fruit:** Ber, pomegranate, mango, fig, tamarind.
- **Medicinal/ Aromatic Plants:** *Withamnia somnifera*, *Rauwolfia serpentina*, *Vetiveria zizanoides*, *Palma rosa*, *Liquorice*.
- **Vegetables:** Chillies, okra, watermelon, cowpea, clusterbean, amaranthus, round melon.
- **Animal Component:** Male/ female cattle, female buffaloes, sheep, goat.

Contingent planning

- **15th to 31st July**
 - Maize – (short duration varieties like Navjot, sathi, etc)
 - Pigeonpea – (under deep soils preferred varieties ICPL 151, T-21, Kh-2, ICPL 87, ICPL 88039 etc.)
 - Sunflower – Morden, Surya, Manjira
 - Sesame – Bhadeli, TKG 22, TKG 37
 - Cowpea – Pusa Komal and Pusa Baisakhi
 - Castor – GCH – 4, Kranthi
- **1st to 15th August**
 - Fodder crops – Sorghum sudanensis, Maize (African tall), Dinanath grass and pearl millet etc.
 - Sunflower – Morden, Surya, Manjira and any of the hybrids
- **15th to 31st August**
 - Sesame – Bhadeli, TKG 22, TKG 37 etc
 - Cowpea – Pusa Komal and Pusa Baisakhi
 - Rajgira (Amaranthus) - CO-1 and CO-2
 - Castor- GCH – 4, Kranthi
 - Fodder crops – Sorghum Sudanensis, Maize (African tall), Dinanath grass and pearl millet etc
 - Safflower – JSF-1, JSF- 7 (spineless), JSF-73, Sharda
 - Sunflower – Morden, Surya and Manjira
 - Sesame – Bhadeli, TKG 22, and RT-46
 - Rajgira – Co-1 and Co – 2
 - Fodder crops – Barley, oats, Maize (African tall)

MAHARASHTRA

In Maharashtra there are five districts viz. Ahmednagar, Aurangabad, Beed, Parbhani and Sangli under low runoff and high yield gap region, five districts viz. Akola, Amaravati, Buldhana, Dhule, and Jalgaon under medium runoff and medium yield gap region, four districts viz. Chandrapur, Jalna, Wardha, Yavatmal, and under high runoff and medium yield gap region and one district viz. Nagpur under high runoff and high yield gap region.



The setting and recommendations follow:

District	Region
Ahmednagar	Low runoff and High yield gap
Aurangabad	
Beed	
Parbhani	
Sangli	

Agro-ecological setting

Ahmednagar

- **Climate:** Hot dry semi arid
- **Physiography:** Western Maharashtra plateau
- **Soils:** Shallow and medium loamy black soils, deep clayey black soils (Vertic Inceptisols – 60%; Vertisols – 40%)
- **Annual rainfall:** 676 mm
- **Potential evapotranspiration:** 1605 mm
- **Moisture availability period:** 90-120 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:** 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

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:** 1425 mm
- **Potential evapotranspiration:** 1642 mm
- **Moisture availability period:** 120 -150days

Sangli

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

Soil and water conservation

Ahmednagar

- 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 or *Leucaena*
- *Leucaena* lopping mulch @ 3.5 t/ha

Aurangabad, Beed, Dhule, 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 @ 3.5 t/ha

Sangli

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

Crop management

Ahmednagar, Beed, Sangli

- **Varieties:** No.148, BDN-2, Maruti, BSMR-736, BSMR 175, ICPL 87119
- **Seed rate:** 12 kg/ha
- **Planting pattern:** 60 x 20 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 kg S/ ha
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg Neem seed extract in 500 l of water/ ha sprayed at branching and pod filling
- **Some other important practice**
 - Sowing upto 2nd fortnight of August
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Aurangabad, Parbhani

- **Varieties:** Patur-96, Co-1, T-21 and No 148
- **Seed rate:** 12 kg/ha
- **Planting pattern:** 60 x 20 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 kg S/ ha

- **Pest management:**

- For pod borer:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

- **Some other important practice**

- Sowing upto 2nd fortnight of August
- Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed
- For pod borer control:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg Neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

Suitable cropping systems

Ahmednagar, Beed, Sangli

- Shallow soils: Pearlmillet + pigeonpea (2:1)
- Sunflower + pigeonpea (2:1)
- Sorghum + pigeonpea (1:1)
- Hybrid Pearlmillet (Paired row at 30 cm spacing) + pigeonpea (2:1)
- Pigeonpea + clusterbean (1:2)
- Pigeonpea + soybean (2:1)
- Pigeonpea + green gram (2:1)
- Pigeonpea + groundnut (2:1)

Aurangabad, Parbhani

- Pigeonpea + soybean (1:3/2:1)
- Pigeonpea (142) + groundnut (SB-11) (1:3/2:1)
- Pigeonpea + greengram (1:3/2:1)
- Pigeonpea + setaria (1:3)
- Pigeonpea + cotton (12:2)

Farm implements/ tools

Ahmednagar, Beed, Dhule, Nanded, Sangli

- 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, Parbhani

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

Alternate farming systems

Ahmednagar, Beed, Pharbani

- **Agri-Horti system** - ber (5 x 5 m) + mothbean (8 lines) (30 x 10 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, karonda
- **Medicinal/ aromatic plants:** *Plantago ovata*, *Cassia angustifolia*, *Safed musli*, *Papaver somniferum*
- **Vegetables:** Clusterbean, cowpea, amaranthus, round melon
- **Animal component:** Female buffalo/ sheep, goat

Sangli

- **Silvipasture:** *Leucaena* + Marvel -8
- **Alley cropping:** Ber (20 m alleys) + pearl millet + pigeonpea for shallow soils
- **Fodder:** Maize (African Tall), Oats (Kent), *Stylo hamata*
- **Fodder/ green biomass:** *Dalbergia sissoo*, *Albizia 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, clusterbean, drumstick
- **Animal Component:**
 - Cow breeds: Gir, Jersey
 - Poultry: White Leghorn

- Rams
- Male/ female cattle, female buffaloes, sheep, goat.

Aurangabad, Buldhana

- **Fodder/green biomass:** *Stylosanthes* sole and Stylo-marvel pastural system recorded higher green fodder yield than sole or combination of grasses. *Leucaena leucocephala*, *A.lebbeck*, *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 and poultry

Alternate land use system

Ahmednagar, Aurangabad, Sangli

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

Beed

- Lands < 22.5 cm depth of soil should be cultivated with agro forestry and dryland horticulture including ber, custard apple, amla, wooden apple, jambhul etc.
- Silvopastoral system of subabul + Marvel – 8 with cutting of the alternate trees at 7th year onwards for fuel is also recommended.

Contingent planning

Ahmednagar, Aurangabad, Beed, Parbhani, Sangli

- 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)
 - Clusterbean + pigeonpea (2:1)
 - Clusterbean + 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
Akola Amaravati Buldhana Dhule Jalgaon	Medium runoff and Medium yield gap

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

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

Jalgaon

- **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 Inceptisols- 65%; Vertisols – 35%)
- **Annual rainfall:** 841 mm
- **Potential evapotranspiration:** 1912 mm
- **Moisture availability period:** 120-150 days

Soil and water conservation

Akola, Amaravati

- 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 seed 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

Dhule, Jalgaon

- 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 @ 3.5 t/ha

Crop management

Akola, Amaravati, Buldana, Jalgaon

- **Varieties:** Patur-96, C – 11, Maruti (ICPL 8863), Asha (ICPL 87119), BSMR 736, BSMR 175
- **Seed rate:** 10 kg/ha
- **Planting pattern:** 60 x 30 cm
- **Pest management:**
 - For pod borers control:
 - Application of Methyl parathion 2% dust @ 20 kg/ha or spraying Quinolphos 25 % EC @ 16 ml/10 l water.
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ha sprayed at branching and pod filling

Dhule

- **Varieties:** No.148, BDN-2, Maruti, BSMR-736, ICPL 87119 (Asha)
- **Seed rate:** 12 kg/ha
- **Planting pattern:** 60 x 20 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 kg S + 20kg ZnSO₄ / ha
- **Pest management:**
 - For pod borers control:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ha sprayed at branching and pod filling
- **Some other important practice**
 - Sowing upto 2nd fortnight of August
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Akola, Amaravati, Buldhana, Jalgaon

- Pigeonpea + greengram (2:1/1:3)
- Pigeonpea + soybean (1:3/2:1)
- Pigeonpea + groundnut (1:3/2:1)
- Pigeonpea + setaria (1:3)
- Pigeonpea + cotton (12:2)
- Cotton + sorghum + pigeonpea + sorghum (CSH9) in 6:1:2:1 row ratio

Dhule

- **Shallow soils:**
 - Pearl millet + pigeonpea (2:1)
 - Sunflower + pigeonpea (2:1)
 - Sorghum + pigeonpea (1:1)
 - Hybrid Pearl millet (Paired row at 30 cm spacing) + pigeonpea (2:1)
 - Pigeonpea + clusterbean (1:2)
 - Pigeonpea + soybean (2:1)
 - Pigeonpea + green gram (2:1)
 - Pigeonpea + groundnut (2:1)

Farm implements/ tools

Akola, Amaravati

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

Buldhana

- Bullock drawn two-row seed cum fertilizer drill
- Bullock drawn Shivaji multi purpose farming machine

Dhule, Jalgaon

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

- Tractor drawn double bottom reversible plough: Tested on farmers' field for ploughing and identified for ploughing operations in dryland region as the field operation was effective and economical. Rs. 23600/-
- Bund 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/-

Alternate farming systems

Akola, Amaravati

- **Fodder/ green biomass:** *Leucaena Leucocephala*, *Albizia lebbbeck*, *Dalbergia sissoo*, *Acacia procera*, *Gliricidia*
- **Fruit:** Pomegranate, ber, mango, sapota, guava, tamarind
- **Medicinal/ Aromatic Plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanooides*, *Ocimum viridae*
- **Vegetables:** Onion, chilli, brinjal, okra, amaranthus, bottle gourd.
- **Animal component:** Male/ female cattle, female buffaloes, sheep, goat, poultry

Buldana

- **Fodder/ green biomass:** *Stylosanthes* 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 anola and custard apple.
- **Horticulture system:** Pomegranate, ber, mango, sapota, guava, tamarind
- **Medicinal & Aromatic Plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanooides*, *Ocimum viridae*
- **Vegetables:** Onion, chilli, brinjal, okra, amaranthus, bottle - gourd.
- **Animal Component:** Female cattle, male cattle, female buffaloes, goat and poultry

Dhule, Jalagoan

- **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 and Aromatic Plants:** *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanooides*, Rose, Geranium.
- **Vegetables:** Onion, tomato, okra, cowpea, clusterbean, drumstick

- **Animal Component:**

- Cow breeds: Gir, Jersey
- Poultry: White Leghorn
- Rams
- Male/ female cattle, female buffaloes, sheep, goat

Contingent planning

Akola, Amaravati, Buldhana

Regular Monsoon

- The regular monsoon starts by 24th 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 should be reduced and replaced by sorghum.
 - Sowing of sorghum should be completed before 10th July. Sorghum CSH-1 variety is sown instead of CSH-5/ CSH-9.
 - Area under greengram/ blackgram should be replaced by early pigeonpea varieties such as ICPL 8863 or ICPL 87119
 - Area under groundnut should 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, *kharif* crop fails, to follow *rabi* crop safflower (N.7), pigeonpea (C.11) in September.

Extended monsoon

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

Dhule, Jalgoan

- 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)
 - Clusterbean + pigeonpea (2:1)
 - Clusterbean + 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 Jalna Wardha Yavatmal	High runoff and Medium yield gap

Agro-ecological setting

Chandrapur

- **Climate:** Hot dry moist sub humid/ hot dry 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

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

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

Chandrapur, 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)

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 @ 3.5 t/ha

Crop management

Chandrapur, Jalna, Wardha, Yavatmal

- **Varieties:** Patur-96, C – 11, Maruti (ICPL 8863), BSMR 736, BSMR 175
- **Seed rate:** 10 kg/ha
- **Planting pattern:** 60 x 30 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ + 20 kg ZnSO₄/ha
- **Pest management**
 - For pod borers control:
 - Application of Methyl parathion 2% dust @ 20 kg/ha or spraying Quinolphos 25% EC @ 16 ml/ 10 l water
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

Suitable cropping systems

Chandrapur, Jalna, Wardha, Yavatmal

- Pigeonpea + groundnut (1:3/2:1)
- Pigeonpea + greengram (1:3/2:1)
- Pigeonpea + setaria (1:3)
- Pigeonpea + cotton (12:2)
- Cotton + sorghum + pigeonpea + sorghum (CSH9) in 6:1:2:1 row ratio
- Pigeonpea + soybean (2:1/1:3)

Farm implements/ tools

Chandrapur

- 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.

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 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/-

Wardha, Yavatmal

- Manually operated fertilizer drill: Simple two row tool top dressing (hand metered)
- Bullock drawn serrated blade for interculture: Two rows, improved blades for intercultivation
- A four row seed cum fertilizer drill for multi purpose tool carrier (NIKARJ)
- Israeli model of tractor drawn seed drill (PDKV, Akola)

Alternate farming systems

Chandrapur

- **Fodder/green biomass:** *Leucaena leucocephala*, *Albizia lebbeck*, *Delbergia sissoo*, *Azadirachta indica*, *Acacia procera*, *Gliricidia*
- **Fruit:** Pomegranate, ber, mango, sapota, guava, tamarind
- **Medicinal and aromatic plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, *Ocimum viride*
- **Vegetables:** Onion, chilli, brinjal, okra, amaranthus, bottlegourd
- **Animal component:** Female cattle, male cattle, female buffaloes, goat, poultry

Jalna

- Agri-horticultural system - Ber (5 x 5 m) + mothbean (8 lines) (30 x 10 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, karonda
- **Medicinal/ aromatic plants:** *Plantago ovata*, *Cassia angustifolia*, *Safed musli*, *Papaver somniferum*
- **Vegetables:** Clusterbean, cowpea, amaranthus, round melon, Long melon
- **Animal component:** Female buffalo/ sheep, goat

Wardha, Yavatmal

- **Fodder/ green biomass:** *Leucaena leucocephala*, *Albizzia lebbeck*, *Dalbergia sissoo*, *Acacia procera*, *Gliricidia*
- **Fruit:** Pomegranate, ber, mango, sapota, guava, tamarind
- **Medicinal and aromatic plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, *Ocimum viride*
- **Vegetables:** Onion, chilli, brinjal, okra, amaranths, bottlegourd
- **Animal Component:** Male/ female cattle, female buffaloes, sheep, goat, poultry

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.
- Silvopastoral system of Subabul + Marvel-8 with cutting of the alternate trees at 7th year onwards for fuel is also recommended.

Contingent planning

Chandrapur, Wardha, Yavatmal

Regular Monsoon

- The regular monsoon starts by 24th 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 10th July. Sorghum CSH-1 variety is sown instead of CSH-5/ CSH-9.
 - Area under greengram/ blackgram should be replaced by early pigeonpea varieties such as ICPL 8863 or ICPL 87119
 - Area under groundnut be reduced and replaced by sunflower (EC 68414)

Regular monsoon followed by long gaps:

- Wherever possible, life-saving irrigation be given.
- Cotton can sustain some stress, but sorghum, groundnut, chickpea are not able to sustain such stress. Therefore, use of some conditioner such as spray of urea, not exceeding to 2 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, *kharif* crop fails, to follow *rabi* crop safflower (N.7), pigeonpea (C.11) in September.

Extended monsoon

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

Jalna

- 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)
 - Clusterbean + pigeonpea (2:1)
 - Clusterbean + 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
Nagpur	High runoff and High yield gap

Agro-ecological setting

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%, Entisols-20%)
- **Annual rainfall:** 1242 mm
- **Potential evapotranspiration:** 2050 mm
- **Moisture availability period:** 150-180 days

Soil and water conservation

- 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)

Crop management

- **Varieties:** Patur-96, C – 11, Asha (ICPL 87119), Maruti (ICPL 8863), BSMR 175, BSMR 736
- **Seed rate:** 10 kg/ha
- **Planting pattern:** 60 x 30 cm
- **Nutrient management:** 20 kg N + 50 kg P₂O₅ + 20 kg ZnSO₄/ha
- **Pest management:**
 - For pod borers control:
 - Application of Methyl parathion 2% dust @ 20 kg/ ha or spraying Quinolphos 25% EC @ 16 ml/10 l water
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg Neem seed extract in 500 l of water /ha sprayed at branching and pod filling

Suitable cropping systems

- Pigeonpea + soybean (1:3/2:1)
- Pigeonpea + greengram (1:3/2:1)
- Pigeonpea + setaria (1:3)
- Pigeonpea + cotton (12:2)
- Cotton + sorghum + pigeonpea + sorghum (CSH-9) in 6:1:2:1 row ratio
- Pigeonpea + groundnut (2:1/1:3)

Farm implements/ tools

- 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.

Alternate farming systems

- **Fodder/ green biomass:** *Leucaena leucocephala*, *Albizia lebbeck*, *Dalbergia sissoo*, *Acacia indica*, *Acacia procera*, *Gliricidia*
- **Fruit:** Pomegranate, ber, mango, sapota, guava, tamarind
- **Medicinal and aromatic plants:** *Solanum viarum*, *Catharanthus roseus*, *Palma rosa*, *Vetiveria zizanioides*, *Ocimum viridae*
- **Vegetables:** Onion, chilli, brinjal, okra, amaranthus, bottlegourd
- **Animal Component:** Male/ female cattle, female buffaloes, sheep, goat, poultry

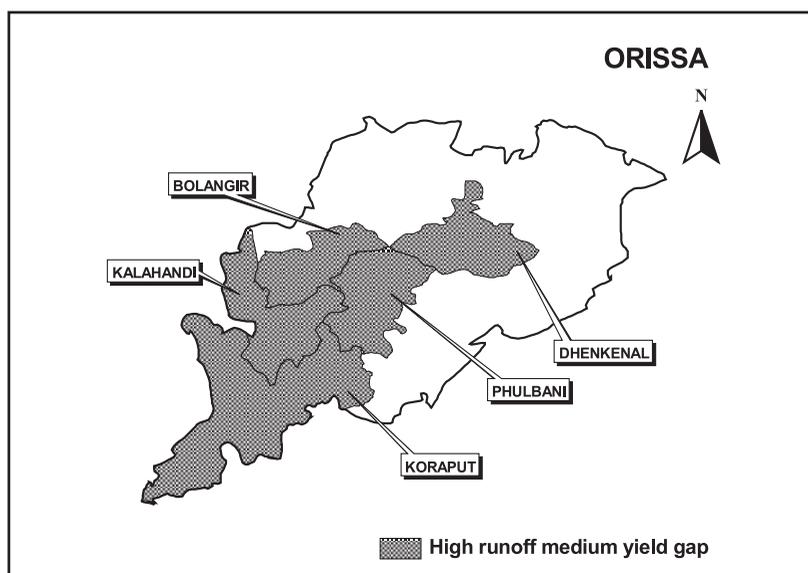
Contingent crop planning

Regular Monsoon

- The regular monsoon starts by 24th 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.
 - Area under cotton should be reduced and replaced by sorghum.
 - Sowing of sorghum should be completed before 10th July. Sorghum CSH-1 variety is sown instead of CSH-5/ CSH-9.
 - Area under greengram/ blackgram should be replaced by early pigeonpea varieties such as ICPL 8863 or ICPL 87119 (Asha)
 - Area under groundnut should 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, *kharif* crop fails, to follow *rabi* crop safflower (N.7), pigeonpea (C.11) in September.
- **Extended monsoon**
 - Advantage of this situation is exploited for double cropping with safflower and chickpea. Safflower (No.7) may be sown after sorghum till 15th October. Beyond 15th October chickpea may be sown.

ORISSA

In Orissa there are five districts viz. Bolangir, Dhenkenal, Kalahandi, Koraput and Phulbani under high runoff and medium yield gap region.



The setting and recommendations follow:

District	Region
Bolangir Dhenkenal Kalahandi Koraput Phulbani	High runoff and medium yield gap

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

Dhenkenal

- **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

Kalahandi

- **Climate:** Hot moist sub humid
- **Physiography:** Eastern ghats
- **Soils:** Deep loamy red and lateritic soils (Ustalfs/ Ustolls – 70%; Alfisols – 30%)
- **Annual rainfall:** 1511 mm
- **Potential evapotranspiration:** 1524 mm
- **Moisture availability period:** 180 -210 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

Phulbani

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

Soil and water conservation

Bolangir, Dhenkenal, Kalahandi, Koraput, Phulbani

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

Crop management

Bolangir, Dhenkenal, Kalahandi, Koraput, Phulbani

- **Varieties:** T-21, Mukta (A-60), Kanse-9, T-21, ICPL- 87, Laxmi CO 5
- **Seed rate:**
 - Late variety: Seed rate - 12 kg/ ha
 - Early variety – Seed rate -20 kg/ ha

- **Planting Pattern:**
 - Late variety: 60 x 30 cm
 - Early variety: 45 x 20 cm
- **Nutrient management:**
 - Late variety: 20 kg N + 60 kg P₂O₅ + 20 kg K₂O + 20 kg S/ ha – all to be applied as basal
 - Early variety: 20 kg N + 40 kg P₂O₅ + 20 kg K₂O + 20 kg S/ ha – all to be applied as basal
 - Application of 20 kg N as FYM or green leaf + 25 kg N/ha as chemical fertilizer or 45 kg N/ha as greenleaf gives similar yield as 45 kg N from chemical source in pigeonpea + rice (2:5) intercropping system. Resource poor rainfed farmers should raise greenleaf manuring plants viz. *Leucaena leucocephala* (Subabul), *Gliricidia sepium* (Gliricidia) and *Cassia siamea* (cassia) in field boundaries/road sides to meet nitrogen need of the system.
- **Pest management:**
 - One weeding before 30-40 days from sowing
 - For pod borers control:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg Neem seed extract in 500 l of water per hectare sprayed at branching and pod filling

Application of Thiobencarb @ 1.0 kg/ ha as pre emergence spray in pigeonpea + rice and Oxadiazon @ 0.5 kg/ha as pre-emergence spray in pigeonpea + blackgram intercropping system reduce cost of cultivation, offer satisfactory weed control and increase crop yield.
- **Some other important practices**
 - Sowing second fortnight of July
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and Rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Bolangir, Dhenkenal, Kalahandi, Koraput, Phulbani

- 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
- Pigeonpea (T-21, R-60) + rice (ZHU 11-26) in 2:5 row ratio
 - Five rows of short statured, drought tolerant and short duration rice varieties in 15 cm apart rows are intercropped in 90 cm space between paired rows of long duration pigeonpea with set specification 30-90-30 cm. In this system, 100% population of sole pigeonpea and 62.5% of sole rice are maintained (Plate-6).
- Pigeonpea (T-21, R-60) + groundnut (OG 52-1, JL 24) in 2:6 row ratio
 - Six rows of short duration, bunch type groundnut are grown in 210 cm interspace between paired rows of long duration pigeonpea with set specification 30-210-30 cm. Plant protection in pigeonpea becomes easier in this row ratio as compared to row ratio of 2:4 (set specification 30-150-30 cm).
- Pigeonpea (T-21, ICPL 87) + greengram (PDM 54, K 851) or blackgram (Pant U 30, T-9, Sarala) in row ratio of 2:3.
 - Three rows of short statured, short duration greengram or blackgram varieties are grown between paired rows of long duration pigeonpea with set specification 30-120-30 cm. The intercrops are grown

in 30 cm apart rows. Harvesting of greengram or blackgram coincides with wetspell. Matured pods should be plucked in phased manner, dried and threshed to check moisture related damage.

- Pigeonpea (T-21, R-60) + finger millet (Dibyasingha)
 - Four rows of short duration, short statured finger millet in 20 cm apart rows are intercropped in 100 cm interspace between paired rows of pigeonpea with set specification 30-100-30 cm.
- Pigeonpea (T-21, R-60) + radish (Pusa chetki)
 - Two rows of radish are intercropped between paired rows of pigeonpea with set specification 30-90-30 cm. Radish is harvested early within 40-50 days.
- Pigeonpea (T-21, R-60) + Okra (Parbhani kranti)
 - Two rows of okra are intercropped in between the paired rows of pigeonpea with set specification 30-90-30 cm.
- Pigeonpea + sorghum (2:1)
- Pigeonpea + green gram / blackgram
- Pigeonpea + maize (1:1)

Farm implements/ tools

Bolangir, Dhenkanal

- Mould board plough: Suitable for primary tillage (1st and 2nd 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.1232/-
- IADP puddler: 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: Pulverizing 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 multi crop 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/ha
- Three row multi crop 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 two men and covers 20 ha/day. Rs. 4000/-
- Pedal paddy thresher: Threshing of paddy. Requires two men and covers 2.5 q/day. Rs. 2754/-
- Power paddy thresher: Threshing of paddy. Requires 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 two men and covers 2.2 q pods/day. Rs.2818/-

- Groundnut decorticator: Spreading seeds from groundnut pods. Requires one man and covers 50 kg/ha. Rs. 764/-
- Maize sheller: Spreading seeds from maize cobs. Requires a one man and covers 1.0 q/day. Rs. 25/-

Kalahandi, Koraput

- Bishu Mould board plough
- Bullock drawn seed drill

Phulbani

- Fertilizer cum seed drill

Alternate farming systems

Bolangir, Dhenkenal, Kalahandi

- **Fodder/ Green biomass:** *Dalbergia sissoo, Albizzia 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 zizanioides*, Rose, Geranium
- **Vegetables:** Onion, tomato, okra, cowpea, clusterbean, drumstick
- **Non – arable wastelands:**
 - Tree farming (Sal, *Teak*)
 - Silvi-pastoral (*Shisham/ Subabul/ Gambar* + *Stylosanthes/ 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 80 x 25 cm)
 - Yam (100 x 60 cm) + maize/ castor
 - Tapioca (100 x 100 cm) + maize/ castor
 - Colocassia (80 x 25 cm) + maize/ castor
 - Alley cropping: Subabul (4 m interval) + groundnut/ sesame/ cowpea (grain)
 - *Leucaena* + turmeric/ ginger

Koraput

- **Fodder/ Green biomass:** *Dalbergia sissoo, Albizzia lebbeck, Anogeissus latifolia, Sesbania, Stylosanthes hamata*, Marvel – 8 grass
- **Fruit:** Ber, custard apple, pomegranate, amla+ *kharif* spreading crops.
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- Colocassia (80 x 25 cm) + maize/ castor
- Alley cropping: Subabul (4 m interval) + groundnut/ sesame/ cowpea (grain)
- *Leucaena* + turmeric/ ginger
- Tree on top lands: *Albizzia spp*, *Cassia siamea*, *Gravellea robusta*, *Dalbergia sissioo*
- Fruit: Mango, jackfruit, guava, lime
- Medicinal/ aromatic plants: *Vetiveria zizanioides*, *Cymbopogon flexuosus*, *Palma rosa*, *Solanum viarum*, *Cinnemon*, *Citronella fara*
- Vegetables: Bottle gourd, ridge gourd, water melon, long melon, tomato, brinjal
- Animal component: Female buffalo/ sheep, goat

Contingent planning

Bolangir, Dhenkenal, Kalahandi, Koraput, Phulbani

Normal season

- **Rice:**

- Very early group (less than 95 days): Heera, Rudra, ZHU 11-26, Vandana
- Early group (95 days to 115 days): Pathara, Kandagiri, Udayagiri. Ghanteswari and Parijat
- Early medium (115 days 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, Bhai *rabi* and Subhra

- **Maize:** Navjot, Vijaya, DHM-103 and Ganga-5

- **Greengram:** PDM-54, K- 851, Dhauri and TARM-2. Pusa 9072

- **Blackgram:** Pant U-30, T-9 and Sarala

- **Pigeonpea:** UPAS-120, R-60, T-21 and S-5, TT 6

- **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
- **Rape seed 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, Srirupa

Aberrant weather

Upland

- **Early season drought/ Delay in onset of monsoon:**
 - When upland rice is completely damaged, the crop may be cut down for supplying straw to the cattle. Non-paddy crops viz. finger millet (Subhra, Bhairabi, Dibyasingha and Godavari), Greengram (K 851, PDM-11 and PDM-54), blackgram (T-9, Sarala and Pant U-30), Cowpea (SEB-2, SGL-1, Arka Kamal), horsegram (Urmi), ricebean (RBL 6), Sesame (Usha, Uma) and 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 litre 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 rainwater should be recycled as life saving irrigation.

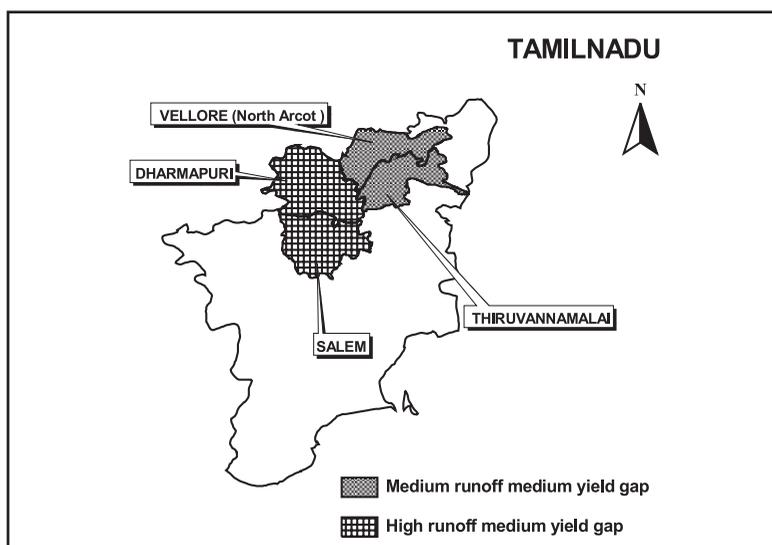
Medium and low land

- **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 powertiller 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/ m². 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.

TAMIL NADU

In Tamil Nadu there are two districts viz. Tiruvannamalai and Vellore under medium runoff and medium yield gap region and two districts viz. Dharmapuri and Salem under high runoff and medium yield gap region.



The setting and recommendations follow:

District	Region
Dharmapuri Salem	High runoff and Medium yield gap

Agro-ecological setting

Dharmapuri

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu Plains
- **Soils:** Deep red loamy soils (Alfisols – 100%)
- **Annual rainfall:** 876 mm
- **Potential evapotranspiration:** 1651 mm
- **Moisture availability period:** 120-150 days

Salem

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu Plains
- **Soils:** Deep red loamy soils (Alfisols – 100%)
- **Annual rainfall:** 965 mm
- **Potential evapotranspiration:** 1729 mm
- **Moisture availability period:** 120-150 days

Soil and water conservation

Dharmapuri, Salem

- More emphasis on *in situ* water conservation and semi permanent structures
- Increasing soil infiltration capacity and reducing soil crusting problem
- Inter-plot water harvesting of 1:1 cropped to uncropped land
- Furrows at 3.6 m intervals
- On sloppy land contour cultivation along vegetative hedge of *Vetiveria* or *Leucaena* at 0.5 m Vertical interval in sorghum and cotton crops
- Supplemental irrigation by harvesting runoff water at dry spells.
- Field bunds for smaller areas may be encouraged for wider adoption.

Crop management

Dharmapuri, Salem

- **Varieties:** CO 6, Kharogon – 2,C.II, SA1, ICPL 87119, COPH 1, COPH 2, Vamban 1
- **Seed rate:** 10 kg/ha
- **Spacing:** 60 x 20 cm
- **Nutrient management:** 40 kg N + 20 kg P₂O₅ + 20 kg S + 20 kg ZnSO₄ / ha
- **Pest management:**
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed
 - For pod borers control:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg Neem seed extract in 500 l of water/ha sprayed at branching and pod filling
 - For Pod borers:
 - Dusting with Endosulfan 4% dust @ 25 kg/ ha or spraying of Endosulfan (2 ml/ l water) at the time of pod formation
 - For weed control:
 - Give 2 hand weeding and keep fields weed- free for the first 35 days after sowing or Herbicide application + one hand weeding on 35 to 40 days after sowing.
 - Pre emergence application of Pendimethalin 2 l/ ha on 3rd day after sowing

Suitable cropping system

Dharmapuri, Salem

- Sorghum + pigeonpea
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)
- Pigeonpea + pearl millet (2:1)

Farm implements/ tools

Dharmapuri, Salem

- Tractor drawn seed drill

- Bullock drawn seed drill
- Multipurpose implement

Alternate farming systems

Dharmapuri, Salem

- **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)
- **Silviculture:** *Alianthus excelsa* + blackgram, *Alianthus excelsa* + dinanath grass
- **Fodder/ green biomass:** *Alianthus excelsa*, *Albizzia lebbbeck*, *Leucaena leucocephala*, *Hardwickia binata*, *A.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:** Sheep, goat.

Integrated farming system

Dharmapuri, Salem

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 per cent as compared to the percentage contribution of dairy component with 90 and 93.3 per cent.

Contingent planning

Dharmapuri, Salem

Normal monsoon

- 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.

District	Region
Tiruvannamalai Vellore	Medium runoff and Medium yield gap

Agro-ecological setting

Tiruvannamalai

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu Uplands
- **Soils:** Deep red loamy soils (Alfisol – 85%; Orthids – 15%)
- **Annual rainfall:** 974 mm
- **Potential evapotranspiration:** 1720 mm
- **Moisture availability period:** 120-150 days

Vellore

- **Climate:** Hot moist semi arid
- **Physiography:** Tamil Nadu Uplands
- **Soils:** Deep red loamy soils (Alfisol – 85%; Orthids – 15%)
- **Annual rainfall:** 969 mm
- **Potential evapotranspiration:** 1687 mm
- **Moisture availability period:** 120-150 days

Soil and water conservation

Tiruvannamalai, Vellore

- Soil water balance studies
- Runoff-erosion measurements
- More emphasis on in situ 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 intervals
- Absorption/ drainage type terraces
- On sloppy land contour cultivation along vegetative hedge of Vetiver or *Leucaena* at 0.5 m V.I. in sorghum and cotton crops

Crop management

Tiruvannamalai, Vellore

- **Varieties:** Kharogon – 2, C.II, SA1, CO 6, COPH 1, COPH 2
- **Seed rate:** 10 kg/ha
- **Spacing:** 60 x 15 cm
- Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

- For pod borers control:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
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- **Nutrient management:** 40 kg N + 20 kg P₂O₅ + 20 kg S + 20 kg Zn/ ha
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 - For weed control:
 - Give 2 hand weedings and keep fields weed- free for the first 35 days after sowing or Herbicide application + one hand weeding on 35 to 40 days after sowing.
 - Pre emergence application of Pendimethalin 2 l/ ha on 3rd day after sowing

Suitable cropping system

Tiruvannamalai, Vellore

- Sorghum + pigeonpea
- Pigeonpea + soybean (2:1)
- Pigeonpea + small millets (2:1)
- Pigeonpea + pearl millet (2:1)

Alterante farming systems

Tiruvannamalai, Vellore

- **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)
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Contingent planning

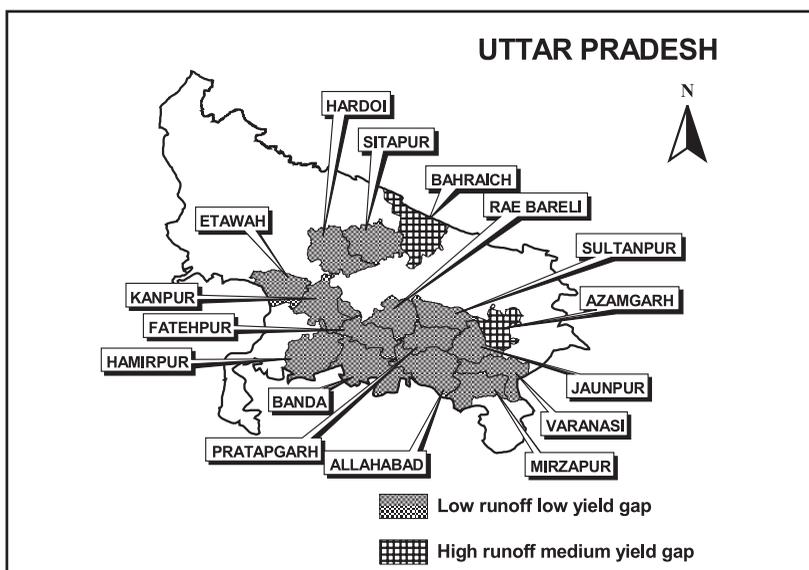
Tiruvannamalai, Vellore

- 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, green gram, 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 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 (K1) 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.

UTTAR PRADESH

In Uttar Pradesh there are fifteen districts viz. Allahabad, Banda, Etawah, Fatehpur, Hardoi, Hamirpur, Jaunpur, Kanpur (rural), Kanpur (urban), Mirzapur, Pratapgarh, Rae Bareli, Sitapur, Sultanpur and Varanasi under low runoff and low yield gap region, two districts viz. Azamgarh and Bahraich under high runoff and medium yield gap region.



The setting and recommendations follow:

District	Region
Allahabad	Low runoff and low yield gap
Banda	
Etawah	
Fatehpur	
Hardoi	
Hamirpur	
Jaunpur	
Kanpur (rural)	
Kanpur (urban)	
Mirzapur	
Pratapgarh	
Rae Bareli	
Sitapur	
Sultanpur	
Varanasi	

Agro-ecological setting

Allahabad

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga - Yamuna Doab

- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 1027 mm
- **Potential evapotranspiration:** 1537 mm
- **Moisture availability period:** 120-150 days

Banda

- **Climate:** Hot moist semi arid
- **Physiography:** Bundelkhand Uplands
- **Soils:** Deep loamy and clayey mixed red and black soils (Inceptisols – 100%)
- **Annual rainfall:** 1005 mm
- **Potential evapotranspiration:** 1455 mm
- **Moisture availability period:** 120-150 days

Etawah

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga - Yamuna Doab
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 553 mm
- **Potential evapotranspiration:** 1464 mm
- **Moisture availability period:** 120-150 days

Fatehpur

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga-Yamuna Doab (Northern plains)
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 885 mm
- **Potential evapotranspiration:** 1464 mm
- **Moisture availability period:** 120-150 days

Hardoi

- **Climate:** Hot dry moist semi arid
- **Physiography:** Ganga Yamuna Doab, Central Uttar Pradesh
- **Soils:** Deep loamy alluvium derived soils (Inceptisols – 100%)
- **Annual rainfall:** 1062 mm
- **Potential evapotranspiration:** 1494 mm
- **Moisture availability period:** 120-180 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

Jaunpur

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga Yamuna Doab, Eastern Uttar Pradesh
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 1079 mm
- **Potential evapotranspiration:** 1538 mm
- **Moisture availability period:** 120 - 150 days

Kanpur (Rural)

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga - Yamuna Doab
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 882 mm
- **Potential evapotranspiration:** 1661 mm
- **Moisture availability period:** 210 days

Kanpur (Urban)

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga - Yamuna Doab
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 903 mm
- **Potential evapotranspiration:** 1576 mm
- **Moisture availability period:** 187 days

Mirzapur

- **Climate:** Hot/ subhumid/ moist/ dry (transitional)
- **Physiography:** South East Uttar Pradesh
- **Soils:** Deep loamy to clayey, red and yellow soils (Inceptisols – 60%; Udupts/Udalfs – 40%)
- **Annual rainfall:** 1112 mm
- **Potential evapotranspiration:** 1527 mm
- **Moisture availability period:** 187 days

Pratapgarh

- **Climate:** Hot moist semi arid
- **Physiography:** Aradh plains (Northern plains)
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 1035 mm
- **Potential evapotranspiration:** 1524 mm
- **Moisture availability period:** 120 – 150 days

Rae Bareli

- **Climate:** Hot moist semi arid
- **Physiography:** Ganga Yamuna Doab, Eastern Uttar Pradesh
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 100%)
- **Annual rainfall:** 987 mm
- **Potential evapotranspiration:** 1500 mm
- **Moisture availability period:** 120-150 days

Sitapur

- **Climate:** Hot dry sub humid
- **Physiography:** Kohil Khand plains (Northern plains)
- **Soils:** Deep loamy alluvium derived soils (Inceptisols – 100%)
- **Annual rainfall:** 1099 mm
- **Potential evapotranspiration:** 1411 mm
- **Moisture availability period:** 150-180 days

Sultanpur

- **Climate:** Hot dry sub humid
- **Physiography:** Aradh plains (Northern plains)
- **Soils:** Deep loamy alluvium derived soils (Inceptisols – 100%)
- **Annual rainfall:** 1111 mm
- **Potential evapotranspiration:** 1515 mm
- **Moisture availability period:** 150-180 days

Varanasi

- **Climate:** Hot moist semi arid/ hot dry sub humid
- **Soils:** Deep loamy alluvium - derived soils (Inceptisols – 80%; Udupts/ Udalfs – 20%)
- **Annual rainfall:** 1114 mm
- **Potential evapotranspiration:** 1557 mm
- **Moisture availability period:** 120-150 days

Soil and water conservation

Allahabad, Jaunpur, Mirzapur, Sitapur, Sultanpur, Varanasi

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

Banda

- Sowing across the slope and ridging later
- Compartment bunds for raising crops on conserved soil moisture

Fathepur, Hamirpur

- 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.

Etawah

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

Hardoi, Kanpur (Rural), Kanpur (Urban), Pratapgarh, Rae Bareli

- Sowing across the slope and ridging later
- Compartment bunds for raising crops on conserved soil moisture
- Contour farming
- Deep ploughing during summer followed by two cultivators

Crop management

Allahabad, Hardoi, Jaunpur, Kanpur (Rural), Kanpur (Urban), Mirzapur, Pratapgarh, Rae Bareli, Sitapur, Varanasi

- **Varieties:** Long duration: MA 13, Amba, Azad, Bahar, Narendra arhar-1
- **Short duration:** IJPAS 120, Pusa 992, Mank
- **Seed rate:** Short duration: 15-18 kg/ha; Long duration: 10-12 kg/ha
- **Planting pattern:** Short duration: 45 x 15 cm; Long duration 60 x 20 cm
- **Nutrient management:** 20 kg N + 60 kg P₂O₅ + 20 kg K₂O + 20 kg S + 20 kg ZnSo₄/ ha
- **Pest Management:**
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 2. 25 kg neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

Pests:

- | | |
|---------------------|-------------------------------------|
| (i) Pod fly | Spray Monocrotophos 40 EC @ 1 ml/ l |
| (ii) Tur plume moth | Spray Dimethoate 30 EC @ 1.5 ml/ l |
| (iii) Heliothis sp. | Spray Endosulfan 35 EC @ 2ml/ l, |
| (iv) Tur pod bug | 5% NSKE and 350 LE NPV |

Diseases:

- | | |
|----------------|--|
| Wilt, PSB, SMD | Eradicate affected plants.
Use disease free seed.
Seed treatment with Thiram @ 3 g/kg seed |
|----------------|--|

Pigeonpea + blackgram Pre emergence application of Pendimethalin 3 l/ha One interculture by dry land weeder 30 DAS Keep the field free of weeds in the first 4 days. Work 20 to 3 times

• **Some other important practices**

- Seed treatment with Thiram/ Captan –3 g, 6 g Trichoderma / kg seed against wilt and rhizobium culture –25 g/ kg seed

Banda, Etawah, Fatehpur, Hamirpur

- **Varieties:** Bahar, MA 13, Amar, Narendra Arhar 1
- **Seed rate:** 10-12 kg/ha
- **Planting pattern:** 60 x 20 cm
- **Nutrient management:** 20 kg N + 60 kg P₂O₅ + 20 kg K₂O + 20 kg S /ha
- **Pest management**
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 2. 25 kg neem seed extract in 500 l of water/ ha sprayed at branching and pod filling

Pests:

- | | |
|---------------------|-------------------------------------|
| (i) Pod fly | Spray Monocrotophos 40 EC @ 2 ml/ l |
| (ii) Tur plume moth | Spray Dimethoate 30 EC @ 1.5 ml/ l |
| (iii) Heliothis sp. | Spray Endosulfan 35 EC @ 2ml/ l, |
| (iv) Tur pod bug | |

Diseases:

- | | |
|------|--|
| Wilt | Eradicate affected plants.
Use disease free seed.
Seed treatment with Thiram @ 3 g/kg seed |
|------|--|

Pigeonpea + blackgram Pre emergence application of Pendimethalin 3 l/ha as PE One interculture by dry land weeder 30 DAS Keep the field free of weeds in the first 4 days. Work 20 to 3 times

• **Some other important practices**

- Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Allahabad, Hardoi, Jaunpur, Kanpur (Rural), Kanpur (Urban), Mirzapur, Pratapgarh, Rae Bareli, Sitapur, Sultanpur, Varanasi

- Pigeonpea + sesame (1:1)
- Pigeonpea + blackgram/ Urdbean (1:1)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + sorghum (2:1)
- Pearl millet + pigeonpea (2:1)

Banda, Etawah, Fatehpur, Hamirpur

- Sorghum + pigeonpea (2:1)
- Groundnut + pigeonpea (2:1)
- Sesame + pigeonpea (1:1)
- Pigeonpea + sunhemp (fodder) (mixed)
- Pigeonpea + forage sorghum (mixed)
- Pigeonpea + sudan grass (mixed)
- Pigeonpea + *pennisetum pedicellatum* (mixed)

Farm implements/ tools

Allahabad, Hardoi, Jaunpur, Mirzapur, Pratapgarh, Rae Bareli, Sitapur, Sultanpur, Varanasi

- Bullock drawn Malviya multi –farming machine: For field preparation. For seeding dryland crops and fertilizing through mechanical metering device. For intercultivation between two plant rows (particularly *Kharif* season crop). Rs. 2350/-
- Dryland weeder (modified from of weeder supplied by T.A.U): For weed control between plant rows of rainfed crops. Rs.70/-

Banda

- Dryland weeder
- Seed cum fertilizer drill

Fatehpur, Hamirpur

- Ferti – cum - seed drill

Etawah

- Shivaji seed cum ferti drill

Kanpur (Rural), Kanpur (Urban)

- Star Weeder

Alternate farming systems

Allahabad, Hardoi, Jaunpur, Kanpur (Rural), Kanpur (Urban), Mirzapur, Rae Bareli, Sitapur, Sultanpur, Varanasi

- **Agro horti system:** Guava + pigeonpea/ fieldpea
- **Fodder/green biomass:** *Luecaena leucocephala*, *Azadirachta indica*, *Albizia lebbek*, *Bauhinia purpurea*, *A. procera*, *B.monosperma*, *A.amara*, *D.sissoo*.
- **Fruit:** Guava, amla, ber, mango bael, jamun.
- **Medicinal & Aromatic Plants:** *Papaver somniferum*, *Cymbopogon flexuosus*, *P.rosalea*, *Palma rosa*, *Vetiveria zizanoides*
- **Vegetables:** Bottle gourd, brinjal, chillies, clusterbean, cowpea, round melon
- **Animal Component:** Female and male cattle, female buffaloes, sheep, goat, poultry

Banda, Fatehpur, Hamirpur

- **Fodder/ green biomass:** *Leucaena*, *Melia azadirachta*, *Dichrostachys cineraria*, *Albizia amara*, *A.lebbek*, *Hardwickia binata*, *A.nilotica*.

- **Fruit:** *Embllica officinalis* (amla), guava, ber, mango.
- **Medicinal/ Aromatic Plants:** *Rauvolfia serpentina*, *Vetiveria zizanooides*, *Palma rosa*, *Safed musli*, *Aswagandh*.
- **Vegetables:** Bottle gourd, brinjal, tomato, chillies, cowpea, okra
- **Animal Component:** Female and male cattle, female buffaloes, goat, poultry

Etawah

- **Agro - horti system:** Ber + pearl millet + cowpea as fodder
- **Agro horticulture:** Ber + greengram/ clusterbean/ cowpea for grain purpose
- Ber + pearl millet (fodder)
- **Fodder/ green biomass:** Neem, subabul, *Hardwickia binata*, *Pongamia*, *Casuarina siamea*, *Bauhinia*
- **Fruit:** Mango, guava, amla, phalsa, jamun, karonda, *Papaver somniferrum*, *Palma rosa*, *Cymbopogan flexuosus*, *Vetiveria zizanooides*.
- **Vegetables:** Tomato, chillies, brinjal, okra, bottle gourd, cowpea.
- **Animal component:** Female buffalo/ sheep, goat

Pratapgarh

- **Agro horti system:** Guava + maize
- **Fodder/green biomass:** *Leucaena leucocephala*, *Azadirachta indica*, *Albizia lebbbeck*, *Bauhinia purpurea*, *A.procera*, *B.monosperma*, *A.amara*, *D.sissoo*.
- **Fruit:** Guava, amla, ber, mango, bael, jamun.
- **Medicinal and aromatic plants:** *Papaver somniferum*, *Cymbopogan flexuosus*, *Prosalea*, *Palma rosa*, *Vetiveria zizanooides*.
- **Vegetables:** Bottle gourd, brinjal, chillies, cluster bean, cowpea, round melon.
- **Animal component:** Female and male cattle, female buffaloes.

Contingent crop planning

Allahabad, Hardoi, Jaunpur, Kanpur (Rural), Kanpur (Urban), Mirzapur, Rae Bareli, Sitapur, Sultanpur, Varanasi

Normal season:

- **Kharif season**
 - Rice: NDR-97, NDR-118, Govind and Vandana
 - Maize: Ganga safed2, Knachan, Jaunpuri
 - Pearl millet: BJ 104, Pusa 23, Pusa 322
 - Blackgram: T.9, Pant U-19, Pant U 35, Uttara, Shekhar
 - Greengram: Jyoti, Jagriti, Narendra moong-1, Pant M4, Samrat Pusa Vishal, Pant M2
 - Sesame: T4, T12, Gujrat Sesame-1.
 - Pigeonpea: Bahar, NA-1, MA 13, Sharad
- **Rabi season**
 - Lentil: Pant L-406, PantL-639, L 4076, K 75, Sheri, IPL 81, Noori
 - Wheat: HUW-533, K-8027, C-306
 - Barley: DL3, Jyoti, K125

- Rapeseed mustard: Varuna, Vardhan, Sanjukta, Kranti
- Linseed: Garima, Neelam
- Chickpea: Pusa 256, Awarodhi, DCP 92-3, KWR 108, JG 315, JG 74

Aberrant weather

- **Normal onset of monsoon followed by long gaps in rainfall:**
 - In the case of very early break in monsoon i.e. 7-10 days after seeding and if seedlings are killed resow with the same variety.
 - Gap filling/ transplanting in case of cereals like upland rice and pearl millet may be done if drought occurs about a month after seeding and is followed by showers. Follow this by light topdressing i.e. 10-15 kg/ha. For this purpose community nurseries or emergency nurseries should be kept ready.
- **Delayed onset of monsoon:**
 - If monsoon sets in as late as the last week of July, short duration upland rice such as NDR-97 and Vandana are recommended on medium & low lands. Uplands should be considered for Pigeonpea base intercrop. If rains are delayed beyond the period but start somewhere in the first to second week of August and growing season is reduced to 60-70 days, then the cultivation of hybrid pearl millet (BJ560, BJ.104), blackgram (T9), greengram (Jagriti, Jyoti) should be taken up. Pulse base intercropping is also recommended. Yet another alternative could be to harvest a fodder of sorghum, pearl millet, maize or mixture of either of cowpea, blackgram, greengram and one of the above fodder crops. Winter crops like rapeseed mustard, barley, lentil, linseed and chickpea will follow these crops.
- **Early stoppage of rains towards the end of season:**
 - Normal growing of short duration *kharif* crops such as upland rice (NDR-97 or Vandana), blackgram (T.9), sesame (T.13) may be done. Sorghum, maize, pearl millet, and cowpea for fodder could be harvested. If the rain stops very early, i.e. by the end of August or first week of September, only fodder crops and grain legumes could be harvested. Later on as a mid-season correction sunflower could be planted as it could be sown any time in the year.
- **In extreme drought conditions:**
 - Only short duration crops like grain legumes (black and greengram) should be grown
 - Among cereals, pearl millet (BJ.104) gave a fair performance
 - Intercropping blackgram in inter rows of pigeonpea was found successful
 - Rice crop, if already sown is not likely to succeed, may be ploughed under to conserve the moisture in the soil. This may permit growing of lentil, chickpea, rapeseed mustard or barley during rabi
 - Late season drought coinciding with reproductive phase of upland rice is frequently experienced (3/7 years). If period of drought approaches 8-10 days, 25% yield could be compensated by one life saving irrigation (5 cm depth)

Etawah

Kharif

- **Under normal rainfall:**
 - Pearl millet (Proagro 9402, HHB-67), pigeonpea (UPAS 120), greengram (K 851), clusterbean (RGC 197)
- **Rainfall upto end of July**
 - Cereals and Pulses: Pearl millet (Proagro 9402) intercropped with pigeonpea (UPAS 120, IPCL 87) blackgram (T-9) and greengram (K 851). Pure crop of clusterbean, blackgram and greengram.
 - Oilseeds: Groundnut (Chandra) and sesame (Pratap) upto the end of third week of July

- **Rainfall upto third week of August**
 - Cereals and pulses: Clusterbean (RGC 197) and transplanting of pearl millet (MBH 163)
- **Rainfall upto end of August**
 - Clusterbean as pure crop (RGC 197)
 - Castor with a seed rate of 15 kg/ha.

Rabi

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

Pratapgarh

Normal season

- **Kharif**
 - Rice: N-97, N-118, Baranideep
 - Maize: Jaunpuri, Tipakhiya
 - Sorghum: PKV-400, Varsha
 - Pearl millet: Manupur, WCC-75
 - Pigeonpea: UPAS-120, Bahar
 - Blackgram: T-9, Narendra Urd-1
 - Greengram: Pant Moong-54, Narendra Moong-1
- **Rabi**
 - Chickpea: Avrodhi, T-3
 - Lentil: NDL-2, DPL-15
 - Rapeseed mustard: Vibhav, Varuna
 - Linseed: Garima, Sweta
 - Wheat: Atal, C-306, K-8027
 - Barley: Lakhan, Narendra Jau-4
 - Compatible genotypes for cropping system
 - Sequence - Rice – Lentil NDR-97 – NDL-1
 - Intercropping – Linseed + chickpea (Sweta + Avrodhi)

Aberrant weather

- **Normal onset of monsoon followed by long gaps in rainfall:**
 - In the case of very early break in monsoon i.e. 7-10 days after seeding and if seedlings are killed resow with the same variety.
 - Gap filling/ transplanting in case of cereals like upland rice and pearl millet may be done if drought occurs about a month after seeding and is followed by showers. Follow this by light topdressing i.e. 10-15 kg/ha. For this purpose community nurseries or emergency nurseries should be kept ready.
- **Delayed onset of monsoon:**
 - If monsoon sets in as late as the last week of July, short duration upland rice such as NDR-97 and Vandana are recommended on medium & low lands. Uplands should be considered for Pigeonpea base intercrop. If rains are delayed beyond the period but start somewhere in the first to second week of August and growing season is reduced to 60-70 days, then the cultivation of hybrid pearl millet (BJ560, BJ.104), blackgram (T9), greengram (Jagriti, Jyoti) should be taken up. Pulse base intercropping is also recommended. Yet another alternative could be to harvest a fodder of sorghum, pearl millet,

maize or mixture of either of cowpea, blackgram, greengram and one of the above fodder crops. Winter crops like rapeseed mustard, barley, lentil, linseed and chickpea will follow these crops.

- **Early stoppage of rains towards the end of season:**
 - Normal growing of short duration *kharif* crops such as upland rice (NDR-97 or Vandana), blackgram (T.9), sesame (T.13) may be done. Sorghum, maize, pearl millet, and cowpea for fodder could be harvested. If the rain stops very early, i.e. by the end of August or first week of September, only fodder crops and grain legumes could be harvested. Later on as a mid-season correction sunflower could be planted as it could be sown any time in the year.
- **In extreme drought conditions:**
 - Only short duration crops like grain legumes (black and greengram) should be grown
 - Among cereals, pearl millet (BJ.104) gave a fair performance
 - Intercropping blackgram in inter rows of pigeonpea was found successful
 - Rice crop, if already sown is not likely to succeed, may be ploughed under to conserve the moisture in the soil. This may permit growing of lentil, chickpea, rapeseed mustard or barley during rabi

District	Region
Azamgarh Bahraich	High runoff and Medium yield gap

Agro-ecological setting

Azamgarh

- **Climate:** Hot dry / moist subhumid
- **Physiography:** Aradh plains (Northern plains)
- **Soils:** Deep loamy alluvium derived soils (Inceptisols – 100%)
- **Annual rainfall:** 1048 mm
- **Potential evapotranspiration:** 1505 mm
- **Moisture availability period:** 150 - 210 days

Bahraich

- **Climate:** Hot moist subhumid
- **Physiography:**
- **Soils:** Deep, loamy alluvium - derived soils, deep loamy to clayey tarai soils (Inceptisols – 100%)
- **Annual rainfall:** 1177 mm
- **Potential evapotranspiration:** 1435 mm
- **Moisture availability period:** 180-210 days

Soil and water conservation

Azamgarh, Bahraich

- Sowing across the slope and ridging later
- Compartment bunds for raising crops on conserved soil moisture
- Contour farming
- Deep ploughing during summer followed by two cultivators

Crop management

Azamgarh, Bahraich

- **Varieties:** Type-21, UPAS-120, Bahar, Pusa 992, MA-13
- **Seed rate:** Short duration: 15-18 kg/ha; Long duration 10-12 kg/ ha
- **Planting pattern:** 60 x 30 cm
- **Nutrient management:** 20 kg N + 40 kg P₂O₅ +20 kg K₂O + 20 kg S/ ha
- **Pest management:**
 - For pod borers:
 - NPV culture – extract of 500 caterpillars in 500 l of water/ ha
 - 25 kg Neem seed extract in 500 l of water per hectare sprayed at branching and pod filling
- **Some other important practices:**
 - Seed treatment with Thiram/ Captan –3 g per one kg of seed and rhizobium culture –25 g per one kg of seed

Suitable cropping systems

Azamgarh, Bahraich

- Pigeonpea + pearl millet (2:1)
- Pigeonpea + sorghum (2:1)
- Pigeonpea + groundnut (2:1)
- Pigeonpea + sesame (1:1)
- Pigeonpea + blackgram (1:1)

Farm implements/ tools

Azamgarh, Bahraich

- Land preparation and sowing of seed and application of fertilizer by power operated tiller plant machine

Alternate farming systems

Azamgarh

- **Agrohortisystem:** Guava + maize
- **Fodder/ green biomass:** *Leucaena leucocephala*, *Azadirachta indica*, *Albizia lebbeck*, *Bauhinia purpurea*, *A. procera*, *B. monosperma*, *A. amara*, *D. sissoo*
- **Fruit:** Guava, amla, ber, mango, bael, jamun.
- **Medicinal and Aromatic Plants:** *Papaver somniferum*, *Cymbopogon flexuosus*, *P. rosalea*, *Palma rosa*, *Vetiveria zizanioides*.
- **Vegetables:** Bottle gourd, brinjal, chillies, cluster bean, cowpea, round melon
- **Animal component:** Female and male cattle, female buffaloes.

Bahraich

- **Agrohortisystem:** Guava + maize
- **Fodder/ green biomass:** *Leucaena*, *D. sissoo*, *Azadirachta indica*, *Syzygium cumini*, *Sesbania*, *Pongamia*, *Cassia siamea*
- **Fruit:** Mango, guava, amla, ber, phalsa, bael, jamun.

- **Medicinal and Aromatic Plants:** *Papaver somniferum* *Palma rosa*, *Vetiveria zizanoides*, *Cymbopogon flexuosus*.
- **Vegetables:** Tomato, brinjal, okra, chilli, amaranthus.
- **Animal component:** Female cattle, female buffaloes, male cattle, sheep, goat, poultry.

Contingent crop planning

Azamgarh

Normal season

- **Kharif**
 - Rice: N-97, N-118, Baranideep
 - Maize: Jaunpuri, Tipakhiya
 - Sorghum: PKV-400, Varsha
 - Pearl millet: Manupur, WCC-75
 - Pigeonpea: UPAS-120, Bahar
 - Blackgram: T-9, Narendra Urd-1
 - Greengram: Pant Moong-54, Narendra Moong-1
- **Rabi**
 - Chickpea: Avrodhi, KWR 108, BG 256, DCP 92-3, CSG-8962
 - Lentil: NDL-2, DPL-15, Noori, Sheri, Pant L 406, K 75
 - Rapeseed mustard: Vibhav, Varuna
 - Linseed: Garima, Sweta
 - Wheat: Atal, C-306, K-8027
 - Barley: Lakhan, Narendra Jau-4
- Compatible genotypes for cropping system
 - Sequence - Rice – Lentil NDR-97 – NDL-1
 - Intercropping – Linseed + chickpea (sweta + avrodhi)

Aberrant weather

- **Normal onset of monsoon followed by long gaps in rainfall**
 - In case of very early break in monsoon i.e. 7-10 days after seeding and if seedling are killed resown with the same variety.
 - Gap filling/ transplanting in case of cereals like uplands rice and pearl millet may be done if drought occurs about a month after seeding and is followed by showers. Follow this by light topdressing i.e. 10-15 kg N/ha. For this purpose community nurseries of emergency nurseries should be kept ready.
- **Delayed onset of monsoon**
 - If monsoon sets in as late as the last week of July, short duration upland rice such as Narendra-118 and Baranideep are recommended if the rains are delayed beyond the period but start somewhere in the first week of second week of August and growing season is reduced to 60-70 days, then the cultivation of pearl millet (WCC-75, Mannpur), blackgram (Narendra Urd-1) and greengram (Pant Moong-1) should be taken up. Yet another alternative could be to harvest a fodder of either sorghum, pearl millet, maize or a mixture of either of cowpea, blackgram, greengram one of the above fodder crops. These crops will be followed by *rabi* crops like chickpea, rapeseed mustard and barley.

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

- Normal sowing of short duration *kharif* crops such as upland rice (N-97, Mutmuri), blackgram (T-9), sesame (T-13) may be done. Sorghum, maize, pearl millet and cowpea for fodder could be harvested. If the rain stops very early, i.e. by the end of August or first week of September, only fodder crops and grain legumes could be harvested. Later on as a mid-season correction, sunflower could be planted as it could be sown any time in the year.
- Depending on the soil moisture condition, relay sowing of *rabi* crops such as chickpea, lentil, linseed and barley could be done in the *rabi* season.

- **In extreme drought conditions**

- Only short duration crops like grain legumes (black and greengram) should be grown.
- Among cereals, maize (Tipekhiya) gave a fair performance
- Intercropping maize in inter rows of pigeonpea was found successful
- Rice crop, if already sown is not likely to succeed, may be ploughed under to conserve the moisture in the soil.

SUMMARY

Pigeonpea is grown as annual but varieties grow like perennial plants. The plants are bushy, densely branched having a height of about 150 cm to 300 cm depending upon type and management practices. It bears taproot with well-developed lateral or secondary roots that carries nodules on them like any other leguminous plants. The stem is strong, woody, round but slightly ridged during active growth period having numerous branches. The leaves are pinnately compound and trifoliate with oblong, lanceolate leaflets. The flowers are born on short racemes. They open in the evening and remain open whole night and up to noontime of the next day. The structure of flower, nature of pollination, pod setting and pod characters are similar to that of any other Papilionaceous plants. Majority of the *Cajanus cajan* cultivated types belong to two categories and described below.

***Cajanus cajan* var. *bicolor*:** They are late maturing, plants grow very tall or probably they are tallest of both the types which are freely branched and bear flowers at the end of the branches. The pods are relatively longer and use to contain 4 to 5 seeds in them.

***Cajanus cajan* var. *flavus*:** They have shorter duration and accordingly they fall in early maturing category of plants. Plants are shorter, bushy having flowers at several points along the branches. The pods are also shorter which bear two to three seeds in them.

Climatic and soil requirements: Pigeonpea needs moist and warm weather during germination (30-35° C), slightly lower temperature during active vegetative growth (20-25° C) but about 15 –18° C during flowering and pod setting, however, at maturity it needs higher temperature of around 35-40° C. Water logging, heavy rains, frost are very harmful for the crop. Hailstorm or rain at maturity damages the entire crop. The crop may be grown on any type of soil but sandy loam to clayey loam soils are supposed to be best. Soil must be very deep, well drained and free from soluble salts in them.

Varieties: The pigeonpea varieties grown are broadly categorized into early maturing (140-150 days), medium duration (160-200 days) and late duration varieties (more than 200days) Duration wise, zone wise and state wise pigeonpea varieties recommended by Indian Institute of Pulses Research, Kanpur are given below. The states under different zones are described below also include other than mentioned in the main text for greater adoption/diversification in non-traditional areas and/ or wherever relevant (Masood Ali and Shiva Kumar 2001).

North East Plain Zone (NEPZ)- Eastern Uttar Pradesh, Bihar, Orissa, West Bengal, Assam, Arunachal Pradesh, Mizoram, Manipur, Meghalaya, Nagaland, Tripura

North West Plain Zone (NWPZ)- Punjab, Haryana, Himachal Pradesh, Jammu&Kashmir, Western Uttar Pradesh, North Rajasthan)

Central Zone (CZ) - Gujarat, Maharashtra, Madhya Pradesh, Parts of Rajasthan

South Zone (SZ) - Andhra Pradesh, Karnataka, Tamilnadu, Kerala

Early maturing varieties

Variety	Duration (days)	Recommended area	Yield (kg/ha)
Type 21	160 – 180	North & Central Zone	15 -18
Co 5	110 – 115	Tamilnadu	12 - 14
UPAS 120	140 –150	Western Uttar Pradesh	11 - 15
Vishaka (T.T.6)	130 –140	Central & Southern Zone	10 – 17
Manak (H 77 – 216)	120 –130	Western Uttar Pradesh	18 – 20
T.A.T 10	100 –115	Maharashtra	10 –12
Pusa 33	145 – 155	Western Uttar Pradesh	18 – 20
Pusa 84	140 – 150	Western Uttar Pradesh	15 – 16
Gujarat Tur 100	120 –135	Gujarat	16 – 18

Variety	Duration (days)	Recommended area	Yield (kg/ha)
ICPL 151 (Jagriti)	110 – 150	South & Central India, Western Uttar Pradesh	18 –20
Pusa 855	145 – 150	Western Uttar Pradesh	24 – 25
Durga (ICPL 84031)	120 – 125	Andhra Pradesh	8 –10
Vambhan 1	95 – 100	Tamilnadu	8 – 10
C.O.P.H 1	115 – 120	Tamilnadu	10 – 15
C.O.P.H 2	120 – 130	Tamilnadu	10 – 12
AKPH 4101	130 – 140	Central India	20 – 24
Pusa 992	130 – 145	Western Uttar Pradesh	18 – 20

Medium duration varieties

Variety	Duration (days)	Recommended area	Yield (kg/ha)
C11	195 – 200	Central & Southern India	15 –20
No.148	165 – 170	Central India	9 –10
BDN2	150 – 160	Maharashtra, Madhya Pradesh, Gujarat	10 –12
BSMR 736	180 – 185	Madhya Pradesh, Maharashtra	12 –18
TTB6	160 – 170	Karnataka	15 – 17
LRG 30	170 – 180	Andhra Pradesh	17 – 19
ICP 8863 (Maruthi)	155 – 165	Madhya Pradesh	10 –12
Abhaya (ICPL 332)	170 – 175	Andhra Pradesh	18 – 20
BSMR 175	165 – 170	Maharashtra	11 – 12
Asha (ICPL 87119)	160 – 170	Maharashtra, Karnataka, Tamilnadu, Andhra Pradesh	16 –18
KM 7 (Jawahar)	170 – 180	Madhya Pradesh	18 –20
Co. 6	170 – 180	Tamilnadu	9 –10
Maalviya Arhar 3	178 – 162	Central India	20 –22

Late duration varieties

Variety	Duration (days)	Recommended area	Yield (kg/ha)
Type 7	260 – 270	Uttar Pradesh, Madhya Pradesh	20 –22
Bahar	240 – 250	Uttar Pradesh	20 –25
TS 3	180 – 190	Karnataka	14 –16
Sharad (DA 11)	240 – 250	Uttar Pradesh	18 – 20
Pusa 9	210 – 248	Uttar Pradesh	22 –26
Amar (KA 32-1)	250 – 270	Uttar Pradesh	16 –20
Narendra Arhar	240 – 260	Uttar Pradesh	20 –22
Aajad	250 – 270	Uttar Pradesh	18 – 20
Malaviya Arhar 6	178 – 262	Uttar Pradesh	20 – 22

Land preparation: The land may be prepared as for most of the *kharif* legumes keeping in view that there are no bigger clods, established weeds and left over stubbles of the previous crop. The field should be thoroughly leveled so that there is no accumulation of water in the field.

Sowing: Treated seeds of suitable variety having high germination and high real value should be selected for sowing the crop. In irrigated condition the crop should be sown by giving one pre-monsoon irrigation at least a fortnight earlier than the first shower so that plants are well established during rainy season, however, under rainfed conditions the sowing may be done immediately after rains have started.

Thus in no case the sowing should be delayed beyond last week of June. In case of *diara* lands which are prone to flood, the sowing should be done by mid of September. Line sowing by seed drill or *malabasa* at a depth of about 7-10 cm using a row to row spacing of 60-75 cm and plant to plant 15-20 cm is always better than broadcasting. About 10-15 kg high quality seed would be sufficient for one hectare area but it depends on variety and sowing time. At Kharagpur, 15th October was optimum for planting *rabi* pigeonpea. Advance planting of pigeonpea in May at Ludhiana reduced 18% grain yield on loamy sand soil (Rana and Malhotra 1993). Low plant population is one of the major constraints for low productivity of pulses under rainfed conditions. Several studies under All India Co-ordinated Pulses Improvement Project have shown that the grain yield of pigeonpea had an optimum population. In case short duration pigeonpea, 15-16 plants m², in case of pigeonpea 20-30 plants m² for timely sowing and 30-40 plant m² for late sowing were found optimal under northern Indian conditions. Higher seed rates reduced nodulation.

Nutrient Management: As a practice the pigeonpea crop is grown on marginal and sub-marginal lands of poor soil fertility status due to which the yield is found to be so poor that it does not give much profit. The crop is heavy feeder but due to symbiotic bacteria present in the root nodules, most of the required nitrogen is fixed from atmosphere, however, it needs heavy doses of phosphate. The crop grown from inoculated seeds needs lesser quantity of nitrogen as the plants emerged from treated seeds are well nodulated hence they have high nitrogen fixing capacity than the plants grown from untreated seeds.

Adequate and balanced supply of plant nutrients is a prerequisite for achieving and sustaining higher productivity. Pulse crops are energy rich crops and remove sizable quantity of nutrients from the soil. A crop of pigeonpea producing 1.2 tonnes seed ha⁻¹ removes 85 kg N, 8 kg P, 16 kg K and 9 kg S per ha. Because of low soil fertility and continuous nutrient depletion in soils, pulses now respond to external supply of nutrients. In northern region, pulses respond up to 40 kg P₂O₅ ha⁻¹ significantly, but in some cases the response had been up to 75 kg P₂O₅ per ha. Significant increases in yield of legumes to basal application of 20-30 kg N ha⁻¹ have been reported for several legumes (Tandon 1992). These experiments have been conducted mostly on low N soils. In general, N levels reduce nodulation and nitrogen fixation. Thus, high use of N annually seems to be making soils unfit for harnessing BNF. Alternatively, it may need legume varieties whose BNF system can tolerate high concentration of soil N. The organic N in legume residues, especially roots, can act as slow release N fertilizer to increase N use efficiency.

Optimum fertilizer schedule for pulses crops under dryland conditions of northern region

State/ region	Nutrient doses (kg/ha)	
	N	P ₂ O ₅
Bihar (Plateau), Haryana, Madhya Pradesh (Baghel khand), Uttar Pradesh	20	40-50
J & K	15	45
Madhya Pradesh (Malwa)	40	60
Uttar Pradesh (Bundelkhand), Semi arid		
South-West	10	40
Submontane	0	60-75

Source: Vittal *et al.*, 2003

Next to N, phosphorus is another nutrient element, which is critical for achieving good yields in dryland. There are numerous reports which have described the responses of P in dryland crops (Sharma and Das, 1992; Singh and Das 1995). Retrieval of P recommendation data generated by various centres of All India Coordinated Research Project for Dryland Agriculture (AICRPDA) show that out of 113 situations (28 locations), the quantities recommended (kg P₂O₅) were 15 – 30 kg in 35% cases, 30-45 kg in 56% cases and 45-60 kg P₂O/ha in 9% situations. Co @ 500 mg cobalt nitrate kg⁻¹ (Raj,1987) and 0.45 kg Mo ha⁻¹ as sodium molybdate increased seed significantly. In salt affected soils at Faizabad, application of ZnSO₄ 30 kg/ha corrected the nutrient deficiencies and further has shown to increase BNF and increase yields by four times (AICRPDA 2003a; 2003b).

Experiments on farmers' fields were conducted under All India Coordinated Pulse Improvement Project (AICPIP) have determined the response of pulse crops to applied P. In pigeonpea + groundnut intercropping, when both crops received 17 kg P/ha, productivity was higher than that of sole crops (Pareek and Turkhed 1991). Since most of the soils are rich in K, response to applied K is either low or absent. Some benefit /cost ratios for pigeonpea in various states are given.

Economics of fertilizer use in pigeonpea

State	Benefit-cost ratio		
	N	P ₂ O ₅	K ₂ O
Andhra Pradesh	16.5	8.1	12.0
Gujarat	14.6	4.5	6.5
Karnataka	7.5	4.5	3.9
Madhya Pradesh	9.9	7.0	3.3
Orissa	17.9	6.4	6.5
Rajasthan	12.2	6.6	1.1

Wani *et al.*

The benefit cost ratios for pigeonpea in various agro-climatic conditions to P application follows.

Benefit-cost ratio of P application to pigeonpea

Location/ soil type		Response level of P (kg P ₂ O ₅ ha ⁻¹)	Yield response kg ha ⁻¹	kg seed per kg P ₂ O ₅	Benefit: Cost ratio
Pigeonpea					
Hisar	Inceptisol	80	370	4.6	3.5
Bhopal	Vertisol	90	110	1.2	0.9
Ranchi	Alfisol (low P fixing soil)	60	590	9.8	7.5
Kalyani	Alfisol (High P fixing soil)	105	410	3.9	3.0

(Ganeshamurthy *et al* 2003)

The sulphur deficiency is more pronounced without the use of sulphur through fertilizer. Pigeonpea responded to 40 kg/ha sulphur. Results of coordinated trials of AICPIP and concluded that gypsum, pyrites and single super phosphate are almost identical as source of sulphur (Ali and Singh 1995). Genotype variation to susceptibility to deficiency of micronutrients has been observed (Ahlawat and Ali 1993). For raising an ideal crop it is required to apply about 25-30 kg N, 50-75 kg P₂O₅, 30 kg K₂O (if the soil is poor in K) and 10-15 kg ZnSo₄ in one hectare area. The entire dose of fertilizer should be basal placed at a depth of 12 to 15 cm or 7 to 10 cm below the seed layer in the same row. The legume-Rhizobium symbiosis is a highly integrated and, to a considerable degree, self-regulating process. It is particularly sensitive to such environmental influences as drought, salinity, and extremes of temperature, more so than rhizobia growing alone. All the stress factors impair the development of root hairs and the site of entry of rhizobia into the host, resulting in poor nodulation or even absence of nodules. Salinity and high temperature affect nodulated plants more than nitrogen-fertilized plants. Existing knowledge on the effects of stress factors on symbiotic nitrogen fixation has been derived mostly for legumes other than pigeonpea, future research may concentrate on this gap.

Intercropped legume made available N to associated non-legume through decaying roots and nodules and by direct transfer (Patra *et al.*, 1986). Medium duration pigeonpea variety intercropped with sorghum reduced N need of sorghum by 50 per cent (Adu-Gyamfi and Ito, 1997). Rego and Burford (1992) reported that a grain legume intercropping system (cowpea/ pigeonpea) benefited the succeeding sorghum crop to the equivalent of 40 kg fertilizer N ha⁻¹ for 8 years, while a sorghum/ pigeonpea intercropping increased

soil N content benefiting equivalent to 25 kg fertilizer N ha⁻¹, respectively. Residual effect of preceding legume on cereal yield in terms of fertilizer N equivalents are 40, 30 and 20-67 kg/ha after pigeonpea (Wani *et al.*, 1994). Upland rice + pigeonpea, and pigeonpea + okra are a few of the intercropping system catching up in rainfed rice belt (Vittal *et al.*, 2003).

Large genotypic variation for BNF trials has been reported for pigeonpea (Kumar Rao 1990). Growing legumes in rotation does improve mineral N content in soil as compared with the cultivation of non-legume crops (Wani *et al.* 1995). Estimates of the amount of N₂ fixed by pigeonpea were 7-235 kg/ha fixed N, 0.52-0.62 N harvest index, + 15 additional soil nitrate N kg/ha (Ladha *et al.* 1996). Symbiotic partnership between pulse crops and *Rhizobium* under best compatibility and crop management supplies approximately 80-90 per cent of total N required by the crop. However, the N contribution depends on the effectiveness of *Rhizobium* strains, its compatibility with the host, biomass accumulation of host, soil and environmental factors. Recent estimates indicated fixation of 3-330 kg N ha⁻¹ under different agro-climatic conditions. The pulses utilize majority of the fixed N for their growth, and also leave some residual amount of N in soil for the succeeding crops. In a Vertisol, pigeonpea ICPL-87 had 20 kg N ha⁻¹ residual effect of sorghum crop grown in the following rainy season, while ICP 1-6 had a residual effect equivalent to about 40 kg/ N ha. The beneficial effect of pigeonpea can also be leaf litter or deep rooting that might facilitate recycling of nutrients from deeper horizons like P. The root exudates may also solubilize iron phosphates. Short and long duration grown pigeonpea had very low nodulation but produced greater biomass in Inceptisols of Central India than in Vertisols and Alfisols of peninsular India. Furthermore, short duration pigeonpea was reported to benefit the succeeding cereal crop in a double-cropping system in that environment and the benefit was equivalent to an application of about 40 kg N ha⁻¹ (Johansen *et al.* 1990).

The beneficial effect of sole crop pigeonpea could be due to enhanced mineralization of legume residues and/or di-nitrogen fixation increasing the N available for carry over to subsequent crops. Although the mechanisms underlying this beneficial effect have not been clarified, the considerable amount of leaf fall from pigeonpea, reported to be able to provide 30 – 40 kg N ha⁻¹, could be a contributing factor. Although, the amount of leaf fall was not measured, it was less in intercropping than in pure stands. Even larger inputs of residual-N from the legume would have been obtained if shoots had been returned to the soil after harvest. The other likely benefits include increased availability of nutrients other than N (through increased total soil microbial activity and/or increased activity of such specific groups of micro-organisms as vesicular Arbuscular mycorrhizae or plant growth promoting rhizobacteria), improved soil structure, enhanced level of growth-promoting substances, and reduced pest and disease incidence. The extent of these benefits is dictated by site, season, and crop sequence. However, a legume-based rotation is generally more sustainable than a rotation without a legume. Extra yield from a rotation can result from:

- Increased availability of nutrients other than N such as K, Ca, magnesium, Zn, S, and Fe through increased soil microbial activity, deep rooting, and root exudates (Wani *et al.* 1991).
- Improvements in soil structure, mainly soil aggregate formation following legumes (Latif *et al.* 1992);
- Improvements in soil water-holding and buffering capacity with incorporation of legume residues (Buresh and De Datta 1991).
- Growth promoting substances in legume residues (Ries *et al.* 1977).

Soil and water conservation: It is of primary importance for increasing the rain water use efficiency. First step towards water conservation is bunding the fields on grade. Bunding is beneficial in increasing the yields of pigeonpea. As an *insitu* soil and moisture conservation practice deep ploughing residue incorporation and conservation furrows play an important role. Mulching of the pigeonpea after maize in maize + pigeonpea intercropping conserve soil moisture and helps in increasing the grain yields. In the watersheds the live barriers as vetiver was found to be effective in soil and water conservation. This also helps to increase yield of pulses from the micro watersheds (AICRPDA 2003). Soil and water conservation measures viz., bed configuration improved the yields of various pulse crops. Pigeonpea yields improved to the tune of 40 per cent with raised bed at 2.7 m width as compared to flat bed system in North - west plain zone (Ali 1995). In rainy season, legumes especially pigeonpea, plant population is often vitiated due to water stagnation or poor drainage.

Irrigation: The crop is mostly grown as rainfed but one light irrigation (5cm) between flowering and pod filling stage increases the seed yield. In the event of drought or under aberrant weather condition the crop needs life saving or protective irrigation which is in addition to those mentioned earlier.

Interculture: The crop plants grow very slowly during their early growth period of 45-50 days and the crop suffers from a severe weed infestation which causes a drastic reduction in grain yield. Therefore, it is advisable to keep the field free from weeds and a weed free condition may be achieved by giving two hand weedings once about 25-30 days and another about 45-50 days after sowing of the crop. Where hand weeding is not possible use of Lasso (Alachlor) at the rate of 3.0 kg/ha as pre-emergence or Basaline at the rate of 1.0 litre/ha as pre-sown incorporation in soil may be done. By using herbicides the field will be weed free upto 50 days of sowing and least damage to the crop will take place. In early stages of crop growth, legumes are poor competitors to weeds and consequently suffer heavy yield losses. Studies under AICPIP during 1983-85 revealed high loss of 0.65 t ha⁻¹ (44%) in pigeonpea over weed free plots. Among various practices, pre-emergence application of Pendimethalin at 1.0 – 1.5 kg ha⁻¹, Metachlor at 1.0 to 1.5 kg ha⁻¹ and pre-plant incorporation of 1.0 kg ha⁻¹ Fluchloralin were effective in controlling seasonal weeds in northern India (Ali 1994b). High doses of herbicides adversely effects nodulation. Cowpea followed by greengram is efficient in smothering weeds.

Insects and pests management:

There are several insects which are found to attack the crop like pod borers, tur pod fly, plume moth, hairy caterpillar, leaf hopper, bean fly, etc., but the pod borers are found to cause a considerable loss to the crop.

Medium & late pigeonpea

- i) Pod borer (*Helicoverpa* = *Heliothis armigera*)
- ii) Podfly (*Melanagromyza obtusa*)

Early Pigeonpea

- i) Pod borer (*Heliothis armigera*)
- ii) Spotted pod borer (*Maruca testulalis*)
- iii) Pod fly (*Melanagromyza critica*)
- iv) Leaf tier (*Eucosma critica*)

Pest other than pod borers

Termites: Soil application of 25 kg BHC 10% dust at sowing time.

Aphids: Spraying with 0.05% Malathion (1 ml of 50 EC/l) or 0.03% Phosphomidon (0.3 ml of 100 EC/l) or 0.03% Dimethoate @ 600 to 1000 L/ha.

Thrips: Spraying with 0.04% Monocrotophos or 0.03% Methyl demeton (1.1 ml of 25 EC/l) or Fenthion (1.1 ml of 25 EC/l) @ 600 to 1000 L/ha.

Hairy Caterpillars: Spraying with 0.05% Quinalphos (2 ml of 25 EC/l of water) or dusting with Methyl-parathion 2% dust, Carbaryl or BHC 10% at 25 to 30 kg/ha.

Weevils and beetles: Spraying with 0.05% Malathion or 0.15% Carbaryl (4 g of 50 WP/l) or 0.05% Dichlorvos (0.5 ml of 100 EC/l) or dusting with Malathion 5% dust or BHC 10% dust or methyl-parathion 2% dust or Endosulfan 2% at 25 to 30 kg/ha.

Pod bugs: Spraying with Endosulfan (0.07%) or Malathion (0.05%) or dusting with insecticides mentioned for weevils and beetles.

Leaf tiers and binders: Spraying with Monocrotophos 0.04% or Quinalphos 0.05% or Dichlorvos 0.05% @ 600 to 1000 L/ha.

Nematodes

- Pre-emergence application of Pendimethalin @ 1 - 1.25 sq/ha has been proved highly efficient in controlling seasonal weeds
- By using sex pheromone trap monitoring of population build up pattern and peak activity of *Helicoverpa armigera* is possible for timely application of insecticides and control measures

Most of the insects or almost all of them can be killed by spraying of 0.2 to 0.3 percent solution of Endosulfan 35 EC or Nuvacrone 40 EC soon after they are visible in the field. The spraying should be repeated for their complete control and if needed a higher concentration of 0.4 or 0.5 per cent may be used for spraying.

Damage to plants by pests and disease both above ground and underground have deleterious effects on plant growth. In pigeonpea excessive nodule damage was caused by a Dipteran larva (*Riverllia angulata*) in farmers' fields. There are as many as 150 species of insects attacking different pulse crops in India. Of these, pod borer complex comprising of chickpea pod borer (*Helicoverpa armigera*), pod fly (*Melanagromyza obtusa*) and plume moth (*Exelastis atomosa*) cause considerable losses in the yield of pigeonpea. Several microbial pathogens are known to infect the larvae of *Helicoverpa* sp. Infecting pulses. However, Nuclear Polyhedrosis Virus (NPV) has been the only pathogen extensively studied for its physico-chemical characteristics, pathogenicity, mass-production and persistence on foliage, soil and effect of host plants. Several adjuvants have been screened for increasing its effectiveness. The NPV has been found compatible with botanicals like neem seed extract, neem oil, and methanol extracts of *Ocimum sanctum*, *Acorous calamus*, *catharanthus rosues* and Monocrotophos. Virus infection resulted in reduced parasitization by *Campoletis chloridae* under laboratory conditions however; under field conditions there was no adverse effect of virus application on percent parasitization by *C. chloridae* on chickpea. *Carcelia illota* a predominant parasite of *H. armigera* on pigeonpea was also not affected. Three sprays of NPV @ 250 LE/ha were found to give good control of *H. armigera* on pigeonpea while two sprays of NPV @ 500 LE/ha were equally effective as Endosulfan 0.07% on chickpea. Application of NPV with adjuvants like egg albumen (0.06%) and Tinopal (0.01%) increased the persistence and effectiveness of the virus. Spraying with knapsack sprayer or mist-blower was more effective than CDA. *Bacillus thuringiensis* (Bt) when used alone was not effective in controlling the pest. However, a combination of Bt with NPV and Endosulfan at reduced dosages was found promising in controlling the pest. For the control of *Helicoverpa armigera* (pod borer) in pigeonpea, neem seed kernel extract @ 2 to 5% and soil application of neem cake @ 150 kg/ha are recommended. Commercial formulation of bacteria (*Bacillus thuringiensis*) @ 1.5 to 2 kg/ha is recommended. The IPM module of sequential application of HNPV 500 LE/ha Endosulfan 0.075% and NSKE 5% with bird perches) and IPM module of sequential application of HNPV 250 LE/ha + NSKE 2.5%, Endosulfan 0.07% and HNPV 250 le/HA + NSKE 2.5% with bird perches were effective against lepidopteran pod borer recorded highest % reduction of larval population. Crop rotations break the cycle of cereal pests and diseases, and allelopathic effects of different crop residues (Francis *et al.* 1986). Crop rotation is an effective tool against certain pests and weeds.

Cultural Methods

To provide an effective and timely control of insect, preventive measures is use of pesticides is necessary. However, suggestions given below may also prove useful in suppressing the pest populations by manipulation of cultural practices:

- i) Sowing carried out earlier or later than the normal time of sowing result in more damage due to pests. Avoid such sowing or adopt pest control measures strictly.
- ii) Close spacings or high plant populations per unit area attract more pests. Therefore, dense or close planting may be avoided, wherever it is possible.
- iii) Ratoon or stray plants of pigeonpea become a major source of pest carry-over. They should be destroyed during the summer season.

- iv) For pests like blister beetles, grey weevils, brown bug, leaf tiers, hairy caterpillars etc. hand picking, jarring or bagging is effective, in a limited way.
- v) Deep ploughing of the fields in summer season is useful, as it would reduce the chances of pest propagation and Fusarium population.
- vi) Intercropping with sorghum (2:1 ratio) reduces wilt and insect incidence.

Biological Control

Nuclear polyhedrosis virus (NPV) has been found very effective for the control of *H.armigera* in pigeonpea crop NPV at 350 larval equivalent along with adjuvants + 0.035 %. Endosulfan (half the recommended dose) or alternate spray with NPV 350 LE and 0.07% of Endosulfan provides effective control of *H.armigera* larvae in the field.

Host Plant Resistance

- i. Grow wilt resistant/tolerant varieties:
NP (WR) 15, Sharda, DA 11 - NEPZ
BDN 1, BDN 2, ICPL – CZ 87119 (Asha), TT 6
ICP 8863 (Maruthi), ICPL – SZ 87119 (Asha), TT 6
- ii. Grow sterility mosaic resistant varieties:
Bahar, DA 11 (Sharad), T 9 – NEPZ
Hy3c, ICPL 87119 (Asha) – SZ
ICPL 87119 (Asha) – CZ
- iii. Grow Alternaria blight resistant varieties:
DA 11 (Sharad), T 9 – NEPZ

Chemical Control

Pest infesting floral buds, pods and seeds

The lepidopteran insects (*Heliothis armigera*, *Exelastis atomosa*, *Catochrysops cnejus*, *Lampides boeticus*, *Catochrysops strabo* and *Maruca testulalis*) first infest the floral buds and then the pods. The dipteran (*M.obtusa*), the coleopteran (*Callosobruchus* spp. and *Apion* sp.) and the hymenopteran (*Tanaostignoides* sp.) borer commence their activity with the beginning of the pod formation. The most essential part of measures to control pests is the timing of the control operation. First spraying should be done at 50% flowering/ pod initiation or when economic threshold level is reached i.e. one larva of *H.armigera* or 2 - 3 larvae of other lepidopteran borers per plant. To control these pests effectively, the use of the following is suggested. The spraying should be done @ 600 -1000 L/ha with hand sprayer and @ 200 - 300 L/ha with power sprayer.

- a) Neem seed kernel extract has been found effective against borer complex. To prepare the extract, take 1 kg pounded kernel and tie them loosely in a muslin cloth. Soak them in 20 liters of water overnight. Press and extract it thoroughly. Untie the cloth and remove the undissolved material. To this solution, add 200 gm. of ordinary soap and dissolve properly, leaving no particles and use the emulsion for spraying the crop at 10 - 15 day intervals.
- b) Spray the following at the rate of 600 - 1000 liters per hectare against respective pests:
 - i) **Lepidopteran borers** (pod borers): 0.07% Endosulfan (2 ml of 35 EC/liter of water) or 0.04% Monocrotophos (1 ml of 40 EC/liter of water), Fenvalerate or Cypermethrin.
 - ii) **Dipteran borer** (pod fly): 0.04% Monocrotophos or 0.03% Dimethoate (1 ml of 30 EC/liter of water).
 - iii) **Coleopteran borers** (weevils): 0.07% Endosulfan or 0.07% Chlorpyrifos (3.5 ml of 20 EC/liter of water).

- c) Dusting with Methyl parathion 2%, Quinalphos 1.5%, Malathion 5% or Carbaryl 5% dusts at 25 to 30 kg/ha is also effective but not superior to spraying.

Disease management

The crop mostly suffers from wilt, stem rot and sterility mosaic diseases. The wilt and stem rot may be controlled by using resistant varieties, providing well drained soil conditions and adopting a nice crop rotation. Using resistant variety may control the sterility mosaic and three to four spraying of Metasystox 0.1% solution when the mites (*Eriophyid mite*) start attacking the crop and first attacked plant is visible in the field.

- i) Seed treatment with Carbendazim + Thiram (1g + 2g/kg seed) or Carbendazim (2 g/kg) or Thiram (3 g/kg) reduces initial mortality due to wilt/ root rot.
- ii) Foliar spray of fungicide Mancozeb gives good control of Alternaria blight.
- iii) Seed treatment with Metalaxyl (Apron 6 g/kg seed) + ridge planting + cover crop (soybean in CZ, cowpea in NEPZ) effectively control Phytophthora blight diseases.

List of diseases resistant pigeonpea varieties

Variety	Resistant to
NP (WR) 15	Wilt
BDN 1	Wilt
BDN 2	Wilt
C 11	Wilt
Maruthi (ICPL 8863)	Wilt
Bahar	Sterility mosaic
WB 20 (105)	Alternaria leaf blight
HY 3 C	Sterility mosaic
Maruthi	Wilt
Asha (ICPL 87119)	Wilt and sterility mosaic
BSMR 736	Wilt and Sterility mosaic
Narendra Arhar 1	Sterility mosaic

Harvesting and Yield

A good crop of one hectare gives about 25-30 quintals of grains and about 50 to 60 quintals of sticks and 10 quintals of dried leaves in the form of bhusa. **The area, productivity, nature of degradation in the region and month wise rainfall is presented in Fig.1.** The total area under pigeonpea is about 3.6 m.ha. The rainfed area is 3.4 m.ha covering about 96% of total pigeonpea. Under pigeonpea, most of the area is in Madhya Pradesh, Maharashtra and Karnataka. The areas bordering UP, Punjab, Rajasthan, also covers considerable extent. The range of yield varies from 0.12 to 1.7 t/ha. Most of the area is under medium range of productivity (0.52 to 1.1 t/ha) with 1.74 m.ha followed by low productivity of 1.13 m.ha. The area under the crop is extending more in peninsular India due to its wide adoption as intercrop in a wide range of the cropping systems. Apart short duration pigeonpea is also catching up as a sole crop in many of the country.

In the pigeonpea region, the rainfall in high productivity area coincides with more rain especially from July to September. In the medium productivity area, rainfall has fallen short from high productivity area from July onwards. Under both of the productivity ranges, it was more or less same after the second fortnight of September. In the low productivity area, the amount of rainfall was low even though the duration was more than in the other regions. It can be expected that the additional rainfall received in high productivity

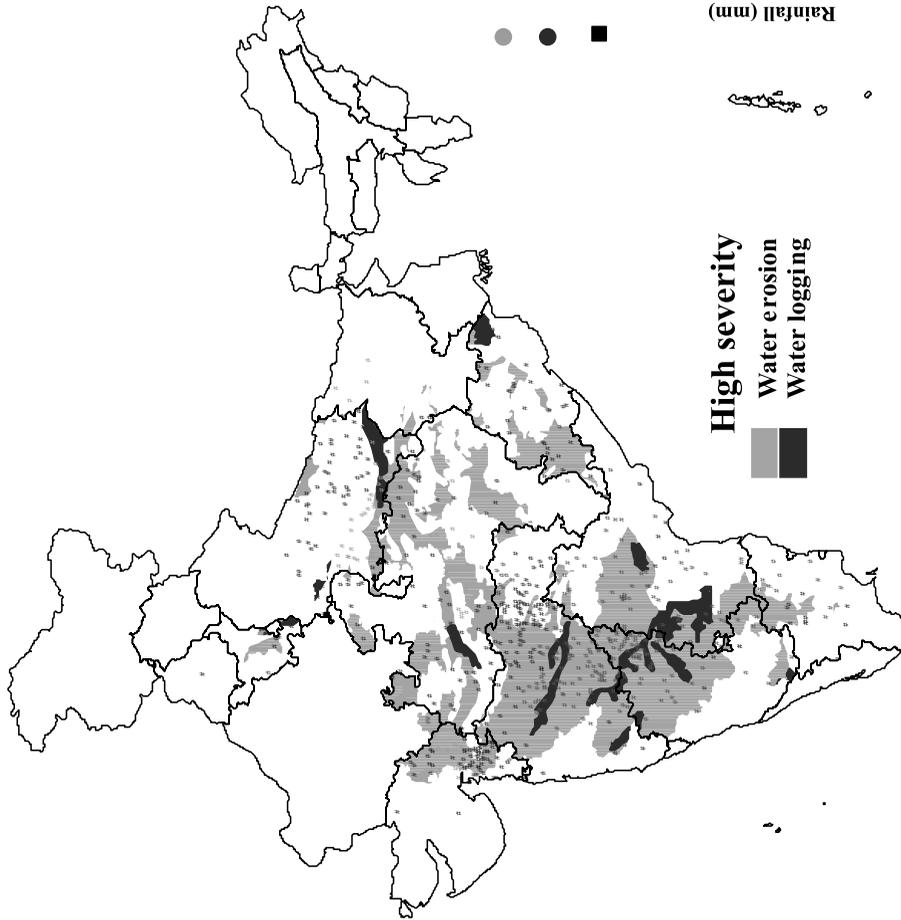
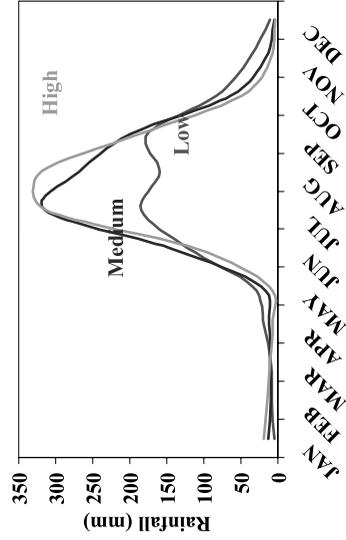
Pigeonpea

Area, Productivity,
Soil Degradation,
and Rainfall

Total Area 3.57 mha
Total Rainfed Area 3.42 mha
Rainfed Area 96%

Range kg/ha Rainfed

Yield	Max	Min	Area (mha)
High	1705	1128	0.37
Medium	1127	564	1.74
Low	563	106	1.31



Dot = 5,000 ha

area over other productivity regions helped in more vegetative expression during rainy season followed by flowering. In low and medium productivity areas, this benefit perhaps was lacking. Thus, supplemental irrigation from August onwards to match evapotranspiration demand would be beneficial to acquire more productivity. A water harvesting system linked to the production system for better water management can be thought of. In the high productivity areas even sole cropping would be advantageous to increase cropping intensity. In the low rainfall areas intercropping may be more advantageous for this deep-rooted plant.

In the water logged areas, drainage becomes more important especially in the black soils. Use of broad bed furrow system, cropping on ridges in ridge-furrow system and raised and sunken bed system may be advantageous. Contour cultivation may result in standing of water in the furrows. The cultivation should be on grade to overcome the drainage problem. There is a possibility of recycling the runoff storage by using efficient lifting devices. This water will be useful especially after cessation of monsoon to reduce flower dropping. In situ soil water conservation is more important in the severely eroded areas for avoiding further degradation. In shallow Alfisols of Anantapur, the residual effect deep tillage as *insitu* conservation measures was found to extend up to 3 years. For this widely spaced crop, small furrow and ridge system nearer to the row across the slope would be beneficial. Maintenance of ridges and furrows would also be advantageous, but requires continuous operations. Continuous tilling of the soil would incorporate the littered leaf mass spread of over the field from being carried away by wind. However, this operation would become difficult after cessation of monsoon when leaf drop starts. Implements are to be developed for incorporating soft leaf material into the soil under limited soil moisture. This not only adds organic matter, but also reduces the evaporation from soil surface apart from adding nitrogen. Growing of green-manuring crops always provides a canopy cover against unexpected rains in off seasons. In other areas, where degradation problems are not severe soil water conservation may be extended.

Tips for increasing Pigeonpea productivity

- Use of 20 kg sulphur/ ha has been found quite useful with nutrient use efficiency of 10-15 kg. Similarly pre-emergence application of Pendimethalin @ 1.0-1.25 kg/ha proved highly efficient in controlling seasonal weeds.
- Seed treatment with Captan (3g) or Thiram (3g) or mixture of Carbendazim + Thiram (1g + 2g) per kg seed assures better plant stand and protection against soil and seed borne diseases.
- Cultivating of 'Bahar' and 'Abhaya' (ICPL 332) is advised in south India while, medium maturing varieties like JA 3 and JA 4 should be preferred for cultivation in central India.
- Avoid cultivation of different maturity groups of pigeonpea in the same area.
- Intercropping of pigeonpea with sorghum, bajra and maize should be preferred as these crops after their early harvest provide the required gangway for undertaking the plant protection operations.
- North West Plain Zone (Western Uttar Pradesh): In this zone majorly early maturing pigeonpea varieties are recommended for pigeonpea & wheat rotation areas. The best time for sowing is Second fortnight of May to first fortnight of June is the best time.
- Northeast plain zone (Eastern & Central Uttar Pradesh): In this zone late maturing varieties are recommended under rainfed condition. In Uttar Pradesh, *rabi* pigeonpea is also grown.
 - Recommended sowing time
 - Early maturity variety: First fortnight of June
 - Late maturity variety: First fortnight of July
 - Rabi pigeonpea: First fortnight of September
- Central Zone (Gujarat, Maharashtra, Madhya Pradesh, Rajasthan & Chattisgarh): For this zone, Medium duration (maturing) varieties are recommended under rainfed condition. Recommended sowing time is July coinciding with rainy season.
- Southern Zone: (Andhra Pradesh, Karnataka, Tamilnadu & Orissa) :In South India, recommended sowing time is second fortnight of June coinciding with rainy season.

- Fertilizer management in pigeonpea based cropping system:
 - Intercropping in agriculture needs more attention while using fertilizers. If millets are intercropped with pigeonpea then recommended amount of fertilizers (60kg N + 40kg P /ha) should be used. In this situation pigeonpea does not need fertilizers separately. But in light and low fertile lands recommended amount of fertilizers (18kgN:45kg P: 20kg K: 20 kg S /ha) increases the productivity. In the irrigated lands, to intercrop the Blackgram or greengram with pigeonpea recommended amount of fertilizers should be used. In this half of the amount of Nitrogen, full phosphorus, potassium and sulphur at the time of sowing and remaining half of the amount of nitrogen should be used at the time of harvesting. To control weeds in intercropping in agriculture weeding should be done by kurpi after 40-45 days of sowing. Spraying with Pendimethalin @1kg/ha soon after sowing for effective weed control.

New niches for pigeonpea production

Crop situation	Region	Potential	Area coverage expected in IXth Plan
Area expansion			
Pigeonpea (Post-rainy season)	NEPZ, South Gujarat, A.P. and Maharashtra	1.0	0.1

Pigeonpea Varieties for non – traditional seasons

Crop/Variety	State
<i>Pre rabi</i> Pigeonpea	
Bahar, Sharad and Pusa 9	Bihar and U.P
WB 20 (105)	West Bengal
AS – 71-37	Maharashtra
BDN 1	Maharashtra
C11	Orissa
<i>Rabi</i> Pigeonpea	
LRG 30	Andhra Pradesh
C 11	Andhra Pradesh
Co 2	Tamil Nadu

Technology pays

Results of front line demonstrations under the All India Coordinated Pulses Improvement Project (AICPIP) during 1992-93 showed that with the component technology the mean yield of 37 demonstrations of pigeonpea with fertilizer management was 1.41 t ha⁻¹ as against 1.01 t ha⁻¹ with no fertilizer. Similarly, improved weed management recorded 1.52 t ha⁻¹ grain yield as against 1.28 t ha⁻¹ with traditional practice. Insect management technology alone resulted in a 56% increase in seed yield (Lal *et al.* 1994).

Effect of management technology on the productivity of legumes during 1992-93¹

Technology	Grain yield (t/ ha)			
	Number of demonstrations	Improved technology	Local technology	Increase in yield (%)
Fertilizer management	37	1.41	1.01	38
Weed control	20	1.52	1.28	26
Insect control	29	1.11	0.71	56

¹ All India Coordinated Pulses Improvement Project (Anonymous 2002)

Production constraints: A survey was carried out in 16 districts covering 320 farmers on resource technological, institutional, sociological and economic constraints (Maruthi Sankar 2003).

Soilwise Pigeonpea yield and constraints

Soils	Grain (t/ha)			Rainfall	Constraint (% farmers' response)			
	Small (<2 ha)	Medium (2-4 ha)	Large (>4 ha)		Plant Protection		Seed	Others
					Insects	Diseases		
Alluvial	1.27	1.60	1.50	8	26	32	25	17
Black	0.68	0.76	0.81	54	27	3	5	11
Red	0.52	0.59	0.68	52	27	5	-	16
Overall	0.78	0.89	0.92	36	34	9	11	10

Legumes have an important role as intercrops and sequential crops in sustaining the productivity of different cropping systems. A holistic system approach is a must for maximizing the benefits from BNF in legumes. High N₂-fixing legumes and cultivars should be selected for inclusion in the cropping systems. Appropriate soil and water management practices are sowing on ridges or broad beds for protecting from water logging, using scoops for light textured soils to increase water storage. To ensure good nodulation and N₂-fixation by legumes in cropping systems, farmers must use appropriate crop management practices, such as application of phosphatic fertilizers or other deficient plant nutrients, control pests and disease that may affect plant canopy and in turn photosynthate supply to roots, practice N-management in soil (e.g., use of slow releasing formulations, applying N to cereals only by placement, use of organic sources); and use need – based inoculations with good quality rhizobial inoculants. If returned to the soil, plant residues would help in increasing the soil organic matter content, and thereby increase the soil fertility. Through such an approach, benefits from legumes BNF can be maximized for improving or sustaining productivity of cropping system.

Some Prioritised cultural option for rainfed pigeonpea based production system are

State	District	Yield gap (%)	Prioritised Options	Average yield (kg/ha)	Expected yield (kg/ha)
Andhra Pradesh	Adilabad, Hyderabad, Kurnool, Mahaboobnagar, Medak, Nalgonda	79	Better adoption of improved package of practices including improved seeds	250	300 to 315
	Guntur, Rangareddy	55	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	540	625 to 650
Andhra Pradesh	Khammam	79	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	655	755 to 790
Chattisgarh	Rajnandagaon	21	Utilization of natural resources and improved management practices	940	1035 to 1080
Gujarat	Baroda, Bharuch	45	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	655	755 to 790

State	District	Yield gap (%)	Prioritised Options	Average yield (kg/ha)	Expected yield (kg/ha)
Gujarat	Sabarkantha, Surat	21	Utilization of natural resources and improved management practices	940	1035 to 1080
	Kaira, Panchmahals	0	Utilization of the available surplus water through suitable water management techniques	1405	1550 to 1620
Karnataka	Bijapur, Gulbarga, Raichur	79	Better adoption of improved package of practices including improved seeds	250	300 to 310
	Belgaum	67	Efficient utilization of available water through water harvesting for supplement irrigation, <i>In situ</i> water management and introduction of improved cultural practices to bridge the yield gap	395	475 to 495
	Bidar, Dharwad	55	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	540	625 to 650
Madhya Pradesh	Shahdol	67	Efficient utilization of available water through water harvesting for supplement irrigation, <i>In situ</i> water management and introduction of improved cultural practices to bridge the yield gap	395	475 to 495
	Khargone	55	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	542	625 to 650
	Betul, Dewas, Satna, Sidhi	45	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	655	755 to 790
	Raisen	38	Utilization of natural resources and improved management practices	740	855 to 890
	Bhind, Khandwa, Sehore	21	Utilization of natural resources and improved management practices	940	1035 to 1080
Maharashtra	Chhindwara, Hoshangabad, Narsinghpur	0	Utilization of the available surplus water through suitable water management techniques	1405	1550 to 1620
	Ahmednagar, Aurangabad, Beed, Parbhani, Sangli	79	Better adoption of improved package of practices including improved seeds	250	300 to 310

Districtwise Promising Technologies for Rainfed Pigeonpea based Production System in India

State	District	Yield gap (%)	Prioritised Options	Average yield (kg/ha)	Expected yield (kg/ha)
Maharashtra	Chandrapur, Jalna, Nagpur	67	Efficient utilization of available water through water harvesting for supplement irrigation, <i>In situ</i> water management and introduction of improved cultural practices to bridge the yield gap	395	475 to 495
	Akola, Amaravati, Buldhana, Dhule, Jalgaon	55	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	540	625 to 650
	Wardha, Yavatmal	45	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	655	755 to 790
Orissa	Bolangir, Dhenkenal, Kalahandi, Koraput, Phulbani	38	Utilization of natural resources and improved management practices	740	855 to 890
Tamilnadu	Vellore, Tiruvannamalai	55	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	540	625 to 650
	Dharmapuri, Salem, Azamgarh	45	Exploiting the surplus water through <i>in situ</i> rainwater management, improved crop management practices to increase productivity	655	755 to 786
Uttar Pradesh	Ballia, Hardoi, Jaunpur, Mirzapur, Pratapgarh, Rae Bareli, Sitapur, Sultanpur	21	Utilization of natural resources and improved management practices	940	1035 to 1080
	Allahabad, Banda, Etawah, Fatehpur, Hamirpur, Kanpur, Varanasi	0	Utilization of the available surplus water through suitable water management techniques	1405	1550 to 1620

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
<i>Blue panic</i>	<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
<i>Foxtail millet (Setaria, Italian millet)</i>	<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 x P. typhoides)</i> F1
Indian bean (Lablab)	<i>Lablab purpureus</i> (L.) Sweet
Indian rape (Toria)	<i>Brassica campestris</i> L.
<i>Indian squash melon (Tinda)</i>	<i>Citrulus fistulosus</i>
Italian millet (Foxtail millet, Setaria)	<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 (dew gram)</i>	<i>Vigna aconitifolia</i> (Jacq.) Marechal
Mustard (Raya)	<i>Brassica juncea</i> Coss.
<i>Napier Grass</i>	<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. <i>Triticale 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), Specclor (Southern Pesticides), Hiltaklor (Hindustan Insecticides), Trapp (Searle India), Delchlor (Coromandel Indag), Bilchlor (Bayer)

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

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

CARBOSULPHAN 25% DS: Marshal (Rallis)

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

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

CYPERMETHRIN 25 EC: Cymbush (ICI-Zeneca), Ralothrin (Rallis), Cypersul (Sulphur Mills) Spec Cyperin (SPEC), Angel (Hyderabad Chemicals), Cyper Top (Thakar Chemicals), Trofy 25 EC (Searle India), Cypercine (IOCL), Challenger (Tropical Agro), Cypermil (Montari), Cyperguard (Gharda Chemicals), Polytrin (Novartis), Cyproid (AIMCO), Clicord (De'Nocil), Colt-25 (Pesticides India), Volcyper (Voltas), Shakti (Lupin), Basathrin (BASF), Hilcyperin (Hindustan Insecticides), Cybil (Bayer), Cyrex (United Phosphorus), White Gold (Newchemi), Panther (Bhaskar Agro Chemicals), Blaze (Indofil), Super Killer (Parry Chemicals), Starcip (Shaw Wallace), Super Killer (Dhanuka), Baadha (Sabero)

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

DICHLOROVOS 76 EC: Nuvan (Novartis), Vapona (De'Nocil), Suchlor (Sudarshan Chemicals), Specvos (SPEC), Dicotop (Thakar Chemicals), Amidos (AIMCO), Doom (United 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), Hilthoate (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 Chemicals)

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), Agrofene (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 (Rhone – Poulenc), 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), Sulmathion (Sulphur Mills), Specmal (SPEC), Agromala (Gujarat Agro), Malatop (Thakar Chemicals), Himala (Hindustan Insecticides), Malamar (Parry Chemicals), Luthion (Lupin), Malataf (Rallis), Maltax (AIMCO)

MONOCROTOPHOS 36% SL: Nuvacron (Novartis), Monocil (De'Nocil), Monovol (Voltas), Atom (Indofil), Sufos (Sudarshan Chemicals), Monostar (Shaw Wallance), 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 (Pesticides India), Agromonark (Gujarat Agro), Moncar (Bhaskar Agro), Azodrin (Cyanamid Inida), Hilcron (Hindustan Insecticides), Macrophos (Tropical Agro), Croton (Searle India), Balwan (Rallis), Monophos (Parry Chemicals), Monocron (NFCL), Corophos (Coromandel Indag), Bilphos (Bayer), Monosect (Agr Evo)

METHYL-PARATHION 50 EC: Metacid (Bayer), Parataf (Thakar Chemicals), Dhanumar (Dhanuka), Milion (Montari), Paratop (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 Wallance), Specphor (SPEC), Forcin (IOCL), Dhan 100 (Dhanuka), Milate (Montari), Granutox (AIMCO), Umet (United Phosphorous), Lumphate (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), Rilone (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), Ekatorp (Thakar Chemicals), Smash (Searle India), Chemlux (New Chemi), Shakti (E.I.D. Parry), Dhanulux (Dhanuka), Quinatox (AIMCO), Kinalux (United Phosphorous), Vazra (Lupin), Agroquin (Gujarat Agro), Basquin (Bhaskar Chemicals), Hilquin (Hindustan Insecticides), Tagquin (Tropical Agro), Quick (NFCL), Volquin (Voltas), Bayrusil (Bayer), Krush (Wockhardt)

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

THIODICARB 75% WP: Larvin (Rhone-Poulenc)

Fungicides

AUREOFUNGIN 46.15% SP: Aureofungin Sol (Hindustan Antibiotics)

CAPTAFOL 80%: Foltaf (Rallis)

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

CARBENDAZIM 50 WP, 5 Gr: Barvistin, Subeej (BASF), Zoom (United Phosphorous), Agni (EID Parry), Dhanusten (Dhanuka), Derosal (Agr Evo), Aimcozim (AIMCO), Bengard (De'Nocil), Hycarb (Hyderabad Chemicals), Calzin (Lupin), Benzin (Bhaskar Agro), Benfin (Indofil), Carzim (Lupin), Nirmool (Shaw Wallance), 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 Agrovat)

SULPHUR 85 W.P. & DUST: Sultaf (Rallis), Insulf (United Phosphorous), Dhanusulf (Dhanuka), Sulphosan (AIMCO), Thiovit (Novartis), Farmasulf (Shaw Wallance), 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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