an AICRPDA contribution

Improved Agronomic Practices for Dryland Crops in India

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

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About the Book ...

This updated ***"Improved Agronomic Practices for Dryland Crops in India"*** provides major findings made under the All India Coordinated Research Project for Dryland Agriculture, Indian Council of Agricultural Research. The recommendations reported some of the major agronomic findings by multi-disciplinary team(s) of scientists working in 21 research centers of the project located in diverse production systems from State Agricultural Universities and institutions of the Council. Many of these centers have Operational Research Projects and watersheds adopted in various programmes to provide effective feed back for refinement of technologies and to identify the socio-economic and operational constraints in the cycle of transfer of technology. The dryland agriculture research, about 32 years old, has resulted in considerable database on better soil moisture conservation and use, new cropping patterns/ cropping systems, crop life saving techniques, mid-season corrections in crop planning in the drought prone tract. New implements have been developed for different cropping systems. An effective drought code may be formulated for typical drought prone region under a crop based production system from these recommendations to help administration/ line departments to be ready for any weather pattern. Crop schedules can be developed for each of the situations. It could be appropriate to build seed, fertilizer and other buffers to organize community action to put into practice alternative crops schedules. Obviously the valuable tool will be holistic community management of the watershed for coping with the drought.

Cover page : Greening the grey areas

Designed by : I Ram Mohan and KVGK Murthy

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Improved Agronomic Practices for Dryland Crops in India

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May 2003

May, 2003

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FOREWORD

The All India Coordinated Research Project for Dryland Agriculture (AICRPDA) in association with State Agricultural Universities, Technical Universities and Indian Council of Agricultural Research Institutes has developed Improved Agronomic Practices for different agro climatic regions of India which can have the potential to double the crop yields on farmers' fields. The package of practices includes inter-alia improved seed, moderate levels of fertilizers and optimized management comprising low risk low cost technologies. The project further identified efficient crops for the agro ecological regions located in the Rainfed Agro ecosystem. Amongst them, groundnut in Ranchi Plateau, sorghum in black soils of the southeast Rajasthan, safflower in the Malwa Plateau, castor beans in west Rajasthan and in southern parts of India and fieldbeans for Deccan *rabi* region have proved promising. Alternate cropping strategies have been worked out over time and space. Suitable bullock drawn efficient implements have been developed for various cultural operations. With the technology that is made available by the project, it is now possible to mellow the effects of drought. First bulletin on Improved Agronomic Practices for Dryland Crops was published in 1979. Subsequently, second and third editions were published in 1981 and in 1983. In the present compilation, efforts have been made to incorporate all the important research recommendations to bring out a revised and updated version on agronomic practices for dryland crops including suitable alternate land use evolved at different centers for various crop based production systems. A few locally popular varieties from private sector are included. Soil and water management practices including water harvesting and use are also covered.

I am happy that the major findings made under AICRPDA have been put together in this publication for use of the extension personnel, farmers, non-governmental organizations and others. My gratitude is due to Dr.K.P.R. Vittal, Project Coordinator and all the scientists of the projects from various centers numbering 130 with a total staff strength of about 550 for their painstaking efforts in bringing out this compilation. I congratulate the staff of the project and the Coordinator wholeheartedly.

H.P. Singh
Director

27 January 2003

Contents

INTRODUCTION

Background and Functional Profile of All India Coordinated Research Project for Dryland Agriculture

The Green Revolution in mid sixties, though a boon to Indian agriculture, ushered in era of wide disparity between productivity of irrigated and rainfed agriculture. Alarmed by such a situation, the Fourth Plan (1969-74) specifically emphasized the urgent need for creating circumstances that would enable the hitherto neglected farmers of the dryland to participate meaningfully in the agricultural development process (Fourth Plan, 112p). This socio-economic imbalance led to a serious rethinking on inducting an in-depth network research program to stabilize the performance of the then introduced hybrids of coarse cereals in rainfed region and to moderate the periodic drought related adverse impact on total agricultural productivity. The droughts of mid sixties catalyzed further the process of vigorous efforts in dryland research establishment. The Indian Council of Agricultural Research (ICAR) rose to the occasion and formulated a comprehensive program on dryland research.

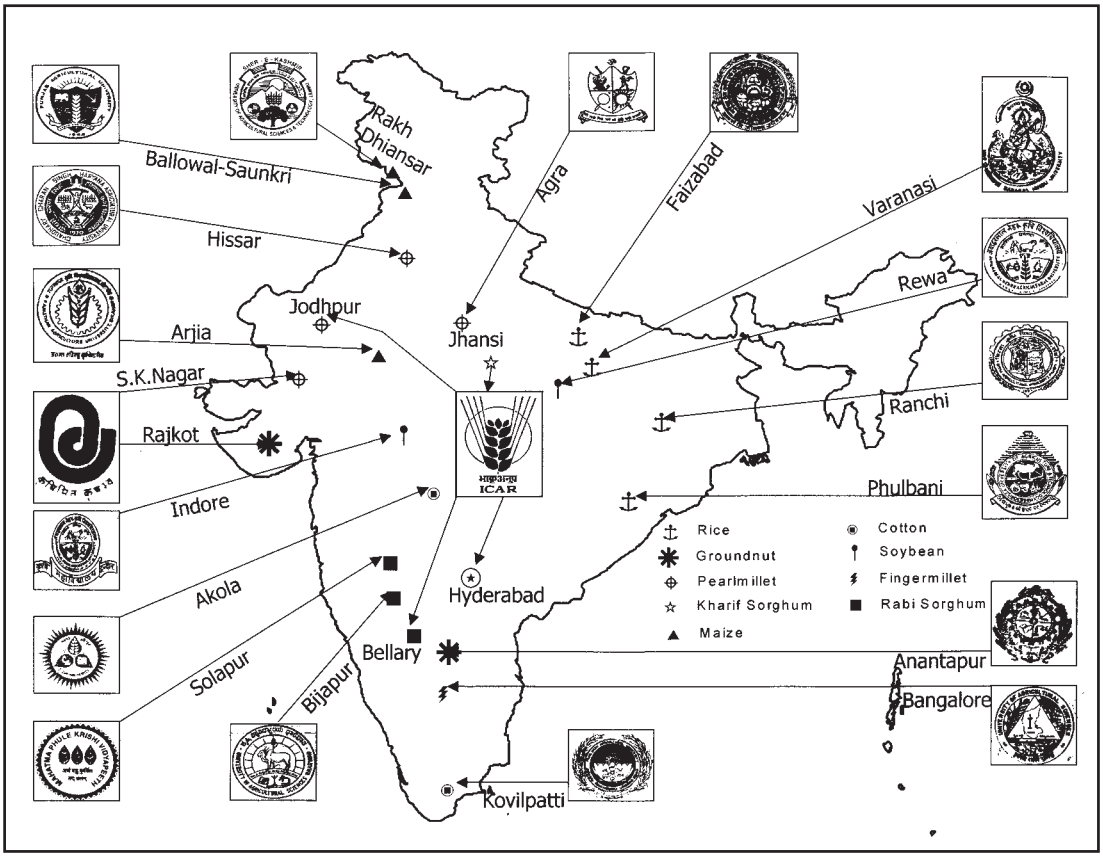
Project Features

In1969, the then Prime Minister Mrs. Indira Gandhi with strong aim for eradicating poverty evinced keen interest in dryland research and development programs. The dryland research project, originally proposed in 1967, was finally approved in 1969. All India Coordinated Research Project for Dryland Agriculture (AICRPDA) was launched in 1970 by the Indian Council of Agricultural Research (ICAR) in IV Plan period (vide ICAR letter No. 1-2/69-SC(1)/DF, dated June 18, 1970), in collaboration with the Government of Canada through Canadian International Development Agency (CIDA) with Co-ordinating Cell at Hyderabad, Andhra Pradesh. The project has seventeen main centers (one Chief Scientist, four Scientists and others totaling twenty two staff), two sub-centers (four scientists and others totaling fourteen staff) and eight operational research projects (three scientists and others totaling seven staff). There are three other centres in the institutes of the council. Apart, there is a co-ordinating cell. The total strength of project staff is more than 550 including more than 130 scientists. These centers are identified based upon moisture index.

The main centers were Hisar, Jodhpur, Bellary, Rajkot and Anantapur in Moisture Index 60-80%; Solapur, Akola, Kovilpatti, Hyderabad, and Varanasi in Moisture Index 40-60%; and Bangalore and Indore in Moisture Index 20-40%. The sub-centers were Udaipur (shifted to Arjia in 1985), Jhansi, Anand and Agra in Moisture Index 40-60%; Bijapur, Rewa, Ludhiana and Samba (Moisture Index 20-40%). The special problem areas were Bhubaneswar, Ranchi and Dehradun. Dehradun was discontinued in April 1985. Later on Anand was shifted to Sardar Krishinagar and Ludhiana to Hoshiarpur to Ballowal-Saunkhri and Samba to Rakh Dhiansar. Bijapur and Rewa were upgraded as main centers. One additional special centre was located at the Indian Agricultural Research Institute (IARI), New Delhi, which was merged, with the Coordinating Cell of the Project later. Faizabad was added as one of the centers in 1985. Bhubaneswar center was shifted to Phulbani in 1996.

At present, the project has seventeen centers in State Agricultural Universities, two in technical/ other Universities and three in ICAR institutes. These are Akola, Arjia, Anantapur, Bangalore, Bijapur, Hisar, Ballowal-Saunkhri, Indore, Kovilpatti, Phulbani, Ranchi, Rajkot, Rewa, Sardar Krishinagar, Solapur, Varanasi, Agra, Faizabad, Jammu, Bellary, Jhansi and Jodhpur, Eight of the centers have Operational Research Projects in villages. These are Anantapur, Arjia, Bangalore, Hisar, Ballowal-Saunkhri, Indore, Ranchi and solapur.

Network of AICRPDA Centres



The preamble of the project is **"Better Crop With Every Rain Drop".** The primary function is to improve and stabilize the crop production capability of dryland farmers towards a reduction of social vulnerability through drought planning. It covers the rainfed agriculture in its entity from arid to sub-humid through semi-arid climates. The project has several unique features compared to other projects. Some are:

- Only project to have started with a multi-disciplinary team with Agronomy, Soil Science, Soil Physics, Soil and Water Conservation Engineering, Plant Breeding, Agricultural Engineering etc. disciplines offering back up support to the developmental projects besides testing the technology in farmers' field
- With the need for location specific research obligatory due to diversity in natural resources and poverty, theme based systems, research was adopted in major agro climatic regions of the country in place of simple network of type experiments/demonstration adopted in other projects.
- Integrated Dryland Development Pilot Projects were started simultaneously and linked with this research network.
- Introduction of collaborative on-farm participatory research efforts in the Operational Research Project concept goes to the credit of the project. Self-evaluation is the main thrust for trusted feedback.

Mandate and Thrusts

The primary mandate assigned to the Project is to **improve and stabilize the crop production capability of dryland farmers** spread over the vast areas in the country. The objectives are-

- To optimize the use of natural resources, ie. rainfall, land and water, and to minimize soil and water loss and degradation of environment,
- To evolve a simple technology to substantially increase crop productivity and viability,
- To increase stability of crop production over years by providing improvements in natural resources management and crop management systems and alternate crop production technologies matching weather aberrations,
- To develop alternate and sustainable land use systems, and
- To evaluate and study transferability of improved dryland technology to farmers' fields.

In 1975, the scope of the project was enlarged to focus on transfer of technology through training of extension personnel and teachers of Krishi Vigyan Kendras (farm Science Centers) in innovative dryland technology. Another significant milestone in the field of dryland agricultural research was achieved by the start of the Operational Research Project (ORP) in 1974 with further expansions in 1976 and 1980 and 1984 to presently eight centers. The objectives are–

- To understand the strength and weakness in the traditional system of dryland agriculture,
- To evaluate the performance of each component of dryland technology under the farmers management conditions,
- To provide feedback to the research stations for refinement of unsuitable recommendations,
- To achieve a first hand working experience in the development of micro-watersheds so that they may serve as a model for extension agencies,
- To identify operational and institutional constraints in the transfer of dryland technology, and
- To provide consultancy services to the extension agencies for transfer of dryland technology.

In the ORPs, the scientists worked in the real farm situations. They demonstrated the economic viability, and feasibility of the recommended location specific technology. Feed back to research was an important conduit from the ORPs – eg. the need for striga resistant sorghum hybrids/ varieties, need for chaffing hybrid of sorghum stems for livestock feed, wilt in castor hybrids etc. Introduction and spread of *Stylosanthes hamata*, *Leucaena leucocephala,* dryland horticulture, agro-forestry based land capping etc. emerged out of these efforts. Soil moisture conservation practices on a small agricultural watershed including the development of water harvesting were also a result of the program. Another significant achievement was quantification of intercropping management.

The research program of the project is based on six major thrust areas viz., resource characterization, rainwater management, crops and cropping systems, integrated nutrient management, energy management, and alternate land use systems. These were to be achieved through the following programs:

- Identification of efficient crops and varieties for different agro-climatic regions,
- Screening available new crops/ varieties for introduction/substitution,
- Determining optimal crop geometry – population levels and planting patterns,
- Determining optimal fertilizer use levels and improving fertilizer use efficiency; reducing fertilizer amount with addition of organics,
- Developing crop sequences and intercrop system for increasing intensity of cropping/ stabilization of production,

- Evaluating tillage implements and practices for improving water intake and storage in the soil profile, better crop stand establishment and control of weeds including low till,
- Designing and developing animal drawn implements for speedy and efficient cultural and seeding operations,
- Evaluating the use of surface mulches for short term moisture conservation/retention,
- Harvesting and storing inevitable runoff and recycling it for "Life Saving Irrigation"
- Developing strategies for meeting aberrant weather with alternate crops and agroforestry, dryland horticulture, silvi-pastures etc., and
- Development of contingency practices for changing weather conditions.

These broad areas have largely remained focal points for both on-station research and ORP. However, in the ORP the major emphasis has been laid on crop demonstrations on farmers' fields at a later date.

Project Evaluation

The project was periodically evaluated. A few of the reviews done are -

- 1972 Travelling Seminar on Crop Life Saving Research organized by the ICAR with support from the International Development Research Center, Ottawa, Canada.
- 1976 Prof.S.C. Mandal Committee.
- 1977 Prof. Dwarakinath Committee.
- 1979 Sub-committee on Indo-Canadian Collaborative Project. of Dr.D.R. Bhumbla, Chairman, Dr.U.S. Kang, Mr.D.T. Anderson, and Dr.S.L. Chowdhury.
- 1980 CIDA Review Committee of Dr.L.H. Shebeski, Plant Scientist, Winnipeg, Leader, Dr.M.E. Andal, Agricultural Economist, Ottawa, Dr.H.H. Austman, Extension Specialist, Winnipeg; Dr.J.L. Dillon, Agricultural Economist, Armidale, Australia; an Mr.P.G. Ramachandran, Management Consultant, New Delhi as Members.
- 1982 First Quinquennial Review Team (QRT) of Dr. B.A. Chaugle and others.
- 1989 Second QRT of Dr.J.S. Kanwar, Dr.S.S. Prihar, Dr.P.D. Mistri, Dr.K.M. Nag and Dr.M. Velayutham.
- 1996 Third QRT of Dr. Ambica Singh, Dr.I.V. Subba Rao, Dr.R.K. Dutta, Dr.H.C. Sharma, Dr.N.K. Umrani, Dr. H.N. Verma, and Dr.J.C. Katyal.
- 2001 Fourth QRT of Dr.S.S.Khanna, Dr.H.C. Sharma, Dr.J. Venkateswarlu, Dr.M.V.R. Prasad, Dr. Veerabhadraiah, Dr.S.R. Singh.

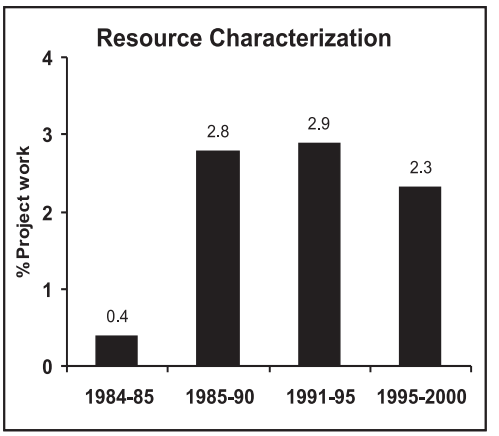
Besides, the AICRP is regularly monitored and evaluated on a continuous basis based on the set objectives and demands of the clientele.

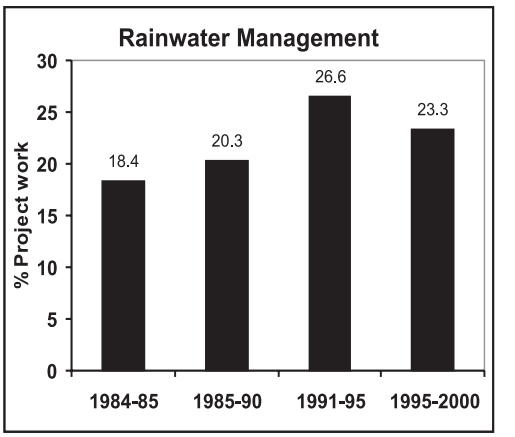
Changes in Thrusts Areas

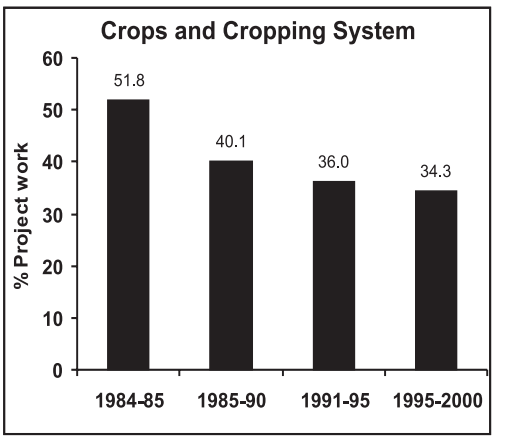
The research focus and emphasis was on six thrusts areas during 1985-2001. It is seen that the emphasis was more on crops and cropping systems which somewhat reduced after '85. Integrated nutrient management received more attention with time. In general, the rainwater management research also was on increase. The alternate land use systems found a place but are yet to receive significant attention. The emphasis on energy management received attention up to 90s. Resource characterization received marginal. The trends are depicted in the figure.

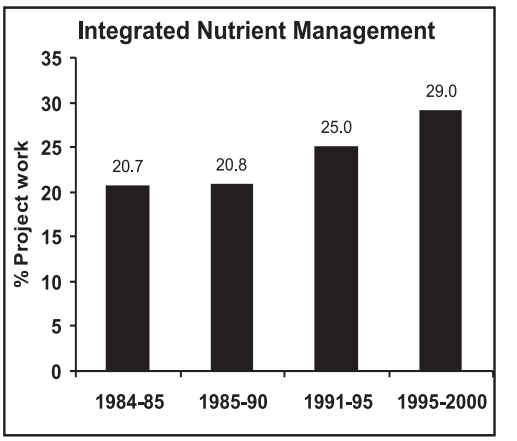
A Ranking Analysis of the thrusts and themes in various crop based production systems was carried out based up on the utilization of a scientists' time. The details on analysis are given in the following table:

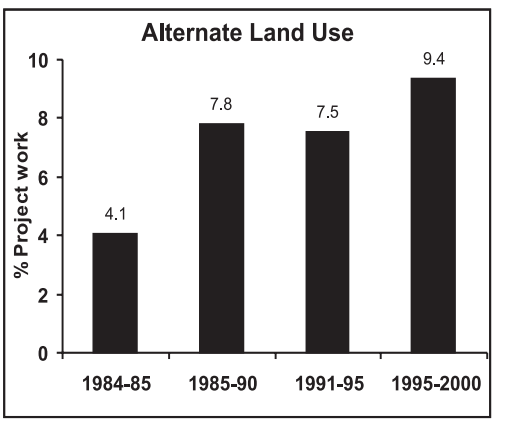
Changes in Thematic Areas during 1985-2001

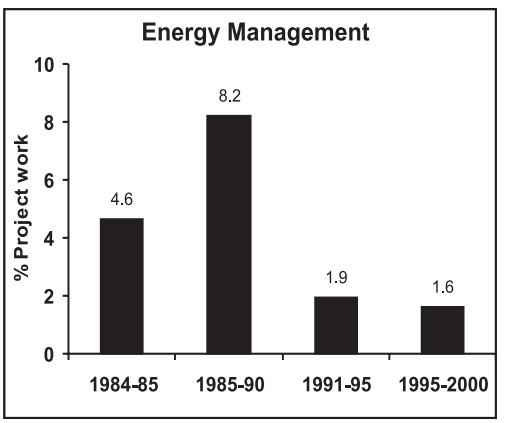












Program	Thrusts	Rank in a Production System								Ranking sum	% Work load over all production systems
		Rice	Ground-nut	Soy bean	Sor ghum	Pearl millet	Finger millet	Maize	Cotton		
1. Resource characterization		11	3				8		6	28	1.5
2. Water management	a) *In situ conservation*	6	3	5	3	3	5	6	3	34	8.1
	b) *Supplemental irrigation including water harvesting ponds, etc*	9	3	6		7	7	4	8	44	4.3
3. Crop(s) and Cropping System	a) *Crop improvement & Evaluation*	1	3	2	2	7	4	5	1	25	12.0
	b) *Agronomic Practices*	5	6	5	7	5	7	7	4	46	5.9
	c) *Inter/Summer cropping system*	4	7	4	8	6	6	3	3	41	7.0
	d) *Weed/Pests/ Disease management*	7	7	6	8	8	7	7	6	56	3.7
4. Soil Fertility and Nutrient management	a) *Major nutrients*	1	2	5	5	1	2	2	2	20	13.1
	b) *Secondary and micro nutrients*	9	5			11	8	9	8	50	2.0
	c) *Organics, bio-fertilizers, biota, etc.*	2	1	4	4	2	3	3	2	21	11.9
5. Alternate land use system	a) *Agro forestry*	10				9	8	7	8	42	1.8
	b) *Dryland horticulture*	8	6	6	8	10		8	5	51	3.0
	c) *Medicinal/Aromatic/ Spices etc*					10			7	17	0.5
	d) *Livestock*		8							8	0.1
6. Post-harvest Technology		7							7	0.2	
7. Energy management	a) *Animals*	11	8			9				28	0.9
	b) *Tractors*		6	6		10	8			30	1.0
	c) *Hand tools*	11								11	0.1
8. Socio-economics and policy		8							8	0.2	
9. On-farm work	a) *Operational Research Project/ watersheds*		7	1	1	3	1	1		14	11.6
	b) *Front Line demonstration*	3	4	3	6	4		3	4	27	8.5
	c) *KVK*			3		8				11	1.7

The proportion of the experiments during the last few years has been shifting more towards crops and cropping systems and integrated nutrient management on a template of resource management particularly rainwater management on watershed basis and field efficient implements. Emphasis on alternate land use systems for diversification of the livelihood security systems through horticulture, growing multi-purpose trees (MPTs) for fodder, fuel, green-leaf manure, botanical pesticides, etc., was increased. Collaborating efforts on medicinal and aromatic plants were considered. Among various themes, the on-farm work at operational research projects ranks top especially in soybean, *rabi* sorghum, finger millet and maize. The research on major nutrients is second, but tops in rice and pearlmillet. The work on organics, bio-fertilizers and biota etc. has maximum in groundnut being done. This is followed by crop improvement and/ evaluation with more work done in rice and cotton. Once again the frontline demonstrations occupy important role. The sixth rank went to rainwater *in situ* conservation. Intercropping, sequence cropping,

relay and mixed cropping systems occupy seventh rank followed by agronomic practices and water harvesting and recycling. The on farm research in the form of participation in KVKs ranks ten. Thus overall the on-farm participatory research work in the form of ORPs, Front Line Demonstrations (FLDs), and KVKs receives top most ranking followed by research on nutrient management, cropping systems and water conservation.

Impact Indicators

The visible indicator of achievement of the project is sound and efficient blending of increasing productivity, reducing cost of production and sustaining the growth by controlling degradation in a watershed mode. The project has since started on-farm location specific research, grew to backstop National Watershed Development of Rainfed Areas (NWDRA). Sound drought management strategies reduced land degradation and stabilized crop yields which to a certain extent reflected in contribution to the national food basket. The principles developed in network have laid a sound foundation to a new subject of science and art of Dryland Agriculture in the education front.

- Fertilizer cost can be reduced by 50% substitution with organics in almost all agro-eco regions
- At Anantpur, fertilizer cost was reduced with deleting phosphorus application as the soils have become rich in soil phosphorus.
- The ridger seeder of Hisar traveled from north to south and proved its capacity with the farmers.
- The water harvesting technology spread to more than four neighbouring districts for come-up irrigation of wheat in Rewa
- Straightening of gullies reduced the soil loss and improved reservoirs within the watersheds in Indore.
- The technologies on intercropping spread from Rajkot to different Agro climatic zones is heartening
- At Hisar, the improved *Tankas* provided anchor to the farmers who otherwise were migrating
- At Arjia, mixed cropping is providing not only yields, but also sustainable fodder.
- Rice + pigeonpea intercropping is spreading in uplands at Varanasi at fast rate.
- In Phulbani, a simple hoe, costing about Rs. 15/- had spread like wild fire among tribals.
- The land productivity model developed with cotton-soybean and other crops is gaining importance in the Akola-Yeotmal-Nagpur belt.
- Animal based farming systems with goats and other ruminants is likely to gain importance in time at Kovilpatti, Anantapur, etc.
- Groundnut in uplands was found to be successful but spread is limited by social problems at Ranchi.
- Faizabad is providing template for intercropping in rice for higher cropping intensity.
- Rakh Dhiansar is spreading blackgram (mash) in maize based production system and intensifying with agroforestry.
- Kovilpatti went far ahead with their traditional mandate of crop improvement of more than one century old, but found that the resource management and nutrient sprays of nitrogen and phosphorus, magnesium etc., improved the crop yields significantly which is widely accepted.
- Bijapur provided the sand mulching, compartmental bund and paired rows sunflower based cropping which received wider adoption and did well during drought.

- In Solapur, intercropping/ mixed cropping to evade pests, and soil testing in drylands is taking roots.
- A new orientation of more than three intercrops was made at Sardar Krishi Nagar in aridisols.
- A few nomograms developed are -
    - A sustainability index was developed to identify promising package of dryfarming practices for high and low rainfall areas
    - Past century-based rainfall variations were analyzed and need based future programs were identified.
    - Productive systems based on rainfall, soil and land capability with supporting soil and water conservation measures and nutrient needs were prepared.
    - A terminal/ mid/ early season drought management scheme was prepared for various production systems in different soils based on drought index.
    - Marginal and small farmer based high biomass producing agro forestry based models were formulated for drought proofing
    - Based on crop yield gap, runoff etc district-wise recommendations were identified
    - Fallow areas in *rabi* season were identified and productivity plans were prepared
    - Strengthening of ITK structures in water harvesting were proposed
- Advanced courses in curricula, post graduation and doctoral specialization are being offered by all most all SAUs. Non-agricultural universities are offering Dryland Agriculture as a Science subject as one of the optional at undergraduate level. Even technical Universities like Jawaharlal Nehru Technological University (JNTU), Hyderabad are offering courses and degrees in watershed management.

An Appreciation of Work

The Minutes of 11th Meeting of High Powered Price Monitoring Board (HPPMB) held on 5th December 2002 at 3.30 PM in the Cabinet Secretariat, Rashtrapati Bhavan, stated that -

> "The Chairman appreciated the presentation on Dryland farming in the country by DDG (NRM). He appreciated the efforts made by ICAR and observed that the dryland farming is an old problem. The presentation from ICAR contained details of aspects of dryland farming of oilseeds and pulses in different regions of the country, the present yields, additional inputs required and benefits of technology developed by ICAR to improve production and productivity. There is also a proposal to earmark Rs. 500 crore to Agricultural Universities to address the local issues of dryland farming. He summing up the discussion on Dyland farming desired that a workable plan, agreeable to Department of Agriculture, ICAR and Planning Commission."

Extension, Training and Other Collaborations

To take the message of the research and ORP's to more farmers in different areas, extension and other officers connected with development in the states were trained. Training programs were developed using an innovative methodology for Trainers' Training called "Farmer Oriented Approach" from inception. The training programs were also planned for farmers in Krishi Vigyan Kendras. These programs were need based and skill oriented. The project has wide linkages with watershed programmes. These centers also work in close collaboration with the respective state Governments, primarily providing the technical support on rainfed farming and watershed development etc. with national agencies, Australian Center for International Agricultural Research (ACIAR), International Crops Research Institute for Semi-Arid Tropics (ICRISAT) and others in international scene. The AICRPDA scientists are actively involved at the State Agricultural Universities (SAUs) in teaching and guiding new generations in rainfed agriculture.

In addition to the above work load, work is also going on in NATP projects. They are Rainfed Farming production system project on Indigenous technology in soil and water conservation, Mission Mode projects on land use planning in rainfed farming for resource management, and Mission Mode project on Mechanization in dryland Agriculture. There are several AP Cess Fund/ Department of Science and Technology, UK department of International Development (DFID), AP Rural Livelihood Project, and others with the centers. The centers also involved with on-farm watersheds with Government and Non-governmental agencies. Varietal trials of crop improvement projects of the council are also being tested under dryland conditions.

Rainfed Agriculture Scenario

In the absence of adequacy of water resources for irrigation, rainfed farming is practiced in nearly two third of the arable land (96 mha) in India. The gross cropped area of the country is 182 mha. Out of an estimated 142 mha net cultivated area, about 67% is rainfed. In this, 76 mha is under irrigation. The National Commission on Agriculture in 1976 predicted that even when the full irrigation potential is tapped by 2013 AD, over 50% of the arable land would continue to remain rainfed in the foreseeable future. So far much of the agricultural growth achieved in past decades occurred in irrigated areas. The potential for additional production gains in these areas may lessen with time from inherent problems. It is in the rainfed belt where cultivation of coarse cereals (91%), pulses (91%), oilseeds (80%) and cotton (65%) predominates. About 44% of the total production is contributed by rainfed region. Rainfed agriculture supports 40% of country's population. The rainfed areas are increasingly being warranted to help meet the raising demand for food, pulses, oilseeds, feed, fuel, fruits, vegetables etc. Thus, the country's economy depends on a sustained increase in the productivity from drylands.

In this context, the Indian Council of Agricultural Research (ICAR) brought out a first edition the "Improved Agronomic Practices for Dryland crops in India" by All India Coordinated Research Project for Dryland Agriculture in April 1979. This was subsequently updated and the second edition was published in December 1981. Because of the large demand of this publication from several quarters, this went out of stock towards the end of 1982. The revised third edition was brought out in October 1983.

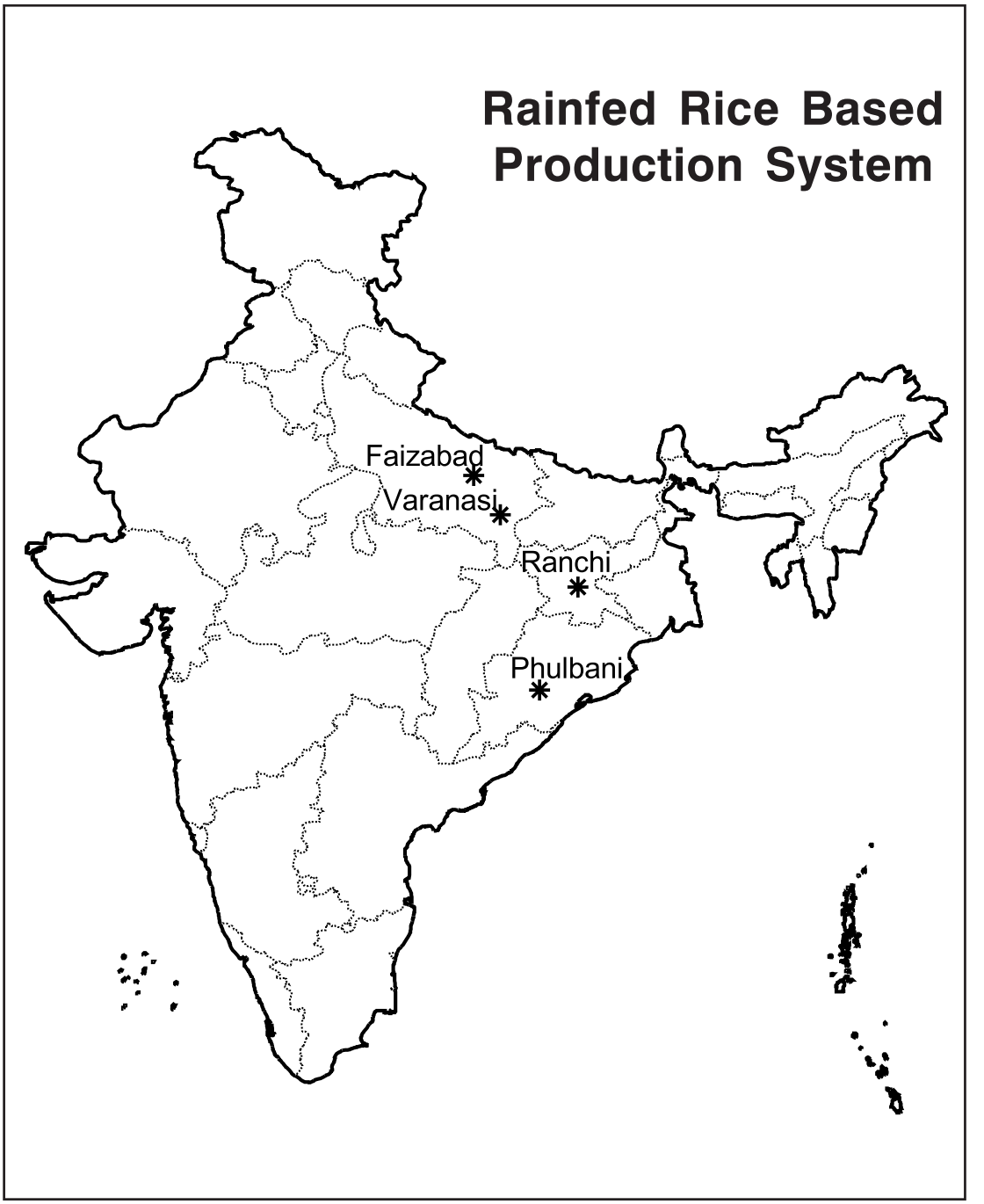
An effort was made in 2002-2003 to collate the available recommendations on the cropping systems. Agronomic practices including plant protection, contingency plans for aberrant weather conditions form suitable implements etc. It is hoped that the information contained in this fourth edition herein would be found useful by all the concerned agencies connected with the development of rainfed agriculture in various regions of the country. This technology will be utilized to mellow the effects of droughts and capitalize of good rainfall years (good season code) with such adaptation as may warranted by prevailing local conditions.

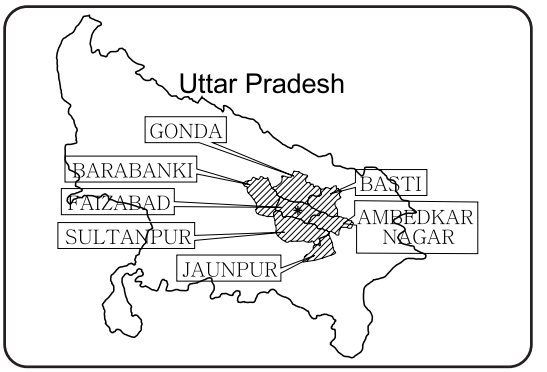
During the period of more than 30 years, the project has been provided leadership by several scientists. The Director, Central Research Institute for Dryland Agriculture (CRIDA) heads the project. The Project Coordinator looks after research coordination of this outreach program. The association of these leaders follows:

S.No.	Name	Duration	
		From	To
	Project Directors/Directors		
1.	Dr.Ch. Krishnamoorthy	21-10-1970	16-6-1978
2.	Dr.S.L. Chowdhury	17-6-1978	31-8-1979
3.	Dr.J. Venkateswarlu (I/C)	1-9-1979	28-7-1981
4.	Dr.R.P. Singh	29-7-1981	11-3-1985
5.	Dr.R.P. Singh	12-3-1985	31-3-1990

S.No.	Name	Duration	
		From	To
6.	Mr.C.K. Ramanatha Chetty, (I/C)	1-4-1990	3-9-1991
7.	Dr.J.C. Katyal	4-9-1991	10-3-1997
8.	Dr.Y.S. Ramakrishna, (I/C)	11-3-1997	26-11-1997
9.	Dr.H.P. Singh	27-11-1997	31-5-2003
	Project Coordinators		
1.	Dr.S.L. Chowdhury	1-2-1972	16-6-1978
2.	Dr.J. Venkateswarlu (I/C)	17-6-1978	27-11-1983
3.	Dr.S.P. Singh	28-11-1983	4-12-1988
4.	Dr.S.K. Das (I/C)	5-12-1988	9-2-1995
5.	Dr.T. Vishnumurthy	10-2-1995	30-6-1999
6.	Dr.Y.S. Ramakrishna (I/C)	1-7-1999	4-8-1999
7.	Dr.G. Subba Reddy (I/C)	5-8-1999	30-8-2001
8.	Dr.K.P.R. Vittal	31-8-2001	Current

Items 1 to 4 under Project Directors/ Directors were Project Directors. Items 5 to 9 were Directors.


Rainfed Rice Based
Production System
Faizabad
Varanasi
Ranchi
Phulbani



FAIZABAD

Rainfed Rice based Production System in *Kharif – Rabi* Sub-humid Deep Inceptisols

1. Region

Faizabad, Sultanpur, Gonda, Basti, Barabanki, Jaunpur, Ambedkarnagar districts of Uttar Pradesh.

2. Climate

Sub tropical zone having sub-humid climate receiving a mean annual rainfall of 984 mm. 85% of total rainfall is received during the monsoon period from June to September. Winter rains are unreliable. Winter season is cold with occasional frost. Period from March to May is generally hot and dry.

3. Soils

The soils are alluvial, silty loam and light brown in colour, slightly acidic to neutral and have saline patches. The soils are levelled and are on gentle slopes.

4. Crops and varieties

Crop	Varieties/ Hybrids	Yield potential (t/ha)	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Rice	NDR – 118	4.5-5.0	85-90	Resistant to blast and leaf spot	Suitable for direct seeding in upland rainfed
	NDR-97	5.0-5.5		Resistant to blast, leaf blight, seed rot and brown spot	Suitable for direct seeding in upland rainfed
	Baranideep	4.5-5.0	95-100	Blast resistant	Suitable for upland rainfed
Maize	Naveen	3.5-4.0	80-85		Suitable for sequence and intercropping system
	Jaunpuri	2.0-2.5	70-75		Suitable for sequence and intercropping system
Pigeonpea	T-21	1.6-2.0	160-170	Susceptible to wilt and pod borer	Suitable for intercropping system
	Narendra Arhar-1	2.5-3.0	260-270	Wilt resistant/ tolerant	Suitable for monocropping system
	Bahar		250-260		Suitable for monocropping system

Crop	Varieties/ Hybrids	Yield potential (t/ha)	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Sorghum	PKV-400	3.0-3.5	105-110	–	
	Varsha	2.5-3.0	125-130		
	UP Chari-1	40.0-50.0	60		Only for forage
Pearlmillet	Manupur	1.5-1.8	100-110	–	
	WCC-75	3.0-3.5	80-90		
	Rajkot	30.0-35.0	60		Only for forage
Blackgram	Narendra Urd-1	1.2-1.5	80-85	Resistant to mosaic	Suitable for *kharif* season
	T-9	1.0-1.2	85-90	Susceptible to mosaic	Suitable for *kharif* season
	Pant Urd-35	1.2-1.5	80-85		
Greengram	Narendra Moong–1	1.2-1.5	65-70	Tolerant to yellow mosaic	Suitable for late sowing in *Kharif* and Zaid
	Pant Moong–1	0.8-1.0	70-75	Tolerant to yellow mosaic	Suitable for late sowing in *Kharif* and Zaid
	Pant Moong–54	1.2-1.5	65-70	Resistant to yellow mosaic	—
Sesame	T-4	0.6-0.7	90-100	Susceptible to stem rot	Suitable for sequence and intercropping
	T-12	0.5-0.6	85-90	Susceptible to stem rot	Suitable for sequence and intercropping
Lobiya	T-2	1.4-1.6	130-135	–	–
	T-5259				
Groundnut	Chitra (MA-10)	2.5-3.0	125-130	–	–
	Kausal (G-201)	2.0-2.2	115-120	–	–
Safflower	N-62-8	2.5-2.8	160-165	Susceptible to *Alternaria* blight and *Rhizoctonia*	Suitable for sequence and intercropping
	IC-11842	2.0-2.5	155-160	Susceptible to *Alternaria* blight and *Rhizoctonia*	Suitable for sequence and intercropping
Chickpea	Radhey	2.5-3.0	150-155	Susceptible to wilt	Suitable for late sowing in rainfed condition
	K-850		145-150	Susceptible to wilt	–
	Avrodhi		150-155	Resistant for wilt	–
	T-3	2.0-2.4	160-165	–	Suitable for moisture retentive soils
Pea	Rachana	2.0-2.5	130-135	Resistant to powdery mildew	–
	Aparna	2.5-3.0	125-130	–	Dwarf variety
	Malviya Pea–2	2.0-2.5		–	–

Crop	Varieties/ Hybrids	Yield potential (t/ha)	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Lentil	Plant L-639	1.8-2.0	135-140	Resistant to rust	For sequence and intercropping
	Narendra Masoor	2.0-2.5	120-125	Resistant to rust and root	For rainfed and irrigation
	Priya (DPL-15)	2.0-2.2	135-140	–	–
Mustard	Varuna	2.0-2.5	125-130	–	For rainfed and irrigation
	Narendra Rai-1	2.0-2.5	120-125	–	For saline and alkali soils
	Vaibhav	1.5-2.0	125-130	–	For rainfed conditions
Linseed	Sweta	1.0-1.5	130-135	–	Only for rainfed
	Garima	1.6-2.0	125-130	–	For rainfed and irrigated
	Shubhra	1.3-1.5	130-135	–	For rainfed and irrigated
Wheat	Atal	2.0-2.5	130-135	–	–
	C-306	2.0-2.5	140-145	–	–
	Mahar (K-8027)	3.0-3.5		Resistant to smut and blight disease	For eastern Uttar Pradesh
Barley	Narendra Jau–1	3.5-4.0	110-115	–	For saline alkaline soils
	Narendra Jau–4	3.5-4.0	110-115	Resistant to rust and strip disease	For rainfed
	Lakhan	3.5-40	110-115	Slightly resistant to strip disease	For rainfed

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Rice/ wheat/ barley	100	30	Thick sown
Chickpea	80	45	10
Blackgram/ greengram	15	30	—
Maize	15	60	20
Safflower	15	45	10-15
Mustard	5	45	10-15
Pearlmillet	5	45	10-15
Lentil	30		

6. Nutrient management

Crop	Nutrients (kg/ha)					Mode of application	Remarks
	N	P_2O_5	K_2O	S	Zinc		
Upland rice	80	*	*	—	—	During *kharif* place 1/2 N as basal in seed furrows and remaining 1/2 top dress when surface is moist (30 to 40 days after seeding). In *rabi* place fertilizer 10 – 15 cm deep in the seed furrows	Apply P_2O_5 and K_2O on soil test basis to these crops
Barley	60	*	*				
Wheat	60	*	*				
Chickpea	0	40	*				
Sesame	40	*	*				
Mustard	40	*	*				
Safflower	40	*	*				
Linseed	40	20					

Crop	Nutrients (kg/ha)					Mode of application	Remarks
	N	P_2O_5	K_2O	S	Zinc		
Linseed (Garima)	30	–	–	–	–	–	–
Lentil	–	30	–	15	–	–	–
Mustard	60	–	–	40	–	–	–
Sorghum	60	40	30	–	–	50% N at sowing and 50% at 40 days after sowing	–
Chickpea	–	60	–	–	25	–	–

** In upland rice use of Agromin (chelated micronutrients) 0.16% solution spray when crop is about 45 days old helps in increasing yield.*

7. Pest and disease management

Weed management – mechanical

Keep upland rice fields weed free for the first 30 to 45 days followed by either mechanical or chemical control measures.

Crop	Time of operation	Implement/tool	Remarks
Upland rice	10 – 40 days after sowing	Hand weeding or mechanical with sweep hoe/dryland weeder	Keep the field free of weeds in the first 40 days. Work 2 to 3 times

Weed management – chemical

Crop	Herbicide	Mode of application
Upland rice	Lasso or Machete + Stam F-34 4.5 + 6 to 7 l/ha	Pre emergence + post emergence at 21 days after sowing

Insect pest management

Crop	Pest	Control measures
Kharif		
Rice	Stem borer	Dusting of Furodon 15–16 kg/ha 30 days after sowing is recommended.
	Ghundi bugs	Dusting of 10% BHC 15 kg/ha at the time of heading controls Gundhi bugs
	Armyworms	Folidon 15–20 kg/ha at heading stage (after sunset).
Pearlmillet and maize	Stem borer	Broadcast Lindane (6%) 20 kg/ha
Rabi		
Wheat and barley	Insect pests	Mixture of 2 kg/ha Diathane Z-78, or 1 kg. Diathane M–45, and 75 g Agrimycine dissolved in 1000 l/ha water sprayed after 30–40 days sowing
Chickpea and Lentil	Pod borers	Spray of 250 ml Dimecron or 1.5 l Thiodon in 1000 l/ha water at the time of flowering and at pod formation is recommended
Mustard, linseed and safflower	Insect pests	Two sprayings of 250 ml Dimecron in 1000 l/ha water, at intervals of 15 days starting with flowering stage, if the weather is cloudy one additional sparying should be done

Disease management

Rice	Blight disease	Spray mixture of 75 g Argimycine 2 kg Diathane Z-78 and 1.0 l Thiodon dissolved in 1000 l/ha of water
Balckgram/greengram/ Sesame	Virus diseases (Mosaic)	Mixture of 75 g Agrimycine and 2 kg Diathane Z-78 dissolved in 1000 l/ha of water spray

8. Suitable cropping systems

Sequence cropping

- Rice – chickpea/ lentil
- Pearlmillet – chickpea/ mustard
- Sesame – chickpea/ mustard
- Blackgram – barley/ mustard (if barley or mustard are taken after blackgram in *kharif* 20 kg N/ha can be saved in *rabi*)
- For fodder:
  - Maize + cowpea – oats
  - Pearlmillet + cowpea – oats

Intercropping

- Maize (Tipekhiya) in pigeonpea (Narendra Arhar –1) crop in 1: 1 row ratio
- Chickpea + mustard (4:1)/ (3:1)
- Pigeonpea + groundnut/ blackgram (1:3)
- Sorghum + greengram (2:2)

9. Farm implements / tools

Implement	Cost unit in Rs.	Operation
Til plant machine (Power tiller operated)	10,000	Field preparation and sowing in one pass

10. Contingent crop planning

- *Kharif*
  - Rice: N-97, N-118, Baranideep
  - Maize: Jaunpuri, Tipakhiya
  - Sorghum: PKV-400, Varsha
  - Pearlmillet: 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: Vaibhav, Varuna
  - Linseed: Garima, Sweta

  - Wheat: Atal, C-306, K-8027
  - Barley: Lakhan, Narendra Jau-4
- Compatible Genotypes for cropping system:
  - Sequence – Rice (NDR-97) – Lentil (NDL-1)
  - Intercropping – Linseed (Sweta) + Chickpea

Contributors

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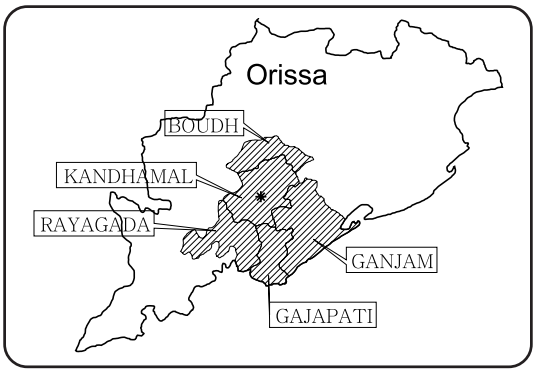

PHULBANI

Rainfed Rice based Production System in *Kharif-Rabi* Sub-Humid Deep Alfisols/ Oxisols

1. Region

Phulbani centre caters to the needs of the North Eastern Ghat Zone of Orissa. The zone occupies an area of 32,089 km^2 comprising 21 percent of the total geographical area of the state. It extends from 19°00 – 20°40' N latitude and 82°50' – 84°45' E longitude. The zone consists of five revenue districts i.e., Kandhmal, Boudh, Rayagada, Gajapati and part of Ganjam districts covering five agricultural districts i.e Phulbani, Boudh, Rayagada, Gajapati and Asoka.

2. Climate

The climate of the zone is tropical hot moist sub humid with mean annual rainfall of 1597 mm received in 77 rainy days. Monsoon (June-September), pre-monsoon (February-May) and *rabi* (October – January) periods receive 79, 10 and 11 percent of total rainfall, respectively. About 48 percent of the annual rainfall is received during July and August. The mean maximum temperature in the hottest month (May) is 38.4°C and the mean minimum temperature in the coldest month (December) is 7.7°C. The highest and the lowest temperature recorded are 41^{0}C and 1°C, respectively.

3. Soils

The area in the zone excepting Northern part of Boudh, Gajapati and Rayagada consists of hill ranges which belong to the main line of Eastern Ghats alongwith some plains and valleys lying between the hill ranges. These hill ranges also contain a large area under plateau some of which have an elevation of 300 to 800 m.

Red and yellow soils and brown forest soils belonging to alfisols and oxisols pre-dominate. A regular toposequence of soils occur from upper hill to *Jhola* land through mid-hill, foot hill, unbunded upland, bunded upland, medium and low land. Uplands constitute 45-81 percent of total cultivated area in different revenue districts compared to state average of 46 percent. The upland soils are well drained, light textured sandy loams and prone to crust formation. Soil depth varies from 45 cm to more than 100 cm. Soils are acidic with low organic carbon, low available N, low available P and medium available K. Deficiency of calcium, sulphur and boron are noted. Phosphorus fixation is a problem due to low soil *p*H (5.0 - 5.5). Alluvial sandy clays occur in medium and low lands. Iron toxicity occurs in medium and low land transplanted rice.

4. Crops and varieties

Crop	Varieties	Yield potential (t/ha)	Days to 50% flowering	Duration (days)	Reaction to disease, pest & stress condition	Remarks
Upland rice	ZHU 11-26	3.0	57	82	Tolerant to leaf blast disease and moisture stress	Suitable for intercropping and sequence cropping systems in rainfed uplands
	Vandana	2.9	68	93	Tolerant to leaf blast, bacterial leaf blight and moisture stress	Suitable for sequence cropping system
	Pathara	2.9	82	109	Moderately tolerant to leaf blast and bacterial leaf blight	Care must be taken to sow the crop early at the onset of monsoon to escape the terminal drought situation
Blackgram	OBG-23	1.3	36	69	Moderately resistant to *Cercospora* leaf spot, powdery mildew and yellow mosaic virus	Suitable for sowing in last week of July in rainfed upland condition to synchronize harvesting with dry period
	OBG-15	1.2	37	67	-do-	-do-
	Pant U-30	1.1		72	-do-	-do-
	T-9	1.0		69	-do-	-do-
	Sarala	1.0	36	70	-do-	-do-
	LBG-645	1.1	47	87	Moderately resistant to *Cercospora* leaf spot and powdery mildew disease	-do-
Greengram	PDM-54	0.7	36	70	Tolerant to Yellow mosaic virus, moderately tolerant to powdery mildew and susceptible to *Cercospora* leaf spot disease during *Kharif* season	Suitable for sowing in last week of July in rainfed upland condition to overcome harvesting problem
	K-851	0.8	35	60-65		
Pigeonpea	R-60	1.0	140-145	180	Susceptible to pod borer	Suitable for mono and intercropping systems in rainfed uplands
	T-21	0.8	120-125	160	Susceptible to pod borer	Suitable for mono cropping in rainfed uplands

Crop	Varieties	Yield potential (t/ha)	Days to 50% flowering	Duration (days)	Reaction to disease, pest & stress condition	Remarks
Fingermillet	PR-717 Sodangi-6	2.5 2.4	70-75	100	Susceptible to neck blast	Suitable for mono cropping
	A 2-3-4	2.0	60-65	90	-do-	-do-
	Dibyasingha	1.8	55	85	–	Suitable for mono and intercropping
	Nilachal Bhairabi	2.5 3.0		110 105	– –	Suitable for mono cropping
Maize	Navjot DHM-103	3.9 4.2	45 47	95 100	Moderately resistant to leaf blight disease	The varieties are suitable for accommodating cowpea (cv. SEB-2 and SGL-1) as intercrop and are also suitable for sequence cropping like maize-mustard
Cowpea	SEB-2	0.8	49	90	Susceptible to leaf eating caterpillar and pod borer	The variety is suitable for intercropping with maize and sequence cropping in cowpea-mustard system during *Kharif*
	SGL-1	0.6	42	70	Susceptible to leaf eating caterpillar and pod borer	The variety is suitable for intercropping with maize and sequence cropping in cowpea-mustard system during *Kharif.* For seed purpose sowing should be done during last week of July to 1st week of August
Groundnut	Smruti (OG 52-1)	1.7	28	103	Moderately tolerant to leaf eating caterpillar and tikka disease	Suitable for sequence cropping system like Groundnut-mustard in rainfed uplands
	JL-24 (HN)	1.7	29	101	Moderately tolerant to tikka disease	-do-
	TAG-26 ICGS-11	1.5 1.5	26 29	104 103	Moderately tolerant to leaf eating caterpillar and tikka disease	-do-

Crop	Varieties	Yield potential (t/ha)	Days to 50% flowering	Duration (days)	Reaction to disease, pest & stress condition	Remarks
Castor	DCH-177	0.8	57	106	Tolerant to wilt disease	Suitable for monocropping in rainfed uplands
	DCH-30	0.5	61	104		
	Aruna	0.5	57	106		
Mustard	M-27	0.8	30	75	Moderately tolerant to pod borer	Suitable for sequence cropping in maize-mustard and upland rice (short duration) - mustard system
Horsegram	Urmi	0.8	53	94	Tolerant to moisture stress, moderately resistant to leaf spot, leaf eating caterpillar and pod borer	Suitable for rainfed uplands after harvest of early rice
Sesame	Usha	0.6	–	83	–	–
	Uma	0.6	–	83	–	–
Niger	Phulbani local	0.5	55-60	85	No serious disease or pest problem	Suitable for sequence cropping after cowpea
	Deomali(GA-10)	0.6	63	110		
	IGP-76	0.5	60	106		
Turmeric	Sudarsan	5.7	—	190	Resistant to leaf spot and leaf blotch disease	Suitable for mono cropping in rainfed uplands and have high curcumin content 7-8%
	Suguna	5.7				
	Subarna	5.6		200		
Ginger	Vardhan	4.3	—	200	Moderately resistant to soft rot and leaf-spot disease	Suitable for monocropping in rainfed uplands
	China	3.9	—		Resistant to soft rot and leaf spot disease	-do-
	Nadia	3.4	—		Moderately resistant to soft rot and leaf spot disease	-do-

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Upland rice	100	15-20	—
Medium land rice (Transplanted)	50-75	15-20	10-15
Maize	15	60	30
Fingermillet (Direct sown)	10	20	—
Fingermillet (Transplanted)	6	15-20	10
Pigeonpea (Early variety)	20	45	20

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Pigeonpea (Late variety)	15	60	30
Blackgram	25	30	10
Greengram	25	30	10
Horsegram	50	30	5-10
Cowpea	20	45	15
Niger	10	30	10
Sesame	7	30	10
Groundnut	105 (kernels) i.e. 150 (pods)	30	10-15
Mustard	8	30	8-10
Sunflower	10	45	30
Linseed	25	30	5
Turmeric	1700 (fresh rhizome)	30	20
Ginger	1000 (fresh rhizome)	25	20
Yam	925 (tuber pieces of 50-100g)	90	90
Cotton	2-3 (hybrids)	120	60

6. Nutrient management

Crop	Nutrients (kg/ha)			Mode of application			Remarks
	N	P_2O_5	K_2O	Basal	First top dressing	Second top dressing	
Upland rice							
Local	30	20	20	All P_2O_5 and K_2O, 25% N	50% N at 21 days after germination	25% N at panicle initiation stage	–
Improved	40	20	20	-do-	-do-		
High yielding	60	30	30	-do-	-do-		
Medium land rice							
Local	50	25	25	All P_2O_5 and K_2O, 25% N at at transplanting	50% N three weeks after transplanting	25% N at panicle initiation stage	–
Improved	60	30	30	-do-	-do-		
High yielding	80	40	40	-do-	-do-		
Maize	80	40	40	All P_2O_5 and K_2O, 25% N	50% N at 21 days after germination	25% N at 6-7 weeks after germination	–
Fingermillet	20	12	12	All P_2O_5 and K_2O, 50% N	50% N at 21 days after germination	–	–

Crop	Nutrients (kg/ha)			Mode of application			Remarks
	N	P_2O_5	K_2O	Basal	First top dressing	Second top dressing	
Pigeonpea (Early variety)	20	40	20	All N, P_2O_5 and K_2O	–	–	–
Pigeonpea (Late variety)	20	60	20	All N, P_2O_5 and K_2O	–	–	–
Blackgram	20	40	20	All N, P_2O_5 and K_2O	–	–	–
Greengram	20	40	20	All N, P_2O_5 and K_2O	–	–	–
Horsegram	10	25	0	All N and P_2O_5	–	–	–
Cowpea	25	50	25	All N, P_2O_5 and K_2O	–	–	–
Niger	40	20	20	All P_2O_5 and K_2O, 50% N	50% N at 21 days after germination	–	–
Sesame	40	20	20	All P_2O_5 and K_2O, 50% N	50% N at 21 days after germination	–	–
Groundnut	20	40	40	All N, P_2O_5 and K_2O	–	–	Lime should be applied based on the *p*H value for correction of soil acidity
Mustard	30	15	15	All N, P_2O_5 and K_2O	–	–	–
Linseed	30	20	15	All N, P_2O_5 and K_2O	–	–	–
Sunflower	60	30	30	All P_2O_5, K_2O and 50% N	50% N at 3-4 week stage	–	–
Turmeric	60	30	90	100% P_2O_5 and 50% K_2O	50% N at 45 days after planting	50% N and 50% K_2O at 90 days after planting	15.5 and 5t/ha *Sal* twigs are applied as mulch after planting, at first topdressing and second top dressing respectively
Ginger	125	100	100	100% P_2O_5 and 50% K_2O	50% N at 45 days after planting	50% N and 50% K_2O at 90 days after planting	15.5 and 5t/ha *Sal* twigs are applied as mulch after planting, at first topdressing and second top dressing respectively

Crop	Nutrients (kg/ha)			Mode of application			Remarks
	N	P_2O_5	K_2O	Basal	First top dressing	Second top dressing	
Yam	80	60	80	All P_2O_5	50% N and 50% K_2O at 30 days after planting	50% N and 50% K_2O at 60 days after planting	Nitrogen and Potash can be given in three equal splits at 30, 60 and 75 days after planting in sandy soils
Cotton (Hybrids)	120	60	60	All P_2O_5, 50% K_2O and 25% N	50% N at 21 days after germination	25% N, 50% K_2O at 45 days after germination	–

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ Implement	Time of operation
Upland rice	Phulbani dryland weeder	20-35 days after germination
Medium land rice (direct sown)	Narrow wooden country plough (Interculture plough)	The standing crop of broadcast rice is ploughed down at one month after germination by the implement in presence of standing water of 5 cm followed by laddering. The weeds, being mostly C4-plants decomposed, while rice (C3-plant) recovers.
Transplanted rice	Japanese paddy weeder	20-35 days after transplanting
Maize	Trench hoe/ Rake weeder/ Garden rake/ Local 'Gadi'	3 weeks after germination
Groundnut	Trench hoe/ Rake weeder/ Phulbani dryland weeder	3 weeks after germination
Greengram/ Blackgram	Phulbani dryland weeder/ Rake weeder	2-3 weeks after germination
Pigeonpea	Trench hoe/ Rake weeder/ Wheel finger weeder	3, 6 and 9 weeks after germination

Weed management – chemical

Crop	Herbicide	Dose kg(a.i.)/ha	Method of application
Rice (Upland)	Thiobencarb Butachlor Pendimethalin	0.1 0.1 0.1	The liquid formulation of the herbicides are applied in moist soil one day after sowing seeds using 1000 l/ha of water
Rice (Medium and low land)	Butachlor Thiobencarb Pendimethalin Anilophos	1.5 1.5 1.0 0.4	The liquid formulations of the hebicides are mixed with 1000 l/ha of water and sprayed uniformly over the soil one day after seeding in moist soil using flat fan nozzle. If dry seeding is done and soil is not having enough moisture for seed germination, the herbicides are applied one day after occurrence of rainfall.

Crop	Herbicide	Dose kg(a.i.)/ha	Method of application
Rice (Transplanted)	Butachlor Pendimethalin Anilophos Thiobencarb	1.5 1.0 0.4 1.5	The liquid or granualar formulations are mixed with 30-40 kg sand/ha and applied uniformaly at 4 days after transplanting. There should not be stones or pebbles in sand. Mixing of herbicide with sand should be done by using rubber glove in hand. Thin film of water should be maintained at the time of application of herbicides. Water level of 5 cm should be maintained 7 days after application of herbicides.
			The liquid formulation are mixed with 1000 l/ha of water and sprayed uniformly on the soil at 4 days after transplanting.
Maize	Atrazine Simazine Pendimethalin Oxadiazon	1.0 1.0 0.75 1.0	Preemergence spray at 1 day after planting mixing with 1000 l/ha of water
Greengram Blackgram	Fluchloralin Metolachlor Oxadiazon Thiobencarb Butachlor Pendimethalin	1.0 0.5 0.5 1.0 1.0 0.5	Pre-planting application of herbicides in moist soil at 1 day before sowing by mixing with 1000 l/ha of water. Light hoeing should be given for incorporation of herbicide in the soil to avoid loss through volatilization and photo decomposition
			Preemergence spray by mixing with 1000 l/ha of water at 1 day after sowing
Pigeonpea	Fluchloralin Oxadiazon Thiobencarb	1.0 0.5 1.0	Pre-planting application of herbicides in moist soil at 1 day before sowing by mixing with 1000 l/ha of water. Light hoeing should be given for incorporation of herbicide in the soil to avoid loss through volatilization and photo decomposition
			Preemergence spray by mixing with 1000 l/ha of water at 1 day after sowing
Groundnut	Fluchloralin Metolachlor Pendimethalin Oxadiazon Thiobencarb Butachlor	1.0 0.75 1.0 1.0 1.0 1.0	Pre-planting application of herbicides in moist soil at 1 day before sowing by mixing with 1000 l/ha of water. Light hoeing should be given for incorporation of herbicide in the soil to avoid loss through volatilization and photo decomposition
			Preemergence spray by mixing with 1000 l/ha of water at 1 day after sowing
Mustard	Oxadiazon Isoproturon	0.5 0.5	Preemergence spray
Niger	Pendimethalin	1.0	Preemergence spray

Insect pest management

Crops	Pest	Control Measures
Paddy	Gall midge	Early sowing/ transplanting to escape Gallfly incidence in endemic areas.
		Growing of resistant varieties
		Application of granular insecticides like Phorate 10G 0.5 kg or Diazinon 5G 1.0 kg or Carbofuran 3G 1.2 kg or Quinalphos 5G 1kg per 400m^2 of nursery 7-10 days before up-rooting, or
		Spraying the seedlings with Chlorpyriphos 20 EC 40ml or Monocrotophos 40 EC 40 ml or Phosphamidon 100 EC 15 ml or Quinalphos 25 EC 30 ml or Fenitrothion 50 EC 35 ml in 20 liters of water for 400 m^2 of nursery
		Dipping roots of the seedling in insecticide solution for a period of 8-10 hours before transplanting. Mixing 200 ml of Chlorpyriphos in 200 l/ha water and keeping the roots of paddy seedlings sub-merged for 8-10 hours for seedling dip
		Application of granular insecticides like Phorate 10G 6 kg or Carbofuran 3G 12 kg or Diazinon 5G 10 kg or Quinalphos 5G 25 kg/ha. The water in treated field is impounded for 6-7 days after application of pesticides, or
		Spraying the crop with Chlorpyriphos 20 EC 400 ml or Monocrotophos 40 EC 400 ml or Phosphamidon 100 EC 150 ml or Quinalphos 25 EC 300 ml or Fenitrothion 50 EC 350 ml or Endosulfan 35 EC 400 ml per acre in 200 l/ha water
		Spraying is repeated at 15 to 20 days interval beginning from 15 days after transplanting
	Stem borers	Summer ploughing and destruction of stubbles by first week of February will kill sheltering stem borer and other pests. For suppressing gallmidge and stem borer populations, spraying should be done in nursery beds once between 15 to 25 days after germination with Monocrotophos 40 EC 40 ml or Chlorpyriphos 20 EC or Quinalphos 25 EC 40 ml for 10 cents (400 m^2) of nursery area, or
		Application of Phorate 10 G 0.5 kg or Carbofuran 1.2 kg or 1 kg Cartap per 10 cents (400 sq.meters) of nursery 8 to 10 days before transplanting. Alternatively, seedling root dip treatment should be done with 0.02% Chlorpyriphos for 12 hours, before transplanting for stemborer control. Application of Phorate 12.5 kg or Carbofuran 3 G 30 kg or Padan 4 G 25 kg/ha once after 20-25 days of transplanting in the main field and spraying the crop twice at boot leaf stage at 7-10 days interval with Monocrotophos 1000 ml/ ha, or
		Spraying should be done twice, once at 21 and twice at boot leaf stage with Monocrotophos 1000 ml or Quinalphos 25 EC 1500 ml or Chlorpyriphos 20 EC 2000 ml or Phosphamidon 375 ml/ha for controlling stemborer where water management is not possible.
	Plant hoppers	Spraying with Monocrotophos 40 EC 1000 ml, or Carbaryl 50 WP 2.0 kg/ ha against the plant hopper. Lower parts of the plants must be thoroughly covered for effective plant hopper control. Monitoring is important for plant hoppers management
	Leaf roller	Spraying with Monocrotophos 40 EC/ Endosulfan 35 EC 1000 ml/ha for leaf roller control

Crops	Pest	Control Measures
	Grass hopper	Dusting the crop with Carbaryl 5% or Phenthoate 2% or Methylparathion 2% or Quinalphos 1.5% dry dust 25 to 30 kg/ha. Trimming the bund and summer ploughing exposes the eggs which are killed
	Ghundi bug	Carbaryl 5% dust 25 kg/ha
	Rice hispa	Spraying Monocrotophos 40 EC or Methyl Parathion 25 EC or Quinalphos 25 EC 1000 ml/ha for control of grubs and adults
	Case worm	The cases can be disloged by moving rope on the crop and collecting them at one point from the water and destroying the larvae. Draining out water from the field and spraying Monocrotophos 40 EC or Endosulfan 35 EC 1000 ml/ ha
	Swarming caterpillar	Raising seedling away from weed infested areas. Affected areas should be segregated by applying a heavy dusting with any one of the insecticides mentioned for grass hopper control. If the crop is nearing harvest then dusting with Carbaryl 5% in the evening hour should be done
	Cut worms	Alternatively spraying with Carbaryl 50 WP 2.5 kg or Endosulfan 35 EC 1500 ml or Monocrotophos 40 EC 1000 ml/ha or DDVP 500 ml should be done in the evening. Dusting with Methyl Parathion 50 EC or Phenthoate in the evening hours. Water should be kept impounded for 5 days
	Surti caterpillar	Trimming bund destroys the hibernating pupae. Dusting the field with Quinalphos 1.5% or Methyl parathion 2% or Endosulfan 4% 25-30 kg/ha
Fingermillet	Termites	Application and incorporation of Chlorpyriphos dust into the soil 25 kg per ha before sowing. If termite problem appears in the later growth stage, drenching of the soil is done with Chlorpyriphos 0.05%
	Pink stem borer	Spraying Quinalphos or Endosulfan 1000 ml/ha
	Aphids	Spraying Chlorpyriphos 20 EC 1000 ml or Endosulfan 35 EC 1000 ml or Methyldemeton 750 ml or Dimethoate 1000 ml/ha
	Jassids	Spraying Monocrotophos 1000 ml/ha or Carbaryl 2 kg/ha
Maize and Sorghum	Termites	Application and incorporation of Chlorpyriphos dust into the soil 25 kg per ha before sowing. If termite problem appears in the later growth stage, drenching of the soil is done with Chlorpyriphos 0.05%
	Hairy caterpillars and grass hoppers	Dusting with any one of the insecticides like Carbaryl
	Grass hopper	Quinalphos or Carbaryl or Methyl Parathion dust 25 kg/ha. Alternatively spraying with any one of the following ensuring through coverage DDVP 500 ml/ ha or Carbaryl 2.0 kg or Endosulfan 1000 ml/ha
	Stem borer	Foliar application of Endosulfan 35 EC 1500 ml/ ha 15-20 days after sowing followed by application of 1% Lindane granules 15 kg/ha in plant whorl 15 days after the foliar application
	Aphids	Alternatively spraying with Methyldemeton or Dimethoate 1000 ml/ha. In case cobs are to be harvested green and aphid incidence occurs in cob stage Malathion 50 EC should be sprayed 1000 ml/ha

Crops	Pest	Control Measures
	Jassids	Monocrotophos 36 SL 1000 ml or Carbaryl 50 WP 20 kg/ha to be sprayed
Groundnut	Termites	Application and incorporation of Chlorpyriphos dust into the soil 25 kg/ha before sowing. If termite problem appears in the later growth stage, drenching of the soil is done with Chlorpyriphos 0.05%
	Red hairy caterpillar	Dusting with any one of the insecticides like Carbaryl
	Thrips	For control of thrips, aphids and leaf miner, spraying Monocrotophos 36 SL or Quinalphos 25 EC or Endosulfan 35 EC 1000 ml/ha
	Leaf miner	Use of Monocrotophos 36 SL or Methyl Parathion 50 EC 1000 ml/ha or Chlorpyriphos 20 EC 2000 ml/ha if leaf miner alone is the problem
	White grub	Suggestions for controlling termites of groundnut be followed. Carbafuran granules 30 kg/ ha during the time of sowing is effective
Sesame	Shoot and pod borer	Spraying Endosulfan 35 EC 1250 ml or Carbaryl 50 WP 2 kg/ha should be done ensuring thorough coverage after 3 weeks of germination and at flowering initiation stage.
Castor	Semilooper	Application of Endosulfan 35 EC 1500 ml or Fenvalerate 20 EC 500 ml or Carbaryl 50 WP 2 kg/ha
	Shoot and capsule borer	Alternatively spraying with Quinalphos 25 EC 1500 ml or Endosulfan 35 EC 1500 ml or Monocrotophos 36 SL 1250 ml/ha
Cotton (Unified pest control schedule)	Aphids Jassids White fly, Leaf roller	First and Second sprayings with Methyldemeton 1000 ml/ ha or Dimethoate 1000 ml/ha, at 20 days interval commencing after 2 to 3 weeks of germination
	Red cotton and Dusky cotton bugs	Third spraying is done after 15 days of the second spraying with any one of Monocrotophos 40 EC/ 1250 ml or Quinalphos 25 EC 1500 ml or Carbaryl 2.5 kg/ha
	Spotted	Fourth spraying with any one of the following. Monocrotophos 1000 ml/ha boll worm or Quinalphos 1000 ml/ha be done after 70 days of germination, (15 days after the third spraying)
	Pink boll worm	Fifth spraying – the insecticidal schedule of third spraying be repeated after 15 days of the fourth spraying
Pulses	Aphids	Application of Methyldemeton 1000 ml/ha or Dimethoate 1000 ml or Endosulfan 875 ml/ha
	Leaf eating caterpillars & pod borers	Spraying of Endosulfan 1000 ml or Carbaryl 2 kg/ha be done. Against Heliothis pod borer on pigeonpea, application of Endosulfan 35 EC 1500 ml/ ha at 15-20 days interval commencing from pod initiation stage should be done
Mustard	Aphids	Spraying the crop with Methyldemeton or Dimethoate 750 ml or Chlorpyriphos 20 EC 1000 ml or Quinalphos 25 EC 1000 ml/ha ensuring thorough coverage. Mustard sowing should be completed in the month of October to reduce aphid infestation

Crops	Pest	Control Measures
	Saw fly	Spraying Endosulfan 35 EC 1000 ml or Chlorpyriphos 20 EC 1000 ml/ ha ensuring through coverage
	Large cabbage moth	In Orissa aphid and leaf webber incidence is observed simultaneously. Hence alternate application of accphate or Quinalphos and Methyl Demeton or Dimethoate can check both the pest satisfactory. Acephate is to be applied at 500-625 g/ha

Disease management

Crops	Disease	Control Measures
Rice	Blast	Seed treatment with Emisan or Topsin-M or Thiram – 75% DSD or Cuman-L 2.5 g/kg of seeds.
		Spraying of the crop should be done with carbendazim 1 g/l of water or Hinosan 1 to 1.5 ml/l of water. 500 l of fungicidal suspension may be sprayed per hectare. Atleast three sprayings, one at boot leaf stage, another two at tillering and grain formation stages may be given
		Growing moderately resistant varieties
	Bacterial leaf blight	Before sowing, soaking the seeds for 6-12 hours in 50 ppm suspension of Plantomycin (5 g of Plantomycin dissolved in 10 l of water) to which 20 g of Copper oxychloride should be added or hot water treatment of seeds at 54^0C for 10 minutes
		Dipping the seedling in 100 ppm suspension of Plantomycin 10 g of Plantomycin dissolved in 10 l of water for 30 minutes
		Spraying the crop at early boot leaf seage with Plantomycin 150 ppm. (750 g in 500 l of water mixed with Copper oxychloride 500 g. In 500 l/ha water. This can be combined with Hinosan 1 ml/l of water for control of both blast and bacterial leaf blight
		If plantomycin is not available then spraying is done at tillering stage with fresh cowdung suspension in water 100 g cowdung/l of water. Spraying is repeated 2-3 times at an interval of 10-12 days with 500 l spray solution/ha
		Potash application at tillering and preflowering stages will reduce diseases severity and judicious supply of N fertilizers
		Alternate drying and filling with water in paddy fields will help in reducing the infection
	False smut	Spraying twice at 7 days interval at boot leaf stage with Blue copper or Blitox or Mancozeb or Captafol 1875 g/ha
		Growing resistant varieties
	Sheath blight	Reduction in supply of nitrogen and adoption of wider plant spacing
		Spraying with Carbendazim (1g/l) or Topsin M-70 (0.1%) or Mancozeb (2g/l). Two to three sprayings of 500 l/ha of water suspension will be required.
		Growing of tolerant varieties.
	Brown spot	Seed treatment with Cuman L or Mancozeb or Thiram 0.20%. Spraying with Blitox 50 or Blue copper or Captan (0.25%) or carbendazim (0.15%) 2 to 3 times.

Crops	Pest	Control Measures
Fingermillet	Blast	Seed treatment with Thiram 3 g/kg per kg of seeds.
		Growing of moderately resistant varieties
		Two to three sprayings with Blitox (0.25%) or Blue copper (0.25%) or spraying Carbendazim 375 g in 500 litres of water first in nursery and second at boot leaf stage.
	Leaf spot/ Blight	Seed treatment with Thiram (0.3%) or with Mancozeb (0.25%). Spraying with Copper oxychloride or Mancozeb (0.25%) 2-3 times
Sorghum	Leaf spot	Spraying Zineb 2.5kg or Mancozeb (Dithane M-45) 1875 g/ha or 0.2% Captan or Deltan (0.2%) or Cuman L (0.25%) or Blue copper or Blitox (0.25%)
	Grain smut	Seed treatment with Captan or Thiram 2.5 g/kg of seed or seed treatment with Carbendazim 1-2 g/kg of seed
Castor	Rust	Dusting Sulphur WP 2.5 kg/ha or spray 0.05% Calixin
	Leaf spot	Spraying Blitox or Blue copper or Mancozeb 1875 g/ha or Cuman-L (0.2%) at 14 days interal or Kavach 0.15%
	Phytophthora blight	Spraying the crop with Blue copper or with Blue copper or with and Copper oxychloride (0.5%) for two times at an interval of 15 days of Redomil (Metavaxyl) (0.15%) or with Mancozeb (0.25%) or with Kavach 0.15%
Sesame	Phyllody	Spraying a combined solution of Carbaryl 50% WP 1000 g/ha, each for vector control and prophylaxis. Growing early duration varieties.
	Fungal blights	Seed treatment with Carbendazim 0.15% or with Captan (0.2%) or Thiram (0.2%)
		Spraying at 2 weeks intervals with Mancozeb (0.2%) or Carbendazim (0.15%). First spray after 4 weeks of planting Kavach 1.5 g/l of water or any copper compond at 0.2% concentration may also be sprayed
Groundnut	Tikka disease	Seed treatment with Topsin M or Thiram 1.5 g/kg of kernels, or with Carbendazim 1.5 g/kg.
		Spraying with Cuman-L 0.2% or with Topsin M-70 WP (0.15%) or Mancozeb 1875 g or Carbendazim 500 g/ha or Kavach 1.5 g/l water
		Growing of moderately resistant varieties
	Seedling blight	Treatment of the kernels with Topsin-M or with Carbendazim 1.5 g/kg 1.5 g/ha of seed or Thiram 3.0 g/kg of kernel
		Spraying the seedling with Cuman-L (0.2%) 1875 g/ha or with Carbendazim 375 – 500 g/ha
		Growing of resistant varieties
	Stem rot	Seed treatment with Thiram or Carbendazim 2 g/kg of seed or with Topsin-M 70 (0.15%) 2.5 g/kg of seeds
		Growing resistant varieties
		Excessive soil moisture in plots should be avoided
	Collar rot or blight	Seed treatment with Mancozeb, Dithane-M 45 or Topsin M (0.15%) or Thiram 3 g/kg mixed with Carbendazim 1.5 g/kg of seed in 1:1 proportion
		Use of fresh and healthy seeds

Crops	Disease	Control Measures
		The nuts should be kept in storage after properly drying and removal of soil particles under dry and cool conditions
		Chemical treatment of nuts with kernels gives better results to avoid seed infection. Spraying with Carbendazim 0.15% or Blitox or Blue copper 0.25% 2 to 3 times beginning from 4 week old stage of the crop
		To avoid seed infection, the fungicide treated seeds should be stored for next season crop
		Surplus soil moisture and flooding of plots at seedling stage of the crop should be avoided
		Removal and destruction of diseased seedlings at early stage of infection
	Bud necrosis	It is a virus disease and transmitted by thrips. Hence, vector control by use of Phosphamidon 375 ml/ha will reduce disease spread Growing crop at high plant population and sowing the crop by mid June. Growing of resistant varieties
Cotton	Angular leaf spot	Soaking the seeds in 50 PPM solution of plantomycin (5 gms in 10 lits of water) for a period of 2 hours. Hot water seed treatment (54^0C) for 10-15 minutes is also useful. Drying the seeds before sowing in shade
		Spraying the crop with 40 PPM of plantomycin (80 gms in 200 litres of water) to which 750 gms of any Copper oxychloride fungicide is added or spraying the crop with Blue copper 50 or Mancozeb or Carbendazim 500 g in 500 l/ha water for atleast 3 times: Before flowering, after flowering and 20 days after second spraying use seeds only from healthy crop.
	Anthracnose leaf spot	Seeds should be treated with Thiram (0.3%) or Cuman L (0.25%). Spraying Blitax-50 or Blue copper or Cuman L (0.2%) or spraying with Carbendazim 500 gms in 500 l/ha water.
	Wilt	Crop rotation Seed treatment with Carbendazim (0.15%) + Thiram (0.3%) in 1:1 proportion or with Carbendazim 2g/kg or seeds or with Vitavax 75 WP 2.5-3 g/kg of seed. Application of groundnut oil cake with zinc into the soil will reduce severity.
Pulses	Powdery mildew	Spraying with Sulfex or Wettable Sulphur 2.5 kg or Carbendazim g/ha. or dusting with finely powdered sulphur dust 30-37.5 kg/ha. Tridemorph (Calixin) 0.1% may also be sprayed.
	Yellow mosaic	Spraying Malathion 875 ml/ha for vector control
		Growing tolerant varieties
	Leaf spot and wilt	Seed treatment with Carbendazim (0.15), Thiram (0.3%) or Topsin – M 1.5 g/kg of seeds. Spraying the crop with Carbendazim 500 g/ha. Dithane M-45 or Mancozeb 1875 g/ha for two times at an interval of 15 days commencing from three weeks old crop. Growing resistant cultivars
	Pod blight and wilt	Seed treatment with Carbendazim (0.15%) + Thiram (0.3%) or Topsin-M (0.15%) or Captan (0.2) or Thiram (3.0 g/kg)
		Spraying Carbendazim 0.15% at 14 days intervals. Storage of seeds after air-drying under cool and dry conditions

Crops	Disease	Control Measures
Mustard	Downy mildew	Spraying the crop with Ridomil MZ-72 WP (0.3%) or any Copper fungicide 2.5 kg or Cuman L 2.5 litre in 500 l/ha water for 2 times at an interval of 10 days
		Ridomil (Metalaxyl) may also be used for spraying at the concentration of 0.3% at 10 days intervals
	Leaf spot or blight	Spraying with Coman-L (0.25%) or Blitox (0.2%) at 14 days interval
	White rust	Seed treatment with Ridomil (Metalaxyl) 0.4% and spraying of same chemical at 14 days interval after 4-6 weeks of sowing
		Spraying with Blitox (0.25%) or Cuman L (0.15%) at 14 days interval. Seeds from diseased crop should not be used

8. Suitable cropping systems

Non – arable wastelands

- Tree farming (Sal, Teak)
- Silvi-pastoral *(Shisham* / *Leucaena* / *gambar* + Stylo/Cenchrus/mixure)

Arable wastelands

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

Low fertility, unbunded uplands

- Sunhemp (green manure) – Niger (IGP 76, Phulbani local)
- Cowpea (SGL-1, SEB-2) – Niger (IGP-76, Phulbani local)

Uplands

Monocropping

- Turmeric (Sudarsan, Suguna, Subarna). Planting is done in 1.0 m width, 15-30 cm high beds. Channels of 30cm width are left between the beds.
- Ginger (Suprabha, Nadia, Vardhan and China) planting is done in beds as in turmeric.

Sequence cropping

- Rice (ZHU 11-26/ Vandana/ Heera) – horsegram (Urmi/local) / toria (M-27, PT-303)
- Maize (Navjot) – toria (PT 303/M-27)
- Maize (Navjot) + cowpea (SGL-1, Arka Kamal)- toria (PT 303, M-27).

Relay cropping

- Rice (ZHU 11-26, Heera) + horsegram (Urmi, local).
- Rice (ZHU 11-26, Heera) + pigeonpea (UPAS 120)

In relay cropping, short statured rice is sown in 20 cm apart rows. The succeeding crops are dibbled in the inter row space alternately. The row spacing of the succeeding crop is maintained at 40 cm. Skipping of one row facilitates harvesting of rice. The intercultural operations and final top-dressing in rice should be over before dibbling of succeeding crops. In general, dibbling is done one month before harvesting of rice. After harvesting of rice, one hoeing is given to check the emerging weeds.

Intercropping

Pigeonpea based

- Pigeonpea (T-21, R-60) + rice (ZHU 11-26) (2:5): Five rows of short statured, drought tolerant and short duration rice varieties in 15cm apart rows are intercropped in 90cm space between paired rows of long duration pigeonpea with set specification 30-90-30cm. In this system, 100% population of sole pigeonpea and 62.5% of sole rice are maintained.
- Pigeonpea (T-21, R-60) + groundnut (OG 52-1, JL 24) (2:6): Six rows of short duration, bunch type groundnut are grown in 210 cm interspace between paired rows of long duration pigeonpea with set specification 30-210-30cm. Plant protection in pigeonpea becomes easier in this row ratio as compared to row ratio of 2:4 (set specification 30-150-30cm).
- Pigeonpea (T-21, R-60) + greengram (PDM 54, K 851) or blackgram (Pant U 30, T-9, Sarala) (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 30-120-30cm. The intercrops are grown in 30cm 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) + fingermillet (Dibyasingha): Four rows of short duration, short statured fingermillet in 20cm apart rows are intercropped in 100 cm interspace between paired rows of pigeonpea with set specification 30-100-30cm.
- Pigeonpea (T-21, R-60) + radish (Pusa chetki): Two rows of radish are intercropped between paired rows of pigeonpea with set specification 30-90-30cm. 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 30-90-30cm.

Maize based

- Maize (Navjot) + pigeonpea (T-21, R-60): Short duration maize and long duration pigeonpea are grown in uniform alternate rows in 1:1 row ratio or paired rows of maize are alternated with paired rows of pigeonpea in 2:2 row ratio. Maize is harvested before canopy development starts in pigeonpea. In this system, 100% population of each of the sole crop is maintained.
- Maize (Navjot) + cowpea (SEB-2): Two rows of low-trailing cowpea are grown between paired rows of maize with set specification 30-90-30cm. Green pods of cowpea are harvested during 60-70 days after germination.
- Maize (Navjot) + cowpea (SGL-1, Arka Kamal): Maize and non-trailing cowpeas are grown in 30cm apart uniform rows alternately. Green pods of cowpea are harvested within 50-60 days after germination. Green biomass of cowpea is used as mulch-cum-manure between rows of maize. Cowpea may be harvested for grain purpose at 70 days after germination.
- Maize (Navjot) + runnerbean (local): Runnerbean is planted in basins prepared with 90cm spacing. In each basin, 2 runnerbean plants are maintained. Two rows of maize are planted in 90cm spacing between 2 basins of runnerbean. Maize acts as live-staking material for runnerbean.

Rice based

- Rice (ZHU 11-26, Vandana) + radish (Pusa chetki): Four rows of rice in 15 cm apart rows are grown in the 75cm interspace between paired rows of radish with set specification 30 (radish) – 75 (rice) – 30cm (radish).
- Rice (ZHU 11-26) + Okra (Parbhani kranti): Four rows of rice in 15cm apart rows are grown in 75cm space between paired rows of okra with set specification 30 (okra) – 75 (rice) – 30cm (okra).
- Rice (ZHU 11-26) + blackgram (Pant U 30)/greengram (PDM 54): Five rows of rice, spaced at 15cm, are sown between paired rows of blackgram/ greengram with set specification 30 (blackgram/greengram) – 90 (rice) – 30cm (blackgram/ greengram). The blackgram/ greengram varieties are ready for harvest in 60-70 days.
- Rice and blackgram/ greengram may be grown in 2:1 row ratio: If rice crop fails in drought years, pulse crop is maintained. If rainfall is normal, pulse crop is cut for fodder and rice crop is maintained.

Yam based

- Yam (Hatikhoja) + maize (Navjot): The well-drained light texured soil of the zone is very congenial for tuber crops like yam. Yam is planted in mounds with row to row and plant to plant spacing of 90cm. Two rows of maize are planted in both sides of yam to act as live staking. Green cobs of maize are harvested at 75 days after crop emergence.

Medium lands

Sequence cropping

- Rice (Lalat, Konark) – Linseed (Kiran, Laxmi 27 and Pusa 3)
- Rice (Lalat, Konark) – rapeseed mustard (PT 303, M-27, Local rai)
- Rice – greengram/ blackgram/ linseed/ safflower/ mustard

Paira (Relay) cropping

- Rice (Lalat, Konark, Jajati, Swarna) – Lathyrus (Local).

Low land

Sequence cropping

- Rice (CR 1014, Utkal Prabha) – greengram (PDM-54)
- Rice – linseed/ castor

Relay cropping

- Rice (CR 1014, Utkalprabha) – Lathyrus

Jhola land

- Rice

9. Farm implements / Tools

- Bishu mould board plough for preparatory tillage
- Gujarat state fertilizer corporation seed drill for seeding in fingermillet
- Implement factory seed – cum fertilizer drill for line sowing of upland rice

Tools/ Implements	Cost/ unit in Rs.	Purpose	Source of power	Field capacity
Mould board plough	252/-	Suitable for primary tillage (1st and 2nd ploughing)	Pair of bullock	0.3 ha/ day
Heavy soil plough	324/-	Suitable for black cotton soil	Pair of bullock	0.24 ha/ day
Cast iron plough	266/-	Suitable for ploughing and puddling in fields free from roots of trees and pebbles	Pair of bullock	1.0 ha/ day
Zig-zag puddler	1788/-	Puddling	Pair of bullock	1.0 ha/ day
IADP Pubbler	1700/-	Pulverizing light sandy loamy soil Puddling Suitable for heavy soils of western Orissa	Pair of bullock	1.0 ha/ day
Puddler 99	1232/-	Pulverising all soils Puddling	Pair of bullock	1.0 ha/ day
One row seed drill	246/-	Seed sowing in rice, maize and groundnut	Pair of bullock	0.3 ha/ day
Two row multicrop seed drill	1164/-	Seed sowing in rice, wheat, groundnut and bengalgram	One man	0.5 ha/ day
Two row mustard seed drill	827/-	Mustard sowing	One man	0.5 ha/ day
Three row multicrop seed drill	1570/-	Seed sowing in rice, wheat, bengalgram and groundnut	One man	0.8 ha/ day
Paddy transplanter (Manual)	4000/-	Transplanting paddy with proper spacing	Two men	0.20 ha/ day
Pedal paddy thresher	2754/-	Threshing of paddy	Two men	2.5 q/ day
Power paddy thresher	8778/- (With motor and starter)	Threshing of paddy	Electric motor (1 HP)	10-12 q/ day
Groundnut digger	548/-	Digging groundnut	Pair of bullock	0.3 ha/ day
Pedal groundnut thresher	2818/-	Separating groundnut pods from the plants	Two men	0.22 t pods/ day
Groundnut decorticator	764/-	Spreading seeds from groundnut pods	One men	50 kg/hour
Maize sheller	25/-	Spreading seeds from maize cobs	One man	0.1 t/day

10. Contingent crop planning

Normal Season

- Rice:
  - Very early group (less than 95 days): Heera, Rudra, ZHU 11-26, Vandana
  - Early group (95 days to 115 days):Pathara, Khandagiri, 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, Ramachand , Mahanadi and Indrabati
- Fingermillet: Dibyasinha, Nilachala, Bhairabi and Subhra
- Maize: Navjot, Vijaya, DHM-103 and Ganga-5
- Greengram: PDM-54, K- 851, Dhauli and TARM-2
- Blackgram: Pant U-30, T-9 and Sarala
- Pigeonpea: UPAS-120, R-60, T-21 and S-5
- Cowpea: SEB-2, SGL-1, 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
- 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, 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. fingermillet (Subhra, Bhairabi, Dibyasingha and Godavari), greengram (K 851, PDM-11 and PDM-54), blackgram (T-9, Sarala and Pant U-30), Cowpea (SEB-2, SGL-1, Arka Kamal), horsegram (Urmi), ricebean (RBL 6), Sesame (Usha, Uma) 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 fingermillet gives good results. For this, 200 g of urea is mixed with 10 l of water and sprayed on the foliage of the crop. Plant protection chemicals may be mixed with urea solution to minimize the cost of spraying. In a single spray 10 kg/ha of urea is applied through 500 l solution.

- Excess plants in the crop row should be thinned to reduce moisture loss from the soil.
- Use of tender twigs of *Leucaena, Glyricidia 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 or shallow ground water should be recycled as life saving irrigation.

Medium and low land

Direct sown rice

- Re-sowing of rice is needed if plant population is less than 50 percent. 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 gaps. 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/m^2. 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.

11. Other supportive practices

- Method of cultivation on sloppy lands near foot-hills (3-5 percent slope) with crops viz. one row of pigeonpea or two rows of blackgram on ridges and two rows of short duration rice or fingermillet in the furrows offer many advantages.
- Ridges and furrows, 60 cm apart are laid out across the slope at a gradient of 0.3%.
- Integrated nutrient supply system comprising 50 percent N (30 kg N/ha through chemical fertilizer) + 50% N (30 kg through Farm yard manure) and full (40-40 kg) phosphorus and potash maintains soil health and gives sustained productivity of rice and horsegram.
- 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/ha from chemical source in pigeonpea + paddy (2:5) intercropping system. Resource poor rainfed farmers should raise green leaf manuring plants viz. *Leucaena leucocephala* (Leucaena), *Glyricidia sepium* (Glyricidia) and *Cassia siamea* (Cassia) in field boundaries/road sides to meet nitrogen need of the system.
- Establishment of vetiver barriers in unbunded (2-3 percent slope) upland rice at 0.4 m vertical intervals reduces runoff by 26% and soil loss by 52% and increases rice yield by 49 percent as compared to no vegetative barrier. Vetiver is preferable to other vegetative barriers from ease of establishment and sustainability point of view.

- Application of Thiobencarb 1.0 kg/ha as pre emergence spray in pigeonpea + paddy and oxadiazon 0.5 kg/ha as preemergence spray in pigeonpea + blackgram intercropping system reduce cost of cultivation, offer satisfactory weed control and increase crop yield.
- Fingermillet - application of farmyard manure or water hyacinth compost + 50 percent recommended dose of fertilizer i.e., 30 kg N/ha + 20 kg P_2O_5/ha + 20 kg K_2O /ha
- Maize – 800kg /ha of calcium carbonate (liming) alongwith the recommended fertiliser
- Soybean – application of phosphorus 60 kg P_2O_5/ha either as rock phosphate or super phosphate or mixture of rock phosphate and super phosphate (1:1) is recommended for red and lateritic upland soil.
- Groundnut – application of single superphosphate 100 percent 60 kg P_2O_5/ha or soil application of sulphur 25 kg /ha alongwith other phosphate fertilizers increases pod yield.
- In medium and low land situation – direct seeding of short duration rice (DR –92) + with late duration Jaganath in 2:2 ratio and followed by transplanting of Jaganath after harvesting of DR –92.

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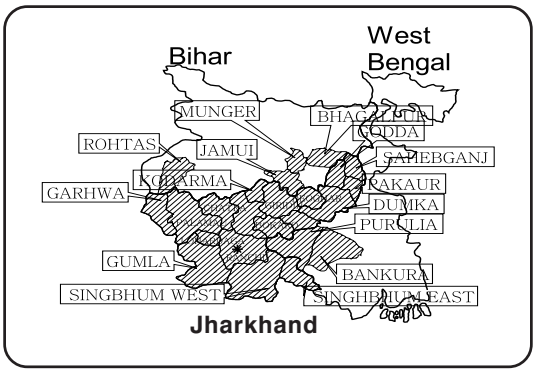

RANCHI

Rainfed Rice based Production System in *Kharif* Sub-Humid Alfisols

1. Region

Entire plateau of Jharkhand state, parts of Rohtas, Gay, Jamui in Monghyr district, Banka sub-division of Bhagalpur district in Bhir and Purulia and Bankura districts of West Bengal.

2. Climate

The climate of the plateau region, in general, is classified as sub-humid mega thermal with large winter water deficiency. The variation in the amount of total rainfall is very much (900 to 1500 mm). About 90 percent of the total rainfall occurs during the four monsoon months, June to September, the rest 10 percent is received during winter. During the monsoon sharp peak, amounting to 200 to even 350 mm of rainfall in a week, with intensities, as high as 250 mm per day, have been observed.

During the cropping season, climate changes from hot and humid during major part of *kharif* (June to September/October) to cold and arid during *rabi* (mid October to March). The winter rains, although not substantial in amount and duration are almost sure to occur in most parts of the plateau. In such high rainfall areas, therefore, it is a problem of safe disposal of runoff water during monsoon, while it is a question of moisture storage, conservation and its availability to crop plant during the *rabi* season.

3. Soils

The soils on the ridges are red, light textured and shallow. On the slopes, they are yellow, medium deep and relatively heavy. In the valleys, the soils are light grey, heavy and very deep. The upland soils are sandy loams, have moisture enough to grow only a single crop in *kharif*. Medium lands are sandy clay loams, have adequate moisture for double cropping provided supplemental water is available for timely sowing of *rabi* crops. The lowland soils are invariably under rice and have also facilities of supplemental irrigation from tanks or wells. Crust formation in upland soils is a serious problem and available phosphorus is invariably very low irrespective of the location of the soils. The soils are acidic. *Rabi* crop benefits from mulching.

4. Crops and varieties

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Rice	Brown gora	1.5-2.0	60-65	90-95	Moderately resistant to blast	Suitable for monocropping, intercropping and sequence cropping

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
	Bandana	2.0-2.5	55-60	80-90	-do-	Suitable for mono and sequence cropping
	Kalinga-III	2.0-2.5	60-65	85-90	–	Fine grain quality
	B.D.101	2.0-2.5	55-60	85-90	Moderately resistant to blast	Suitable for mono as well as sequence cropping
Fingermillet	A-404	Dir.2.5-3.0 Tran.3.0-3.5	75-80	115-120	Moderately resistant to blast	Suitable for monocropping, drought tolerant
	Birsa Marua-1	1.6-2.0	50-55	90-95	Susceptible to blast and blight	Suitable for mono and intercropping
	PR-202	Dir.2.0-2.5 Tran.2.5-3.0	65-70	110-115	Moderately resistant to blast	Suitable for monocropping
	Birsa Marua-2	Dir.1.8-2.2 Tran.2.4-2.8	65-70	100-105	Moderately resistant to blast and blight	Suitable for moisture stress condition
Sorghum	CSH-5 CSH-6	3.5-4.0 4.0-4.5	53-55 53-55	95-100 95-100	Moderately to resistant to insect pest	Drought resistant
Gundli	Birsa Ghundi-1	1.0-1.2	35-37	55-60	Nothing in particular	Suitable for waste land and early and first crop to be grown
Maize	Swan comp.-1	5.0-5.5	Days to flower 55-58	105-110	Tolerant to foliar disease	Tall plant, medium maturity
	Birsa Makka -1	3.5-4.0	Days of flower 47-52	80-85	Highly resistant to turcicum leaf blight	Early maturing
Mesta	AS-7	1.0-1.2	–	125-130	–	Can withstand weed competition
	CPEL DPLL	0.8-1.0 0.8-1.0	– –	115-120 115-120	– –	Suitable for poor type of upland condition, can withstand weed competion
Jute (seed)	JRO-632	0.3-0.4	–	135-140	–	–
	JRC-212	0.4-0.5	–	140-145	–	–
Groundnut	AK 12-24	1.5-1.7	25-30	100-105	Highly resistant to tikka disease	Early maturing, small pods
	BG-3	2.2-2.4	30-35	110-115	Moderately resistant to tikka	–

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
	GG-2	2.0-2.2	25-30	100-105	-do-	Small seed
	JL-24	1.8-2.0	25-30	100-105	Moderately tolerant to tikka	Medium sized seed
	Birsa bold	2.5-3.0	30-35	125-130	Resistant to tikka disease	Highly bold seed (export quality)
Niger	Birsa niger 1	0.6-0.7	62-67	100-105	Resistant to disease and pest	Drought resistant
	N5	0.5-0.6	60-65	95-100	-do-	Highly drought resistant
Sesame	Kanke white	0.4-0.5	40-45	100-105	Moderate resistant to disease and pest	Susceptible to water logging
	Krishna	0.3-0.4	35-40	90-100	—	-do-
Greengram	Sunayna	0.7-0.8	35-40	55-60	Tolerant to *Cercospora* leaf spot	Capable to being grown as a summer crop
	K 851	0.6-0.7	35-40	60-65	–	–
Blackgram	T9	1.0-1.2	38	75-80	Susceptible to leaf post	Suitable for mixed cropping with marua (1:1)
	Birsa urad-1	1.0-1.2	—	80	Resistant to yellow mosaic virus and powdery mildew	-do-
	Pant U-19	2.0-1.2	36	75-80	Resistant to yellow mosaic virus	Erect type
Horsegram	Madhu	1.0-1.2	50-55	100-110	–	Highly drought resistant
	Birsa kulthi-1	1.0-1.2	45-50	90-95	Resistant to macro-phomina disease	–
Soybean	Punjab-1	2.0-2.2	35-38	105-107	Moderately resistant to yellow mosaic virus	Vigorous plant growth
	Birsa soya-1	2.2-2.5	38-40	110-115	Moderately resistant to Cater pillar and yellow mosaic virus	Black seeded
Linseed	T-397	0.7-0.8	65-67	125-130	Susceptible to rust	Drought and rainfed condition
	Sweta	0.7-0.8	60-65	125-130	–	Suitable for irrigated condition
	Shubhra	0.7-0.8	60-65	125-130	–	
Toria	BR-23	0.3-0.4	35-40	70-75	Immune to white rust	Escapes aphid attack
	Assam selection	0.3-0.4	35-40	70-75	-do-	-do-

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
	PT-303	0.4-0.5	30-35	65-70	Moderately resistant to aphids	–
Safflower	A-1	1.0-1.2	120-125	160-165	–	Drought resistant
	A-300	1.0-1.2	110-115	155-160	–	Highly drought resistant
Chickpea	BR-77	0.8-0.9	65-70	135-140	–	Suitable for normal sowing
	H-208	1.0-1.2	70-75	140-150	–	Suitable for late sowing
	Pant G.114	1.2-1.6	–	140-145	–	Normal and late sowing
Rai	BR-40	0.4-0.6	55-60	110-120	Susceptible to white rust	Drought resistant
	Baruna	0.4-0.6	–	110-120	–	–
	Pusa bold	0.6-0.7	–	115-120	–	–
Lentil	Pant 209	1.2-1.5	65-72	115-120	–	Drought resistant
	BR-25	1.6-1.8	70-75	120-125	–	
	Pant 406	1.8-2.0	75-80	130-140	–	
Barley	BR-31	1.5-1.7	–	105-110	*Helminthosporium* in traces	Drought resistant
	BR-32	1.5-1.7	—	110-115		
Wheat	C-306	1.0-1.2	55-60	115-120	Tolerant to rust	

Dir. Direct planting; Tran. Transplanting

5. Seeding rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Upland rice	100	20-25	Lines
Medium land rice	40-50	15	15
Low land rice	40-50	15	15
Fingermillet direct sown	10	20	Lines
Fingermillet (transplanted)	6	15-20	10
Maize	16	60	30
Sorghum	10	45	20
Minor millets	6-8	25	5
Pigeonpea	18	60	30
Soybean	60	45	5
Greengram	20	30	10

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Blackgram	20	30	10
Horsegram	20	30	10
Groundnut (Shelled)	80-85	30	10
Groundnut bold varieties (shelled)	100-110	30	15
Sesame	8	30	15
Niger	6	30	15
Rapeseed Mustard	10	30	5
Linseed	20	30	10
Safflower	15	40	10
Chickpea	75	30	20
Lentil	30	25	8
Barley	100	25	Lines
Wheat	60	23	Lines

6. Nutrient management

Crop	Nutrients (kg/ha)			Mode of application		
	N	P_2O_5	K_2O	Basal	1st top dressing	2nd top dressing
Rice -						
Local	30	20	20	All P_2O_5, K_2O and 50% N	50% N at 21 days after sowing	–
Improved	40	20	20	All P_2O_5, K_2O and 50% N	50% N at 21 days after sowing	–
High yielding	60	30	20	All P_2O_5, K_2O and 50% N	25% N at 21 days after sowing	25% N at 35 days after sowing
Rice - Medium land						
Local	40	30	20	All P_2O_5, K_2O and 50% N	50% N at 21 days after sowing	–
High yielding	80	40	40	All P_2O_5, K_2O and 50% N	25% N at 25 days after transplanting	25% N at 50 days after transplanting
Maize	100	60	40	All P_2O_5, K_2O and 50% N	25% N at 21 days after sowing	25% N at tasseling
Sorghum	80	40		All P_2O_5, K_2O and 50% N	25% N at 21 days after sowing	25% N at 50 days after sowing
Fingermillet (direct sown or transplanted)	40	30	20	All P_2O_5, K_2O and 50% N	50% N at 25 days after sowing	–
Minor millets	20	20	20	All P_2O_5, K_2O and 50% N	50% N at panicle initiation	–
Pigeonpea	20	40	20	All N, P_2O_5, K_2O	–	–
Soybean	20	40	20	All N, P_2O_5, K_2O	–	–

Crop	Nutrients (kg/ha)			Mode of application		
	N	P_2O_5	K_2O	Basal	1st top dressing	2nd top dressing
Greengram	20	40	20	All N, P_2O_5, K_2O	–	–
Blackgram	20	40	20	All N, P_2O_5, K_2O	–	–
Horsegram	20	40	20	All N, P_2O_5, K_2O	–	–
Groundnut	20	40	20	All N, P_2O_5, K_2O	–	–
Sesame	40	40	20	All P_2O_5, K_2O and 50% N	50% N at 21 days sowing	–
Niger	20	20	20	All N, P_2O_5 and K_2O	–	–
Rapeseed Mustard	20	30	20	All N, P_2O_5 and K_2O	–	–
Linseed	20	20	20	All N, P_2O_5 and K_2O	–	–
Safflower	20	20	20	All N, P_2O_5 and K_2O	–	–
Chickpea	20	20	20	All N, P_2O_5 and K_2O	–	–
Lentil	20	20	20	All N, P_2O_5, K_2O	–	–
Barley	20	20	20	All P_2O_5, K_2O and 50% N	50% N at panicle initiation	–
Wheat	20	20	20	All P_2O_5, K_2O and 50%	50% N at panicle initiation	–

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ Implement to be used	Time of application
Upland rice	Dutch hoe/ small spade	After three weeks of sowing and second after 35-40 days of sowing
Medium land (direct seeding)	Beushening by wooden plough	After 25-30 days of sowing
Medium land (transplanting)	Paddy weeder	After 20-25 days of transplanting
Low land (transplanted)	Paddy weeder	After 20-25 days of transplanting
Fingermillet	Dutch hoe/ small spade	After 20-25 days of sowing/ transplanting
Maize	Big size spade	After 20-25 days of sowing
Sorghum	Medium spade	After 20-25 days of sowing
Minor millets	Dutch hoe/ small spade	After 20-25 days of sowing

Crop	Tool/ Implement to be used	Times of application
Pigeonpea	Big size spade	After 20-25 days of sowing
Soybean	Medium size spade	After 20-25 days of sowing
Greengram	Dutch hoe/ small spade	After 20-25 days of sowing
Blackgram	Dutch hoe/ small spade	After 20-25 days of sowing
Horsegram	Dutch hoe/ small spade	After 20-25 days of sowing
Groundnut	Dutch hoe/ small spade	After 20-25 days of sowing
Sesame	Dutch hoe/ small spade	After 20-25 days of sowing
Niger	Dutch hoe/ small spade	After 20-25 days of sowing
Rapeseed Mustard	Dutch hoe/ small spade	After 20-25 days of sowing
Linseed	Dutch hoe/ small spade	After 20-25 days of sowing
Chickpea	Dutch hoe/ small spade	After 20-25 days of sowing
Lentil	Dutch hoe/ small spade	After 20-25 days of sowing
Barley	Dutch hoe/ small spade	After 20-25 days of sowing
Wheat	Dutch hoe/ small spade	After 20-25 days of sowing

Weed management – chemical

Crop	Effective herbicide	Dose l/kg (ai)/ha	Mode of application
Rice direct seeding	Butachlor 50 EC or Benthiocarb 50 EC	1.5 to 2 l	One or two days after sowing
Rice (transplanted)	Butachlor 50 EC or Benthiocarb 50 EC	1.5 to 2 l	5 to 7 days after transplanting
Maize	Atrazine 50%	1 to 1.5 kg	4 to 5 days after sowing
Oilseeds	Alachlaor 50 EC 2 sport 75 EC grain Fluchloralin 45 EC	2 l 1 l 2 l	1 to 2 days after sowing 15 days after sowing At the time of preparation of land
Pulses	Fluchloralin 45 EC	2 l	At the time of preparation of land
	Alachlor 50 EC	1 l	1 to 2 days after sowing
Pigeonpea + maize	Butachlor	1.5 kg	1 to 2 days after sowing

Insect pest management

Crop	Pest	Control measures
Rice	Gall midge	Resistant varieties IR 36 Rajendra dhan 202. Broad casting of carbofuran 3 G 16.0 kg/ha (ii) Forat 10 kg 5 kg/ha are used after 35 days of transplanting
Rice	Stem borer	Spraying of insecticide, Monocrotophos 36 E.C. 1000 ml/ha
Rice	Cut worm	Spraying of Endosulfan or 0.24 carbaryl
Rice	Rice hispa	Clean cultivation, or dusting Linden
Rice	Gundhi bug	Adopt clean cultivation, or dusting to Linden
Maize	Stem borer	Apply Endosulfan 4% dust or Phorate 10G, in the whorl after 3 weeks of sowing
Blackgram Greengram Soybean	Bihar hairy caterpillar	In the beginning stage, affected, plants are up rooted and burring in the soil. Early stage of caterpillar, spraying chlorpyrophos, 5 ml in 10 l water is effective.

Crop	Pest	Control measures
Pigeonpea	Pod borer	Spraying of Endosulfan 2.c.c./water at the time of 50 percent flowering second spraying after 15 days of first spraying
Chickpea, wheat	Termites	At the time of last preparation of land, Lindane 25 kg/ha is used In case of standing crop chlorophos 20 EC 2.5 l/ha is sprayed.
Mustard or Toria	Aphids	Spraying of Monocrotophos 36 EC 2l/ha

Diseases management

Crop	Diseases	Control measures
Paddy	Blast, leaf blight	Seed treatment with Bavistin/Captan 2 g/kg seed Hinosan 1 litre (50 EC) per 1000 l water spraying. Spraying of Indofil 45, 2.5 g/l of water
Finger millet	Wilt	Crop rotation Use resistant varieties. Seed treatment with Bavistin 2 g/kg seed
Chickpea	Wilt	Same as pigeonpea
Blackgram	Leaf blight	Spraying of Indofil 45 23 g/l of water every 10 days interval and greengram
Maize	*Helminthosporium*	Seed treatment with Thiram 2.5 g/kg Spraying, Indofil 45 or Indofil Z 78, 2.5 g/kg of seeds

8. Suitable cropping systems

Non arable lands

- Tree farming (Sal, Teak, *Shorea robusta*)
- Silvipastoral system (Shisham/ *Leucaena*/ gamhar + Stylo/ *Cenchurus*/ mixture)
- Arable wastelands
- Agri-horticulture: Fruit crops (Nungo/ citrus/ sapota/ pomegranate/ custardapple/ litchi/ Jack fruit jamun) + Field crops (pulses/ oilseeds)
- Alley cropping: *Leucaena* + turmeric/ginger

Low fertility, unbunded uplands

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

Uplands

Mono-cropping

- Upland, fingermillet, pulses, oil seeds and *kharif* vegetables like cauliflower, capsicum, lady's finger and French bean etc.

Sequence cropping

- Rice (Brown gora 23 –19), Birsa dhan 101, and Vandana Niger and Toria

Intercropping

Pigeonpea based

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

Medium lands

- Rice (IR 36, IR 64, Pant 4) / linseed (T 397)/ chickpea (BR 17, BR 77 and C 235)/ safflower (A 300, 59-2-1)/ lentil (BR 25) Rai (BR 40) and Niger (N5)
- Relay cropping
- Rice (Ladut, Swarna, IR 36 etc)- Lathers (local)

Lowland

Sequence cropping

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

9. Farm Implements/ Tools

Tool / implement	Cost / unit (Rs)	Operation
Bullock drawn 2 row seed-cum-fertilizer drill	2300/-	For seeding and fertilizer application
Bullock drawn ridger Seeder (single row)	480/-	For seeding when 8-10 cm topsoil gets dry, soil moisture is available below this depth. Seed metered by hand
Bullock drawn potato digger	280/-	For digging potato crop
Birsa seed-cum-fertilizer drill – *kharif* crops	400/-	For intercrulture operation
Dutch hoe	40/-	For intercrulture operation
Grubber	40/-	For intercrulture operation
Dryland weeder	80/-	For intercrulture operation

10. Contingent crop planning

Normal sowing period (15th to 30th June)

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

Intercropping

- Pigeonpea + rice, pigeonpea +maize, pigeonpea + groundnut, pigeonpea + 2 rows pigeonpea, pigeonpea + blackgram/greengram, (two row) pigeonpea + 2 rows soybean.
- If the onset is delayed but is expected with in a week or 10 days of normal onset date – Dry seeding of all the rice and groundnut varieties mentioned above in mid June

Delayed sowing period (1 – 7 July)

- Groundnut seeding with AK 12-24 can be extended upto first week of July. BG1 and BG2 should not go beyond June.
- Direct seeding of fingermillet: A 404, PR 202, IE 723
- Pigeonpea: BR 183, BR 165, Upas 120, T 21
- Blackgram: T 9
- Maize (ridge planting): Rajendra Makka, Diara
- Pigeonpea (BR 65)+ Groundnut (AK 12-24) intercrop
- Greengram: Sunayana

Much delayed sowing (2nd to 4th week of July)

- Transplanting of fingermillet (all varieties) but spacing to be reduced from 20 x 15 to 20 x 10 cm

- Greengram: Sunaina
- Blackgram: T.9
- Sasame: Kanke white (normal sowing time), Krishna
- Sweet potato: Cross 4 and Local (normal sowing time)
- Much too late for general crops (early August). Niger (N.5) and horsegram (BR 10 Madhu) are the natural choice seeding
- Transplanting of fingermillet if seedlings are available could be resorted to in early August.

11. Other supportive practices

- Apply post – monsoon pre-sowing mulching with locally available straw (10.0 t/ha) to get better plant stands of wheat.
- Grow niger even as *rabi* crop if moisture is adequate for germination particularly in medium textured deep soil.
- Diversify with adoption of rice, grow plant short (90-100 days), medium (120 days) and long duration (140 days) varieties of rice in tanr (upland), medium land and low (don I) land respectively on toposequence. Increase the acreage under 90-100 days varieties up to don II land to escape the damage caused due to early cessation of monsoon. Take advantage of late rains for *rabi* sowing if any.
- In Fingermillet – farm yard manure (2.5 t/ha) + 40kg N (50% basal + 50% one month after transplanting) + 30kg P_2O_5 + 20 kg K_2O /ha is effective.
- Chickpea – farm yard manure compost (4 t/ha) + 30 P_2O_5 + 20kg P_2O_5 /ha.
- Rice – early season drought (with in one month after sowing) application of 5 cm minimal irrigation.
- General precautions in case of delayed sowing
    - Pre-monsoon tillage will pay dividends under such a situation in keeping weeds under control.
    - Crops should be spaced a little closer to compensate for loss in growing period.
    - Heavier dose of basal nitrogen and less number of splits should be followed specially in short duration crops.
    - Under these conditions, since there is possibility of continuous rains proper care should be taken for the drainage of upland crops that suffer from water logging at emergence state and some even at later stages.

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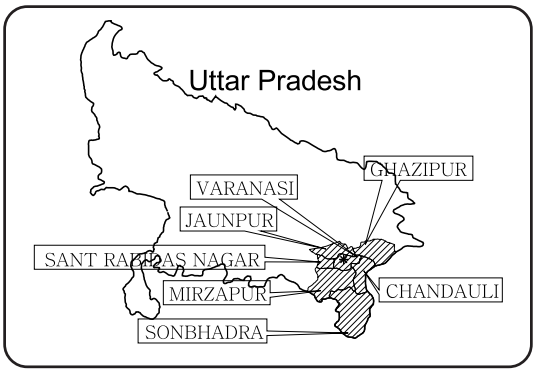

VARANASI

Rainfed Rice based Production System in *Kharif Rabi* Sub-humid Deep Inceptisols

1. Region

Varanasi, Chandauli, Sant Rabidas Nagar, Jaunpur, Ghazipur, Mirzapur and Sonbhadra districts of Uttar Prdesh in Varanasi and Vindhyachal commissionaires

2. Climate

The mean annual rainfall of the region is 1080 mm (909 mm dependable). Mean annual potential evapotranspiration is 1525 mm for Varanasi and 1625 mm for Mirzapur and Sonbhadra districts. Variability in commencement of South West monsoon is 37±9 and of withdrawal 35±12 days. Moisture availability period extend from standard week 26 to 05 (moisture availability index 70.5) with growing season ranging between 26 to 30 weeks.

3. Soils

Region representing Varanasi mandal is located in physigraphic belt of Northern plain, hot sub humid (dry) ecoregion of hot dry sub humid Avadh and South Bihar plains, with deep loamy Alluvium derived soil, medium to high available water capacity and length of growing period 150-182 days. Mirzapur and Sonbhadra districts are located in moderately to gently slopping hot moist/ dry sub humid transition with deep loamy to clay red and yellow soil, medium available water capacity and length of growing period 150-180 days.The region comprising districts of the region represents broadly 3 major soil groups: Landforms generally comprise Vindhyan hills (undulating topography) foothills and Vindhyan range (with depression) and plains (rolling topography).

Alluvial regions have uplands, midlands, lowlands, flood plains. Vindhyan region have upper plateau plains, escarpments, lower plateau plain, valley plain, reservoir and hillocks. Alluvial soils are characterized by entisols and inceptisols. Red soils are Alfisols and black soils are Vertisols. Moisture availability 180-260 mm (120 cm profiles). Crusting is a problem in uplands.

Medium severity water erosion occurred with slight loss of top soils, affecting 26-50% area. Moderate physical deterioration due to water logging affected 11-25% area.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Rice	NDR-97	3.0	70	96	–	Suitable for sequence cropping
	NDR-118	2.7	71	95	–	-do-

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
	Govind	2.5	70	100	Resistant to bacterial leaf blight & blast	Suitable for sequence cropping
	Vandana Cauvery Akashi	2.5	65	93	–	–
Maize	Ganga safed-2 Kanchan Jaunpuri Ganga-5	2.8-3.0 2.5-3.0 2.0-2.5	100-105 45-45 40-45	60-65 75-80 70-75	–	Suitable for sequence and intercropping
Pearlmillet	Pusa-23	1.7-2.3	45-50	80-85	–	Suitable for sequence and intercropping
	Pusa-322	2.5-3.0	40-45	75-80		
Blackgram	T-9	1.7	44	82	Susceptible to mosaic	Suitable for sequence and intercropping
	Pant U-19 Pant U-35	1.5-1.6 1.2-1.5	45 45	85	Resistant to mosaic yellow mosaic virus	-do-
Greengram	T-44	1.0-1.1	43	66	Susceptible to yellow mosaic virus	Suitable for sequence and intercropping
	Pant Moong-1	1.0-1.2	45	65-70	Resistant to yellow mosaic virus	
	Narendra Moong-1	1.2-1.5	52	70-75		
Sesame	T-13 T-4 T-12	0.7 0.6 0.5	64 60 64	92 90	Susceptible to stem rot	Suitable for sequence and intercropping
Pigeonpea	Bahar	2.5-3.0	200-210	260-270	Resistant to wilt	Suitable for pure and intercropping
	Narendra arhar		200-220		-do-	Suitable for pure and intercropping
	T-21	1.2-1.3	99	176	Susceptible to wilt & pod borer	Suitable for sequence and intercropping
Wheat	Malviya –533	2.8-3.0	72	135	–	–
	C 306	2.6-2.7	87	142		
	K 8027	2.8-3.0	78	140	Resistant to smut & blight	–
Barley	DL 3	3.5-3.6	71	127	Affected by	–
	K 125	3.2-3.3	72	128	helminthosporium	
	Ratna		71	129	-do-	

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Chickpea	T-3	3.3	97	154	Severe wilt	–
	T-6	3.0-3.1	90	153	infestation	
	BG 1	3.4-3.5	97	155	-do-	
	BG 2		99	156	-do-	
	Type -1					
Lentil	Pant L-406	1.6-2.0	90	135	Resistant to wilt	Small seed
	Pant – 639	1.6-1.8			-do-	–
	L-4076	1.4-1.6	85		-do-	Bold seed
	K-75		75	125	-do-	–
Safflower	N 62-8	2.6-2.7	116	162	Susceptible to *Alternaria* blight *Rhizoctonia*	–
	K-65	1.4-1.5	120	180-190	–	–
	Malaviya Kusum 30		110	160	–	–
	Local	2.6-2.7	117	160	–	–
	IC-11842	2.5	119	162	–	–
Rapeseed mustard	T-59 (varuna)	1.9	65	110	Susceptible to aphids	–
	Vardhan	1.8-2.0	60		Susceptible to	–
	Kranti	1.6-1.0			aphids	
	Sanjukta	1.5-1.8	55	95	-do-	–
Linseed	T-397	1.8	95	130	–	–
	Neelam	1.5-1.6	105	135	Susceptible	
	Garima Mukta	1.5-1.6	105	135	to aphids	

5. Seeding rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Rice/ wheat/ barley	100	30	Thick sown
Chickpea	80	45	10
Blackgram/ greengram	15	30	—
Safflower	15	45	10-15
Maize	15	60	20
Rapeseed mustard/ pearlmillet	5	45	10-15
Sesame	5		
Lentil	30		
Linseed	25		

6. Nutrient management

Crop	Nutrients (kg/ha)		
	N	P_2O_5	K_2O
Upland rice	80	40	30
Barley	80	40	30

Crop	Nutrients (kg/ha)		
	N	P_2O_5	K_2O
Wheat	80	40	30
Chickpea	20	40	20
Sesame	40	*	*
Rapeseed Mustard	40	*	*
Safflower	40	*	*
Linseed	40	20	*
Lentil	20	40	20

- During *kharif* place 1/2 N basal in seed furrows and remaining 1/2 top dress when surface is moist (30 to 40 days after seeding). In *rabi* place fertilizer 10-15cm deep in the seed furrows. Apply P_2O_5 and K_2O based on soil test basis to these crops.
- In upland rice use of Agromin (chelated micronutrients) 0.16% solution spray when crop is about 45 days old helps in increasing yield.
- On availability of organic source of fertilizer, its conjunctive use along with chemical fertilizers in proportion of 50:50 has confirmed its utility in sustaining the productivity of component crops in the proven system due to improved soil health.

7. Pest and disease management

Weed management

Keep upland rice fields weed free for the first 30 to 40 days followed by either mechanical or chemical control measures. Weed free upto 30 days after sowing in *kharif* crops in all other crops

Weed management – mechanical

Crop	Implement/tool	Time of operation
Rice	Dryland weeder	25-30 and 45-50 days after sowing
Pigeonpea/ blackgram/ greengram	-do-	-do-
Pearlmillet/ sorghum	-do-	-do-

Weed management – chemical

Crop	Herbicide	Dose kg (a.i.) ha	Method of application
Upland rice	Butachlor	2	Preemergence
Pigeonpea/ blackgram	Pendimethalin	2	-do-
Pearlmillet/ sorghum/ maize	Atrazine	1	-do-

Integrated - mechanical and chemical

Crop	Chemical	Mechanical	Remarks
Upland rice	Butachlor 4 to 7 kg a.i./ha as preemergence	One interculture by dry land weeder 30 days after sowing	Keep the field free of weeds in the first 4 days. Work 2 to 3 times
Pigeonpea + blackgram	Pendimethalin 3 l/ha as preemergence	-do-	-do-

Crop	Chemical	Mechanical	Remarks
Pearlmillet / sorghum	Atrazine 1-2 kg a.i. /ha as preemergence	Two interculture operations 30-35 days after sowing and 40- 45 days after sowing with Dryland weeder	

Insect pest management

Crop	Pest	Control measures
Upland rice	Stem borers	Dusting of Furadon 15-16 kg/ha 30 days after sowing
	Ghundi bugs	Dusting of 10% BHC. 15 kg/ha at heading
	Army worms	Dusting of Folidol 15-20 kg/ha at heading (after sunset)
Pearlmillet and maize	Stem borer	Broadcast of Lindane (6%) 20 kg/ha
Pigeonpea and chickpea	Pod borer	Spraying of 250 ml Dimecron or 1.5 l Thiodon in 1000 l/ha of water at flowering and pod formation.
Mustard, linseed and safflower	Aphids	Two sprayings of 250 ml Dimecron at flowering

Disease management

Crop	Diseases	Control measures
Rice	Blight	Spray mixture of 75 g Agrimycin 2.0 kg Diathane M-45 and 1.0 l Thiodon dissolved in 100 l/ha water
Blackgram/ greengram	Mosaic	Spray mixture of 75 g Agrimycin and 2.0 kg Diathane M-45 in 1000 l/ha water
Wheat and Barley	Brown spot	Spray mixture of 2.0 kg/ha Diathane M-45 and 75 g Agrimycin in 1000 l/ha water at 30-40 days after sowing

8. Suitable cropping systems

Water availability period (days)	Double cropping system	Intercropping system
	Inceptisols and related soils	
200-230	Rice – chickpea	Chickpea + mustard (4:1)
	Rice – lentil	Maize+ blackgram (1:1)
	Rice – mustard	Pigeonpea + blackgram (1:1)
	Maize – lentil	Pigeonpea + sesame (1:1)
		Pigeonpea + groundnut (1:2)
		Barley + mustard (6:1)
180-200	Pearlmillet – chickpea	Pearlmillet + pigeonpea (2:1)
	Greengram – mustard	Chickpea + mustard (4:1)
	Greengram – barley	Chickpea + barley (2-3:1)
	Blackgram – mustard	Chickpea + linseed (2-3:1)
	Blackgram – barley	
	Alfisols and related soils	
150 and above	Sesame – chickpea	
	Blackgram – chickpea	Pigeonpea + blackgram
	Blackgram – mustard	Pigeonpea + groundnut (1:1)
	Mazie – mustard	
Less than 150	Niger – mustard	Maize + blackgram (1:3)
		Maize + okra (1:1)

Sequence cropping

- Rice-lentil/ rapeseed mustard/ chickpea
- Pearlmillet - lentil/ rapeseed mustard/ chickpea
- Sesame-lentil / rapeseed mustard/ chickpea
- Blackgram –barely/ rapeseed mustard (if barley or mustard are taken after blackgram in *kharif* (20 kg N/ha can be saved in *rabi)*
- For fodder: Maize + cowpea – oats, pearlmillet + cowpea – oats
- Blackgram (T.9)/ sesame in pigeonpea (Bahar NA-1) as base crop (30+90 cm)
- Blackgram + pigeonpea (1:2)
- Sesame + pigeonpea (3:4)
- Barley + rapeseed mustard (8:1)
- Lentil + rapeseed mustard (4:1)
- Okra + pigeonpea
- Tomato + linseed

9. Farm implements / Tools

Tool implement	Cost/ unit (Rs)	Operations
Bullock drawn Malviya multi-farming machine	2350/-	For field preparation For seeding dryland crops and fertilizing through mechanical metering device For intercultivation between two plant rows (particularly *Kharif* season crop)
Dryland weeder (modified from of weeder supplied by TNAU)	70/-	For weed control between plant rows of rainfed crops

TNAU - Tamilnadu Agricultural University

10. Contingent crop planning

Normal season

Recommended crop and varieties along with other cultural practices should be followed

Kharif

- Rice: NDR-97, NDR-118, Govind, Vandana
- Maize: Ganga safed-2, Kanchan, Jaunpuri
- Pearlmillet: BJ 104, Pusa 23, Pusa 322
- Blackgram: T9, Pant U-19, Pant U-35
- Greengram: Jyoti, Jagriti, Janpriya, Pant moong-1, Narendra moong-1
- Sesame: T4, T12, Gujrat til-1
- Pigeonpea: Bahar, NA-1, T21

Rabi

- Lentil: Pant L-406, Pant L-639, L 4076, K 75
- Wheat: HUW-533, K-8027, C-306

- Barley: DL3, Jyoti, K125
- Mustard: Varuna, Vardhan, Sanjukta, Kranti
- Linseed: Garima, Neelam
- Chickpea: Pusa 256, Awarodhi

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, resowing with the same variety.
- Gap filling/transplanting in case of cereals like upland rice and pearlmillet may be done if drought occurs about a month after seeding and is followed by showers. Follow this by light top dressing i.e. 10-15 kg/ha N. 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 and low lands. Uplands should be considered for pigeonpea based 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 pearlmillet (BJ 560, BJ 104), blackgram (T9), greengram (Jagriti, Jyoti) should be taken up. Pulse based intercropping is also recommended. Yet another alternative could be to harvest a fodder of sorghum, pearlmillet, maize or mixture of either of cowpea, blackgram, greengram and one of the above fodder crops. These crops will be followed by winter crops like mustard, barley, lentil, linseed and chickpea.

Early withdrawal of rains towards the end of season

- Normal growing of short duration *kharif* crops such as upland rice (NDR-97 or Vandana), blackgram (T9), sesame (T13) may be done. Sorghum, maize, pearlmillet, 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 grain legumes (blackgram and greengram) should be grown
- Among cereals, pearlmillet (BJ-104) performs better
- Intercropping blackgram in inter rows of redgram 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, 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 percent yield could be compensated by one life saving irrigation (5 cm depth)
- Amongst pulses, blackgram, greengram and pigeonpea even sown with onset of monsoon have performed better in uplands and medium lands and recommended for combating drought.

11. Other supportive practices

- Dry seeding of rice varieties like Vandana, Zhu and NDR 97 (90 to 95 days duration) survived better in the situations as compared to recommended varieties. Such varieties also exhibited better tolerance to drought.
- Interculture operations including preemergence application of weedicide proved effective in judicious utilization of profile soil moisture and intermittent light showers during drought for standing crop of rice.
- Sow all *kharif* and *rabi* crops in lines only
- Sow upland rice after monsoon sets in and when 15-20 cm soil layer in wet
- In case of *rabi* crops, place the seed in moist zone with the help of drills
- Recycle the harvested water for protective irrigation of barley at jointing stage and of wheat at Crown root initiation (CRI) stage as well as for raising tomato and rajmash crop in winters
- For termite control, treat the soil with 20-25 kg/ha of 10 percent BHC and mix thoroughly with the soil during seed bed preparation in both the seasons
- 2 rows of rice (NDR-97) in pigeonpea (Bahar NA-1) as base crop in 1:2 ratio (ridge furrow system)
- Okra (Prabhani kranti/ Arka Anamika) in pigeonpea rows (60cm)
- Tomato with lentil and linseed

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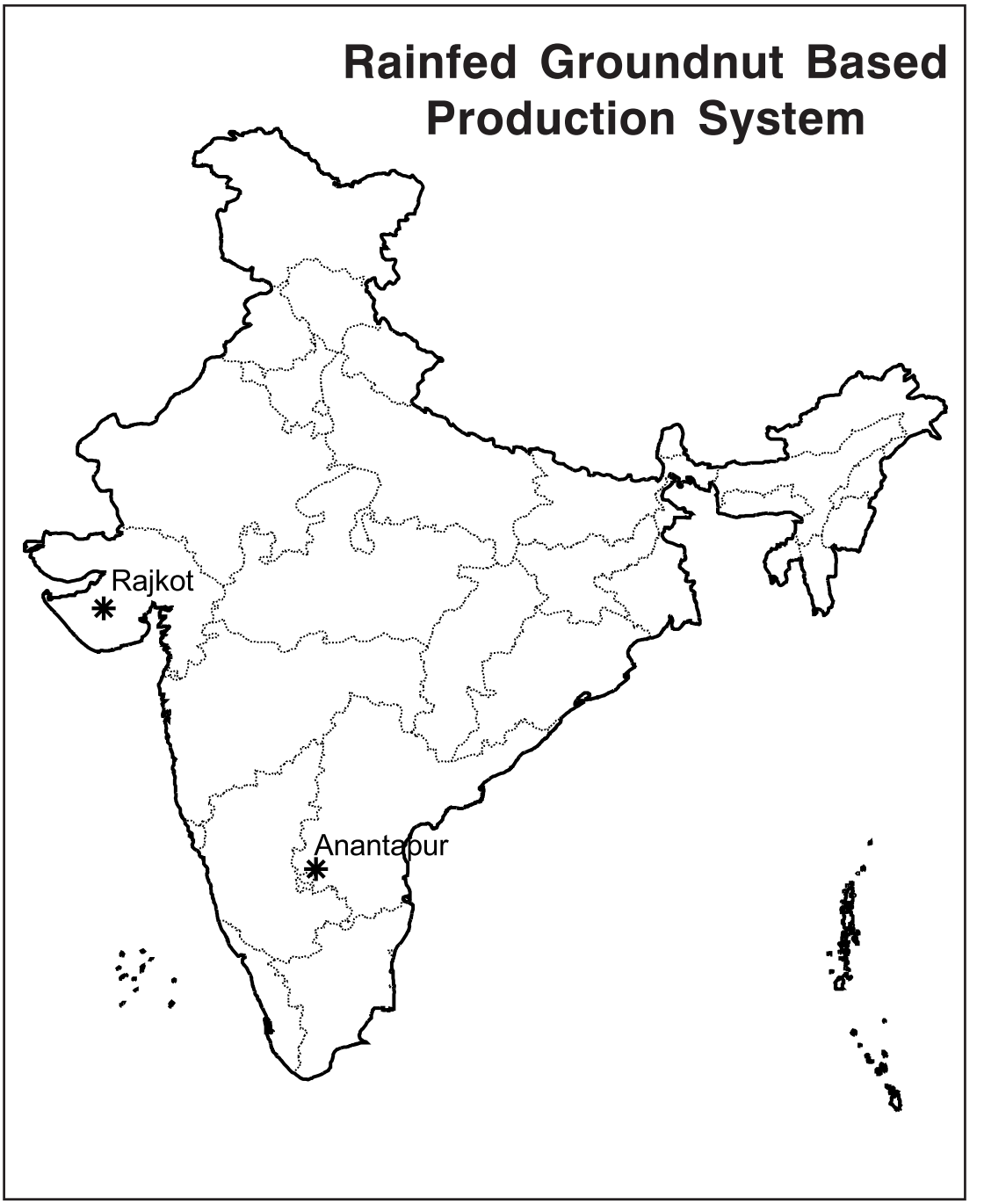
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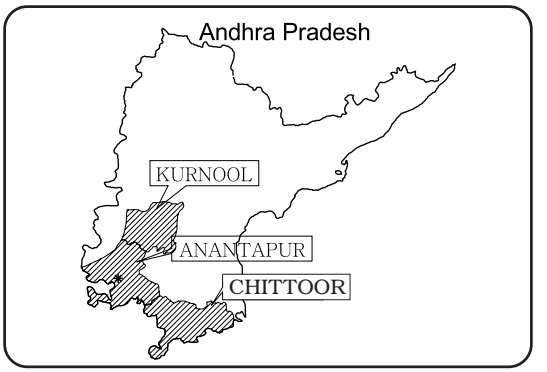

ANANTAPUR

Groundnut based Production System in *Kharif* Arid Shallow Alfisols

1. Region

Anantapur, Kurnool, and Chittoor districts of Andhra Pradesh

2. Climate

The decennial mean annual rainfall is 616 mm received in 36 rainy days. There is an increase in the rainfall during the period from 1990-2000. In the recent past, the sowing rains are being received during August first week instead of second fortnight of July. The decennial normal rainfall during *kharif* (June-September) is 394 mm received in 21 rainy days. Among the months, the mean decennial rainfall in August turned out to be heavy rainfall month with 116.5 mm received in 6 rainy days. The analysis of the rainfall indicated that the crop is subjected to terminal season drought. There are no significant fluctuations in the temperature during the cropping period. High wind velocity ranging between 12.1 to 17.9 km/h exists between May and August.

3. Soils

The soils of the region are red sandy loams with compact subsoil having 10-15 cm/m available water. Soils have serious crusting problem and high infiltration. They are near neutral in soil reaction, deficient in nitrogen and zinc and medium to high in potassium and phosphorus.

4. Crops and varieties

Crops	Varieties/ Hybrids	Duration (days)	Reaction to pests and diseases	Remarks
Groundnut	TMV - 2	105-110	Susceptible for foliar diseases	Suitable for scarce rainfall areas, no dormancy
	Vemana	105-110	Tolerant to foliar diseases	Tolerant to drought, Dormancy present.
	TPT-4	105-110	–	Tolerant to drought
Sorghum	CSH-5	105-110	Tolerant to grain molds	—
	CSH-9	105-110	Tolerant to grain molds	—
	CSH-13	110-115	—	Tall and yields more fodder
	NTJ-1	105	—	Drought tolerant and grain is easily separated from the panicle
	NTJ-2	95-100	—	Early in duration, bold white shiny grain and easily separated from the panicle
	NTJ-3	100-105	Tolerant to leaf spot disease	Yields more fodder and drought tolerant

Crops	Varieties/ Hybrids	Duration (days)	Reaction to pests and diseases	Remarks
Pearlmillet	ICTP-8203	80-85	Tolerant to green ear disease	Grain white and bold, tolerant to drought
	ICMV-221	85-90	Tolerant to green ear disease	Composite variety
	ICMH-451	85-90	Tolerant to green ear disease	Hybrid, grows upto 175cm; 2-3 tillers, grain medium bold, ash colour
Setaria	Lepakshi	80-85	—	Tolerant to drought, suitable for shallow soils with low rainfall areas, more tillers and quality straw
	Krishnadevaraya	80-85	—	Bold grain, light yellow colour, plant height up to 110 cm, 4-6 tillers with quality straw
	Narasimharaya	80-85	—	Bold grain and yellow in colour, plant height up to 110-120 cm, more number of tillers
Castor	Kranthi	90-150	—	Drought tolerant, bold seed
	GCH-4	150-210	Tolerant to wilt and dry root rot diseases	—
Pigeonpea	Palnadu (LRG -30)	170-180	—	Bushy plant, yellow flowers, medium bold grain with brown pod coat. Suitable for intercropping in groundnut

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern spacing (cm)	
		Inter row	Intra row
Groundnut	100	30	10
Castor	10	90	30
Pigeonpea	15	90	20
Pearlmillet	5	45	10
Setaria	5	30	5
Sorghum	8	45	15

6. Nutrient management

Crop	Nutrients (kg/ha)			Remarks
	N	P_2O_5	K_2O	
Groundnut	20	40	40	For groundnut apply P_2O_5 and K_2O as per soil test values. Reduce to 50% of recommendation if soil test value is medium; do not apply if soil test value is high. If soil test value is low, apply as per recommendation
Castor	60	40	30	—
Pigeonpea	20	40	40	—
Pearlmillet	40	40	40	N dose ranges from 40-80 kg N/ha depending on rainfall
Setaria	40	40	40	

7. Pest and disease management

Insect pest Management

Crop	Pest/ disease	Control measures
Groundnut	Root grub	Apply Thimmet or Phorate granules at 10 kg/ha to soil before sowing or treat the seed with Chlorpyriphos 6 ml/kg seed
	Aphids, leaf miner	Spray 0.05% Endosulfan or Dimethoate or Monocrotophos
	Red hairy caterpillar	Arrange bonfires 2 days after soaking rain from 8 PM to 10 PM Make a furrow around the field, and apply Carbaryl dust in the furrow and also on the bunds
		For second and third instars larvae spray Dimethoate 2 ml/l or Monocrotophos 1.6 ml/l
		Poison bait with 10 kg rice bran + 1 kg jaggery + 500 ml Quinolphos can be applied for effective control.
Sorghum	Shoot fly	Prevent sowing early with first showers in the season, use more seed rate and thin by removing the affected seedlings to maintain optimum stand.
	Stem borer	Apply Carbofuran granules 10 kg/ha in whorls with in 35-40 days after sowing
	Mite	Spray wettable sulphur 3 l or Phosalone 35 EC at 2.5 ml/l
Pigeonpea	Pod borer	Spray Chlorpyriphos 20 EC 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.
Castor	Semilooper	Spray Carbaryl (50%) 3 g/l or Monocrotophos (36%) 1.5 ml/l or curacron 2 ml/l
	Capsule borer	Spray Monocrotophos 40 EC 1.6ml/ l or Quinalphos 25 EC 2 ml/l once at flowering and again after 15 days

Disease management

Crop	Pest/ disease	Control measures
Groundnut	Late leaf spot	Spray Mancozeb 2 g + Carbendazim 1 g/litre or Hexaconazole 2 ml/l for Chittoor district. Spraying can be taken up based on leaf wetness at 70 days after sowing in Anantapur district. There is no need to spray for July sown crop in Anantapur and Kurnool districts
	Stem necrosis	Removal of weeds, particularly *Parthenium*, on the bunds and in the field.

8. Suitable cropping systems

- Pigeonpea mostly as an intercrop in groundnut. Groundnut + pigeonpea in 7:1 ratio is the most popular intercropping system. Groundnut + pigeonpea in 11:1 ratio and a tamarind tree for every one ha.
- Horsegram mostly as contingent crop.
- Groundnut + castor in 7:1 or 11:1 ratio

Alternate land use

- Crop + livestock (sheep 10/ha) system of farming will give 80% more income than cropping system alone.

9. Farm Implements/ tools

Name	Cost/unit in Rs.	Operation
Eenatigorru (bullock drawn, four row)	1500/-	Useful for sowing, seed and fertilizer placement. Suitable for those who have light draft animals.
Seed drill/planter (tractor drawn, nine row)	16000/-	It is a mechanical seed drill. More area can be covered in a day and intra row spacing is maintained.
Ashaguntaka (tractor drawn, seven row)	20000/-	Useful for harvesting of groundnut crop. More field capacity and labour saving.
Groundnut thresher cum decorticator	45000/-	Useful for separating groundnut pods from haulms. It was found advantageous to thresh the 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.

10. Contingent crop planning

Early onset of monsoon
- Sorghum, greengram, pigeonpea, castor (May – June)

Normal onset of monsoon
- Groundnut, pigeonpea, groundnut + pigeonpea (July).

Late onset of monsoon
- Pearlmillet, sorghum, greengram (after August 15th)

Very late onset of monsoon
- Pearlmillet, cowpea, horsegram (early September)

11. Other supportive practices
- Deep ploughing once in three years, where soil depth is 20 cm or more.
- Preparatory cultivation with country plough or "*Chekkala guntaka*", a traditional implement increases the yield of groundnut.
- Sand application 40 t/ha applied during summer increases the yield of groundnut
- Drought management practices like application of groundnut shells 5 t/ha at 10 days after sowing.
- Contour bunding with a cross section of 0.63 m and with horizontal spacing of 25 m to 125 m is recommended for red soils. The other soil conservation measures like compartmental 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.
- Lining the pond with Cuddapah slabs can reduce seepage losses in farm ponds.

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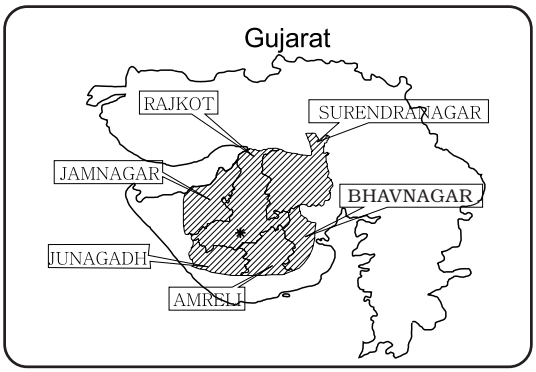

RAJKOT

Groundnut based Production System in *Kharif* Arid Deep Vertic/ Vertisols

1. Region

North Saurashtra agro-climatic zone in Gujarat covering Rajkot, Surendranagar, parts of Jamnagar, Junagadh, Bhavnagar and Amreli districts.

2. Climate

The area comes, predominantly, under the dry region viz., arid and semi-arid climates (73 percent of total area). The region receives rainfall during July to September, about 60 to 65 percent of total rainfall is being received only between the narrow window of July and August months. Annual rainfall over different parts of the zone varies from 350 to 650 mm distributed over 19 to 31 rainy days.

3. Soils

This region is predominantly of *kharif* black soils. The major soil types of the North Saurashtra agroclimatic zone in order of priority are: medium black, coastal alluvial, shallow black saline alkali, residual sandy and hilly. The soils are considered productive and highly retentive of moisture because of more clay content. In general, the soils are sandy clay loam to clayey in texture. The water holding capacity varies from 36 to 58 percent and field capacity varies from 18 to 32 percent and wilting coefficient around 11 percent. The bulk density varies from 1.2 to 1.8 g/cc and pore space ranges from 20 to 60 percent. Infiltration rate is moderate to moderately low.

The chemical characteristics show that the soil reaction is neutral to alkaline, *p*H ranging from 7.4 to 8.5 and electrical conductivity from 0.1 to 0.9 mmhos/cm (1:2.5), soil-water suspension. In most of the profiles the electrical conductivity increases with soil depth. Calcium carbonate content varies from 3.5 to 22.5 percent. The soils are rich in available potash, low to medium in available nitrogen as well as available phosphorus. Because of calcareous nature, the phosphorus fixing capacity is also high. Available zinc and sulphur are also low.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Pearlmillet	GHB-235	2.9	47.52	73-77	Downy mildew	Suitable for scanty rainfall areas of Gujarat
	GHB-316	3.3	52-55	77-82	Downy mildew	
	GHB-558	3.5	55-60	82	Downy mildew	
	MH-169	3.4	42.47	67-22	Downy mildew	Suitable for arid and semiarid areas of Gujarat

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Sorghum grain	GJ-39	3.4	62-65	95-100	—	Suitable for mono and intercropping systems in Gujarat
	GJ-40	3.5	67	104-108	—	
	GJ-41	4.0	70-75	90-100	—	
	GJ-42	4.1	77	121	—	
Sorghum Fodder	GFS-4	3.5	40-45	—	—	—
	GFS-5	3.8	58	—	—	—
Cotton	G.Cot-10	1.0	60-70	180	—	Mathio cotton suitable for Saurashtra region, Amreli, Bhavnagar and part of Rajkot districts and Vagad cotton suitable for part of Surendranagar, Ahmedabad and Rajkot districts
	G.Cot-13	0.4	140	245-280		
	G.Cot-15	0.3	40-50	120-150		
	G.Cot-18	0.4	60-70	175-180		
	G.Cot-21	0.5	142	217		
	V-797	0.8	140	260-300		
	G.Cot-H-8	1.0	50-60	170-190		
Greengram	GM-4	1.4	35-40	60-65	Yellow mosaic	Suitable for mono and intercropping systems
	K-851	1.2		65-70	Yellow mosaic	
Pigeonpea	GT-100	0.9	80-90	145-155	—	Suitable for sole crop and also for intercropping system with groundnut
	ICPL-87	0.9	75-85	134-145	—	-do-
Clusterbean	GG-1	1.0	46-54	85-90	—	Suitable for mono / intercropping system in North Saurashtra and Kachch
	HG-75	1.1	45-52	82-88	—	
Groundnut (bunch)	GG-2	3.5	24-29	100-105	—	Suitable for mono and intercropping systems
	GG-5	3.7	25-30	101	—	
	GG-7	3.9	25-29	100	—	
Groundnut Semi-spreading	GG-20	2.2	28-33	109	—	—
Groundnut Spreading	GAUG-10	2.1	29-34	110-120	—	Suitable as sole crop
	GG-11	2.2	31-37	111	—	
	GG-12	2.4	30-35	112-115	—	-do-
	GG-13	2.3	30-35	120	—	-do-
Sesame	G-Til-1	1.1	45	90	—	Suitable as sole crop
	G-Til-2	1.1	42	85	—	-do-
	Purva (semi-*rabi*)	0.7	55	115-120	—	Suitable for intermediate *kharif* – *rabi* season

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Castor	GAUCH-1	1.53	55-60	210-260	—	Suitable for mono cropping and also for intercropping system with groundnut recommended for north and middle Gujrat and Saurashtra, Kachch area
	GCH-4	1.75	55-60	210-240	Wilt	
	GCH-5	1.71	60-61	210-240	—	
	GCH-6	0.89	50-58	210-240		
	GC-2	7.92	45-50	150-180		
Maize	G.Maize-2	4.42	50-55	75-80	—	—
	G.Maize-4	4.54	45-50	70-75	—	—

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Sorghum	8-1	45	15
Pearlmillet	3.75	60	15
Groundnut (bunch)	100	45	10
Groundnut (semi-spreading)	100	45	10
Groundnut (spreading)	80	60	10
Cotton	12-15	90	30
Castor	10	9	30/45
Greengram	20	30	10
Sesame	3	45	15
Pigeonpea	12-15	60	30

6. Nutrient management

Crop	Nutrients (kg/ha)		Mode of application
	N	P_2O_5	
Groundnut	12.5	25	All basal
Sorghum	90	30	N in 3 splits 25% as basal + 50% at tillering + 25% at flag leaf stage or 2 splits 50% as basal and 50% at tillering
Pearlmillet	80	40	N in 2 splits 50% as basal + 50% at tillering or nitrogen in 3 splits 25% as basal + 50% at tillering + 25% at flag leaf stage
Cotton (G-Cot-10)	40	0	In 2 splits, half as basal + half as 45-50 days after sowing
Cotton (V-797 & CJ-73)	25	25	All basal
Sesame	25	25	-do-
Castor	40	40	-do-
Greengram	20	40	-do-
Pigeonpea	20	40	-do-

Crop	Nutrients (kg/ha)		Mode of application
	N	P_2O_5	
Sorghum (fodder)	50	30	N in 2 splits half as basal + half at 30 days after sowing
Soybean	30	60	N as basal
Blackgram	20	40	All basal
Maize (fodder)	60	0	N in 2 splits 50% as basal + 50% at 30 days after sowing + farm yard manure 10 t/ha

7. Pest and disease management

Weed management – mechanical

Crop	Tool/Implement to be used	Times of operation
Sorghum	Hoe for harrowing Sickle for hand weeding	15, 30 Days after sowing 15, 30 Days after sowing
Pearlmillet	Hoe for harrowing Sickle for hand weeding	15, 30 Days after sowing 15, 30 Days after sowing
Groundnut (bunch)	Hoe for harrowing Sickle for hand weeding	15, 30 Days after sowing 15, 30 Days after sowing
Groundnut (semispreading)	Hoe for harrowing Sickle for hand weeding	15, 30, 45, 60 Days after sowing 15, 30, 45, 60 Days after sowing
Groundnut (spreading)	Hoe for harrowing Sickle for hand weeding	15, 30, 45, 60 Days after sowing 15, 30, 45, 60 Days after sowing
Cotton	Hoe for harrowing Sickle for hand weeding	15, 30, 45, 60 Days after sowing 15, 30, 45, 60 Days after sowing
Castor	Hoe for harrowing Sickle for hand weeding	15, 30, 45, 60 Days after sowing 15, 30, 45, 60 Days after sowing
Greengram	Hoe for harrowing Sickle for hand weeding	After thinning and 30 days after sowing During thinning and 30 days after sowing
Sesame	Hoe for harrowing Sickle for hand weeding	15, 30 Days after sowing 15, 30 Days after sowing
Pigeonpea	Hoe for harrowing Sickle for hand weeding	15, 30, 45 Days after sowing 15, 30, 45 Days after sowing

Weed management – chemical

Crop	Herbicide	Dose kg (a.i.) /ha	Method of application
Pearlmillet	Atrazine	0.5	Preemergence
Groundnut (*kharif*)	Fluchloralin Pendimethalin Alachlor Metachlor	1.0 1.0 1.0 1.0	Preemergence -do- -do- -do-
Groundnut (summer)	Fluchloralin Pendimethalin	1.5 1.0	Preemergence -do-
Cotton	Fluchloralin Diuron	1.0 0.7750 in 600 l of water	Preemergence -do-

Crop	Herbicide	Dose kg (a.i.) /ha	Method of application
Greengram (*kharif*)	Fluchloralin	0.5	Preemergence
	Pendimethalin	0.5	-do-
	Oxydiazone	0.25	-do-
Maize	Atrazine	1.0	Preemergence

Insect pest management

Crop	Pest	Control measures
Groundnut	White grub	Soil application of Lindane 0.65% dust 12.5 kg/ha before sowing
		Spray of carbaryl 0.2% should be applied on trees located around the field and arrange the light trap for attraction of adults
		Ploughing of field for exposure of white grubs to predatory birds
		Seed treatments with Quinalphos 25 EC or Chlorpyriphos 25 EC 20 ml/kg seeds. The treated seeds should be dried
	Helicoverpa	For spray of HNPV suspension 250 LE/ha at five days interval, starting from initiation of the pest
	Aphid, Jassid, Thrips and *Helicoverpa*	First spray: Phosphamidon 0.03%, two weeks after first notice of winged aphid on stick traps Second spray: Dimethoate 0.03% one month after first spray Third spray: Endosulfan 0.07% after 15 days of second spray if Helicoverpa infestation is high
	Pod borer, (*Penthicoides seriatoporus)*	Soil application of the granular insecticide, Cartap hydrochloride 4 g 10 kg/ha at 55 to 65 days after sowing is recommended for effective and economic control for pod borer *Penthicoides seriatoporus* familiar in groundnut crop grown under rainfed conditions of North Saurashtra agroclimatic zone
Sorghum	Shoot fly	Seed treatment with Carbofuran 35 ST 4% (16 g/ 100 g seed)
	Stem borer and army worm	Endosulfan 4 g 0.8 kg ai/ha in leaf whorl 30 days after sowing Endosulfan 4 g 0.8 kg ai/ha in whorl 40 days after sowing Endosulfan 35 EC 0.07% spray 60 days after sowing
Sesame	Gallfly	For effective and economical control of sesame all fly (*Asphondylia sesami*) in North Saurashtra agroclimatic zone, two spray, first at initiation of flowering and second at 15 days after first spray, of any one of the following insecticides are recommended Monocrotophos 0.04% (ICBR 1:9.4) Dimethoate 0.03% (ICBR 1:8.2) Quinalphos 0.05% (ICBR 1:6.4)
	Leaf webber	For effective and economical control of sesame leaf webber one or two spraying / application of endosulfan 0.07% of dusting of Quinalphos 1.5% dust 25 kg /ha at 15 days interval is recommended from the commencement of the pest appearance under rainfed conditions of North Saurashtra agroclimatic zone

Crop	Pest	Control measures
Pearlmillet	Earhead worm	For control of pearlmillet earhead worms, methyl-parathion 2% dust 15 kg/ha is recommended as it gave 20.04% higher yield over control net ICBR 1:3.95
Pigeonpea	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)
Castor	Semilooper	Spray Quinalphos 0.05% 20 ml/ 10 litre of water Spray NSKS 2% or neem seed leaf extract 10%
	Capsule borer	Spray Carbaryl 0.25% 4 g/l water
Chickpea	*Helicoverpa*	Spray Monocrotophos 0.04% at 50% flowering stage, followed by Endosulfan 0.07% at 15 days after spraying (ICBR 1:3.0). it is also recommended to spray Fenvalerate 0.01% if the population of Heliothis is very high (ICBR 1:2.0) synthetic should be used judiciously

ICBR: Incremental cost-benefit ratio; NICBR: Net incremental cost-benefit ratio; NSKS: Neem seed kernel spray

Disease management

Crop	Disease	Control measures
Groundnut	Collar rot Tikka Rust	Seed tratment with Thiram 3 g/kg seed Spray Carbendazim (0.025%) 150 g/ha ai Spray Monocrotophos (0.2%) 1.2 kg/ha ai
Pearlmillet	Ergot Downy mildew / green ear Rust	Avoid early sowing: treat seed with 20% brine solution Rogue the affected plants and grow resistant varieties such as BJ-104, GHB-27 Spray Zineb (0.2%) 2 kg/ha ai
Cotton	Angular leaf spot / arm	Delint the seed with sulphuric acid ; spray Agrimycin-100 or Pausamycin 75 g/ha+ Copper oxychloride 1.87 kg/ha
Sorghum	Striga Sugary disease	Uproot and burn the plants Avoid by early sowing
Sesame	*Cercospora* Powdery mildew	Spray Zineb (0.2%) 2 kg/ha ai Spray Sulfex (80 WP) 2 kg/ha ai or any other sulphur containing fungicide
Greengram	*Cercospora* Powdery mildew	Spray Hexaconazole 500 ml/ha Spray Hexaconazole 500 ml/ha

8. Suitable cropping systems

- Groundnut + castor (3:1)
- Groundnut + pigeonpea (3:1)
- Groundnut + sesame (AHT –60 / GUJ.TIL –1
- Cotton (Pusa Phalguni) (paired rows) + greengram (G-2)
- Pearlmillet + pigeonpea (4:1/2:1)
- Pearlmillet + kidneybean
- Pearlmillet should be grown in paired rows (40 cm apart) with spacing of 30 cm X 15 cm between two rows of pigeonpea

9. Farm implements/ Tools

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

10. Contingent crop planning

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 pearlmillet (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 pearlmillet (GHB-235, GHB-316, GHB-558), sorghum (GJ-39, J-41), sesame (G.Til-1, G-Til-2) and castor (GAUCH-1, GC-2), blackgram (T-9, TPU-4)

3-5 weeks after sowing

- Agricultural operations like interculturing, weeding, hoeing and mulching may be taken up, if drought spell prolongs for two weeks or more weeks. The ratooning of sorghum may be done and top dressing of fertilizer should be suggested if sufficient rainfall after 3-5 weeks dry spell

Early withdrawal of monsoon

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

Satisfactory late rains during September - October

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

11. Other supportive practices

- Harvest water in farm pond for supplemental / life saving irrigation during stress periods
- Follow ridge and furrow system especially in bunch groundnut
- Application of life saving irrigation at pegging and pod-development stages of groundnut
- Inclusion of sorghum in the farm planning and cropping schemes
- Application of farm yard manure or manure in shallow black soils improves the physical properties of the soil

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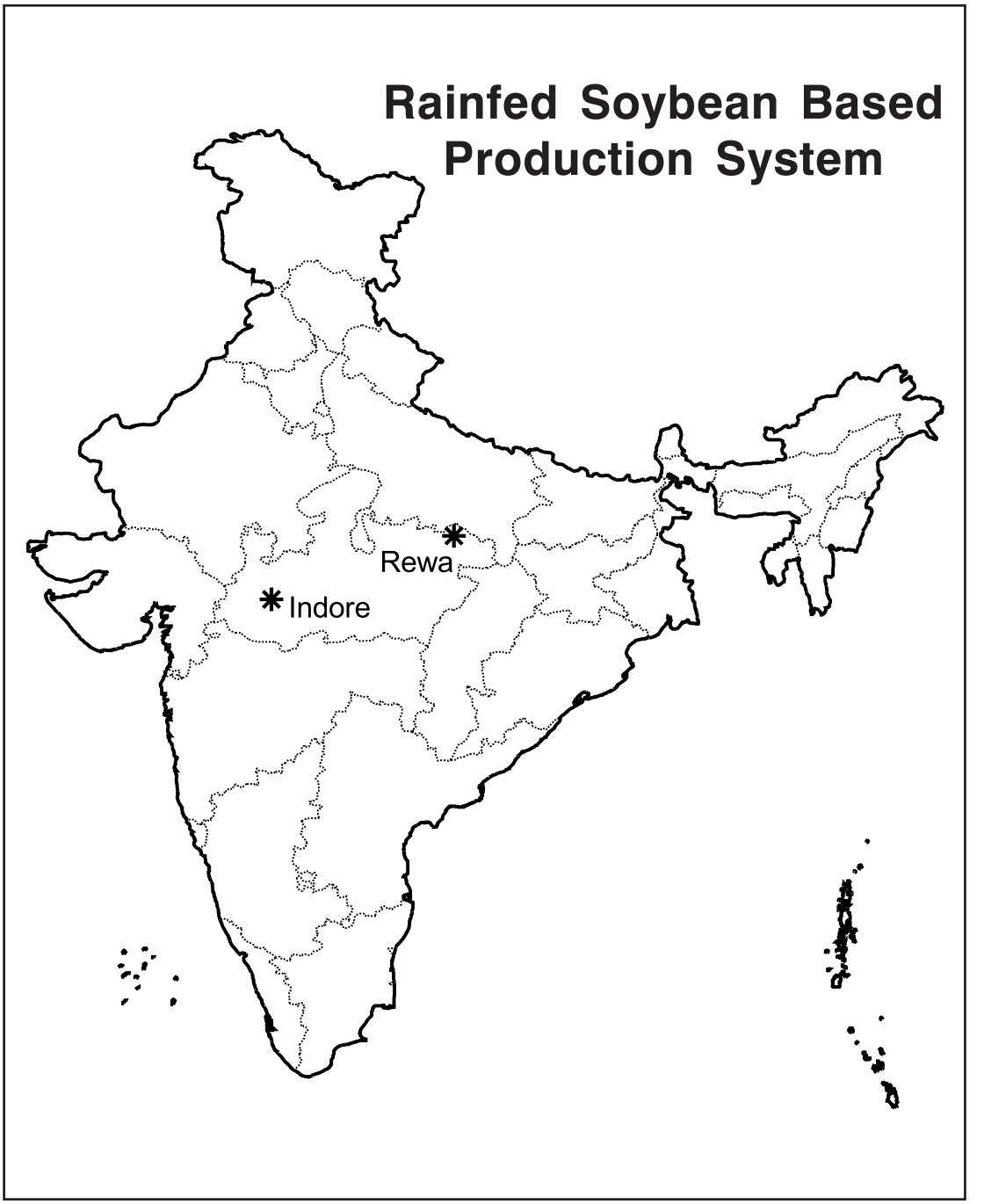
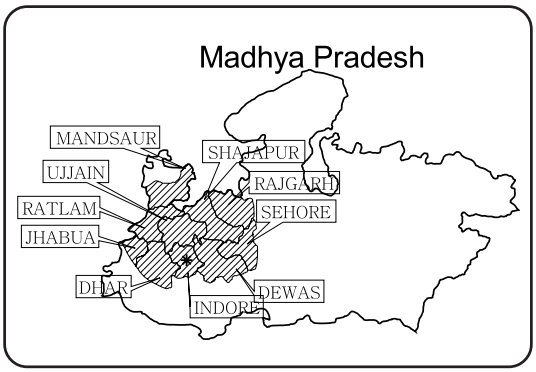

Rainfed Soybean Based
Production System
Rewa
Indore



INDORE

Soybean based Production System in *Kharif-Rabi* Semi-Arid Medium to Deep Vertisols

1. Region

Indore represents Malwa plateau in the state of Madhya Pradesh and is located in between 76º 54' E longitude and 22º 43' N latitude and altitude 618 m above mean sea level. Malwa region comprises of Mandsaur, Rajgarh, Ujjain, Indore, Dewas, Shajapur, Ratlam, part of Dhar (Badnawar and Sardarpur tehsil), Jhabua (Petlawad Tehsil), and part of Sehore district of Madhya Pradesh. The rainfed farming in the state is 69% of the cultivated area.

2. Climate

The annual rainfall for the region varies from 900 to 1000 mm, out of which over 85 % is received during the period from 24 to 39th standard meteorological weeks. Normally southwest monsoon sets at Indore in the second week of June but there are significant variations in the dates of onset of monsoon in individual years. The mean time of withdrawal of monsoon is third week of September. The duration of south west monsoon at Indore is about 98 days. Occurrence of intermittent dry spells is common. Even during drought years one or two run off events are most common.

3. Soils

The soils of the region are medium black with variable depth and clay in texture. The clay content generally varies from 45 to 55 percent. The soils are developed from basaltic parent material 'Basalt or Deccan trap'. These soils are generally low in nitrogen, low to medium in phosphorus and high in potash. These soils are highly erodible and low in infiltration rate under saturated conditions in rainy season. In these soils cracking is also a problem and soil mulching proves useful. Soil management problems arise due to poor soil physical conditions and inadequate drainage through excess runoff as well as water-logging.

4. Crops and varieties

Crop	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Soybean	JS-335	2.5-3.0	35	98-102	Tolerant to mosaic, Resistant to bacterial pustules and blight	Violet flower, very small & sparse pubescence on stem and leaves, glabrous pods, yellow testa, blackish hilum, semi-determinate plant type

Crop	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
	JS-71-05	2.0-2.5	30	90-95	Resistant to Bacterial pustules *Myrothesium* and Anthracnose	Violet flower, very small & sparse pubescence on stem and leaves, glabrous pods, light black hilum, dwarf and determinate plant type
	JS-90-41	2.5-3.0	30	87-98	Tolerant to Water stagnation	Violet flower, tiny pubescence greenish yellow testa lanceolate leaves, four seeded pods, blackish hilum, semi-determinate plant type
	Samrat (local)	2.5-3.0	28	85-90	Susceptible to mealy bug	
	Monetta	2.0-2.3	30	80-85	—	Suitable for intercropping.
	NRC 7 (Ahilaya-3)	2.5-3.5	35	90-99	Resistant to leaf biting insects	Violet flower, gray pubescence, brown hilum, yellow testa, determinant plant.
Maize	JM 8	4.7-5.0	55	90-95	—	Tolerant to drought
(Composite)	JM 12			85-90	—	
	Navjot Chandan-3 Chandan Safed-2 NLD	4.5-5.0 4.5-5.0 4.5-5.0 4.5-5.0 4.5-5.0	55-60	90-95		Tolerant to drought
Maize (hybrid)	Ganga-5 Deccan-101 Deccan-109 KH-510	5.0-6.0 5.0-6.0 5.0-6.0 5.0-6.0	60	90-100 110-115	Tolerant to stem borer	Suitable for intercropping
Pigeonpea	JA-4	1.8	80	165-175	Tolerant to wilt	Medium tall, semi spreading in determinant, brown red seed, test weight 9.5g.
	ICPL-87	2.0	6.0-6.5	130-150	Tolerant to wilt, Susceptible to pod borer	Short stature, determinant, brown streaks in pods, brown seed, test weight 9.5 to 10 g

Crop	Varieties/ Hybrids	Yield potential (q/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
	No.148	1.7	9.0-9.5	180-185	Susceptible to wilt	Medium tall, semi spreading indeterminate, brown red and oval seed, test weight 9 to 9.5g
	JK-7	1.8-2.0	110+	180-190	Tolerant to wilt and pod borer	Tall statured plant, dark brown and round seed.
	Pusa –33	1.7	62	130-135	—	Short stature and indeterminate
	ICPL-151 (Jagrati)	2.0	60	120-130	Resistant to wilt	Short stature and determinate
	ICPL-87119 (Asha)	2.0-2.1	110	195-200	Resistant to wilt/ Sterility mosaic	Medium tall, semi compact and semi determinate
Sorghum (hybrid)	CSH-6 CSH-9 CSH-14 CSH-18	3.3-4.0	65 70 65 70	95-115 110-115 95-100 115-120	Moderately Resistant to all leaf spot diseases, Resistant to Shoot fly/ stem borer	Suitable for intercropping
Sorghum (variety)	JJ-741 JJ-938 JJ-1041 SPV-1022	3.0-3.5	68 70 70 65	100-105 110-115 110-115 90-100		Excellent Bread (*chapati)* making quality. Suitable for fodder also
Greengram	JM-721	0.8-1.0	25-28	65-70	Moderately tolerant to leaf spot and powdery mildew	Medium size pods in clusters on top, dull green colour of seed with 25 to 28 g per 1000 seeds
	K-851		25-28	60 to 65	Susceptible to leaf spot and powdery mildew	Long size pods, shiny green colour of seed, medium bold with 30 g per 1000 seeds
Blackgram	Pusa-16 Pusa-105 Pusa-9531	0.8-1.0 0.8-1.0 0.9-1.0	25-28 25-28 28	60-70 60-65 60-65	— — Tolerant to yellow mosaic	Shiny green colour of seed, medium bold
	Khargone-1	0.7-0.8	28	60-65	—	
	T9	1.0-1.2	30	70-80	Susceptible to powdery mildew	Medium light black seed, 35 g per 1000 seeds
	Khargone-3	0.8-1.0	30	85-90	—	Tall spreading plant, bold black seed 42 g per 1000 seeds

Crop	Varieties/ Hybrids	Yield potential (q/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
	JU-2	1.3	28-30	65-80	—	Medium shining black seed, 33 g per 1000 seeds
	JU-3	1.0-1.2	30	70-75	—	Medium shining black seed, 38 g per 1000 seeds
Sunflower (varieties)	Morden Surya	0.7-0.8 0.8-1.0	40-45	80-90 90-100	Semilooper, white fly and *Heliothis*	
Sunflower (hybrid)	KBSH-1 MSFH-17 Jwalamukhi	1.5-1.6 1.2-1.5 1.8-2.0		90-95 90-95 85-90	are common pests	
Safflower	JSI-7 JSI-73 JSF1	1.3-1.4 1.4-1.5	85-90 85-90	140-145 140-145		Non-spiny, Non-spiny, Spiny
	JG-315	1.5	45-50	110-115	Wilt resistant	120-125 g per 1000 seeds
Chickpea	JG-74	1.5-1.8	50	120-125	Wilt resistant	150 g per 1000 seeds
	JG-218	1.8	45	115-120	Wilt tolerant	180-200 g per 1000 seeds
	JG-322	1.8	45-50	110-120		130 g per 1000 seeds
	Ujjain-21	1.8-2.5	40-45	110-115	Wilt tolerant	150 g per 1000 seeds
	Ujjain-24	1.8-2.5	50-55	115-125	Wilt tolerant	120 g per 1000 seeds
	ICCV-2	1.0-1.2	30-35	85-90	Wilt tolerant	140 g per 1000 seeds
	ICCV-37	1.0-1.2	40	95-100	Wilt tolerant	125 g per 1000 seeds
Mustard	Varuna Pusabold Kranti	1.0-1.2 1.0-1.2 1.0-1.2	45-50	115-125 125-135 130-135	Tolerant to powdery mildew	—
Linseed	Kiran R-552 Jawahar-23 R-17	0.8-1.0 1.0-1.2 1.0-1.2 1.0-1.2	65-70	130-140 120-125 120-125 115-125	Wilt tolerant. Susceptible to alterneria. Wilt resistant. Resistant to rust and gallfly	Blue flower White flower Blue flower
Wheat	Sujata C-306 HW-2004 JWS-17 HD-4672	1.5-1.8 1.5-1.8 1.5-1.8 1.5-1.8 1.5-1.8	70-75	130-35		Aestivum Aestivum Aestivum Aestivum Durum

5. Seed rate and planting pattern

Crops	Seed rate (Kg/ha)	Planting pattern (cm)		Time of sowing
		Inter row	Intra row	
Soybean	80 - 100	30 - 40	5.0	25th June to 7th July.
Maize (composite)	18-20	60	20	Onset of monsoon
Maize (hybrid)	16-18	75	20	Onset of monsoon
Pigeonpea	18-20	45	15	Second week of June to Third week of July.
Sorghum (variety)	8-10	45	12-15	Second week to Third week of June after the receipt of rains
Sorghum (hybrid)	6-8	45	15-20	-do-
Greengram/ Blackgram	20-25	30	8-10	Last week of June to Second week of July
Sunflower (variety)	10	45	30	Onset of monsoon to mid of
Sunflower (hybrid)	5-6	45	30	August
Safflower	20	45	15-20	Last week of September to last week of October.
Chickpea	80-100	30	10	First week of October.
Mustard	5-6	30	10	Mid September to mid October
Linseed	20-25	30	5	Mid September to mid October
Wheat	100	30		October end to first week of November

6. Nutrient management

Crops	Nutrient (kg/ha)				*Remarks
	N	P_2O_5	K_2O	S	
Soybean	30-40	40	20	20-40	Basal
Maize (composite)	80	60	20	—	50 % N as basal and 50 % in two splits at
Maize (hybrid)	100	60	40		knee high and tasseling
Pigeonpea	20	60	20	—	Basal
Sorghum (varieties)	80	40	20	—	50% N as basal and 50% after
Sorghum (hybrid)	120	60	40		25-30 days after sowing
Greengram	20	50	0	20	Basal
Blackgram	20	50	0	20	Basal
Sunflower (varieties)	60	40	20	20	50% N as basal and 50% after
Sunflower (hybrid)	80	40	20		25-30 days after sowing
Safflower	40	40	20	—	Basal
Chickpea	20	40	0	—	Basal
Mustard	40	20	20	20	Basal
Linseed	40	40	20	—	Basal
Wheat	30-40	20	10	—	Basal

7. Pest and disease management

Weed management – mechanical

- Weed is the major problem in *kharif* season. Severe damage in yield due to weeds caused during 20 to 60 days crop growth stage. Common weeds of Malwa region are *Cyperus rotundus, Cynodon dactylon, Echnichloa colonum, Echnichloa crusgalli, Eleusine india, Sorghum halpense, Amaranthus spp., Argemone, Commelina benghalensis, Euphorbia geniculata, Euphorbia hirta, Chochorous spp. Eclipta alba, Physalis minima L. and Xanthium strumarium etc*
- It is recommended that fields should be kept weed free at least upto 45–60 days after sowing. Deep ploughing in summer exposes lower soil layers and also exposes rhizomes and tubers of perennial and abnoxious weeds to scorching sun shine leading to kill them. Conventional tillage, which includes 2 to 3 ploughings, followed by harrowing decreases the weed problem. The simplest method of weed control is either hand weeding or interculture operations through bullock drawn *Dora* at 20 to 25 days after sowing.

Crops	Tool/ implement to be used	Time of operation
Soybean, Maize, Sorghum, Pigeonpea, Greengram, Blackgram	Hand weeding by Kurpi or Hand hoe.	15 to 20 days after sowing and as and when required.
	Bullock drawn Blade harrow (*Dora*)	Up to 20 to 25 days after sowing

Weed management – chemical

- Preemergence application of Trifluralin 35 EC 1 Kg ai / ha. or Pendimethalin 30 EC 1.0 kg ai /ha proves effective in controlling weeds. As post emergence, Imazethapyr *75* g ai /ha spray at 20 to 25 days after sowing has been found effective for controlling weeds in soybean.

Crop	Herbicide	Dose l/kg (a.i.)	Method of application
Soybean	Trifluralin 35 EC	1.00 kg	Pre planting incorporation
	Pendimethalin 30 EC	1.00 kg	Preemergence
	Imazethapyr 10 EC	0.75 l	Post emergence (15 to 22 days after sowing)
	Quizalofop ethyl 5 EC	1.00 l	Post emergence (15 to 22 days after sowing)
	Fluchloralin 48 EC	1.00 kg.	Pre planting incorporation
	Chlorimuran ethyl 25% WP	6 g	Post emergence (15 to 22 days after sowing)
	Alachlor 50 EC	1.00 kg	Preemergence
Maize/ Sorghum	Simazine 50% WP	1 to 1.5 kg	Preemergence
	Atrazine 50% WP	1 to 1.5 kg	Preemergence
Pigeonpea, Greengram and Black gram	Pendimethalin 30 EC	1.0 kg	Preemergence
	Fluchloralin 30 EC	1.00 kg	Pre planting incorporation
Wheat	2,4-dichlorophenoxy acetic acid (Easter) 36 EC	1.4 l	Spray at 32 to 35 days after sowing
	Dosanex	2.0 kg	Spray at 32 to 35 days after sowing
	Isoproturon	2.0 kg	Spray at 32 to 35 days after sowing

Insect pest management

Crop	Pest	Control Measures
Soybean	Stem fly Girdle beetle Blue beetle *Helicoverpa* Semilooper Grass hopper	Spray Endosulfan 35 EC 1100 ml/ha or Chlorpyriphos 20 EC 1.5 l/ha Methyl Parathion 2% dust 25 kg/ha Spray Metasystox 1 ml/l water
Maize	White grub stem borer, Shoot fly earhead caterpiller Aphids	Use Chlorpyriphos 2 % dust 25 kg/ha in soil before sowing or Endosulfan 35 EC 2 ml/l of water for stem borer. Spray Dimethoate 30 EC 1.5 ml/l
Pigeonpea	Pod fly Tur plume moth *Helicoverpa* Tur pod bug	Spray Monocrotophos 40 EC 2 ml/l Spray Dimethoate 30 EC 1.5 ml/l Spray Endosulfan 35 EC 2ml/l
Sorghum	Shoot fly Stem borer Aphids Earhead worms	Sow the crop at the on set of the monsoon rains Dust Endosulphan 4% 25 kg/ha Spray Dimethoate 30 EC 1.5 ml/l Spray Endosulfhan 35 EC 2 ml/l of water
Greengram/ blackgram	Aphids *Helicoverpa* Til Hawk moth (caterpillar)	Spray Dimethoate 30 EC 1.5 ml/l Spray Endosulfan 35 EC 2 ml/l of water
Sunflower	Aphids *Helicoverpa*	Spray Dimethoate 30 EC 1.5 ml/l Spray Endosulfan 35 EC 2 ml/l of water
Safflower	Aphids *Helicoverpa*	Spray Dimethoate 30 EC 1.5 ml/l of water Spray Endosulfan 35 EC 2 ml/l of water
Chickpea	Cut worm *Helicoverpa*	Use Chlorpyriphos 2 % dust 25 kg/ha in soil before sowing Spray Endosulfan 35 EC 2 ml/l of water or spray NPV 250 LE /ha
Mustard	Aphids Mustard saw fly	Spray Dimethoate 30 EC 1.5 ml/l Spray Endosulfan 35 EC 2 ml/l of water

Disease management

Crop	Diseases	Control Measures
Soybean	Yellow mosaic Leaf fungus Bacterial blight	Spray Dimethoate 30 EC 1.5 ml/l for white fly Remove the affected plants Spraying with Dithane M-45 25g/l
Maize	Leaf spot Smut	Spraying with Dithane M 45 2.5 g/l water Seed treatment with Thiram 3 g/kg seed
Pigeonpea	Wilt	Eradicate affected plants Use disease free seed Seed treatment with Thiram 3 g/kg seed

Crop	Diseases	Control Measures
Sorghum	Leaf spot and Leaf rust Ear moulds	Spray Dithane M 45 2 g/l Grow early varieties
Greengram/ blackgram	Powdery mildew	Wettable sulphur 3 g/l
Sunflower	Leaf spot	Spray Mancozeb 5% WP 2 g/l
Safflower	Wilt	Seed treatment with Thrium 2g + Carbendazim 1g/kg
Chickpea	Wilt	Seed treatment with Thrium 2g + Carbendazim 1g/kg
Mustard	Wilt Powdery mildew	Seed treatment with Thrium 2g + Carbendazim 1g/kg Wet Sulphur 3g/l water

8. Suitable cropping systems

For shallow black soils

- Only *kharif* cropping of soybean (about 90 days duration), blackgram (about 70 days duration), and maize (for cobs).

For medium deep black soils

- Intercropping of soybean + pigeonpea (4:2), and sorghum + pigeonpea (2:2) is recommended.

For deep black soils

- Intercropping systems as above may be adopted. Where moisture regime in soil at sowing time of *rabi* crops is favorable, sequential cropping should be preferred. The productive and remunerative sequential systems are:
- Soybean in *kharif* – safflower/ chickpea in *rabi*
- Maize/ sorghum in *kharif* – chickpea/ safflower in *rabi*
- Greengram/ blackgram in *kharif* – safflower/ chickpea in *rabi*

9. Farm implements / Tools

Tool/ Implements	Cost unit in Rs.	Operation
Bullock drawn		
Blade Harrow (*Bakhar*)	800-1000/-	Preparatory tillage
Plough (*Desi*)	800-1000/-	Preparatory tillage
Two coultered seed drill (*Mahakal Dufan*)	1000/-	Seed sowing
Three coultered seed drill (*Mahakal Tifan*)	1200/-	Seed sowing
Bund former	1200-1400/-	Making of ridges and furrows
Small blade harrow (*Dora*)	400/-	For inter culture
Planker (*Pata*)	400/-	Leveling and to conserve moisture
Tractor drawn		
M.B.Plough	11000/-	Deep ploughing
Cultivator-shovel	7000/-	Preparatory tillage
Cultivator-Duck foot shoes	8000/-	Preparatory tillage
Disc plough	12000/-	Preparatory tillage
Seed cum fertilizer drill	12000/-	Seed sowing

10. Contingent crop planning

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

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 other hybrids
- Sesame – Bhadeli, TKG 22, TKG 37 etc
- Cowpea – Pusa Komal and Pusa Baisakhi
- Castor – Gauch and Varuna
- Fodder crops – *Sorghum sudanensis*, Maize- African tall, Dinanath grass and pearlmillet etc.

1st to 15th August

- Sunflower – Morden, Surya, Manjira and any of the hybrids
- Sesame – Bhadeli, TKG 22, TKG 37 etc
- Cowpea – Pusa Komal and Pusa Baisakhi.
- Rajgira (Amaranthus)- Co-1 and Co-2.
- Castor- Gauch, Varuna
- Fodder crops – *Sorghum sudanensis*, Maize- African tall, Dinanath grass and pearlmillet 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)

11. Other supportive practices

Crops	Time of sowing
Soybean	25th June to 7th July
Maize (composite)	Onset of monsoon
Maize (hybrid)	Onset of monsoon
Pigeonpea	Second week of June to third week of July
Sorghum (variety) Sorghum (hybrid)	Second to third week of June after the receipt of rains
Greengram/ Blackgram	Last week of June to second week of July
Sunflower (variety) Sunflower (hybrid)	Onset of monsoon to mid of August
Safflower	Last week of September to last week of October
Chickpea	First week of October
Mustard	Mid September to mid October
Linseed	Mid September to mid October
Wheat	October end to first week of November

Provision of drainage

- It is not so much the scarcity of rains during the normal monsoon season but rather excess of it that limits the cultivation during *kharif* over large areas of the region. Provision of drainage during monsoon is the first line of defence for crop production. It has been proved that the flat sowing on a grade of 0.3 to 0.4% provides adequate drainage on lands having slopes ranging from 1.0 to 1.5 %. Past 3 rainy seasons have witnessed 25 – 30 % deficit of rains during these seasons provision for run off collection and it's recycling helped in achieving normal productivity of crops.

Rain water management

- Raised and sunken beds(8:4 m wide with elevation difference of 0.15 to 0.20m) prove most effective in *in-situ* rain water conservation and controlling nutrient and soil losses.
- Construction of percolation tank or any suitable water storage structures at suitable site for increasing ground water recharge and enhancing ground water storage to provide extra irrigation to the crop.

Salient water management practices that aim at soil and water conservation and drainage are:

- 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 procress.
- Construct percolation tank for increasing ground water recharge and enhancing ground water storage to provide extra irrigation to the crops.
- Use gabion as an inlet and outlet of water harvesting tank without any structural failure to trap silt on the upstream sit to increase life of water storage bodies.
- Construct water harvesting tank to retain the excess run off from the watershed area to use stored water for irrigation purpose.
- Silpaulin (a plastic material) of 90 – 120 g/m^2 has been found effective lining material for farm ponds used for water harvesting purposes.
- Use vegetative barriers to strengthen the mechanical bunds at suitable vertical intervals in order to reduce run off in associated soil losses from the cultivated fields.
- Develop a sort of terracing break the continuity of undulating slope to reduce the chances of degrading cultivated fields in to gullied one.
- Use mould board plough for deep tillage to increase the productivity of *kharif* crops and ensure sowing of *rabi* crop through better moisture conservation and eradication of infested weeds.
- Ensure drainage line treatment for providing safe disposal of excess run off and providing more opportunity time in order to reduce erosive velocity.
- Deep ploughing should be done at least once in three years to improve moisture storage and decrease the run off during first heavy rainfall.
- 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 percent.
- Off-season shallow tillage is important not only in controlling the weeds but also in helping entry of rain water.

- 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.
- Apply 4-6 t/ha of well-decomposed farm yard manure every year and incorporate the same at the time of field preparation.
- Conjunctive use of organic (FYM, Compost) and inorganic fertilizers is recommended for increasing and stabilizing the productivity through increased nutrient availability, water use efficiency and to mitigate short-term drought effects.
- Under rainfed conditions, after soybean, application of 50% of recommended dose of fertilizer (RDF) to *rabi* crops (chickpea/ safflower/ mustard/ linseed is adequate to realize optimum productivity.
- Based on 9 years long term study, half of the RDF (N_{20} P_{13}) for each of soybean and safflower in conjunction with 6 t FYM/ha for soybean – safflower sequence is recommended for achieving highest sustainable productivity and building up of organic carbon in soil.
- The use of 4-6 t/ha of farm yard manure along with half of the recommended level of fertilizer N leads to improved recovery of plant nutrients, alleviate drought effects and enhance yields
- Earthing at 25 to 30 days after sowing enhance the grain yield of maize
- Mechanically metered CIAE seed cum fertilizer drill has been found most suitable for planting of soybean, sorghum and safflower.
- Heavy duty cultivator either alone or along with blade harrowing proved superior for seed bed preparation for higher productivity of *rabi* crops.
- Ploughing by MB plough or dick plough conserve more moisture and increase productivity in *kharif* and *rabi* season.

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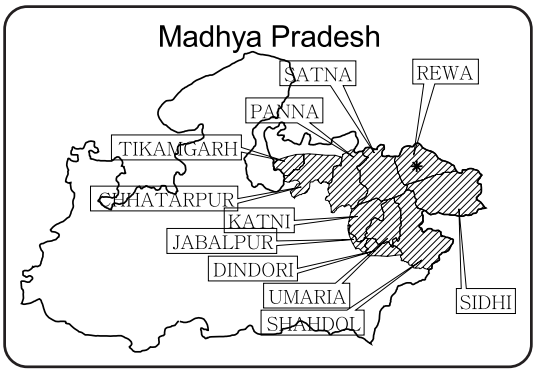

REWA

Soybean based Production System in *Kharif Rabi* Sub-Humid Medium Deep vertisols

1. Region

Rewa centre caters to the needs of agroclimatic zone IV of Madhya Pradesh and ten districts. Viz., Satna, Sidhi, Shahdol, Umaria and Panna districts, North Eastern parts of Katni, Jabalpur and Dindori districts and Southern parts of Tikamgarh and Chhatarpur districts of Madhya Pradesh and is located at the latitude $24^0$30' north and longitude $81^0$15' east at an elevation of 365.7 m above mean sea level. Rewa belongs to Kymore plateau and Satpura hills.

2. Climate

The climate of the zone is sub-humid with mean annual rainfall of 1100 mm received in 40 rainy days. Monsoon (June to September), pre-monsoon (February-May) and *Rabi* (October-January) period received 72.6 and 76.8 mm of total mean rainfall, respectively. About 54 percent of the annual rainfall is received during July and August. The mean maximum temperature in the hottest month (May) is 41.3^0C and the mean minimum temperature in the coldest month (December) is 7.8^0C. The highest and the lowest temperature recorded are 44^0C and 0^0C respectively.

3. Soils

The soils are calcareous black and mixed red and clay loams having enough storage capacity for double cropping. Soils (upland and low land) are well drained, light and heavy textured. The runoff collected is used for timely sowing of *rabi* crops. Soils are deficient in nitrogen and phosphorus whereas available K was found in adequate quantity. Somewhere deficiency of Zn and S are noticed.

4. Crops and varieties

Crop	Varieties	Yield potential (t/ha)	Days to 50% flowering	Duration (days)	Reaction of disease, pest & stress condition	Remarks
Upland rice	Prasanna (IET 7564)	2.0	53	90	Blast resistant also resistant to moisture stress	Good quality suitable sequential cropping
	Kalinga 3	2.5	58	90	Resistant to blast	Good to medium quality rice
	Govinda	3.0	90	115	Tolerance to drought	Medium quality rice
	IR-50	2.5	80	105	Resistant to leaf blast and white backed plant hopper	Good quality rice hopper

Crop	Varieties	Yield potential (t/ha)	Days to 50% flowering	Duration (days)	Reaction of disease, pest & stress condition	Remarks
	JR 3-45	2.5	67	93	Resistant to stem borer, moderate resistant to blast	Suitable for sequential cropping
	Vandana	1.80	65	95	Tolerant to bacterial leaf blight, leaf blast and moisture stress	Suitable for sequence cropping
Lowland rice	JR 353	3.5	90	115	Drought tolerance	Suitable for lai parching
	IR 64	4.0	90	115	Resistant to blast, white hoper also	—
	Jaya	4.5	105	140	For limited irrigation	Bold seeded
	Kranti	4.5	105	—	—	Suitable for all paddy areas
	Mahamaya	4.5	110	135	Resistance to Gall midge	For low land
	Kbasmati	3.0	100	125	Susceptible for Ghundi bug	Fine export quality scented rice
Soybean	JS 335	1.6	58	105	Resistant to disease blight	Suitable for double cropping
	JS 72-44	2.0	68	110	Moderately resistant to yellow mosaic	High germination capacity
	JS 80-21	2.4	60	107	Resistant to bacterial blight	Good germination capacity
	JS 90-41	2.2	58	90	—	—
Sorghum (hybrid)	CSH 5	5.0	87	115	Produce protected grains which will not be damaged due to rains	Suitable for entire state
	CSH 6	4.5	85	110	-do-	-do-
	CSV 4	3.5	90	115	-do-	Suitable for heavy soils and rainy areas
Sorghum (*desi*)	Vidisha 60-1	2.5	120	150	Susceptible for attack of cob caterpillar	Suitable for Malwa region
Kodo millet	JK 155	2.9	65	90	Resistant to head smut and shoofly	Suitable for skeletal soil
	JK 76	2.2	62	85	Tolerant to head smut and shootfly	Suitable for rainfed
	JK 136	2.2	70	105	-do-	Suitable for intercropping
Kutki	Jawahar Kutki 1	0.8	50	75	Free from pest and disease	Suitable for rainfed and marginal soils

Crop	Varieties	Yield potential (t/ha)	Days to 50% flowering	Duration (days)	Reaction of disease, pest & stress condition	Remarks
	J.Kuthi 2	0.8	50	72	—	—
	J.Kutki 8	1.0	45	75	Resistant to shootfly	Suitable for rainfed and marginal soils
Maize	Chandan 2	2.5	48	75	Resistant to blight	Suitable for Chhatisgarh
	Chandan 3	6.0	62	95	—	—
	Ganga 5	6.5	80	110	—	Plants are strong
Pigeonpea	Asha (ICPL 87)	1.8	130	180	Resistant to sterility mosaic virus	Suitable for rainfed upland areas
	NP (WR) 15	2.0	200	240	Wilt resistant	Suitable for intercropping
	JA 4	2.0	160	200		Suitable for rainfed areas monocropping
Blackgram	DU 4	1.8	55	80	Resistant to yellow mosaic	Suitable for rainfed upland area
	JU 2	1.2	40	75	Susceptible to yellow mosaic	Suitable for intercropping
	T-9	1.2	50	80		Suitable for sequence cropping
Greengram	K 851	1.2	40	70	Tolerant to yellow mosaic	Synchronous maturity suitable for summer sowing
	JM 45	1.2	45	75	-do-	—
	Pusa Baisakhi	0.6	32	60	—	Suitable for arid areas
Sesame	JT 7 (Kanchan)	1.1	60	85	Resistant to leaf spot disease	Suitable for arid areas
	Jawahar Sesame 21	0.95	42	66	Resistant to cercospora leaf spot	Suitable for rainfed areas
Groundnut	Jawahar Jyoti	2.5	—	100	—	Suitable for MP
	Exotic 1-1 Jawahar-2	2.5	—	105	—	Suitable for north region
Sunflower	BSH-1	1.4	70	95	Rust resistant	—
	Morden	1.0	67	90	—	Suitable for multiple cropping
Wheat	JW 17 irr	2.0 2.5	90	120	Rust resistant and tolerant to rust	Suitable for rainfed areas and partially irrigated areas
	C 306	2.0	90	120		
	GW 173	4.0	85	110	Rust resistant	Suitable for late sowing
Chickpea	JG 315	1.4	90	125	Wilt resistant	Suitable for timely sowing
	JG 322	1.8	90	125	-do-	-do-

Crop	Varieties	Yield potential (t/ha)	Days to 50% flowering	Duration (days)	Reaction of disease, pest & stress condition	Remarks
Linseed	J 23	1.2	85	125	Wilt resistant	White flowers
	R 552	1.1	82	120	Susceptible to gall midge	Blue flower suitable for rainfed farming
Lentil	JL 1	1.5	90	120	Wilt resistant	Bold seeded
Safflower	JSF 1	1.5	96	135	Rust resistant	Suitable for arid area
	JSF 7	1.3	90	130	-do-	-do-
Barley	K 603	3.5	72	118	Resistant to disease and pest	Suitable for rainfed area
	K 560	3.6	75	120	-do-	-do-
Lathyrus	LSD 1	1.8	75	115	Tolerant to powdery mildew	Suitable for rainfed area with low BOA content
Mustard	Pusa bold	1.8	108	135	Susceptible to aphid attack	Bold seeded
	Varuna	1.5	90	125	Susceptible to aphid attack	Suitable for late sowing

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Rice (drilled)	100	20	5
Soybean	100	30	8
Sorghum	12	45	15
Kutki	6	30	5
Maize	20	45	15
Pigeonpea	25	60	20
Blackgram	20	30	8
Greengram	20	30	8
Sesame	5	30	8
Groundnut	100	30	8
Sunflower	20	45	10
Wheat	100	25	5
Chickpea	80	25	5
Linseed	25	25	5
Lentil	25	25	5
Safflower	20	30	8
Barley	100	25	5
Lathyrus	30	30	8
Berseem	30	15	5
Mustard	6	30	8

6. Nutrient management

Crop	Nutrients (kg/ha)		Mode of application
	N	P_2O_5	
Rice	40	40	If rainfall is low – all P basal and N in splits, 1/2 at tillering and 1/4 at panicle initiation If rainfall is good, 80 kg n three splits viz., 1/4 at sowing, 1/2 at tillering and 1/4 at panicle initiation
Groundnut	10	25	All basally placed
Wheat	40	40	All basal. To be placed in the moist zone at sowing
Chickpea	20	40	All basal. To be placed in the moist zone at sowing
Sorghum (desi)	40	40	Full quantity of P_2O_5 and half dose of N should be applied at sowing and rest half of N after first weeding
Sorghum (hybrid)	80	60	Full quantity of P_2O_5 and half dose of N should be applied at sowing and rest half of N after first weeding
Maize (desi)	40	40	Full quantity of P_2O_5 and half dose of N should be applied at sowing and rest half at N after first weeding
Maize (hybrid)	80	60	Full quantity of P_2O_5 and half dose of N should be applied at sowing and rest half at N after first weeding
Kodokutki	20	20	Full dose of fertilizer should be applied at sowing
Pigeonpea	20	40	All basal application
Blackgram	20	40	All basal application
Greengram	20	40	All basal application
Soybean	20	50	All basal application
Sunflower (*kharif*)	80	40	Half N + full P_2O_5 as basal and half N after first weeding
Sunflower *(rabi)*	40	40	All basal application
Barley	40	40	The fertilizer should be applied at sowing preferably with Dufan (seed cum fertilizer drill below the seed). This method enhances the yield by 20 percent.
Lentil	20	40	
Linseed	40	30	
Mustard	40	30	

7. Pest and disease management

Weed management – mechanical

Crop	Tool/Implement to be used	Times of operation
Rice	Kurpi Wheel hoe	45 days after sowing by hand 25 days after sowing
Soybean	Kurpi Wheel hoe	25 & 45 days after sowing 25 days after sowing
Sorghum and maize	Kurpi Wheel hoe	30 & 50 days after sowing 30 days after sowing
Kodo / kutki	Kurpi Wheel hoe	15-40 days after sowing 15-30 days after sowing
Pigeonpea	Kurpi Wheel hoe	25 days after sowing 25 days after sowing

Crop	Tool/Implement to be used	Times of operation
Blackgram	Wheel Hoe	25 days after sowing
Greengram	Wheel Hoe	25 days after sowing
Sesame	Wheel Hoe	25 days after sowing
Rabi crops	Khurpi with hand	Weeds are not a serious problem in *rabi*

Weed management – chemical

Crop	Herbicides	Dose (kg a.i. /ha)	Method of application
Kharif			
Rice	Butachlor	2.0	Preemergence
Soybean	Alachlor (granules)	2.0	Preemergence
Rabi			
Wheat (irrigated)	Isoproturon	1.5	At 30 days after sowing of Phalaris minor and *Avena fatua* weeds
	2,4-D	0.5	At 30 days after sowing for broad leaf weeds

Pest management

Crop	Pest	Control measures
Rice	Gundhi bug Green hopper	Methyl parathion 2% dust 20-25 kg/ha, Endosulfan, 600 g/ha ai Carbofuran 3 g 15 kg/ha; Phosalone 500 g/ha ai, Monocrotophos 400 g/ha ai, Fipronol 50 g/ha ai
	Climbing cutworm	Endosulfan 600 g/ha ai, Dichlorovos 500 g/ha ai, Malathion 0.05 % at evening
	Grasshopper	Treat seedings with 0.02% cabofuran solution transplant before third week of July, Choloropyriphos 500 g/ha ai, Phosalone 600 g/ha ai
Pigeonpea	Pod borer	Dust lindane 0.65% or Carbaryl 10% 15 kg/ha, Endosulfan 0.07%, Monocroptophos 0.04%
	Hairy caterpillar	Methyl parathion 2% dust or Carbaryl 10% dust 25 kg/ha, or Endosulfan 4% dust 20-25 kg/ha
	Semilooper	Carbaryl 10% dust or Endosulfan 4% dust Collection and destruction of infested plant part use slight higher seed rate
Sorghum	Shootfly	Seed treatment with carbofuran 50 SP Avoid shootfly by sowing within 2 to 3 weeks monsoon
	Stem borer	Destruction of infested plant parts spray with Endosulfan 0.07%, Choloropyriphos 0.05%
	Earhead bug	Dust Malathion 5% or Phosalone 4% 15 kg/ha
	Leaf folder	Endosulfan 35 EC 1.25 lit/ha
Groundnut	Root grub Red hairy caterpillar	Treat soil with Heptachlor 5% 80 kg/ha Carbaryl 10% 20 kg/ha 20% Methyl Parathion dust
	Leaf webber	Phosalone 600 g/ha ai, Monocrotophos 500 g/ha ai, Endosulfan 35 EC 1000 ml/ha ai spray
Chickpea	Pod borer	Coriander intercropping (10G/2C) Chlorpyriphos 600 g/ha ai Dipel 1.5 l/ha 8L NPV 350 LE/ha

Disease management

Crop	Disease	Control measures
Rice	Leaf blast	Hinosan 1 ml/l / Bavistin 1 g/l or Beam 0.6 g/l
	Bacterial leaf blight	Soak seeds in 0.025% water solution of Agromycine (antibiotic containing 15% streptocycline a 83.5% inert material) plus 0.035 wettable ceres for 12 hours and then transferring the seeds to hot water at 52-54^{o} C for 30 minutes
	Khaira	2 kg $ZnSO_4$ and 1 kg slaked lime 2 spray 10 days interval, immediately after the symptoms are notices
	False smut	In hybrid rice – Kavach 2 g/l or Fytolon 2 g/l spray
Pigeonpea	Wilt	Eradicate affected plants use diseases free seeds
Chickpea	Wilt	Treat seeds Saaf 102 g/kg seed Trichoderma Viridae 5-6 g/kg seed
Sorghum	Green ear	Rogue the effected plants and spray the rest – Auranfungisal 80 kg/ha
	Sugary disease	Treat seed with Saaf 1-2 g/kg remove the effected plants
Groundnut	Tikka	Seed treatment with Captan 1:300 or Thiram 3 g/kg
Wheat	Smut	Vitavax 2 g/kg seed
	Rust	Mancozeb 2.5 g/l spray
	Brown spot	Mancozeb 2.5 g/l
	Ear cockle	Disease free seed selection crop rotation practice
Barley	Covered smut Grain smut	Vitavax 2 g/kg seed treatment
Pea/Chickpea/	Powdery mildew	Calaxin 1 ml/lit or Sulfex 2.5 g/l spray
Pigeonpea	*Cercospora* leaf spot	Topsion M –70 or Mancozeb 2.5 g/l
	Sterlity mosaic	Uproot and burn or Monocrotophos 1 ml/l spray
Sorghum/ maize	Downy mildew	Ridomil M Z (pronto) 2.5 g/kg seed treatment spray 2 g/l spray
Vegetables	Root knot Nematode	Neem cake 55 kg/ha Carbofuron 15-20 kg/ha dusting

8. Suitable cropping systems

Arable

- Agri-horticulture: Fruit crops (mango/ guava/ amla) + field crops (wheat, barley, pulses and oilseeds)

Upland

- Rice upland (JR 3-45) – wheat (306)
- Soybean (J 335) – wheat/ chickpea (JG 315)

Monocropping

- Pigeonpea [NP (WR) 15] planted commonly in the farmers field

Sequence cropping

- Rice – wheat
- Rice – chickpea
- Soybean – wheat
- Soybean – chickpea

Intercropping

Kharif

- Sorghum + pigeonpea (2:1)
- Soybean + pigeonpea (2:1)

Rabi

- Wheat + chickpea (2:1)
- Wheat + mustard (2:1 or 4:2)
- Chickpea + linseed (2:1)

9. Farm Implements/ Tools

Tool/ Implements	Cost/unit	Operation
Dufan	Rs. 800	For tillage and sowing in paddy, soybean wheat chickpea etc.
Deshi plough	Rs. 500	For ploughing, sowing and interculture in all *kharif* and *rabi* crops

10. Contingent crop planning

Normal season

- Rice
  - Very early group (less than 95 days): Prasanna, Vandana, JR 3-45
  - Early group (95 to 115 days): IR-64, IR 50, Basmati
  - Medium duration (125 to 145 days): IR-36, Jaya, Kranti
- Sorghum: CSH 5, CSH 6
- Maize: Ganga-1, Ganga 5
- Pigeonpea: NP (WR) 15
- Soybean: JS 335
- Sesame: JT 7
- Groundnut: Jawahar Jyothi-1
- Kodo/ kutki: J.kodo 136, J. kutki
- Blackgram: JU 2, DU 4
- Greengram: K851, JM 45

Intercropping

- Sorghum + pigeonpea (2:1)
- Soybean + pigeonpea (2:1)

Late season

- Rice (late variety): IR 50, JR 3-45
- Kodo: JK 155
- Sorghum: CSH 5
- Pigeonpea: JA 4, Asha
- Groundnut: Exotic 1-1
- Blackgram: DU 4
- Sesame: JT-1
- Safflower: JSF 1
- Sunflower: Morden

Late season drought

- Harvested rainwater recycled as life saving irrigation

Low land – Direct seeded

- Re-sowing of rice is needed if plant population is less than 50%
- Weeds are uprooted by manual weeding practice
- Spray of insecticide make sure if attack of insect pest observed
- Spraying of micronutrient if deficiency is noticed

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 seedling from disease and pest attack. When rainfall occurs puddling is done by tractor drawn power tiller, 30-40 days old seedlings should be transplanted, 3 to 4 seedlings/ hills be planted. Adequate fertilizer should be applied as per requirements.

11. Other supportive practices

- Ridge bed and sunkun bed 60 cm apart are laid out
- Drill rice seeds in rows and employ hand wheel hoe for weeding the crop
- Harvested water utilized for raising two crops like crop sequence-rice-wheat
- Integrated nutrient supply system comprising 50 percent N/ha through chemical fertilizer remaining through farm yard manure/ compost. Cattle urine and full P_2O_5 and potash were used for maintaining soil health and gives sustained productivity of *Kharif* rice/ soybean-wheat/ chickpea sequence cropping system over years. In rice crop split application of N in three doses is recommended. Application of full recommended fertilizer from chemical source only deteriorate soil health.
- Do not delay the primary tillage; Accomplish it within about 3 days after the last rains for seeding *rabi* crops
- In *rabi,* basal dose of full fertilizer in rainfed sowing increases the efficiency of crops.
- Mulching of straw or stubble increase moisture of root zone in *rabi* crops and gives sustained productivity of *rabi* wheat and chickpea
- Establishment of vetivar barriers in unbunded field reduce the run off and collect the productive soils for sustained yield
- Applications of Alachlor (granules) 20 kg/ha in soybean crop reduce cost of cultivation and offer satisfactory weed control and increase crop yield.

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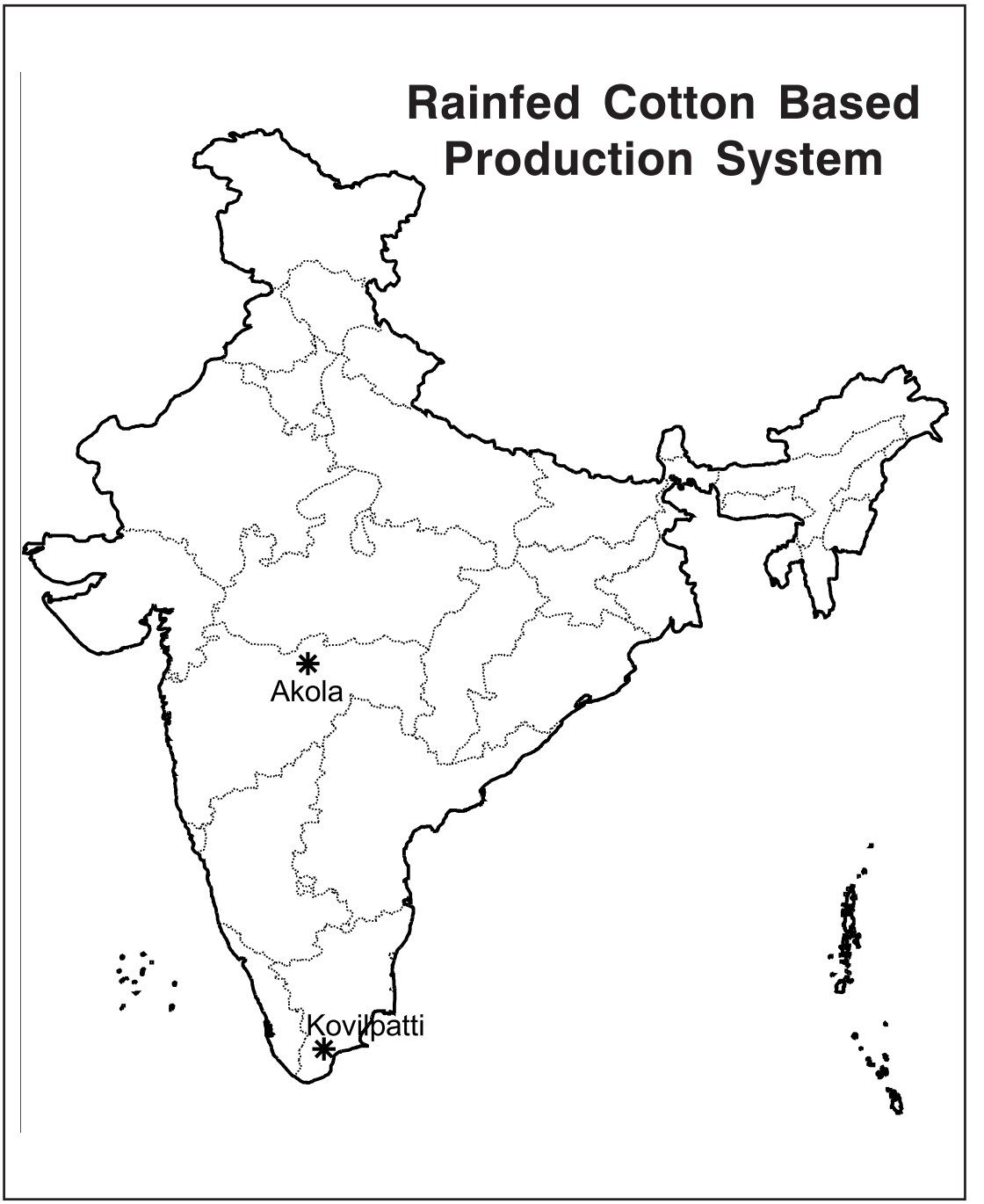
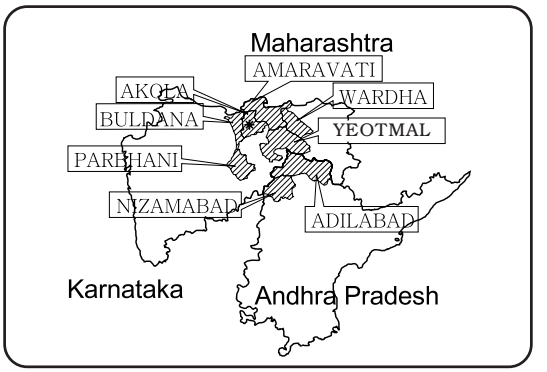

Rainfed Cotton Based
Production System
Akola
Kovilpatti



AKOLA

Cotton based Production System in *Kharif*/ Semi – Arid Vertic Inceptisols/ Vertisols

1. Region

Akola, part of Amaravati, Wardha, Yeotmal, Parbhani, Buldana, east and west Khandesh districts of Maharashtra and parts of Adilabad and Nizamabad districts of Andhra Pradesh.

2. Climate

Climate is semi-arid. Mean annual rainfall is 813 mm from June to September out of which 50 percent is received during July-August.

3. Soils

Soils are black, medium and deep clay loams to heavy clays, calcareous, with lime concretions (*kankars)* at varying depths, and are highly deficient in available phosphorous due to high phosphorous fixing capacity. They have high moisture retention capacity but develop deep cracks from December onwards. Predominantly *kharif* crops but double cropping is possible.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Cotton	AKH 84635 (PKV Rajat)	1.3	73	170-180	—	Suitable for intercropping
	AKH 081	1.1	55	150-160	—	-do-
	AKHA 8401	0.9	78	200-210	Resistant to wilt	-do-
	AKA 5	0.8	68	120-180	Resistant to black arm. Tolerant to grey mildew and jassids	Tolerant to drought. Suitable as pure crop
	AKA 7	1.1	63	140-150	Resistant to wilt	Suitable for intercropping
	AKH-4	0.8	73	180-190	Resistant to black arm. Tolerant to grey mildew and jassids	Tolerant to drought. Suitable for intercropping

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Sorghum	CSH 5	2.5	70	115	Susceptible to stem borer, shoot fly, midge fly, charcoal rot and ergot. Moderately tolerant to headmold (escapes charcoal rot in early sowing)	Good grain quality Suitable for intercropping
	CSH-9	3.0-3.5	70	115		
	SPV-102	3.1	72	117	Susceptible to midge fly, head-mold and ergot. Moderately tolerant to charcoal rot. Tolerant to shootfly and stem borer	Good grain Suitable for cropping
Pigeonpea	C-11	1.2	115	190-200	Moderately susceptible to pod borer. Resistant to *Fusarium* wilt	Suitable for heavy soils
	Asha (ICPL 87119)	1.2	11	180-200	Resistant for wilt and sterility mosaic	-do-
	Maroti (ICPL 8863)	1.0	90	165-170	Resistant to wilt	-do-
Greengram	Kopergaon	0.7	35	65	Moderately susceptible to root rot. Susceptible to powdery mildew	Good grain quality Suitable for sole cropping
	TARM 18	0.9	35	68	Resistant to powdery mildew	Bold seeded and suitable for sole cropping
	AKM 8803	0.9	40	65	Moderately susceptible to powdery mildew	Good grain quality Suitable for sole cropping
Blackgram	TAU-1	0.8-1.0	40	70	Tolerant to powdery mildew	Bold seeded and high yielding
Groundnut	JL-24	1.8	25-27	90-100	Moderately susceptible to tikka. Susceptible to leaf miner and aphids. Moderately resistant to rust and *Colletotrichum*	Suitable for sole cropping
	SB-11	1.0	30-32	100-105	Susceptible to leaf minor and aphids. Moderately resistant to rust, fairly resistant to tikka and *Colletotrichum*	Suitable for sole cropping

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Sunflower	EC 68414	0.9	50-55	85-95	Susceptible to jassids. Fairly resistant to *Alternaria* leaf spot, bacterial leaf spot, leaf blight, *Curcularia* leaf blight	—
	PKVSH-27	1.4	45-50	80-85	—	Hybrid
	PKVSF-9	1.0			—	High yielding
Safflower	N-7	0.9	75	140	Susceptible to aphids. Moderately resistant to powdery mildew, *Alternaria* leaf spot and wilt complex	Widely adopted
	Bhima	1.5	70	130	Susceptible to aphids	

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Sorghum	10	45	15
Pearlmillet	4	30	15
Cotton	10	120/90	30/60
Groundnut	100* (Kernels)	30	10/15
Pigeonpea	10	60	30

If planted beyond 10th July more and rate is required

6. Nutrient management

Crop	Nutrients (kg/ha)			FYM (t/ha)	Mode of application
	N	P_2O_5	K_2O		
Sorghum	80	40	—	—	Placement
Cotton	60-90	60	50	10-15	N– in three splits (1/2 at sowing + 1/4 at squaring + 1/4 at flowering)

7. Pest and disease management

Weed management - mechanical

- Keep the sorghum and other medium to short duration crop(s), weeds free by hoeing and weeding for the first 40 days after sowing.
- Keep the cotton and other long duration crop(s), weeds free by hoeing and hand weeding for the first 70 days after sowing.

Insect pest Management

Crop	Pests	Control measures
Sorghum	Shootfly	Complete seeding in 2 weeks after receipt of monsoon rains, preferably before first week of July
		Only in case of late sowing, soil application of Phorate 10 G granules 10 kg/ha
	Stem borer	Remove affected shoots and burn them whenever noticed
	Midge and earhead worms	Carbaryl 10% 20 kg/ha
Groundnut	White grub	Only in case of late sowing, soil application of Phorate 10 G granules 10 kg/ha
Pigeonpea	Pod borer	Application of Methyl Parathion 2% dust 20 kg/ha or spraying quinolphos 25% EC 16 ml/10 l water
Cotton	Sucking pests (Aphids, Jassids, and Thrips)	Application of Methyl Demeton 25% EC 8 ml/10 l water. First spray to be given only after notice of incidence. Repeat the spray after 15 days interval as per necessity
	Boll worms (Spotted and *Helicoverpa*)	Spray Carbaryl 1.50% WP 0.2% or Endosulfan 0.06% after first incidence and subsequently after 15 days interval
Chickpea	Pod borer	Application of Methyl Parathion 2% dust 20 kg/ha or spraying of Quinolphos 25% EC 20 ml/10 l water. HNPV 250 LE/ha

Disease Management

Crop	Diseases	Control measures
Sorghum	Sugary disease	Collateral and alternative hosts like Pilosum be removed. Spray Thiram 0.2% at the time of cob emergence.
	Charcoal rot	Grow charcoal rot resistant varieties like CSH-6, SPV-297. Seed treatment with *Tricoderma* 4 g/kg seed.
	Foliar leaf spots	Spray Dithane M-45 0.25 after notice of incidence and second spray after 15 days, if required.
	Head molds	Spray Thiram 0.2% at flowering
Pearlmillet	Downy mildew	Seed treatment with metalaxyl 6 g/kg seed
	Ergot	Treat seed with 20% Brine solution before sowing
Groundnut	Pre and post emergence mortality	Treat seeds with Thiram 1.5 g + 1.5 g Carbendazim / kg seed.
	Tikka	Application of Carbendazim (0.05%) thrice with an interval of 15 days starting from 40 days of emergence.
	Rust	Spray thrice with Dithane M-45 0.2% or Tridomorph 0.07%.
	Bud necrosis	Early and closer spacing (22.5 x 10 cm)
Pigeonpea	Wilt	Removal of infected plants. Use of disease free seeds. Grow resistant varieties like ICPL 87119 (Asha), ICPL 8863 (Maruti)

Crop	Diseases	Control measures
Cotton	Seed borne diseases	Treat seeds with 1 g carboxyl + 3 g Thiram/kg seed. Use delinted seeds
	Dahiya	Bavistin 2 g + 3 g Thriam per kg seed. Spray wettable sulphur 25 g / 10 l of water
	Bacterial blight	Copper oxychloride 25 g + 1 g Streptocyclin per 10 l of water, 3-4 sprays during vegetative phase
	Boll rot	Copper Oxychloride 25 g / 10 l of water
Rice	Blast	Spray Copper Oxychloride 25 g / 10 l of water, 3-4 times during vegetative stage
Wheat	Brown rust	Spray Mancozeb 25 g/ 10 l water at in interval of 10-15 days, as required, beginning from appearance of postules
Chickpea	Pre and post emergence mortality	Treat seeds with 3 g Thiram + 1 g Carbendazim per kg of seed. Seed treatment with Tricoderma 4 g/kg seed

8. Suitable cropping systems

Sequence cropping

- Greengram (Kopergaon) – safflower (N.7, Bhima)
- Sorghum (CSH-9) – safflower (N.7, Bhima) If late rains are received.

Intercropping

- Cotton AKA-7 uniform (60 x 30 cm) or paired (40 - 80 cm) + greengram (Kopergaon) in inter rows of cotton
- Cotton AKH 84635 (uniform sowing) + greengram/ blackgram/ soybean in 1:1 row proportion
- Cotton + sorghum + pigeonpea + sorghum (CSH-9) in 6:1:2:1 row ratio
- Sorghum (CSH-9) + greengram (Kopergaon) in paired planting (30-60 cm)
- Sorghum (CSH-9) + blackgram (TAU-1) in paired planting (30-60 cm)
- Sorghum (CSH-9 or CSH-5) + pigeonpea in 6:1 proportion spaced at 45 cm rows

9. Farm implements/ tools

Tools, implements	Operation
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

10. Contingent crop planning

Normal Monsoon

- The monsoon starts from 24th meteorological week.
- Light soils (depth 20 to 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 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 – interspecies 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)

Normal 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 percent concentration, may be useful.
- If there is a total failure of crop, sowing of photo-insensitive crops such as pearlmillet (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 (Bhima), 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.

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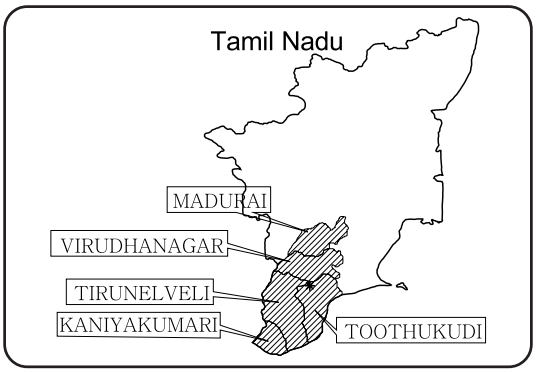

KOVILPATTI

Cotton based Production System in Late *Kharif* - *Rabi* Semi arid Deep Vertisols

1. Region

Black soil tracts of Toothukudi, Tirunelveli, Madurai, Virudhanagar and other southern districts of Tamil Nadu.

2. Climate

The mean annual rainfall at Kovilpatti is 743 mm and the highest and the lowest rainfall recorded were 1126 mm and 353 mm. Mean monthly rainfall revealed that the highest rainfall of 189 mm was recorded in the month of October and the lowest of 16 mm in the month of February. The rainfall during the months of April, September, October and November is fairly dependable and has less deviation. *Rabi*, summer and *Kharif* reasons receive a rainfall of 395, 156 and 150 mm, respectively.

The initial and conditional probabilities of receiving soaking rainfall of 20 mm and above per week indicated that 63 percent probability occurs during the 42nd to 46th standard week. Hence, pre-monsoon sowing of sorghum, cotton and pulses could be taken up from 39th standard week onwards. The summer and south-west monsoon rains are insufficient to raise any crops, since the evapotranspiration is high during this period due to high solar radiation and high wind speed. Thus the length of growing period extends from October to January only.

3. Soils

The soils are moderately deep, clayey, retentive, slowly permeable and are prone to erosion. They are highly deficient in phosphorus and have high phosphorus fixing capacity. The soil depth varies from 150 to 200 cm. The soil texture is clayey with the bulk density varying from 1.23 to 1.32 kg/m^3 in the surface soil and while in the subsurface soil it ranges from 1.23 to 1.53 kg/m^3. The infiltration rate of the soil is low (0.5 – 0.9 cm/hr) with a field capacity of 30-35 percent and having a permanent wilting point of 12-14 percent (with sunflower as indicator plant). *p*H tends towards alkalinity range both in surface and subsurface horizons. The soil has highest cation exchange capacity (CEC) of 40 cmol (p+)/kg with low organic (0.55%) and higher base saturation percentage (99%) in surface and subsurface horizons with exchangeable sodium percentage (ESP) within safer limit of 15. Accumulation of salt is noted at lower depths (91 cm). During summer, these soils develop deep cracks of more than 1 cm wide and 50 cm deep due to the abundance of smectitic type of clay minerals noticed in the sub-soil. These soils are low in N, low to medium in P and high in K.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Cotton	KC-2	0.7	90-95	150	Resistant to jassids	Suitable for September-October sowing
Sorghum	K-Tall	3.7	55-56	90	Moderately tolerant to stem borer	Suitable for September-October sowing
	K-8	2.4	60-65		Moderately resistant to stem borer and shoot fly	-do-
Fodder sorghum	K-3	1.7	60-65	90-95	—	—
Pearlmillet	K-2	2.0	45	80	Tolerant to downy mildew	—
	Co-6	2.0	50	90	—	—
	WCC-75	2.0		95	—	—
Maize	K-1	2.0	50-55	80-85	—	—
Kudiraivali (fodder)	K-2	2.0	55	90	—	—
Blackgram	Co-4	0.6	35	70	—	—
	Co-5	0.7	35-40	70-75	—	Suitable for intercropping
	K-1		40-45		Tolerant to mosaic	-do-
Greengram	Co-1	0.9	50-55	87	—	—
	Co-5	0.9	40-43	70-75	–	—
	KM-2	0.7	35	68	—	Suitable for intercropping
	K-1	0.7		70-75	—	—
Pigeonpea	Co-1	1.0	95-100	145	—	—
	SA –1	0.9		140	—	—
Cowpea	Co-1	1.2	45	80	—	Suitable for intercropping
	Co-3	1.3	40	75	—	-do-
	C-152	1.3		70-75	—	-do-
Fieldbeans	Co-1	1.0	50	100	—	—
	KPT-local	0.9	45	85	—	—
Sunflower	K-1	1.0	45	85	—	—
Sesame	TMV-3	0.6	45	80-85	—	—

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Cotton	20	45	30
Sorghum	10	45	15
Maize	15	45	15
Pearlmillet	6	45	15
Greengram	20	30	10
Cowpea	30	30	15
Sunflower	15	45	30
Sesame	5	30	30

6. Nutrient Management

Crop	Nutrients (kg/ha)		Mode of application
	N	P_2O_5	
Cotton	40	20	Basal
Sorghum	40	20	-do-
Pearlmillet	40	20	-do-
Pulses	40	20	-do-
Sesame	40	20	-do-
Sunflower	20	40	-do-
Fingermillet	40	20	-do-
Pigeonpea	20	40	-do-

7. Pest management

Weed management – mechanical

Crop	Tools/ implements to be used
Rainfed cotton, millets, pulses and oilseeds	One hand weeding using hand hoe and keep fields weedfree for the first 35 days after sowing

Weed management – chemical

Crop	Herbicides	Dose l/g (a.i.)/ha	Method of application
Cotton + blackgram	Pendimethalin	3.3 l	Broadcast after mixing with sand
Cotton	Butachlor	3.3 l	
Pulses, Oilseeds	Pendimethalin	2 l	
Millets	Atrazine 50 WP	500 g	

Preemergence application three days after sowing

Insect pest management

Crop	Pest	Control measures
Sorghum	Shootfly	Seed treatment with Furadon 40 FWP 100 g/kg of seeds Application of Furadon granules 3 g/m row or Thimet 1.5 g/m row at the time of sowing.

Crop	Pest	Control measures
	Stemborer	Application of Carbofuran 3 G or Endosulfan 4 G granules in the leaf whorl on 25th and 35th days after sowing 2.5 kg and 3 kg/acre respectively or
		Spraying of Endosulfan 250 ml/ac thrice at 25, 35 and 45 days after germination
	Earhead midge	Spray of any one of the following insecticides once at the time of flowering and a week after the first application: Carbaryl 1.25 kg/ha, Phosalone 4% 25 kg/ha
		Two applications of BHC 10% or Carbaryl 10% dust 25 kg/ha synchronizing with the milky stage of the crop
Pearlmillet	Shootfly	Spraying a mixture of Carbaryl 2 g + phosphamidan 1 ml in one litre of water thrice, once on 10th another on 25th day after sowing and later at the time of ear head emergence
	Earhead midge	Spraying Endosulfan 1.25 1/ha twice at the time of flowering and second round at 5 days after first round.
Fingermillet	Shoot borer	Spraying of BHC 0.1 % or Carbaryl 0.1 % thrice starting from the month after transplanting at 15 days interval
	Root aphid	Drenching of root portions with BHC WP 1 kg in 65 l of water
Maize	Cob borer	Spraying of Carbaryl 3 kg/ha on 35th, 50th and 75th days after sowing
Greengram Blackgram Pigeonpea Chickpea Soybean	Pod borers	Dusting with Endosulfan 4% dust 25 kg/ha or spraying of Endosulfan (2 ml/ l water) at the time of pod formation
Soybean	Leaf folder and leaf miner	Spraying of Monocrotophos 0.04% or Phosalone 0.05% or Dichlorovos 0.1% once at 30 days after sowing and later at 50 days after sowing
Greengram and Blackram	Stem fly	Spraying of Monocroptophos 1 ml/l (or) Endosulfan 2 ml/l of water on 10th day after sowing
Sunflower	Earhead caterpillars	Spraying of Endosulfan or Phosalone 1 l/ha
Castor	Leaf caterpillars and Capsule borer	Spraying Fenthion 1 ml/l or Malathion 4 ml/l or Sevin 50 WP 2 g/l
Chillies	Aphids and thrips	Spraying of Nuvacron 0.1 % or Nuvacron 0.05% + 4 Nuvan 0.05%
	Nematodes	Soil application of Desanite or Furadon granules 1 g per plant in the first week after planting
Cotton	Jassids, aphids and thrips	Spraying of Methyldemeton 0.025% thrice from 15 days after sowing at 15 days interval
	Boll worms	Spraying of Phosalone (2 l/ha) or Monocrotophos (1.25 l/ha) or Endosulfan (2 1/ha) from 55, 65, 75, 85, 95, 105, 115 and 125 days after sowing or
		Dusting six times with Endosulfan 4% or Carbaryl 5 % dust 25 kg/ha on 21st, 45th, 60th, 75th and 105th days after sowing
Sesame	Pod borer	Spraying of Endosulfan 35 EC 1 l/ha

8. Suitable cropping systems

Intercropping

- Sorghum (K8) + cowpea (C.152) or pigeonpea in interspaces
- Cotton (KC.2) + blackgram (K1) or greengram (CO 5) in paired row system (2:1)
- Cotton + blackgram
- Cotton + coriander
- Cotton + clusterbean (2:1)
- Sorghum + cowpea
- Sorghum + blackgram
- Sorghum + greengram
- Sorghum + siratro (fodder) (1:1)
- Maize + greengram
- Pearlmillet + clusterbean

9. Farm implements/ Tools

Tool/ implements	Operation
Deep ploughing with mould board plough	For sorghum, pigeonpea and sunflower
Drill sowing with compaction	Sowing of sunflower, cotton
Dibbling with compaction	Sowing of sorghum
Dry sowing using country plough and sunflower	Sowing at 4 – 6 cm depth for rainfed, cotton, millets

10. Contingent crop planning

Normal monsoon conditions

- With the onset of *rabi* monsoon in September – October, crops like sorghum, cotton, pearlmillet, pulses and oilseeds can be sown. Sorghum (K Tall or K 8) may be sown during the month of September

Delayed onset of monsoon

- Late in October, pearlmillet (WCC 75) can be sown. Pulses like blackgram, greengram, and oilseeds like sunflower (K 1) can be grown if the rains are received later.

First week of November

- Very delayed monsoon
- Sunflower (K1), sesame (TMV 3), Senna and Coriander can be sown upto.

Early withdrawal of monsoon

- Short duration crops like pearlmillet (Co-6 and X 4) with 75 days duration and sunflower (K1) with 65 days duration are grown.

Cultural practices like shallow intercultural to eradicate weeds, maintain soil mulch to conserve soil moisture, application of surface mulch, thinning of crops by removing alternate rows as in pearlmillet and recycling of stored runoff water are generally resorted to.

11. Other supportive practices

- Create dust mulch (soil stirring) by implements to conserve soil moisture.
- Compartmental bunds to conserve soil and moisture
- Summer ploughing to conserve rainwater.
- In drylands, maintenance of two milch cows along with agricultural component indicated that percentage contribution of agricultural component to the total gross and net income of integrated farming system was 10 and 6.7 percent as compared to the percentage contribution of dairy component with 90 and 93.3 percent.

Alley cropping

- *Leucaena* + sorghum/ pearlmillet/ pigeonpea
- *Leucaena* (6 m width) + mulching with Leucaena leaves in alleys + cotton / blackgram / sunflower
- Tamarind/ neem + sorghum (K-8)
- Tamarind/ neem + blackgram (Co-5)
- Sorghum – surface mulching with sorghum stubbles, pearlmillet straw, paddy straw, raw dust, groundnut shell, dust mulch
- Cotton: Saw dust mulch of 2.5 cm thickness
- Pearlmillet: Ridges and furrows
- Sorghum compartmental bunding (7.2 x 3.6 m), broad bed and furrow system (150 cm width), Ridges and furrow system (4.5 x 15 cm)
- Cotton: Tied inter- rows, compartmental bunding, vegetative barrier with Vetivar grass

Silvipasture

- *Alianthus excelsa* + dinanath grass (Co-1)

Agrohortisystem

- Tamarind (PKM-1) + blackgram (K-1)

Crop varieties/ Compound dryland technology

- Pigeonpea: Co-1, Khargoan – 2, C-11, SA-1, Co-2
- Safflower: K-1, Tara
- Chickpea: a – 62404, C- 130
- Fingermillet: PPQ – 791, Co – 10
- Sunflower: FYM (for 20 kg N/ha) + Urea (20 kg N/ha)
- Cotton: FYM (for 20 kg N/ha) + 20 kg N/ha urea + 10 kg P_2O_5 / ha
- Sorghum: 40 kg N as urea + 20 P_2O_5 /kg ha as enriched FYM
- Pearlmillet: 40 kg N/ha + 20 kg P_2O_5 /kg ha (as rock phosphate) + *Azospirillum*
- Cotton: 40 kg N/ha + 20 P_2O_5 kg/ha + 1% $MgSo_4$ foliar spray at 45 and 60 days after sowing
- Sorghum: 20 kg N (as urea) + 20 kg P_2O_5 (as single sulphur phosphate) + 25 kg $ZnSO_4$/ha
- Sorghum – Pearlmillet sequence: 40 kg N/ha (as urea) + 20 kg P_2O_5 (as single super phosphate) + 25 $ZnSO_4$ /ha

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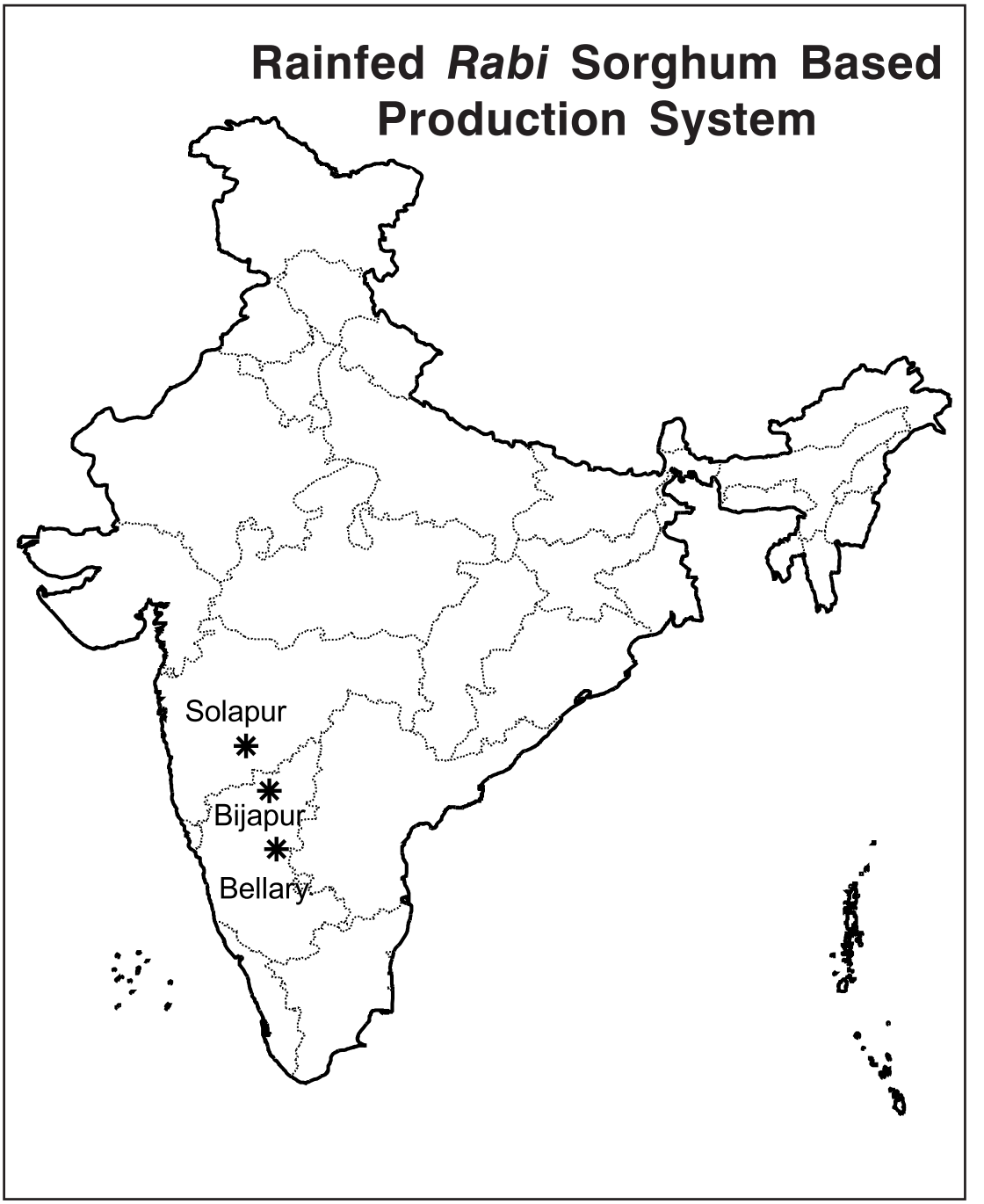
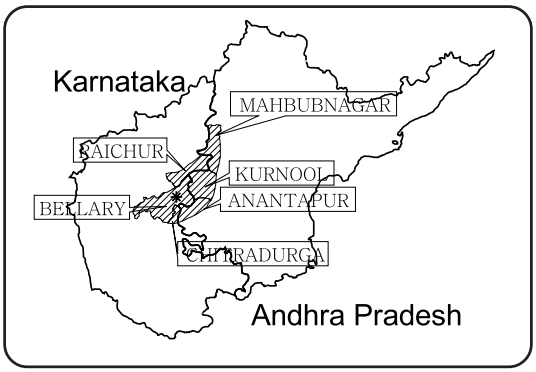

Rainfed *Rabi* Sorghum Based Production System
Solapur
Bijapur
Bellary



BELLARY

Rabi sorghum based Production System in *Rabi* Semi Arid Vertisols

1. Region

Parts of Chitradurga, Bellary, Raichur districts of Karnataka state and parts of Anantapur (black soils), Kurnool and Mahabubnagar (black soils) districts of Andhra Pradesh.

2. Climate

Semi-arid climate with mean annual rainfall of 500 mm of which 50 percent is received during September-October. Rainfall from May to August is unreliable and that of during September-October is of a high intensity resulting in high runoff.

3. Soils

Soils are medium and deep calcareous black clays. The most serious problem is extremely low infiltration rate creating problems of soil and moisture conservation. This could be improved by reducing the Exchangeable Sodium Percentage to less than 5 percent by gypsum application and also by vertical mulching. Soils develop deep cracks about 6 weeks after the last rains. Crops are grown under receding moisture conditions during *rabi* in deep black soils. Both *kharif* and *rabi* crops could be raised in medium deep black soils. Soils are deficient in nitrogen, phosphorus and zinc. Sub-soil salinity associated with high boron is another problem in the lower reaches of the slopes.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Sorghum	SPV-86	1.5-2.0	70	122	—	—
	M-35-1	0.5-1.0	70	124	—	—
	SPV-1341	2.0-2.5	65	110	—	—
Safflower	S.144	0.8	73	112	Susceptible to wilt under excessive moisture condition	Suitable for monocropping
	A.300	0.8	71	109	Susceptible to wilt under excessive moisture condition	Suitable for monocropping
	7-13-3	0.7-0.8	72	109	Susceptible to wilt under excessive moisture condition	Suitable for monocropping

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Chickpea	A.1	1.0-1.1	32	76	—	—
	N-52	1.0-1.1	32	76	—	—
Beans	CO.7	1.1	45	91	—	—
(Dolichos lab lab)	CO.8	1.1	48	91	—	—

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)
		Inter row
Rabi sorghum (M.35-1)	5-6	60-75
Improved *rabi* hybrid and varieties (CSH.8R and SPV-86)	7-8	
Safflower	3.5-4.0	60-90
Sunflower	3.5-4.0	60-75
Fieldbean	15	60-75
Chickpea	50	30-45
Coriander + safflower (4:1)	50+2	30

6. Nutrient management

Crop	Nutrients (kg/ha)		Mode of application
	N	P_2O_5	
Rabi Sorghum	30	30	All basal drilled
Safflower	20	30	-do-
Chickpea	15	30	-do-
Fieldbeans	15	30	-do-

7. Contingent crop planning

Normal rains with timely onset of monsoon in September

- Sorghum (SPV 86, CSH 7R/CSH 8R, 5-4-1), sunflower and fieldbeans (CO.7) : Complete sowing within one week after the receipt of first soaking rains.
- Safflower (A 300) : Complete sowing with 15-20 days after first soaking rains
- Chickpea (A-1, N-52) : Complete sowing within a month after soaking rains

Delayed onset of monsoon in October

Sorghum, fieldbeans and sunflower : Sow SPV 86 up to mid October. Beyond mid October, sorghum may be sown only for fodder. However sorghum M-35-1 may be sown for grain upto first fortnight of November

Safflower and chickpea : Sow up to early November and complete sowing within a fortnight after the receipt of first soaking rains

For failure of post-sowing rains in October

Thin every second or third row within 45 days depending on severity of stress in case of sorghum.

8. Other supportive practices

- Apply gypsum and reduce the exchangeable sodium percentage to around 5 to 7
- In case of drought (failure of October rains) thin out the sorghum population from 1.0/1.3 lakhs/ha to 65,000 or 85,000 plants/ha before grand growth period (end of October/early November) depending upon October rains before boot leaf stage.
- Use runoff water collected in dugout ponds for minimal irrigation of 5.0 cm at around and of October before appearance of moisture stress symptoms/ soil cracks.

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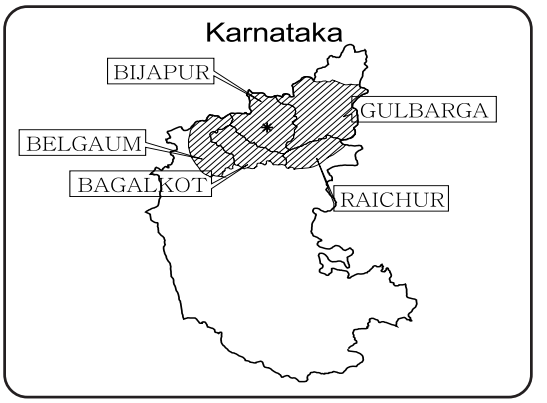

BIJAPUR

Rabi Sorghum based Production System in *Kharif Rabi* Semi-Arid Medium/ Deep Vertisols

1. Region

Bijapur, Bagalkot and Gulbarga, eastern parts of Belgaum, Lingsugur of Raichur of Karnataka and southern parts of Maharashtra.

2. Climate

This semi-arid region, receives a mean annual rainfall of 680 mm from May to October. Rainfall is bi-modal with peaks in July and September.

3. Soils

Mostly, the soils are medium to deep black with patches of mixed red and black. Both *kharif* and *rabi* crops are grown. The soils are low in phosphorus.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
			Kharif			
Greengram	PS-16	0.3-0.4	30	65-70	Susceptible to powdery mildew and pod borer	Suitable for sequence cropping in medium deep black soils
Blackgram	K-3 T-9	0.4-0.5 0.75-1.0	45	85 80	Susceptible to powdery mildew and pod borer	Suitable for sequence cropping in medium deep black soils
Cowpea	C-152 S-488	0.50-0.60 0.75-1.0	50	90-100 80-90	Susceptible to leaf blight mosaic and pod borer	Suitable for sequence cropping in medium deep black soils
Pigeonpea	C-28	1.0-1.2	120	180	Susceptible to sterility mosaic and pod borer	Suitable for monocropping in shallow to medium deep black soils and red soils

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
	PT-221	1.0-1.2		180	Susceptible to sterility mosaic and pod borer	Suitable for monocropping in shallow to medium deep black soils and red soils
	G.S -1	1.0-1.2		180-185	—	—
	KGT-1	1.0-1.2	125	180-190	Tolerant to wilt, sterility mosaic	
Cotton	Suyodhar (*Herbaceum*)	0.7-0.8	90	190-200	No major pests and diseases	Suitable for monocropping in medium deep soils
				Rabi		
Rabi Sorghum	M-35-1 5-4-1	1.0-1.2 1.0-1.2	65-70	125-130 125-130	Susceptible to charcoal rot and shoot bug	Suitable for medium to deep soils
Safflower	A-1	0.8-1.0	85	125-130	Susceptible to aphids and caterpillar	Suitable for monocropping in medium to deep soils
Sunflower	KBSH-1	0.7-1.0	45	90-95	Susceptible to virus	Suitable for shallow soils when sown during July/ August and during September first week in medium to deep black soils.
Chickpea	A-1	0.6-0.7	45	90-95	Susceptible to caterpillar and pod borer	Suitable for monocropping and intercropping systems

5. Seed rate and planting pattern

Crop	Plants/ha	Seed rate (kg/ha)	Planting pattern (cm)	
			Inter row	Intra row
Rabi sorghum	90,000 to 1,00,000	8 to 10	45-60	15
Safflower	60,000 to 70,000	8 to 10	60	30
Cotton	60,000	10	60	30
Chickpea	30,000 to 50,000	60 to 65	30	10
Sunflower	80,000 to 84,000	8	60	20

6. Nutrient management

Crop	Nutrients (kg/ha)		
	N	P_2O_5	K_2O
Greengram followed by *rabi* sorghum	25	50	—
	30	—	—
Hybrid pearlmillet	40	40	40
Rabi sorghum (sole)	50	25	—
Safflower	50	25	
Chickpea	25	50	
Sunflower	50	25	
Pearlmillet	50	25	
Groundnut	25	50	
Sesame	50	25	

- If soil profile is wetted to a depth of 150 cm, 100 percent recommended dose of fertilizer to be applied
- if soil profile is wetted to a depth of 60 – 70 cm, 50 percent recommended dose of fertilizer to be applied
- if soil profile is wetted to a depth of 30 cm, no fertilizer is applied at sowing but after receipt of good rains, 10-15 kg N / ha top dressing advocated.
- *Rabi* sorghum: Green manure (Glyricidia/ leucaena/ sunhemp) at 5 t/ha + 50 percent recommended dose of fertilizer to be applied
- Crop residues (Sorghum Stubble/ cotton stalks/ pigeonpea stalks/ green manuring crops like leucaena, sunhemp and glyricidia) incorporation 3-4 months earlier to sowing of sorghum with 50% or 100% recommend dose of fertiliser, (crop residues + 100 % recommend dose of fertiliser, or crop residues + green manure + 50% recommend dose of fertiliser).
- Farm yard manure to meet 50% N + 50% recommend dose of fertilizer or Vermi compost 1 t/ha + 50% recommend dose of fertiliser are helpful.

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ implement to be used	Time of operation
All crops	Slit hoe	For weeding at initial stage of the crop within one month of sowing
All crops	Blade hoe	Intercultivation in between rows. Remove weeds with 2 to 3 times intercultivation
All crops	Sickle	Hand weeding - once

Weed management - chemical

Crop	Herbicide	Dose a.i./ha	Application
Pearlmillet	Atrazine 50%	1.0 kg	Preemergence
Groundnut	Nitrofen 25 E.C. or	1.2 l	Preemergence
	Alcohol 50 E.C. or	4.0 l	Preemergence
	Fluchloratin 45 EC	2.0 l	Preemergence
Castor	Fluchloralin or	0.98 kg	Preemergence
	Trifluralin	0.98 kg	Preemergence
		1.28 kg	Preemergence

Crop	Herbicide	Dose a.i./ha	Application
Cotton	Pendimethalin 30 EC or Diuron 50%	5.0 l 1.25 kg	Preemergence Preemergence
Rabi sorghum	Atrazine 50%	1.0 kg	Preemergence

Insect pest management

Crop	Pests	Control measures
Pearlmillet	Blister beetle and Earhead bugs	Malathion 20 g/l of water
Groundnut	Aphids	Dimethoate 1.7 ml/l of water or Methyl Parathion 1 ml/l of water or Monocrotophos 1 ml/l of water
	Leaf miner	Use any one of the chemicals as mentioned above for aphids control
	Red head hairy caterpillar	Ploughing Use of light traps on the day of rain Picking of eggmass and caterpillars and destroying Dusting of Endosulfan 4% or Quinolphos 1.5% or Phosalone 4% or Spraying of Endosulfan 35 EC 2 ml/l or Monocrotophos 40 EC 1 ml/l
	Leaf eating caterpillar Termites	Use of poison bait. Identification of termites colony and destroying the queen Frequent irrigation Pouring of Chlorpyriphos 20 EC 3.3 ml/l into the termites colony and use 18 l of water/ colony Alluminium phosphides 2 tables/ colony of one m^2 area
	Root grub	Use of petromax lamps 7.30 to 8.30 pm days after rain 2% Phorate or 3% Carbofuran or 5% Quinolphos granules 25 kg/ha or dusting of 35 kg Carboryl power 4% as soil application Spraying of Chlorpyriphos 20 EC 10 ml/l on the soil surface, spray solution 500 l/ha
Pigeonpea	Pod border	IPM- At the time of sowing, 250 g of sorghum or pundi seeds are mixed with pigeonpea 20 branched poles/ha. This helps birds to sit and predate on larvae or Pheromone traps 5/ha for monitoring the pod border incidence. Methomyl or Thiodicarb 0.6 g or Propentoy 2 ml/l 5% NSKE NPV 250 LE/ha + 1250 g jaggery Chlorphriphos 20 EC 2.5 ml/l or Quinolphos 25 EC 2ml/l or Endosulfan 35 EC 2 ml/l Alphomethrin 0.5 ml/l or Fenvelrate 0.5 ml/l or In the area where secretion of water, drenching is recommended. Malathion 5% or Quinolphos 1.5% 25 kg/ha.
	Weevil and Spider mite	Endosulfan 35 EC 2ml/l or Monocrotophos 40 EC 1 ml/l

Crop	Pests	Control measures
Greengram	Agromyzid fly and leaf eating caterpillars	Methyl Parathion 1 ml/l
	Aphids Leaf hopper	Methyl Parathion 1 ml/l Dimethoate 1 ml/l
Castor	Semilooper Capsule borer and Spodoptera	Methyl Parathion 1 ml/l Endosulfan 2 ml/l or Dusting of 4% Fenevelrate
Blackgram	Agromyzid fly Pod borer and leaf eating caterpillar	Methyl Parathion 1 ml/l
Cowpea	Pod borer Agromyzid fly	Methyl Parathion Phosphomedon 1/2 ml
	Aphids	Dimethoate 1.7 ml/l
Niger	Leaf eating caterpillar	Methyl Parathion 1 ml/l or Dimethoate 1.7 ml/l
Sesame	Capsule border Cut worm Death head moth	Methyl Parathion 1 ml/l
Sunflower	Heliothis	At the time of button stage NPV 250 SL Endosulfan 2 ml Phosalone 2 ml
	Black head hairy caterpillar, Ash weevil	Destruction of egg mass and caterpillars on the leaves Methyl Parathion 2% dusting 2 kg/ha At the time of flowering, spraying and dusting are avoided
Sorghum	Shootfly	Before sowing, phorate 10% or Carbofuran 3% granules 30 kg/ha Endosulfan 4% granule 7.5 kg/ha Carboryl 4% granule 7.5 kg/ha Linden 1% granule 7.5 kg/ha Carbofuran 3% granule 7.5 kg/ha at 25 and 45 days after sowing
	Mite	Dicofol 2.5 ml or Farmothian 2.0 ml/l
	Earhead bug and Shoot bug Shoot bug	Carboryl 4 g/l or Endosulfan 2 ml/l or Melathion 2 ml/l
	Sorghum earhead midge	Melathion 5% dusting 20 kg/ha Endosulfan 4% dusting 15 kg/ha Quinolphos 1.5% dusting 20 kg/ha Carboryl 10% dusting 20 kg/ha Phosalone 4% dusting 20 kg/ha

Crop	Pests	Control measures
Chickpea	Pod border	Before flowering 25 kg/ha – Quinolphos 1.5% or 25 kg/ha – Fenevalrate – 0.4% NPV 250 LE Carboryl 4 g/l, or Fenitrothion 0.5 ml, or Quinolphos 2 ml/l, or Chlorpyriphos 2.5 ml/l, or Methomyl 2 ml/l, or Acephate 75 wp/g/l, or Chlorpyriphos 1.3% 25 kg/ha dust
Safflower	Aphids, capsule borer and leaf eating caterpillar	Methyl Parathion 1 ml Monocrotophos 1 ml Dimethoate 1.7 ml Oxydemeton methyl 1.3 ml Acephate 1 g Dusting 20 kg/ha Malathion 5% Quionolphos 1.5% Endosulfan 4% Phosalone 4%

Disease management

Crop	Diseases	Control measures
Pearlmillet	Ergot	2.2 g Ziram/l at the time of 75% earhead emergence
	Rust (Leaf)	Grow resistant varieties, dust Lakxin 0.5 ml/l or Hexacanazol 0.1%
	Downy mildew	Ridomil M2 0.1% or Zineb 0.25 %
Groundnut	Tikka disease	Carbendazim 0.5% g/l of water
	Rust	Mancozeb 2 g/l
	Bud necrosis	Nuvacron 0.15% or Metasystox 0.15% or Confirdar 0.03%
	Root rot	Practice crop rotation and good cultivation; treat seed with Thirum or Capton 8.0 g/l, 1 part for 400 parts of seeds.
	Dieback	Seed treat with Capton 3.0 g/kg seed or Spray Bavistin 0.1% or Mancozeb 0.25%
Pigeonpea	Wilt	Grow resistant variety (Maruthi)
	Sterility Mosaic	Rogue perennial and self sown arhar plants before the sowing season. ICPL-87 resistant variety
	Leaf spot	Practice crop sanitation spray with Bavistin 0.1% or 0.2% Zineb or Ziram
Greengram	Mosaic	Nuvacron 1.25 ml or Hostothion 1.5 ml/l
	Powdery mildew	Carbendazim 0.5 g/l at the time or before flowering
	Leaf spot	Zineb or Mancozeb 2.5 g/l or Copper Oxychloride 3 g/l
Castor	Root rot disease	Capton 0.3% or Bavistin 0.2% or Thiram 0.2% drenching
	Damping off	Capton 0.3% drenching 3.0 g/l
	Leaf spot Powdery mildew	Carbendazim 0.5 g or Zineb or Mancozeb 2.5 g/l water

Crop	Diseases	Control measures
Blackgram	Mosaic (viral)	Metasystox 1.5 ml/l or Dimethoate 1.75 ml/l
	Powdery mildew	Wetable Sulphur 3 g/l
	Leaf spot	Zineb or Mancozeb 2 g/l or Copper Oxychloride 3 g/l
Cowpea	Mosaic	Rogue out disease plants, select the seed from healthy plants, grow tolerant varieties
	Powdery mildew Leaf spot	Sulphur 3 g or Zineb or Mancozeb 2 g or Copper Oxychloride 3 g/l of water
	Bacterial blight	Agrimycin-100 0.5 g/l of water
Sesame	Leaf spot	Mancozeb 0.25%
	Powdery mildew	Wetable Sulphur 3 g/l of water
Cotton	Bacterial blight	500 ppm Streptomycin + 3 g Copper Oxychloride in one l of water
	Alternaria leaf spot	2 g Zineb or Mancozeb 2.5 g in one l of water
	Root rot	Soil drenching Bavistin (0.2%)
	Grey mildew	Spray the crop with 1% Bordeaux mixture or with any fixed copper fungicide (0.3%) i.e. Copper Oxychloride
Sorghum	Rust	Dust finely powered Sulphur 17 kg/ha
	Red leaf spot	Seed treatment with Streptomycin sulphate 500 ppm for 30 minutres.
	Sugary disease	0.25% Ziram spray
	Downy mildew	Seed treatment before sowing with Redomil MZ 3 g/kg of seeds
Chickpea	Wilt	Seed treatment before sowing with Kypton or Thiuron or Carbaxin or Mancozeb 2 g/kg of seed
	Powdery mildew	Carbendazim 0.5 g/l of water
Sunflower	Rust	Mancozeb 0.25% Hexaconazol 0.1%
	Leaf spot	Mancozeb 0.25%
	Root rot	Ridomil MZ 0.1% drenching
	Downy mildew	Ridomil MZ 0.1% or Zineb 0.25%
Safflower	Collar rot	Capton 2.5 g/l
	Leaf blight Leaf spot	Mancozeb 2.5 g/l of water
Horsegram	Yellow mosaic	Resistant variety or control vector Confidar 0.03% Metasystox 1.5 ml/l Rogar (Dimethoate) 1.75 ml/l

8. Suitable cropping systems

- Advancing the time of sowing of *rabi* sorghum from October to September causes sustained increases in yield
- On medium black soils early sowing in second fortnight of September is better

- Sowing of *rabi* crops during first week of October produces highest grain yield in deep black soils
- Pigeonpea – first fortnight of July
- Cotton – second fortnight of July

Sequence cropping

- Greengram – *rabi* sorghum/ sunflower
- Cucumber – *rabi* sorghum/ sunflower
- Greengram – safflower

Intercropping

Kharif

- Hybrid pearlmillet + castor (3:1)
- Cotton + setaria (1:1)
- Groundnut + setaria (3:1)
- Pearlmillet + pigeonpea (2:1)
- Sesame + pigeonpea (3:1)
- Bunch groundnut + pearlmillet (4:2)
- Bunch groundnut + pigeonpea (3:1 or 4:2)
- Groundnut + cotton (2:1)
- Groundnut + sunflower (3:1)

Rabi

- Chickpea + safflower (4:2)
- Chickpea+ safflower (3:1)
- *Rabi* sorghum + pigeonpea (3:1)
- Safflower + chickpea (2:4 or 1:3)
- *Rabi* sorghum + chickpea (2:1)

9. Farm implements / Tools

Tool/ Implements	Unit/Cost (Rs.)	Operation
Wooden plough (Bullock drawn)	2000/-	Shallow ploughing to a depth of 10 cm
MB plough (Bullock drawn)	4000/-	Deep ploughing
MB plough (Tractor drawn)	15000/-	Deep ploughing
Blade harrow (Bullock drawn)	1000/-	Harrowing
Blade harrow (Tractor drawn)	10000/-	Harrowing
Seed cum fertilizer drill (Bullock drawn)	2500/-	Sowing and fertilizer application
Seed cum fertilizer drill (Bullock drawn – adjustable)	4500/-	Sowing and fertilizer application simultaneously
Seed cum fertilizer drill (Tractor drawn)	26000/-	Sowing and fertilizer application
Ridger	1000/-	Ridges and furrows
Bund former	700/-	Compartment bunding
Slit hoe	500/-	Hoeing operation
Blade hoe	500/-	Intercultivation operations
Wooden float	600/-	Clod breaking
Buck scraper	2500/-	Leveling
Scooper	500/-	Scooping
Multi furrow opener (Tractor drawn)	15000/-	Opening of furrows
Cultivator (Tractor drawn)	15000/-	Cultivating
Rotovator (Tractor drawn)	45000/-	Incorporation of residues and green manures

10. Contingent crop planning

Normal onset of monsoon

- Take up sowing of the following crops in June in light soils. Groundnut (erect and spreading), pearlmillet, 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 pearlmillet + pigeonpea (2:1). Similarly, pulse crops in light and retentive soils may be taken up.
- In *rabi* areas, in medium deep black soils, sow greengram, blackgram, cucumber as a first crop to be followed by *rabi* sorghum/ sunflower/ chickpea/ safflower/ wheat.
- When the land is kept fallow (deep black soils) for *rabi* crops, have compartmental bunds having 1 percent slope, scooping where the land slope is 1 to 2 percent, 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 manure 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 pearlmillet, 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 pearlmillet, 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 hirsutums. 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 1.5 times the normal seed rate relatively at depth without applying

chemical fertilizers. Fertilizers may be applied at appropriate growth stage having optimum moisture condition.

Sowing in October

- Continue the sowing of *rabi* sorghum till October 15th with 50 percent 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 cessation of rains

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

11. Other supportive practices

- Give one shallow ploughing and 2 to 3 harrowings for seeding *rabi* sorghum.
- Form ridge-furrows in June-July after preparing the land for sowing *rabi* sorghum for better moisture conservation.
- Safflower as sole crop is more profitable than wheat under dryland conditions.
- Give supplemental irrigation, in case of drought, to *rabi* crops with runoff water collected in ponds.
- Vertical mulching helps to increase *rabi* sorghum yields by 25-30 percent. Vertical mulching with opening trenches of 30 cm deep and 15 cm width across the slope at horizontal distance of 5 m in deep black soils
- Gravel sand mulching and pebble mulching helps to increase the *rabi* sorghum and sunflower crop yield by 200 and 250 percent and cropping intensity by 200 percent.
- For higher net returns it is recommended to grow cucumber and ridge guard vegetable crops during *kharif* in medium to deep black soils.
- Zingg conservation bench terrace practice in medium to deep black soils has spread to an extent of 25 to 30 percent of the zonal area and resulted in double cropping besides 100 percent increased yields irrespective of drought year. Conservation bench terraces of 1:3 leveled.
- Adoption of wider row spacing (135 cm) and frequent deep intercultivation in sunflower and pearlmillet crops during *kharif* season has spread in 15 to 20 percent of the district cultivable area and yields 35 to 40 percent more. Sequence cropping is possible in all the years.
- Onion + chillies + cotton and indigenous mixed cropping system in medium to deep black soils is more profitable option.
- Contour bunding with land shaping in shallow black soils.
- Contour border strips and Zingg/ conservation bench terrace in medium to deep black soils.

- Unleveled proportion in medium black soils.
- Compartmental bunding in medium and deep black sols at 4.5 m x 4.5 m and 3.0 m x 3.0 m during the second fortnight of July on lands having slope of 2 and 3 percent respectively.
- Opening the ridges and furrows at 45 and 90 cm apart across the slope 45 to 50 days prior to sowing of *rabi* sorghum
- Plenty of vegetative barrier viz., vertivar and leucaena in paired rows at vertical interval of 0.3 m reduces run off and soil loss considerably.
- Gully plugging prevents soil erosion and siltation of nalas and conserves water.
- Construction of nala bund (percolation tanks) increases ground water level.

Intercropping

- Agave (*Agave sisolana*) with 10, 000 plants /ha intercropped with *Leucaena* cutting of agave leaves once in a year for fber extraction with retaining top ten leaves
- Silviculture in shallow black soils with Casuarina, *Dalbergia sissoo, Hardwickia binata*
- Marginal lands: *Dalbergia sissoo*, neem, *Acacia nilotica,* Leucaena
- Alley cropping with Leucaena/ Casuarina + *Kharif* crops
- Agro horti system: Ber (Umran) + curry leaf
- Vegetables – curry leaf
- Ber (umran) – safflower + chickpea
- Ber / custard apple/ promegranate/ amla + *kharif* (spreading) crops
- Horticulture: Mango plants in leveled portion of Zingg conservation terrace
- Polythene mulch / sorghum stuble mulch – in *rabi* sorghum
- Pearlmillet: Skipping one row after every 2 to 3 rows + 75% recorded seed rate and 100% recommended fertilizer
- Chickpea: Skipping one row after every 3 rows + 75% recorded seed rate and 100% recommended fertilizer; early sowing + plant protection; 25 kg N + 50 kg P_2O_5 / ha
- Bunch groundnut: Skipping one row after every 3 rows + + 75% recommended seed rate and 100% recommended dose of fertilizer
- Cotton: Early sowing + 45 to 60 cm row spacing + 100% recommended dose of fertilizer
- *Rabi* sorghum: early sowing + wider spacing + 100% recommended dose of fertilizer (50 kg N + 25 kg P_2O_5 / ha)
- Safflower: early sowing + 60 cm row spacing + plant protection measure + 100% recommended dose of fertilizer (50 kg N + 25 kg P_2O_5 / ha)

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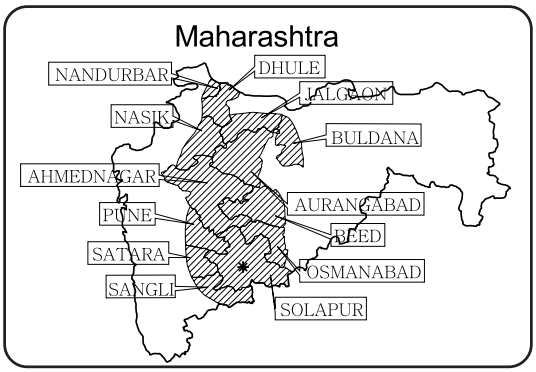

SOLAPUR

Rabi Sorghum based Production System in Semi Arid Shallow to Deep Vertic Inceptisols/ Vertisols

1. Region

Rainfall scarcity zone of Maharashtra covers whole of Solapur and Ahmednagar districts, eastern parts of Nasik, Pune, Satara, Sangli, Dhule and Nandurbar, western parts of Beed, Osmanabad, Aurangabad, some parts of Jalgaon and Buldana districts.

2. Climate

Solapur receives 723 mm rainfall annually, which is not well distributed and annual potential evapotranspiration is 1856 mm resulting in 61 percent deficit. This is a rain shadow region due to western ghats. The climate is usually hot and potential evapotranspiration is far more than the precipitation and is classified as semi-arid tropics.

3. Soils

Topography of this zone is rolling type. The soils exhibit a toposequence of very shallow (< 7.5 cm depth) and shallow (7.5 to 22.5 cm depth) soils on ridge, medium deep (22.5 to 90 cm depth) and deep (> 90 cm) in the valley of the watershed. About 10 percent are marginal skeletal soils, 26 percent shallow soils, 47 percent medium deep and 17 percent deep black soils. The soils are moderate to highly erodable. The fertility status of soil is low in organic carbon (0.35 to 0.50 percent) and total nitrogen (0.035 to 0.05 percent), low to medium in available phosphate (10 to 30 kg/ha P_2O_5) and high in available potash (300 to 750 kg/ha K_2O). Black soils show swelling and shrinkage phenomena. Predominantly *rabi* crops are grown in deep black soils, *kharif* and *rabi* crops in medium black soils and only *kharif* crops in shallow soils.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Pearlmillet	ICTP-8203	2.0-2.2	50-55	70-80	Resistant to *Gosavi*	Bold seed, ash colour
	Hybrid					
	Shradha	2.5-3.0	50-55	75-80	Resistant to *Gosavi*	Bold seeded, seed colour white gray
	RHRBH-8609	2.5-3.0	50-55			
Setaria	Arjun (variety)	1.7-1.8	50-52	103	—	Suitable for moisture stress

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Pigeonpea	No.148	2.1-2.2	75-85	145-155	Tolerant to wilt	Suitable for intercropping
	BDN-2	1.6-1.8	85-90	155-165	Wilt resistant	Bold white seeded, better for intercropping
	T-Vishakha	1.5-1.6	80-85	120-125	—	—
	Maruti (ICP-8863)	1.5-1.6	80-85	185-190	—	—
	BSMR-736	1.5-1.6	80-85	185-190	—	Resistant to wilt
Sunflower	EC-68414	1.0-1.2	60-65	100-110	—	Recommended for *Kharif*
	Morden	0.7-0.8	54-58	80-85	—	Recommended for light to medium type of soil
	SS-56	0.8-1.0	52-55	80-85	—	Recommended for drought prone area
Groundnut	M-13	1.6-1.7	40-45	130-135	—	Erect
	SB-11	1.2-1.4	30-35	105-110	—	-do-
	ICGS-11	2.6-3.0	45-50	125-130	—	-do-
	JL-220	2.0-2.2	30-35	90-95	—	-do-
	TAG-24	1.2-1.4		100-105	—	—
	TG-26	1.8-2.0	35-40	95-100	—	Erect, suitable for whole Maharashtra State
Horsegram	Sina (K-42)	0.8-0.9	55	115-120	Tolerant to mosaic	Pale white seeded, suitable for intercropping
	Man (D-40-1)	0.7-0.8	45	100-105	-do-	Dark brown seeded, suitable for intercropping
Greengram	S-8	0.9-1.0	35-40	75-80	—	Suitable for sequence cropping
	J-781	0.8-1.0	35	65-70	—	Bold, green shining seeds, suitable for sequence cropping
	Phule M-2	1.1-1.2	38-40	60-65	—	Pale green, suitable for both seasons
Blackgram	T-9	0.7-0.8	32-35	78-82	—	Suitable for sequence cropping
	TPU-4	1.1-1.2	35-40	70-75		Bold seeded, Medium
Mothbean	MBS-27	0.7-0.8	75-80	125-130	Resistant to mosaic	Recommended for western Maharashtra

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Castor	VI –9	1.1-1.5	90-95	100-110	—	Recommended for western Maharashtra
	Aruna	1.0-1.2	70-75	115-120	—	-do-
	Girija	1.0-1.4	80-85	110-120	—	-do-
Sorghum	M 35-1	1.5-1.8	70-75	120-125	Resistant to mosaic	Recommended for drought prone area and medium deep soils
	Phule Yashoda	3.0-3.2	75-80	120-125	Resistant to charcoal rot and shootlfy	Recommended for deep soils
	Mauli	M-1.5-2.0* S-0.8-0.9**	70-75	105-110	-do-	Recommended for drought prone area and light soils
	Sel.-3	0.6-0.8	65-70	105-110	-do-	Recommended for light soils
Safflower	Bhima	1.4-1.6	65-70	130-135	—	Recommended throughout Maharashtra for late sowing
Chickpea	Vikas	1.1-1.2	40	115-120	Resistant to wilt	Recommended for Western Maharashtra
	N-59	1.0-1.1		105-110	-do-	Recommended for Vidharbha, Marathwada
	Chaffa	0.9-1.0	37	100-105	-do-	Recommended for drought prone area of Maharashtra
	Phule G-12	1.2-1.3	40-45	105-110	—	Recommended for rainfed and irrigated area
	Vijay	1.5-1.6	38	85-90	Resistant to wilt	Recommended for
	Vishal	1.4-1.5	40	110-115	-do-	rainfed and irrigated area

**M=Medium deep soil; **S=Shallow soils*

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Pearlmillet	03	45	15
Sunflower	10	45	30 (Heavy soils)
		45	22.5 (Light soils)
Groundnut	100		
Errect		30	10
Semi spreading		30	15
Spreading		45	15

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Pigeonpea	12	45 to 60	20
Horsegram	15	30	10
Mothbean	15	30	10
Blackgram	15	30	10
Greengram	15	30	10
Rabi sorghum	10	45	20
Safflower	12	45	20
Chickpea	75	30	10

Preparatory tillage

- Horsegram, mothbean, greengram, blackgram, chickpea – 2 to 3 harrowings
- Pearlmillet, pigeonpea, sunflower, safflower – 3-4 harrowings
- Groundnut – one ploughing, 3-4 harrowings
- Sorghum – ploughing once in three years 3-4 harrowings every year

6. Nutrient management

Crop	Fertilizer (kg/ha)		FYM	Remarks
	N	P_2O_5		
Pearlmillet	50	25	—	*Leucaena* loppings 5 t/ha on shallow strips + 25 kg N
Sunflower	50	25	—	—
Groundnut Pigeonpea Horsegram Mothbean	12.5	25	—	—
Castor	25	12.5	—	—
Rabi Sorghum	50	25	12.5 Cart loads farm yard manure/ha once in three years, to the ploughed fields	Medium deep soils: 25 kg N/ha, Deep soils: 50 kg N/ha Mulching with 5 t/ha dry grass after crop emergence + protective irrigation cowpea (fodder) – *rabi* sorghum – leucaena loppings (5 t/ha) + 25 kg/ha P_2O_5 to cowpea
Safflower	50	25	—	—
Chickpea	12.5	25	—	—
Summer Groundnut (JL-220/ TAG-24)	25	50	—	—
Greengram	12.5	25	—	—
Blackgram	12.5	25	—	—

- General Recommendation
  - Cereals – 50 kg N + 25 kg P_2O_5 /ha
  - Pulses – 12.5 kg N + 25 kg P_2O_5 /ha
- Seed treatment
  - Pearlmillet, sunflower, sorghum, safflower – *azatobacter* culture 25 g/kg seed
  - Pigeonpea, greengram, blackgram, horsegram, mothbean, groundnut, chickpea – *Rhizobium* culture 25 g/kg seed

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ implements	Times of operation
Rabi sorghum	Slit blade hoe Entire blade hoe Tooth blade hoe	First hoeing – 3rd week after sowing Second hoeing – 5th week after sowing Third hoeing – 8th week after sowing
Pearlmillet	Weeding hook/ hoe	Clean cultivation by hand weeding or hoeing upto 30 days after sowing
Pigeonpea	Weeding hook Hoe	Hand weeding upto 30 days after sowing Two hoeing and upto 45 days after sowing
Greengram/ blackgram	Weeding hook Hoe	Hand weeding Hoeing upto 30 days after sowing
Groundnut	Weeding hook Hoe	Hand weeding upto 30 days after sowing Two hoeing and upto 40 days after sowing
Sunflower	Weeding hook Hoe	Hand weeding upto 30 days after sowing Two hoeings at 30 and 50 days after sowing
Chickpea	Weeding hook	Hand weeding at 25-30 days after sowing
Horsegram, mothbean	Hoe	One hoeing at 30 days after sowing

Weed management – chemical

Crop	Herbicide	Dosage kg (a.i.)/ha	Method of application
Pearlmillet	Atrazine 2,4,-D (Sodium)	0.5 1 to 1.5	Preemergence spray in 500-600 l water/ha 3-4 weeks after sowing in 500 l water/ha
Sorghum	Atrazine 2,4,-D (Sodium)	0.5 1 to 1.5	Preemergence spray in 500-600 l water/ha 3-4 weeks after sowing in 500 l water/ha
Pigeonpea	Fluchloralin Pendimethalin	0.5 to 1 1 to 1.5	Immediately after sowing in 500-600 l water/ha Preemergence spray in 500-600 l water/ha
Sunflower	Fluchloralin Pendimethalin	0.75 to 1 1 to 2	Preemergence spray in 500-600 l water/ha Preemergence spray in 500-600 l water/ha
Chickpea	Fluchloralin Pendimethalin	1 to 1.5 1 to 1.5	Preemergence spray in 800-1000 l water/ha Preemergence spray in 800-1000 l water/ha
Safflower	Fluchloralin	0.75 to 1	Preemergence spray in 600-800 l water/ha

Insect pest management

Crop	Pest	Control measures
Sorghum	Sugary disease	Caused by aphids, jassids & delphocids Spraying with 0.03 % Dimethoate is recommended if it is not controlled naturally by predator Ladybird beetle
	Shootfly	Endosulfan 35 EC 350 ml in 250 l water/ ha
Safflower	Aphids	Use of moderately aphid tolerant variety Bhima Sowing of safflower in 2nd fortnight of September Use of Neem seed extract 5 % spray Spraying of 0.3 % Dimethoate on the basis of ETL Dimethoate 30 EC 820 ml in 500 l water/ ha
	Capsule borer	Endosulfan 35 EC 700 ml in 500 l water/ ha

Crop	Pest	Control measures
Chickpea	Pod borer	Seed treatment with Trichoderma Use of chickpea variety Vijay Fixing Pheromone traps of *Helicoverpa* 5 /ha. Ha-NPV spray 500 LE/ha Neem seed extract 5% spray. NPV culture – extract of 500 caterpillar in 500 l/ha water or methyl parathion (2% dust) 20 kg/ha or Quinolphos 25 EC 1 l in 500 l/ha water
Pigeonpea	Pod borer	Seed treatment with *Trichoderma* 5 g/kg seed Dusting with 2 % Methyl Parathion dust 20 kg/ha Fixing pheromone traps 5 /ha Neem seed extract 5% spray Spraying of 0.05% Endosulfan
	Pod borer complex	NPV culture – extact of 500 caterpillars in 500 l water per hectare. Or Endosulfan 35 EC 1 l in 500 l water or methyl parathion dust 2% 20 kg/ha 25 kg neem seed extract in 500 l/ha water
Groundnut	White grub	Hand collection of white grub adults from white grub affected fields immediately after onset of summer rains Seed treatment with Chlorpyriphos 2 ml/kg of seed Soil application of 5 % Heptachlor 80 kg/ha before sowing
	Leaf roller	Dusting of 10 % Carbaryl dust 20 kg/ha Spraying of Monocrotophos 0.05 % as soon as incidence starts
	Aphids, Jassids, Thrips	Phosphamedon 85 EC 120 ml in 500 l/ha water Monocrotphos 36 EC 700 ml in 500 l/ha water
Pearlmillet	Blister beetles	Quinolphos 1.5% or Methyl Parathion 2% dust 20 kg/ha
Greengram, Blackgram	Leaf roller	Quinolphos 1.5% dust 20 kg/ ha or Dimethoate 30 EC 500 ml in 500 l/ha water
Sunflower	Hairy caterpillar	At initial stages of hairy caterpillar attack, removal and dipping of affected leaves in kerosin water Endosulfan 35 EC 700 ml in 500 l/ha water for caterpillar and borers

Disease management

Crop	Disease	Control measures
Pigeonpea	Wilt	Crop rotation and clean cultivation Use of resistant variety Seed treatment with *Trichoderma* 5 g/kg seed
Pearlmillet	Downy mildew	Seed treatment with Metalaxyl M.z.-7L 6 g/kg seed
	Ergot	Clean cultivation Use of resistant variety Seed treatment with 20 % salt solution
Sunflower	Downy mildew	Seed treatment with Metalaxyl 6 g /kg seed
	Leaf spot	Clean cultivation Spray Mancozeb 0.25%
Sorghum	Smut	Eradication of infected plants Seed treatment with 300 mesh Sulphur 4 g/kg seed
	Charcoal rot	Use resistant variety Use mulching with farm wastes 5 t/ha

Crop	Disease	Control measures
Safflower	Wilt	Clean cultivation Crop rotation Use certified seed of resistant variety Seed treatment with Thiram 2 g/kg seed
	Leaf spot	Spray with Mancozeb 0.25% Avoid early sowing
Chickpea	Wilt	Crop rotation Use resistant variety Seed treatment with Captan 4 g/kg seed (or) Trichoderma bio-agent 5 g/kg seed.
Groundnut	Tikka leaf spot	Carbendazim (50%) WP 250 g in 500 l/ha water
Sunflower	Downy mildew	Removal of downy mildew affected plants at early stages
	Anthracnose	Mancozeb 1250 g in 500 l/ha water for anthracnose (karpa)

8. Suitable cropping systems

Sowing time

- Horsegram – upto mid of August
- Mothbean – upto end of July
- Groundnut, pearlmillet – upto first fortnight of July
- Pigeonpea – upto second fortnight of August
- Greengram/ blackgram – upto end of June
- Sunflower – upto September, as contingency planning
- Sorghum, safflower – upto second fortnight of September
- Chickpea – upto end of October

Crop planning as per soil depth

- Soil depth – <7.5 cm (available moisture – 15-20 mm): grasses, agroforestry, dryland horticulture
- Soil depth – 7.5 – 22.5 cm (available moisture – 30-35 mm): grasses, horsegram, mothbean, castor, agroforestry, dryland horticulture, pearlmillet + horsegram / mothbean (2:1)
- Soil depth – 22.5 – 45 cm (available moisture – 40-65 mm): sunflower, pearlmillet, pigeonpea, pearlmillet + pigeonpea (2:1), pigeonpea + clusterbean (1:2), castor + clusterbean (1:2), castor + ridgegourd, castor 90x45 cm line sowing of ridgegourd in the castor row at 100 cm spacing.
- Soil depth – 45 – 60 cm (available moisture – 60-150 mm): *rabi* sorghum, safflower, sunflower and chickpea
- Soil depth – > 60 cm (available moisture – > 150 mm): *rabi* sorghum, safflower, sunflower, chickpea and also double cropping

Sequence cropping

One year rotation

- Blackgram or greengram or cowpea for fodder followed by *rabi* sorghum, safflower, sunflower.
- Pearlmillet or sunflower followed by chickpea
- Sorghum for fodder followed by chickpea or safflower

Two year rotation

- Safflower or chickpea - *rabi* sorghum
- *Rabi* sorghum or chickpea - safflower

Medium deep (60-90 cm) soils

- Normal onset of monsoon
- Greengram – *rabi* sorghum
- Pearlmillet – chickpea

Rabi to rabi rotation

- *Rabi* sorghum – chickpea
- *Rabi* sorghum – safflower
- *Rabi* sorghum – chickpea

Intercropping

- Medium deep soils: *kharif* crops – first fortnight of July
  - Pearlmillet + pigeonpea (2:1)
  - Sunflower + pigeonpea (2:1)
  - Pigeonpea + clusterbean (1:2)
  - Castor + clusterbean (1:2)
  - Castor + ridgegourd, castor 90x45 cm line sowing of ridgegourd in the castor row at 100 cm spacing.
- Shallow soils
  - Pearlmillet + pigeonpea (2:1)
  - Sunflower + pigeonpea – aberrant weather
  - Sunflower + maize (2:1)
  - Dry seeding of sunflower + pigeonpea (2:1) during 11 to 17 June
  - *Kharif* sorghum + pigeonpea (1:1)
  - Hybrid pearlmillet (paired row at 30 cm spacing) + pigeonpea (2:1)

Recommended intercropping practices

Practices	**Pearlmillet + pigeonpea (2:1) intercrop**	**Sunflower + pigeonpea (2:1) intercrop**	**Pearlmillet+ horsegram / mothbean (2:1) intercrop**
Soil	Medium deep	Medium deep	Shallow
Preparatory tillage	3 to 4 harrowings	3 to 4 harrowings	2 to 4 harrowings
Sowing time	Up to 1st fortnight of July	Up to 2nd fortnight of August	Pearlmillet + mothbean – up to 2nd fortnight of June Pearlmillet + horsegram – up to 2nd fortnight of July
N:P_2O_5 kg/ha at sowing	50:25	50:25	50:25
Variety	Pearlmillet - As per sole pearlmillet Pigeonpea - BDN-2, N - 148	Sunflower – SS-56, Morden Pigeonpea – N-148, BDN –2	Pearlmillet – As per sole pearlmillet Mothbean – MBS –27; Horsegram – Sina, Man

Practices	Pearlmillet + pigeonpea (2:1) intercrop	Sunflower + pigeonpea (2:1) intercrop	Pearlmillet+ horsegram / mothbean (2:1) intercrop
Seed rate (kg/ha)	Pearlmillet – 2.5 Pigeonpea - 8	Pearlmillet – 2.5 Pigeonpea – 8	Pearlmillet – 2.5; Mothbean -5; horsegram –5
Seed treatment (per kg seed)	Thriam /captan – 3 g and Azatobacter – 25 g for pearlmillet. Rhizobium – 25 g for pigeonpea	Thiram /captan – 3 g and Azatobacter 25 g for sunflower, Rhizobium – 25 g for pigeonpea	Thiram/captan – 3 g and Azatobacter – 25 g for pearlmillet, Rhizobium – 25 g for legumes
Sowing distance (cm)	Pearlmillet-30 x 15, Pigeonpea-90x20	Sunflower-45x30 cm, Pigeonpea-135x20 cm	Pearlmillet – 30 x 15; Mothbean/horsegram – 90 x 10
Intercultivation	Weeding (one) before 30 days followed by 2 – 3 hoeings	Weeding (one) before 30 days followed by two hoeings	Weeding (one) before 30 days followed by 2 hoeings
Plant protection	As suggested under sole pearl millet and pigeonpea	As suggested under sole sunflower and pigeonpea	As suggested under sole pearlmillet
Protective irrigation (if available)	At flowering of pearlmillet	At flowering of sunflower	At tillering of pearlmillet
	At pod filling of pigeonpea	At seed filling of sunflower	At flowering of pearlmillet
		At pod filling of pigeonpea	
Yield (t/ha)	Pearlmillet 1.2 – 1.5	Sunflower 0.6 – 0.8	Pearlmillet 1.0 – 1.2
	Pigeonpea 0.4 – 0.6	Pigeonpea 0.4 –0.5	Mothbean/ horsegram 0.3 –0.4

9. Farm implements / Tools:

Implement	Cost/Unit (Rs)	Operation
Tractor drawn "V" blade harrow	Rs.9000/-	Land preparation, harrowing, interculturing in orchards cultivation of land
Cycle hoe	Rs.250/-	Interculturing in row crops
Bullock drawn two row seed-cum-fertilizer drill	Rs.900/-	Sowing of all crops i.e. sorghum, pigeonpea, pearlmillet, sunflower, safflower and all pulses etc.
Bullock drawn Shivaji Multipurpose farming machine (3 row)	Rs. 7500/-	Land preparation, sowing of sorghum, pearlmillet and pigeonpea etc.
Tractor multicrop planter	Rs.22800/-	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.
Bullock drawn Jyoti planter	Rs.7500/-	The field trials were conducted and the machine is recommended for sowing the crops of dryland region.

Implement	Cost/Unit (Rs)	Operation
Weeders developed by Maharashtra Agro Industries Development Corporation Ltd. (MAIDC)	Rs.410/-	These weeders were tested on farmer's field and identified for weeding and interculturing in row crops.
Tractor drawn Single bottom reversible plough	Rs.18500/-	Tested on farmers' field for ploughing and identified for ploughing operations in dryland region as the field operation was effective and economical.
Tractor drawn Double bottom reversible plough	Rs.23600/-	Tested on farmers' field for ploughing and identified for ploughing operations in dryland region as the field operation was effective and economical.
Bund former	Rs.1050/-	Bund formers were tested and found suitable for compartmental bunding
Baliram plough	Rs.2500/-	Identified for moisture conservation practices like ridges and furrows and compartmental bunding
Kopergaon bullock drawn two bowl seed drill	Rs.9000/-	The local made seed drill named "Kopergaon seed drill" is operated on the field for sowing crops like sorghum, pearlmillet, pigeonpea etc. and identified for sowing of the crops of dryland region

10. Contingent crop planning

Second fortnight of June

- All *kharif* crops

First fortnight of July

- Pearlmillet, setaria, groundnut, castor, pigeonpea, horsegram
- Intercropping of pearlmillet + pigeonpea (2:1),
- Clusterbean + pigeonpea (2:1),
- Clusterbean + castor (2:1),
- Sunflower + pigeonpea (2:1)

Second fortnight of July

- Sunflower, pigeonpea, horsegram, setaria,
- Castor, pearlmillet (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
    - Mid season corrections during *kharif* with soil having depth upto 45 cm for the scarcity zone can be tried

Delayed onset of monsoon

- *Kharif* fallow – *rabi* sorghum
- Pearlmillet – *rabi* sorghum
- Sorghum (fodder) – safflower
- Sorghum (fodder) – chickpea
- Pearlmillet (fodder) – safflower
- Pearlmillet (fodder) – chickpea
- Dry seeding of sunflower + pigeonpea (2:1) during 11 to 17 June

11. Other supportive practices

- Bangar's harrow plant system for sorghum - In this method two to three harrowings are done before sowing of crops and no interculturing is recommended upto harvest of crop.
- Use surface mulch of farm waste material like pigeonpea stalks, dry grass to cover the soil (5 t/ha). Spread the mulch within 15 days from sowing of *rabi* sorghum.
- Vertical mulching – Suitable organic materials should be stuffed vertically in trenches in such a fashion that they protrude 10 cm above the ground level and act as intake points and guide the water to sub-soil. The trenches recommended are 20 cm wide, 60-90 cm deep and spaced at 4 m.
- Use ferti-seed drills (two bowl) for seeding and placement for fertilizers.
- Use protective irrigation for *rabi* sorghum at 65 to 70 days from sowing. If two irrigations available then for *rabi* sorghum and safflower apply first irrigation 30 days from sowing and second irrigation 60-65 days from sowing. If only one irrigation is available then apply it for *rabi* sorghum and safflower 60-65 days after sowing. If two protective irrigations are available then for chickpea apply first irrigation 35 to 40 days after sowing and second irrigation 65 to 70 days after sowing.
- Use antitranspirants viz. Kaolin (8%) on *rabi* crops to reduce rate of evapotranspiration.
- Leucaena live bunding at 6 to 18 m spacing across the land slope for prevention of soil erosion is found beneficial.
- Agri-horticultural system - Ber (5x5 m) + mothbean (8 lines) (30x10 cm)/ horsegram.
- Use Bangar's Naal method for moisture conservation in dryland orchards.
- Lands < 22.5 cm depth of soil should be cultivated with Agroforestry and dryland horticulture including ber, custard apple, amla, woodapple, jambhul etc.
- On light soils Ber cultivation at 20x5 m spatial arrangement associated with pearlmillet + pigeonpea (2:1) intercropping within two rows of Ber plantation is recommended.
- Silvipastoral system of *Leucaena* + Marvel-8 with cutting of the alternate trees at 7th year onwards for fuel.

- For productivity increment in scarcity area the pearlmillet + pigeonpea (2:1) intercropping or ber (5x5 m) + mothbean (8 lines) is advocated.
- Silvi pasture: Leucaena + Marvel-8
- Alley cropping: Ber (20 m alleys) + pearlmillet + pigeonpea – shallow strips
- Fodder: Maize (African tall), oat (kent), *Stylosanthes hamata*
- Horticulture: Ber, pomegranate, woodapple, custard apple, tamarind, amla
- Animal: Gir, Jersey
- In Leaucaena plantations: cowpea (fodder) – *rabi* sorghum – lopping (Paired row of 3 m – 0 or 6 m –0)
- *Rabi* sorghum: one protective irrigation at 35-40 days increases yield
- Pearlmillet: Sowing of pearlmillet on ridges with furrows prepared one month prior to sowing (second forth night of May) gives higher yield. Paired row planting may be tried.
- Fingermillet, setaria as substitute crops
- Shallow soils – only for *kharif* with pearlmillet, pigeonpea, horsegram, mothbean, sesame or a mixture of all there
- *Rabi*: sorghum, safflower, chickpea
- Sunflower: *kharif* or as mid season crop, in *rabi* either sole or strip cropping in sorghum
- *Rabi* sorghum: early sowing (October) with Carbofuran seed treatment for shoot fly control

Protective Irrigation

- Pearlmillet – at tillering, at flowering
- Pigeonpea – at branching, at pod filling
- Greengram, blackgram – at flowering
- Groundnut – at peg formation, at pod filling
- Sunflower – at flowering, at seed filling
- Sorghum – 30 days after sowing (primordia stage), 55 days after sowing (boot stage)
- Safflower – 35 days after sowing (at vegetative growth), at flowering
- Chickpea – at branching, at pod filling

Suitable soil types

- Horsegram, mothbean – shallow well drained
- Pearlmillet, pigeonpea, greengram, blackgram – shallow to medium deep well drained
- Groundnut – shallow to medium deep with low clay content, well drained
- Sunflower, safflower, chickpea – medium deep to deep
- Sorghum – medium deep to deep soils (if *kharif* crop fails then on shallow soils)

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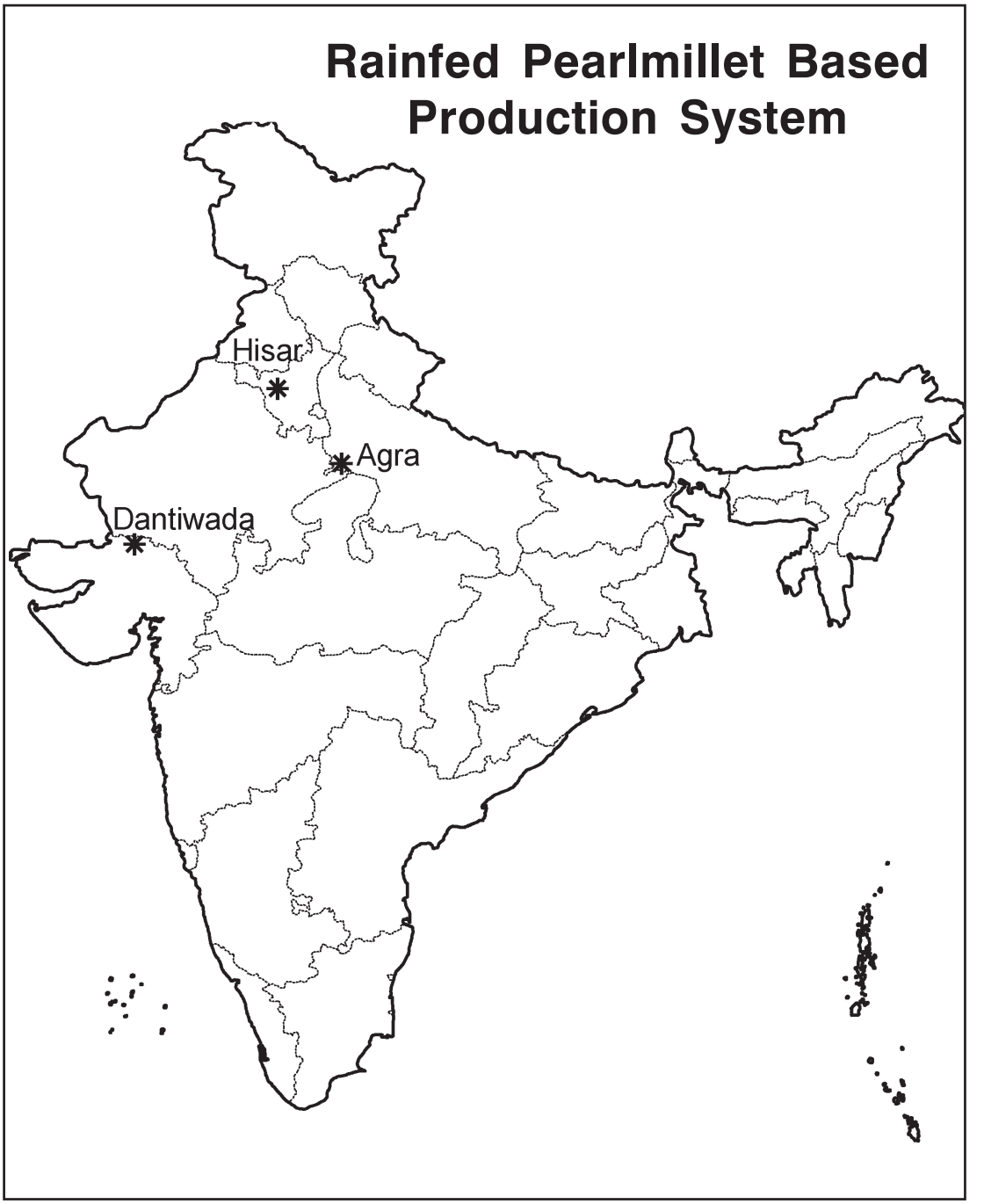
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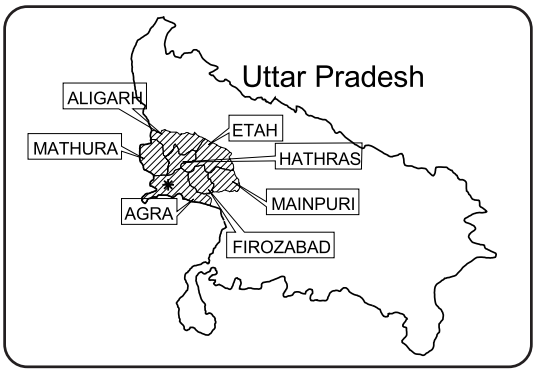

AGRA

Pearlmillet based Production System in *Kharif – Rabi* Semi Arid Inceptisols

1. Region

Agra, Aligarh, Hathras, Mathura, Etah, Mainpuri and Firozabad districts of Uttar Pradesh.

2. Climate

Semi arid sub tropical with dry scorching waves in summer and severe cold in winters. The rainfall is received from South – western monsoon. The probable week of onset of monsoon is 1st week of July and it recedes up to 3rd week of September. The mean annual rainfall is 665 mm, out of which 538 mm (80%) is received during July to September. Winter rains are not appreciable but are crucial for *rabi* crops.

3. Soils

Soils are deep alluvial sandy loams except when calcium carbonate concretions occur at shallow depths. In this area either a *kharif* or a *rabi* crop can be grown successfully. Moisture is generally adequate for intercropping systems with pearlmillet as the base crop. Double cropping is feasible in case of adequate rains in October.

4. Crops and varieties

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Pearlmillet	MBH-110	2.2-2.3	55-60	85-90	Resistant to diseases and pests	Suitable for pure/ intercropping
	MBH-163	2.3-2.4				
	Proagro –9402	2.5-2.6			-do-	-do-
	WCC-75	1.6-1.8	60-65	105-110	-do-	-do-
Pigeonpea	T – 21	2.5-3.0	95-100	160-170	Resistant to diseases and pests	Suitable for pure/ inter cropping
	UPAS-120	2.0-2.5	90-95	130-140		
	ICPL-87	2.5-3.0		140-150		
Clusterbean	Durgapura Safed	1.3-1.4	65-70	115-120	Resistant to diseases and pests	Suitable for pure/ intercropping
	RGC-197	1.0-1.2	65-70	110-120		
Greengram	Pant Moong-1	0.8-1.0	40-45	70-75	Resistant to yellow mosaic and pests	Suitable for pure/ inter sequence (with mustard) crop systems
	Pant Moong-2	0.8-1.0	40-45	65-70		
	T – 44	0.8-1.0	40-45	65-70		
	K – 851	1.0-1.2	40-45	60-65		

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Blackgram	T – 9	1.0-1.2	50-55	80-90	Resistant to yellow mosaic and pests	Suitable for pure/ intercropping
	Pant - U - 19	1.2-1.5	50-55	80-85		
	Pant – U – 30	1.0-1.2	50-55	80-85		
Groundnut	Chandra	1.2-1.5	65-70	145-150	Susceptible to Tikka disease	Suitable for pure cropping
	T – 64	1.0-1.2	65-70	145-150		
Cowpea	C 152	1.2-1.5	55-60	95-100	Resistant to diseases and pests	Suitable for pure/ intercropping
	RC 19	1.0-1.2	55-60	95-100		
Sesame	T – 4	0.6-0.8	55-60	95-100	Resistant to diseases and pests	Suitable for pure/ intercropping
	T – 12	0.6-0.8	45-50	90-100		
	Pratap	0.6-0.8	45-50	85-100		
Mustard	Varuna (T59)	2.0-2.5	45-50	135-140	Susceptible to aphids	Suitable for pure / inter (chickpea)/ sequence (after greengram) crop systems
	RH 30	2.0-2.2	45-50	135-140		
	Pusa Jaikisan	2.0-2.5	45-50	135-140		
Chickpea	BG 256	2.5-2.8	80-90	140-150	Susceptible to blight	Suitable for pure / inter (mustard) cropping
	Gaurav	2.5-2.8	80-90			
	K 850	2.6-3.0	80-90			
Barley	RS 6	2.2-2.5	60-65	145-150	Resistant to diseases and pests	Suitable for pure cropping
	Ratna	2.5-2.8	60-65	145-150		
	DL 70	2.2-2.5	60-65	145-150		
Oats	TMH 1	1.6-1.7	50-55	160-165	Susceptible to *Alternaria* blight	Suitable for pure cropping
	M 630	1.8-2.0	50-55	160-165		

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Pearlmillet	5-6	45	15
Pigeonpea	12-15	60	15
Blackgram/ greengram	12-15	30	10
Mustard	5-6	45	15
Clusterbean	25	45	15
Chickpea	70-75	30	15
Barley	80-85	25	10
Safflower	6-7	45	15
Linseed	10-12	30	10

6. Nutrient management

Crop	Nutrients (kg/ha)			Method of application
	N	P_2O_5	S	
Pearlmillet	60	40	—	P_2O_5 basal and N in two equal splits at sowing and tiller initiation
Pigeonpea/ blackgram/ greengram	10-15	40	—	Placement at 10 cm depth
Clusterbean	10-15	40	—	Placement at 10 cm depth

Crop	Nutrients (kg/ha)			Method of application
	N	P_2O_5	S	
Mustard	60	40	30 (gypsum)	N and P_2O_5 as basal at 10 cm depth
Safflower	60	40	—	N and P_2O_5 as basal at 10 cm depth
Chickpea	10-15	60	—	Treat seed with rhizobium culture. Full dose of N and P_2O_5 as basal at 10 cm depth
Barley	60	40	—	N and P_2O_5 as basal at 10 cm depth
Linseed	45	30	—	N and P_2O_5 as basal at 10 cm depth
Pearlmillet + greengram (2:1)	45	30	—	N and P_2O_5 as basal at 10 cm depth
Chickpea + mustard (4:1)	15-20	45	—	
Barley + chickpea (3:2)	45	30	—	
Fallow – mustard	60	40	—	

Half of recommended dose of N should be substituted by farm yard manure for reducing cost and for increasing productivity

In greengram – mustard sequence: In case of incorporation greengram stover after first picking of pods followed by mustard and green manuring saves 15 and 30 kg N/ha

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ implements to be used	Times of operation
Pearlmillet	Dryland weeder Blade hoe	15 and 30 days after sowing
Pearlmillet/ mustard	Kurpi	15/30 days after sowing

Weed management – chemical

Crop	Herbicide	Dose kg (a.i.)/ha	Mode of application
Pearlmillet	Atrazine, Oxyfluorofen	0.5-1.0 0.5-0.75	Preemergence Preemergence

Insect pest management

Crop	Pest	Control measures
Pigeonpea	Pod borer	Spray Endosulfan 35 EC
Mustard	Aphids	Spray with systemic insecticides
Chickpea	Pod borer	As with pigeonpea
Pearlmillet	Stem borer Shoot fly	Spray of Aldrin 0.3% Thimet 15 kg/ha at the time of seeding

Disease management

Crops	Diseases	Control measures
Pearlmillet	Ergot	Early sowing escapes from ergot. Remove and burn affected ears.
	Downy mildew	Agrosan G.N. 0.1% and Thiram 0.4%
	Smut	Spray of 100 ppm Cupramar and Dithane S-31

Crops	Diseases	Control measures
Mustard	*Alternaria* blight White rust Downy mildew Powdery mildew	Spray of Dithane M-45 0.2% and Metalaxyl 0.2% is useful Spray of Sulfex 0.2% and Karathane 0.1%

8. Suitable cropping systems

Monocropping

- Pearlmillet at 45 cm row spacing
- Pigeonpea at 60 cm row spacing
- Mustard at 45 cm row spacing
- Chickpea at 30 cm row spacing
- Barley at 30 cm row spacing

Sequence cropping

- Greengram (green manuring after first picking) – mustard
- Pearlmillet + cowpea (fodder) – chickpea + mustard
- Sow *kharif* crops early with the onset of monsoon

Intercropping

- Pearlmillet + pigeonpea (2:1) – One row of pigeonpea or greengram or blackgram is intercropped in 75 cm space between paired rows of pearlmillet
- Pearlmillet + greengram (2:1)
- Pearlmillet + blackgram (2:1)
- Pearlmillet + clusterbean (2:1)
- Pigeonpea + greengram (2:2) – Two rows of greengram are intercropped in 90 cm space between paired rows of pigeonpea
- Chickpea + lentil (4:1)
- Chickpea + barley (2:3)
- Chickpea + mustard (4:1)
- Chickpea + linseed (6:1)

Fodder based cropping system

- Pearlmillet (grain) + cowpea (2:1) is grown for fodder and harvested after 45-50 days/ up to end of August or early September followed by chickpea + mustard (4:1)

9. Contingent crop planning

Kharif

Under normal rainfall (first fortnight of July)

- Pearlmillet (Proagro 9402), pigeonpea (UPAS 120), greengram (K 851), clusterbean (RGC 197); pearlmillet (WCC-75; BK –560) + greengram (T-44, K –851, Pant-2 and PS-8) in 2:1 ratio

Monsoon at end of July

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

Monsoon at third week of August

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

Monsoon at end of August

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

***Rabi* (first fortnight of October):**

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

10. Other supportive practices

- Extra intercultivation along with mustard straw mulch 5 t/ha increase pearlmillet yield in early season drought situation.
- Removal of every third row increases the pearlmillet yield in late season drought
- Transplanting of pearlmillet along with one protective irrigation is much advantageous under late seeding condition.
- Integrated use of organic and inorganic fertilizer gives high yield of pearlmillet. 50% N requirement can be met through farm yard manure application.
- Greengram in *kharif* (incorporated into soil after first picking of pods) followed by mustrard in *rabi* proves much productive and remunerative sequence resulting in saving of 15 to 20 kg N per ha.
- Tillage (10-12 cm deep) by disc harrow after each effective rainfall increases *in situ* moisture for mustard
- Deep tillage (20 cm) during summer and compartmental bunding just after seedling emergence reduces the runoff water and soil loss.
- Ber + pearlmillet + cowpea as fodder is sustainable and more remunerative under alternate land use system
- Give one irrigation (8 cm) to mustard (at pre-flowering) and barley (at crown root initiation stage) with runoff water stored in farm ponds
- Use of farm yard manure + *azototbacter* in barley is beneficial
- Kaoline (6 percent suspension) in barley is useful
- Mulching with wheat straw 5 t/ha pearlmillet is beneficial

Agro horticulture

- Ber + greengram/ clusterbean/ cowpea for grain purpose
- Ber + pearlmillet (fodder)
- For *rabi* crops pora seeding (drilling seeds through tube tied to the handle of plough)

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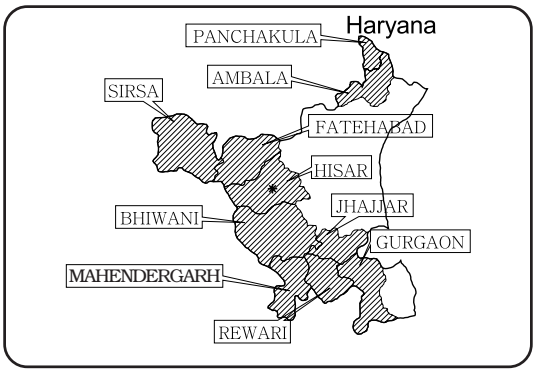

HISAR

Pearlmillet based Production System in *kharif* Arid Deep Aridisols

1 Region

Hisar, Sirsa, Fatehbad, Bhiwani, Jhajjar, Mahendergarh, Rewari, Gurgaon, Kandi area of Panchkula and Ambala.

2. Climate

A sub-tropical, continental secondary, monsoonal type of climate with prolonged hot period from March to October and fairly cool winters. However, extreme temperature fluctuations may occur within a very short-time interval. Total annual rainfall is 320 mm (average of 31 years) with 290 mm in *kharif* and 40-60 mm in *rabi*. The average annual rainy days are 11 (10 years average). Probability of drought is once in 5 years. The water availability period is for 7-8 week (standard meteorological week 27-34). Usually the cropping period is 11 (29 to 39 standard weeks) and 24 (42-13 standard weeks) weeks in *kharif* and *rabi*, respectively.

3. Soils

The soils of Hisar district fall under aridisols (sierozem). Loamy sand to sandy loam soils are found with calcium carbonate (concretions) layers at depths ranging from within the seeding zone to about 125 cm in patches at various locations. Available water capacity is 120-270 mm/m. The soils are characterized by high infiltration rate and low water holding capacity. Salinity is the serious problem in patches, particularly in irrigated areas. Almost all soils are deficient in nitrogen and zinc, low to medium in phosphorus and high in potassium.

4. Crops and varieties

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Pearlmillet	HHB 50	3.2-3.6	40-42	70-80	Resistant to downy	High input conditions
	HHB 60	3.2-3.5	38-40	74-76	mildew	High input conditions, drought and salt stress tolerant
	HHB 67	3.0-3.5	30-32	60-62	-do-	Drought tolerant, suitable for early to late sowing and inter and multiple cropping and first extra early wonder hybrid in the world

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
	HHB 68	3.0-3.2	30-32	60-62	-do-	Tolerant to drought and salt stress, suitable for early sowing and extra early hybrid
	HHB 94	3.2-3.5	38-40	74-76	-do-	Suitable for high input conditions, synchronous tillering and maturity
	HHB 117	3.0-3.5	38-40	72	-do-	Suitable for high input conditions, good tillering and stays green at maturity
Greengram	S 9	1.0-1.1	40-46	70-75	Tolerant to yellow mosaic	Wide adaptability and suitable for mixed cropping with clusterbean and as sole crop
	Asha (MH 83-20)	1.3-1.6	45-48	75-80	Resistant to yellow mosaic virus	For *kharif* season, wide adaptability and suitable for mixed cropping with clusterbean and as sole crop
	MH 85-111	1.2-1.4	42-45	74-76	Tolerant to yellow mosaic virus	For summer season, wide adaptability and suitable for mixed cropping with clusterbean and as sole crop
Cowpea	Charodi	1.0-1.2	30-35	60-65	—	Normal sowing, suitable for mixed cropping with clusterbean paired rows
	CS 88	35.0 Green fodder	50-52	80-85	Resistant to yellow mosaic virus, aphids and jassids.	For summer and rainy season, erect growth and early vigour, long and broad leaves, good for mixed cropping
Mothbean	RMO 40	0.7-0.8	30-32	62-65	Tolerant to yellow mosaic virus, aphids and jassids	Wide adaptability, erect, dark green foliage, suitable for mixed cropping
	RMO 257	0.7-0.8	30-32	62-65		
Clusterbean	FS 277	0.7-0.8	50-55	90-100	—	Timely sown, erect, unbranched

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Sesame	HG 75	1.0-1.2	55-60	110-115	—	Timely sown branched, high yield, bushy
	HG 365	1.1-1.3	50-52	85-100	Tolerant to leaf spot and jassids	Tolerant to drought, suitable for early and late sown, branched, dwarf, serrated leaves, early and suitable for intensive cropping
	HT 1	0.7-0.8	40-42	75-78	Resistant leaf curl and phyllody	White and bold seeds, contains 49 percent oil
Castor	CH 1	1.8-2.2	50-55	130-140	Tolerant to leaf spot and semilooper	Recommended for all kinds of soils, dwarf, seed small and dark brown in colour, contains 49 percent oil
Chickpea	C 235	2.2-2.3	80-100	140-165	Tolerant to Aschochyta blight	North east of Haryana
	C 214	1.8-2.0	80-100	150-170	Tolerant to Fusarium wilt	—
	H 208	2.0-2.2	80-100	145-175	Resistant to Fusarium wilt	For irrigated conditions also
	HC 1	2.0-2.5	78-80	135-145	-do-	For late sown irrigated conditions also
Barley	C 138	1.8-2.3	80-95	125-150	Resistant to Fusarium wilt	Tall, long ears with long yellow grains
	BH 393	3.5-4.5	75-80	115-125	-do-	Dwarf plant type with long ears. Seeds bold thin husk, high malt, early in maturity, tolerant to lodging

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Mustard	Varuna (T 59)	2.0-2.5	58-60	142-145	Susceptible to *Alternaria*, white rust and aphids	Wide adaptability and bold seeded
	RH 30	2.2-2.6	55-60	136-140	-do-	Suitable for mixed cropping, medium plant height, bold seeded, non-shattering and contains 40 percent oil
	RH 819	1.8-2.0	58-62	145-148	Susceptible to *Alternaria*, white rust	Medium bold seeds, contains 40 percent oil
	RH 781	1.8-2.0	58-62	140-145	Susceptible to *Alternaria*, white rust and aphids	Suitable for frost affected areas medium bold seeds, contains 40 percent oil
Taramira	T 27	0.6-0.8	60-65	145-150	—	Seeds are yellowish green and contain 32 percent oil

5. Seed rate and planting pattern

Crop	Seed rate	Planting pattern (cm)	
	(kg/ha)	Inter row	Intra row
Pearlmillet	5	45	15
Clusterbean	20	45	20
Greengram	20	45	10
Mothbean	20	45	10
Cowpea	25	45	15
Sesame	5	45	15
Castor	12	60	30
Chickpea	40-45	45	—
Mustard	5	45	15
Barley	75-80	30	—
Taramira	5	45	15

6. Nutrient management

Crop	Nutrients (kg/ha)		Mode of application		Remarks
	N	P_2O_5	Basal	Topdressing	
Pearlmillet	40	20	All P_2O_5 and 50% N	50% N at knee-high stage	Based on soil test
Clusterbean	20	40	All P_2O_5 drilled	—	
Greengram	0	30	All N and P_2O_5 drilled	—	
Mothbean	20	40	-do-	—	

Crop	Nutrients (kg/ha)		Mode of application		Remarks
	N	P_2O_5	Basal	Topdressing	
Cowpea	20	40	All N and P_2O_5 drilled	—	
Sesame	20	40	-do-	—	
Castor	40	—	All N drilled	—	
Chickpea	20	40	-do-	—	
Mustard	20	40	All N and P_2O_5 drilled	—	
Barley	40	20	-do-	—	
Taramira	30	15	-do-	—	

7. Pest and disease management

Weed Management – mechanical

Crop	Tool/ Implements to be used	Time of operation
Pearlmillet	Hand kanola/ wheel hand hoe	20-25 days after sowing
Clusterbean	Hand kanola/ wheel hand hoe	1st hoeing at 20-25 days after sowing and 2nd at 35-40 days after sowing
Greengram	Hand kanola/ wheel hand hoe	-do-
Mothbean	Hand kanola/ wheel hand hoe	-do-
Cowpea	Hand kanola/ wheel hand hoe	-do-
Sesame	Hand kanola/ wheel hand hoe	20-25 days after sowing
Chickpea	Hand kanola/ wheel hand hoe	1st hoeing at 25 days after sowing and 2nd at 45 days after sowing
Mustard	Hand kanola/ wheel hand hoe	25-30 days after sowing
Barley	Hand kanola/ wheel hand hoe	1st hoeing at 20-25 days after sowing and 2nd at 40-45 days after sowing
Taramira	Hand kanola/ wheel hand hoe	25-30 days after sowing

Weed management – chemical

Crop	Herbicide	Dose kg (a.i.)/ha	Method of application
Pearlmillet	Atrazine (50%)	WP 0.5	Post emergence (7-15 days after sowing)

In pulses and oilseed crops, no herbicide is recommended.

Insect pest management

Crops	Pest	Control measures
Greengram, moth, cowpea, guar Pearlmillet	Hairy cater pillar	Spray 250 ml Monocrotophos (Monocil Nuvacron) 36 SL or 500 ml Endosulfan (Thiodan/ Thitox/ Endocel) 35 ECC or 500 ml and castor Quinalphos (Ekalux) 25 EC in 625 l/ha water
Greengram and chickpea	Pod borer	Spray with 600ml Endosulfan (Thiodan/ Thitox/ Endocel) 35 ECC or 300 ml Monocrotophos (Nuvacron/ Monocil) 36 SL or 120 ml fenvalerate 20 EC or 600 ml quinalphos 25 Ec in 750 l/ha water at 50% pod formation
Chickpea	Termites	For one quintal seeds, use 850 ml Endosulfan 35 EC/ Monocrotophos 36 SL or 1500 ml Chlorpyriphos 20 EC and dilute this in water so as to make the total volume of two liters.

Crops	Pest	Control measures
Mustard	Aphids	Spray with Oxydeneton Methyl (Metasystox 25 EC) or Dimethoate (Rogor 30 EC) 500 ml/ha acre in 500 l of water when 10 percent plants are infested
	Bagrada	Spray with 200 ml Malathion 50 EC in 500 l water/ha in October – November and 400 ml Malathion in 400 l of water in March-April
Sesame	Jassid	Spray with 200 ml Malathion 50 EC in of 500 l water/ha at least twice at 2 to 3 weeks intervals.

Disease management

Crop	Disease	Control measures
Pearlmillet	Ergot	Seed treatment in 10 percent salt solution to remove Sealgortic. Wash seeds thoroughly in pure water after salt treatment and seed should be dried in shade. The dry seed should be treated with a mixture of 2 g Emisan and 4 g Thiram for 1 kg seed.
Chickpea	Wilt and Blight	Seed treatment with Bavistin 2.5 g/kg seed

8. Suitable cropping systems

Sequence cropping

- Pearlmillet – chickpea
- Pearlmillet – raya
- Pearlmillet – fallow
- Fallow – raya
- Fallow – chickpea
- Greengram/ cowpea/ mothbean – raya

9. Farm implements/ Tools

Tool/ Implement	Cost/ unit (Rs)	Operation
Tractor drawn ridger seeder (3 point hitch tools)	14000/- for 3 bottom unit	Lister bottom pushes top dry soil to the sides for seeding in moist soil in the furrow
	10500/- for 2 bottom unit	Establishes crop under receding soil moisture condition where indigenous methods often fail.
Bullock drawn ridger	525/-	Two rows are planted at one time
Bullock drawn	450/-	Interculture in pearlmillet, greengram and blackgram (*kharif* crops)
interculture blade harrow Wheel hand hoe	315/-	Interculture in all harrow crops

10. Contingent crop planning

Normal rainfall

Soil and water conservation practices

- Bunding in Mahendergarh district (rainfall 550 mm) where storm intensity is high. In Hisar region compartmental bunding and leveling of land within the compartments (0.08 ha)
- Runoff collection is possible in Mahendergarh district. In the Hisar region planting with a ridger-seeder which facilitates inter-row water harvesting
- In areas adjoining Rajasthan, stabilization of sand dunes and in areas adjoining Aravali ranges waer harvesting from hills

Suitable cropping systems

- Risk minimization by allotting areas in proportion to the probability of the length of season worked out on the basis of long term rainfall records: pearlmillet 45 percent area; greengram 10 percent; forages 10 percent
- Selection of *rabi* crops is dependent upon the amount of *kharif* rainfall

11. Other supportive practices

- Plough twice with country plough or disc harrow twice to prepare seed bed for rainy season crops.
- Disc harrow or country plough after each effective shower to conserve moisture for *rabi* crops in *kharif* fallows. Towards the end of rainy season in August/ September, planking should follow each ploughing or harrowing.
- Use wheel hand hoe and bullock drawn blade hoe for soil mulch creation and weed control in *kharif* crops. Complete the first hoeing 15-18 days after sowing and the second at about the same interval thereafter. Use manually operated kasola only for removing weeds between the plants in the row.
- Adopt ridge-furrow system of farming during monsoon for proper stand establishment, draining excess water and moisture conservation practices.
- If monsoon is delayed, plant seeds dry at 1.5 to 2.0 cm depth with ridger seeder during July to give satisfactory germination after receipt of rains.
- Plant *kharif* crops on ridges (paired rows) and *rabi* crops in furrow using ridger seeder.
- Intercropping of cowpea (fodder variety CS-88) with grain crop of pearlmillet increase total productivity. The cowpea fodder is harvested after 40-45 days of sowing.

Efficient crops and their sowing time

Crop	Variety	Sowing time
Kharif		
Pearlmillet	HHB 50, HHb 60, HHB 67, HHB 68, HHB 94 and HHB 117	End of June to third week of July by direct seeding. From fourth week of July to second week of August by transplanting about 21 days old seedlings
Clusterbean	HG 75, HG 365	Second fortnight of July. However, it can be sown upto second week of August without suffering much reduction in yield

Crop	Variety	Sowing time
Greengram	S 9, Asha, MH 85 -111	For low rainfall areas for normal (first fortnight of July)
Mothbean	RMO 40, RMO 257	For low rainfall areas for normal (first fortnight of July)
Cowpea	Charodi, Cs 88 (Fodder)	For low rainfall areas for normal (first fortnight of July)
Sesame	HT 1	First fortnight of July
Castor	CH 1	First fortnight of July
Rabi		
Chickpea	C 235, C 214,H 208,HC 1	Second fortnight of October
Barley	C 138, BH 75, BH 393	October 25 to November 10
Mustard	Varuna RH 30, RH 819, RH 781	October 15-25
Taramira	T 27	Throughout October, can be sown upto November 15.
Pearlmillet	5	Plant *kharif* crops on ridges and *rabi* crops in furrows employing ridger seeder for proper plant stands. In the event of delay in monsoon dry seeding of pearlmillet on the shoulder of ridges under ridge-furrow system should be done.

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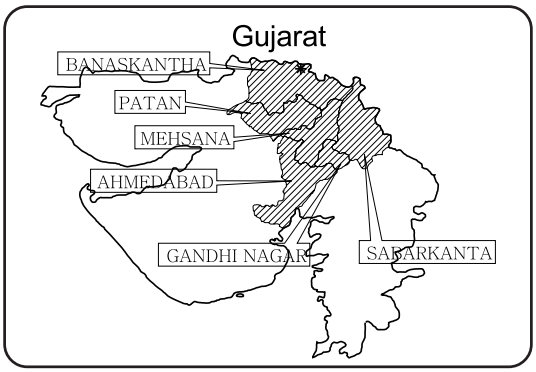

SARDAR KRISHINAGAR

Pearlmillet based Production System in *Kharif* Arid Deep aridisols

1. Region

Sabarkantha, Gandhi Nagar, Banaskantha, Mehsana and parts of Patan and Ahmedabad in North Gujarat.

2. Climate

This centre caters to both arid and semi –arid areas. Average annual rainfall is 550 mm and is received from last week of June to end of September. About 75 percent of the rainfall is received during June- August. Ranifall is inadequate, uncertain and erratic.

3. Soils

The soils are light textured loamy sand having high infiltration rate poor water holding capacity and also poor in organic carbon and medium in available P_2O_5 and K_2O content in soil.

4. Crops and varieties

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest
Castor	GCH-4, GCH-5, GCH-6 GAUCH-1 GAUCH-4 GAUCH-7	Seed: 1.20 –1.50 Straw: 2.00 -do-	55-60 -do- -do-	150-170 -do- -do-	Tolerant to wilt -do- -do-
Pearlmillet	GHB-235 GHB-316 BJ-104 CJ-104 GHB-77 GHB-30 GHB-235	Grain-1.80 Straw-8.50	40-45 -do-	85-90 -do-	Slightly susceptible to downy mildew
Cowpea	Guj.Cowpea-4	Seed-1.00 Straw-2.60	30-35 -do-	75-80 -do-	Susceptible to yellow vein mosaic Virus upto some extent
Clusterbean	Guj. Clusterbean-1	Seed-0.80 Straw-2.90	55-60 -do-	110-115 -do-	Susceptible to bacterial blight
Greengram	Guj. Greengram-4	Seed- 0.70 Straw- 3.90	30-35	75-80	Slightly susceptible to yellow vein mosaic virus

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest
Sorghum	GSF-4 GJ-36 CSH-6 CSH-5 GJ-37 GFS-5 S-1049 GJ-35	Fodder- 13.00	45-50	90-100	Susceptible to shoot fly
Mothbean	Guj.1	Seed- 0.80 Straw- 7.00	50-55	95-100	Slightly susceptible to yellow vein mosaic Virus
Karingado	Guj.	Seed- 0.50 Karmgado-1	50-55 -do-	115-125 -do-	Susceptible to aphids
Pigeonpea	T-15-15 BDN-2 ICPH-8 ICPL-87 Gujarat-1				
Sesame	GS-1 Patern 64				

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Pearlmillet	3.75	45	10-15
Sorghum	60	45	10
Cowpea	16	45	10
Cluster bean	16	45	10
Greengram	16	45	10
Moth bean	16	45	10
Castor	4-6	30, 45 or 60	30 or 45
Karingado	1-1.5	180	60

6. Nutrient management

Crop	Nutrients (kg/ha)			Method of application
	N	P_2O_5	K_2O	
Greengram	20	40	—	Apply both N and P_2O_5 as basal
Pearlmillet	80	40	—	Apply + recommended dose of N and whole dose of P_2O_5 as basal and remaining + dose of N at tillering stage depending on soil moisture content.
Castor	60	30	20	Apply + recommended dose of N whole dose of P_2O_5 and K_2O as basal and remaining dose of N in two splits at 30 and 45 days after sowing depending on soil moisture content
Cowpea	20	40	—	Apply both N and P_2O_5 as basal
Mothbean	20	40	—	Apply both N and P_2O_5 as basal
Sorghum	80	40	—	Apply + recommended dose of N and whole dose of P_2O_5 as basal and remaining + dose of N at tillering stage depending on soil moisture content.
Clusterbean	20	40	—	Apply both N and P_2O_5 as basal

7. Suitable cropping systems

- Greengram + pearlmillet (3:1)
- Cowpea + castor (2:1)
- Sorghum + karingdo (6:1)
- Pearlmillet + clusterbean (2:1)
- Ber + sorghum/ greengram were grown between two rows of ber

8. Contingent crop planning:

Normal sowing (Early July)

Castor - GCH-4, GCH-5, GCH-6
Pearlmillet - GHB-235, GHB-316
Cowpea - Guj. Cowpea-4
Clusterbean - Guj. Clusterbean-1
Greengram - Guj. Greengram -4
Sorghum - GSF-4
Mothbean - Guj.1
Karingado - Guj. Karingado-1

Delayed sowing (15th July to early August)

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

Very delayed sowing (mid August)

Castor - GCH-4

9. Other supportive practices

- Summer ploughing at 30 cm depth for maximum rain water harvesting
- Use glyricidia/ leucaena leaf manuring as mulch as well as for sustaining soil fertility.
- Follow relay cropping in greengram with castor (2:1). Castor should be grown as a relay crop in order to utilize residual soil moisture content.
- Intercropping of cowpea: castor (2:1) for minimizing risk.
- Castor can be grown from normal to very delay sowing condition without affecting much reduction in yield.

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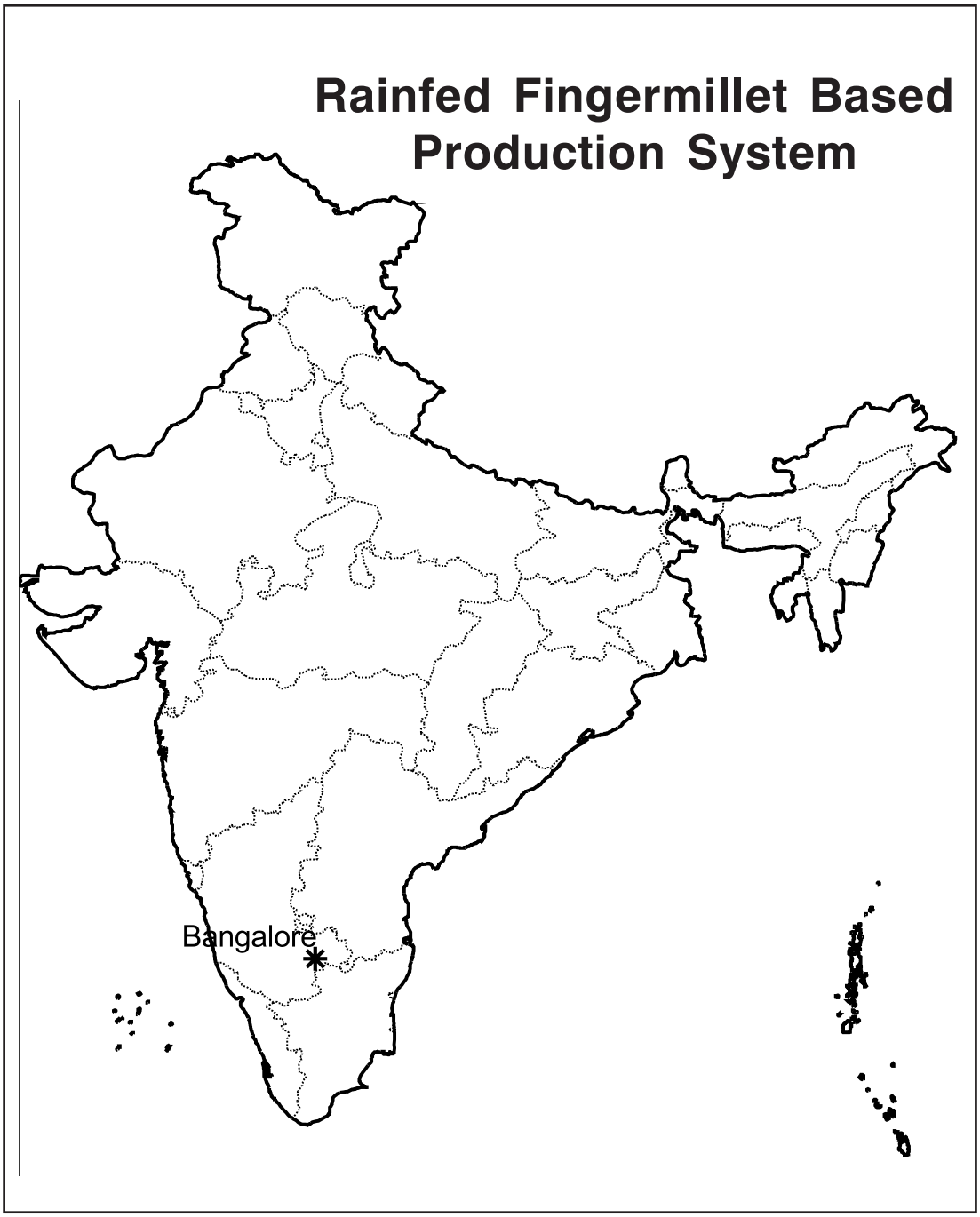
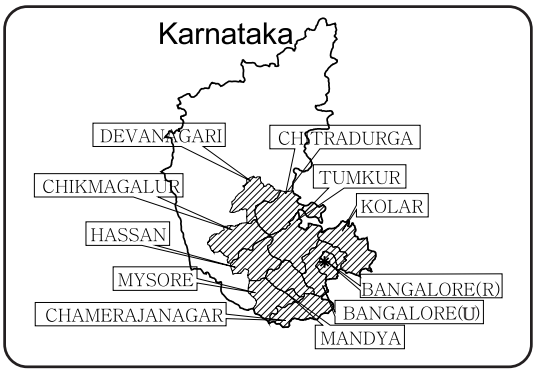

Rainfed Fingermillet Based Production System
Bangalore



BANGALORE

Fingermillet based Production System in *Kharif* Semi-arid Deep Alfisols

1. Region

Bangalore centre develops dryland technology for Central, Eastern and Southern agro climatic zones of Karnataka covering Davanegeri, Chikmagalur, Hassan, Mysore, Chamaryanagar, Chitradurga, Tumkur, Kolar, Bangalore (rural and urban) and Mandya districts.

2. Climate

Central dry zone: Normal annual rainfall is 607 mm, with two peaks of rainfall one in May and another in September- October. *Eastern dry zone*: Normal annual rainfall is 768 mm. with two peaks similar to Central Dry Zone. *Southern dry zone*: Normal annual rainfall is 720 mm with two peaks as for the other zones.

3. Soils

Central dry zone: Red sandy to red loams are the major types. Scattered patches of shallow to very deep black soils also occur. The soils in general are low in organic carbon, medium in P_2O_5 and high in K_2O in drylands.

Eastern dry zone: This zone has three major soil types red loamy, red sandy and red lateritic. Organic carbon and P_2O_5 are low to medium, while potash is high in drylands. In wet situations organic carbon is low, P_2O_5 is medium, while K_2O is medium to high.

Southern dry zone: The soils of the zone vary from red gravelly to red sandy loams, shallow in depth at higher elevations and medium to deep in valley areas. The soils are well drained with very poor water holding capacity. The soil reaction is neutral to acidic. The soils in general are low in organic carbon, medium in P_2O_5 and high in K_2O in dry lands. The fertility levels under irrigated conditions are low in organic carbon, medium in P_2O_5 and high in K_20.

4. Crops and varieties

Central dry zone: Sorghum, fingermillet, groundnut and cotton
Eastern dry zone: Fingermillet, groundnut, pigeonpea and horsegram
Southern dry zone: Sorghum, fingermillet, groundnut and potato

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Fingermillet	L-5	3.0-3.5	72	120-130	resistant to finger blast and neck blast	Long duration
	Indaf-8	3.0-3.5	75	130-135	Susceptible to finger blast and neck blast	Long duration

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
	MR-1	3.0-3.5	70	120-130		Long duration
	GPU-28	2.5-3.0	67	110-120	Resistant to finger blast and neck blast	Medium duration
	PR-202	2.5-3.0	64	110-115		
	HR-911	2.5-3.0	68	115-120		Medium duration, susceptible to lodging
	GPU-26	2.0-2.5	60	90-105	Resistant to finger blast and neck blast	Medium duration
	Indaf-5	2.5-3.0	65	105-110		Short duration
	Indaf-9	2.5-3.0	68	105-115		Short duration cold tolerant
Maize	Ganga-11	3.5	74	110-115	Susceptible to downy mildew	—
	Deccan-103	3.5	70		-do-	—
	Vijay composite	3.5	72	115-120	-do-	—
	NAC-6004 (Composite)	4.5	70		Resistant to downy mildew	
	NAC 6002 (Composite)	4.0	57	85-90	-do-	
Little millet	CO2	1.25	62	90-100	—	
	PRC-3	1.25	60			
Foxtail millet	RS-118	1.0-1.5	65	95-100	—	
	K-221-1	1.0-1.5	63			
Pigeonpea	Hyd-3C	1.2-1.5	98	150-200	Susceptible to wilt and sterility mosaic	Suitable for vegetable purpose also
	TTB-7	1.2-1.5	104	160-210		
Greengram	PS-16	0.6	37	65-70	Susceptible to leaf spot and mosaic	—
	PDM-84-178	0.6	35			
Blackgram	K-7	0.6	48	85-90	Susceptible to leaf spot and mosaic	—
	T-9	0.6	45	75-80		
Cowpea	C-152	1.0-1.25	58	90-95	Susceptible to leaf spot and rust	—
	TVX-944-02E	1.0-1.25	56		Moderately resistant to rust and leaf spot	
	KBC-1	1.0-1.25	60		—	Suitable for late *kharif*
	KBC-2	1.2-1.4	62	95-105	Resistant to leaf spot and rust	—
Fieldbean	Hebbal-3		57	90-100		Short duration, photoperiod insensitive, suitable for double cropping

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Soybean	Hardy	1.0-1.5	53	100-110	Susceptible to rust	—
	KHSb-2	1.0-1.5	60	110-120	and yellow mosaic	
	Monetta	1.0-1.5	45	80-85	-do-	
	KB-79	1.0-1.5	50	90-92	-do-	
Horsegram	KBH-1	0.7-0.9	58	90-100	Susceptible to	—
	PHG-9	0.8-1.0	56		powdery mildew	
Groundnut	TMV-2	0.8-1.0	42	100-120	Susceptible to Tikka and rust	—
	JL-24	0.8-1.0	37	90-120		
	K-134	0.8-1.0	39	95-105		
	VRI-2	0.8-1.0	41	100-110	—	Suitable for low rainfall situations
Sunflower	Morden	1.0-1.5	40	75-80	Susceptible to leaf	
	BSH-1	1.5-2.0	58	88-90	spot, rust and bud rot	
	KBSH-1	1.5-2.0	62	90-95	-do-	
	KBSH-41	1.5-2.0	60		-do-	
	KBSH-42	1.5-2.0	60		-do-	
	KBSH-44	1.5-2.0	59		-do-	
Niger	No.71	0.4-0.5	46	70-80		
Sesame	TMV-3	0.4-0.5	49	85-90	Susceptible to rust and powdery mildew	
Castor	NPH-1 (Aruna)	1.0-1.2	60	125-130		
Chillies	Byadagi	0.75-1.0	55	160-170	Susceptible to leaf spot, powdery mildew and fruit rot	Recommended for Southern Zone Preferred for green chillies
	Mysore	0.75-1.0	52		-do-	Recommended for Southern Zone
	Gauribidnur	0.8-1.0 (green chillies)	60		-do-	Recommended for Southern Zone Preferred for green chillies
	NP-46-A	0.75-1.0	56		-do-	All dry zones
	Arka Lohit		59		-do-	
	Ceylon Selection (Samruddhi)	10-12 (green chillies)	57	140-150	—	For green chillies
Fodder Crops						
Hybrid	NB-21	45-50				—
Napier	BH-18	45-50				
Guinea	Kambu Napier	45-50	—	—	—	
grass	DH-4	45-50				
Green panic	—	35-40	—	—	—	
Rhodes grass		30-35				
Congo signal		25-30				
Anjan grass		25-30				—

Crops	Varieties/ hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Fodder Sorghum	J-set-3	25-32.5 (Green)	—	70	—	—
	MP-Chari	25-32.5		60		
	GS-20	25-32.5		70		
	Pusa chari	25-32.5		80		
	S-1049	25-32.5		70		
	Salabani	25-32.5		60		
	Pioneer x 988 (Hybrid)	25-32.5		70		
	SSG-59-3	30-35 (Green)				
Fodder Maize	Yellow White	40-45 (Green)	—	70	—	—
Fodder Pearlmillet	Giant Pearlmillet	45-50		65-70		

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)		Remarks
		Inter row	Intra row	
Fingermillet	10	30	10	Spacing is same for drilling and transplanting
Sorghum	7.5	37.5	10	—
Pearlmillet	5.0	45	15	
Groundnut	100 kg kernel	30	10	
Maize	15	60 or 75	20	No variation in yield between 60 or 75 cm spacing
Sunflower	5-7.5	60 or 45	30 or 30	Closer spacing for varieties Wider spacing for hybrids
Pigeonpea	15	60	22.5	Wider spacing of 75, 90, 120 cm is recommended in case of May sowing
Blackgram	20	30	10	Suitable for double cropping
Greengram	15-20	30	10	Suitable for double cropping
Chickpea	62.5	30	7.5	Suitable for late *kharif*
Fieldbean	30	45	15	Suitable for inter cropping
Cowpea	20	45	10	Suitable for double cropping and late *kharif* sowing
Foxtail millet				
Little millet	4	30	10	Suitable for contingent crop
(Haraka)	7-10.0	30	10	planning for late *kharif*
	10-12.5	30	10	
Fodder Maize	100	30	10	Suitable for double cropping in
Fodder Pearlmillet	15	30	10	areas with bi-modal rainfall
Sweet Sorghum	15	30	10	distribution.
Sesame	4.0	30	5	Mix the seeds with sand before sowing
Castor	6 and 12	45, 60, 90	45	Spacing to be adopted depending on the duration of the crop
Chillies	1200 g	45	30	

6. Nutrient management

Crop	Nutrients (kg/ha)			Farm yard manure (t/ha)	Mode of application	Remarks
	N	P_2O_5	K_2O			
Fingermillet	50	50	25	1.00	N in 2 equal splits, 1/3 at sowing or drill; 1/3 at tillering initiation; P and K basal placement	—
Maize	75	50	25	1.00	N in 2 splits, + at sowing and + at knee high stage. Place P 5 cm deep from the seed	Apply 10 kg zinc sulphate also
Sorghum	65	40	40	1.00	N in 2 splits + at sowing and + at 30 days after sowing	—
Pearlmillet	50	25	0	0.75	All basal	—
Groundnut	25	50	25	0.75	All basal	Apply 1.0 t/ha lime and also 10 kg/ha sulphur into the soil
Foxtail millet	50	15	0	0.625	All basal	
Little millet and *Haraka*	20	20	0	0.625	All basal	

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ implement to be used
Maize	*Varwari* (Sickle), Hoe
Fingermillet	*Varwari*, Hoe
Pigeonpea	Blade harrow
Groundnut	*Varwari*, Hoe, Duck foot hoe
Cowpea	Hoe
Horsegram	Hoe
Greengram	Hoe
Blackgram	Hoe
Sesame	Hoe
Soybean	Hoe
Castor	Balde harrow

Weed management – chemical

Crops	Herbicides	Dosage l/kg a.i./ha	Spray volume/ha.	Time of application
Maize	Atrazine 50 W	2.0 kg (for sandy soil) 3.75 kg (for clay soil)	750 l of water	To be sprayed within 3 days after sowing
	Oxyfluorfen 23.5 EC or Pendimethalin 30 EC or Fluchloralin 45 EC	375 ml 1.5l	—	—

Crops	Herbicides	Dosage l/kg a.i./ha	Spray volume/ha.	Time of application
Groundnut	Alachlor 50 EC or	2.5 l	750 l of water	To be sprayed within 3 days after sowing
	Pendimethalin 30 EC or Fluchloralin 45 EC or Metolachlor 50 EC	3.25 l 2.0 l	—	—
Sunflower	Alachlor 50 EC or	2.5 l	750 l of water	To be sprayed within 3 days after sowing
	Pendimethalin 30 EC or Fluchloralin 45 EC or Metolachlor 50 EC	3.25 l 2.0 l	—	—
Pigeonpea	Alachlor 50 EC or	2.5 l	750 l of water	To be sprayed within 3 days after sowing
	Pendimethalin 30 EC or Fluchloralin 45 EC or Metolachlor 50 EC	3.25 l 2.0 l	—	—
Groundnut Pigeonpea	Alachlor 50 EC or	2.5 l	750 l of water	To be sprayed within 3 + days after sowing
	Pendimethalin 30 EC or Fluchloralin 45 EC or Metolachlor 50 EC	3.25 l 2.0 l	—	—
Transplanted fingermillet	Butachlor 50 EC	1.5 l	750 l of water	To be sprayed within 3 days after sowing
	2,4-D sodium salt 80 WP	1.25 kg	—	
Drilled fingermillet	Isoproturon 75 W.P	750 g	750 l of water	To be sprayed within 3 days after sowing
Pulses	Alachlor 50 EC or Pendimethalin 30 EC or5	2.5 l 3.25 l	750 l of water	To be sprayed within 3 days after sowing
	Metolachlor 50 EC	2.0 l		

- At the time of spraying there should be adequate soil moisture
- The field should be free from clods to have good weed control
- Herbicides need to be mixed thoroughly with the water before spraying
- Spraying has to be made covering all portion of the field
- While spraying, the person needs to move backwards with less trampling of the sprayed fields
- After spraying, if rain occurs, better herbicide activity will be observed

Insect pest management

Crop	Pest	Control measures
Maize	Stem borer	Endosulfan-35 EC-2 ml/l or Carbaryl-4 kg/ha or Lindane –10 kg/ha
	Aphids	Spray 0/02% Phosphomidan, 0.04% Diazinon, Endosulfan-4 kg/ha
	Earhead caterpillar	Carbaryl-50 W.P. g/l. Malathion-5%
	Shoot fly	10% Phorate or 5% Disulphan granules in seed furrows at the time of sowings

Crop	Pest	Control measures
Fingermillet	Stem borer	Methyl Parathion 50 EC-1ml/l. Phosphomidan 0.5 ml/l. 0.05% Endosulfan
	Aphids	Dimethoate – 30 EC –1.7 ml/l
	Black hairy caterpillar	Dust 10% BHC
	Webbing caterpillar	Malathion – 5% Carbaryl – 10%
	Root grubs	Phorate 10% – 25 kg/ha Carbofuran 3% – 25 kg/ha Carbaryl 4% – 25 kg/ha Chlorpyriphos – 30 EC-10 ml/l
Pigeonpea	Gram pod borer	Endosulfan-35 EC-2 ml/l Chlorpyriphos EC-2 ml/l
	Webbing caterpillar	Quinalphos 35 EC-2 ml/l Methlparathion 50 EC-1 ml/l Phosalone 35 EC-2 ml/l Malathion 5% dust
Groundnut	Aphids	Dimethoate 30 EC-1.7 ml/l Methyl Parathion 50 EC-1.0 ml/l
	Leaf miner	Monocrotophos 36 SL – 1.0 ml/l Quinolphos 25 EC – 2.0 ml/l Phasalone 35 EC – 2.0 /l Carbaryl 50 EC W.P. –4 g/l
	Caterpillar	Dust 10% BHC
	Root grub	Phorate 10% Phorate 3% Carbofuran 3% Chlorpyriphos 35 EC-10 ml/l Chlorpyriphos 20 EC – 3.3 ml/l
	Termites	Chloride 20 EC-3.3ml/l
Cowpea	Agromyzid fly Leaf hopper Aphids Pod borer	Dimethoate – 30 EC – 1.5 ml/l or Phosphomidan 100 EC – 0.5 ml/l or Methyl parathion – 50 EC – 1 ml/l or Chlorpyriphos 20 EC- 2 ml/l
Greengram	Pod borer	Chlorpyriphos 20 EC- 2 ml/l
	Agromyzid fly	Dimethoate – 30 EC – 1.5 ml/l
	Leaf hopper	Phosphomidan 100 EC – 0.5 ml/l
	Aphids	Methyl parathion – 50 EC – 1 ml/l
	White flies	Triazofas 1.5 ml/l
Blackgram	Gram pod borer	4% Carbaryl 0.05% Endosulfan
	Aphids	Chlorpyriphos 20 EC- 2 ml/l
	Gram pod fly	4% Carbaryl + 0.05% Monocrotophos
	Leaf hopper	Methyl Parathion – 50 EC – 1 ml/l
Sesame	Pod borer Leaf eating caterpillar	Methyl Parathion – 50 EC – 2 ml/l

Crop	Pest	Control measures
Soybean	Stem fly	Monocrotophos 36 SL – 1.3 ml/l
	Hairy caterpillar	Chlorpyriphos 20 EC- 2.0 ml/l
	Leaf miner	Endosulfan – 35 EC – 2.0 ml/l Dimethoate 30 EC – 1.7 ml/l Methyl Parathion 50 EC – 1.0 ml/l
	Pod borer	Parathion – 2% Malathion – 5%
Castor	Semilooper Capsule borer	Methyl Parathion 50 EC –1.0 ml/l Parathion – 2%

Disease management

Crop	Disease	Control measures
Maize	Leaf blight Downey mildew Leaf dust	Mancozeb – 2.5 g/l Dithane M-45 (0.2%) Redomyl MZ-72 – 3 g/kg seed
Fingermillet	Blast	Carbendizim 0.5 g/l Edifinfas – 1 ml/l Zineb – 2.5 g/l
Pigeonpea	Wilt Leaf spot Sterility mosaic	Rogue out the infected plants and burn them 0.2% Zineb or Ziram Rogue perennial and self sown Pigeonpea plants before the sowing season
Groundnut	Collar rot Tikka Rust	Captan – 4 g/kg seed Thiram – 4 g/kg seeds Mancozeb – 4 g/kg Seeds Carbandazim – 0.5 g/l Mancozeb – 2.5 g/l
Cowpea	Powdery mildew Rust	Zineb – 2.5 g/l Mancozeb – 2.5 g/l
Horsegram	Rust Leaf spot	Mancozeb – 2.5 g/l Copper fungicide – 7.5 g/l
Greengram	Mosaic Powdery mildew Leaf spot	Sulphur powder – 3.5 g/l Zineb – 2.5 g/l Copper oxy chloride – 3.5 g/l
Blackgram	Blight Collar rot Powdery mildew Leaf spot	Thiram – 5 g/kg seeds Chloronob – 20 kg/ha Zineb – 25 g/l Copper – oxychloride – 3.5 g/l
Sesame	Leaf spot Powdery mildew	Agrimyzin – 100 – 0.55 g/l Wettable Sulphur – 3 g/l
Castor	Leaf spot Rust Botrytis	0.2% Ziram or Zineb Grow resistant varieties Dithanium 45 – 2.5 g/l Bavistin – 2.0 g/l
Soybean	Leaf Rust Yellow Mosaic	Propiconazol – 1 ml/l Hectaconazon – 1 ml/l Dimethoate 30 EC – 1.7 ml/l

Source: Package of practices for Higher yields. UAS, Bangalore. 1999.

8. Suitable cropping systems

Central dry zone	Eastern dry zone	Southern dry zone
Monocropping system		
Fingermillet	Fingermillet	Fingermillet
Groundnut	Groundnut	Groundnut
	Maize	
Horsegram	Horsegram	Horsegram
Sunflower	Sunflower	Sunflower
Sorghum		Sorghum
Pearlmillet		
Cotton		Cotton
	Chilli	
Minor millets	Minor millets	Minor millets
Field bean	Field bean	Field bean
Soybean	Soybean	Soybean
Cowpea	Cowpea	Cowpea
		Tobacco
Double cropping system		
		Sesame – fingermillet
Fodder crops – fingermillet		Fodder crops – fingermillet
Fodder crops – chilli		Fodder crops – chillies
	Fodder crops – tomato	
	Cowpea – fingermillet	Cowpea – fingermillet
	Greengram bean – fingermillet	Greengram bean – fingermillet
	Blackgram bean – fingermillet	
	Sorghum – horsegram	Sorghum – horsegram
	Sorghum – transplanted fingermillet	Sorghum – transplanted fingermillet
Potato – maize/ horsegram/ cowpea		Potato – maize/ horsegram/ cowpea
Pearlmillet – horsegram		
Sunflower – sorghum		
Intercropping system		
Pigeonpea + maize (1:1)	Pigeonpea + maize (1:1)	Pigeonpea + maize (1:1)
Pigeonpea paired row + fingermillet (10:2)	Pigeonpea paired row + fingermillet (10:2)	Pigeonpea paired row + fingermillet (10:2)
Pigeonpea paired row + groundnut (10:2)	Pigeonpea paired row + groundnut (10:2)	Pigeonpea paired row + groundnut (10:2)
Groundnut + castor (8:1)	Groundnut + castor (8:1)	Groundnut + castor (8:1)
Fingermillet + fieldbean	Fingermillet + field bean	Fingermillet + fieldbean
Fingermillet + soybean	Fingermillet + soybean	Fingermillet + soybean
Sorghum + pigeonpea		
		Sesame + pigeonpea(10:2or3:1)
		Castor + niger (8:2)
Horsegram + niger	Horsegram + niger	Horsegram + niger

9. Farm implements / Tools

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

10. Contingent crop planning

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

First fortnight of May
- Monocropping: Pigeonpea
- Double cropping: Sesame, cowpea, greengram bean, blackgram, fodder maize, fodder pearlmillet, fodder sorghum

Second fortnight of May
- Monocropping: Pigeonpea
- Double cropping: Sesame, cowpea, greengram bean, blackgram, fodder maize, fodder pearlmillet, fodder sorghum

First fortnight of June
- Monocropping: Long duration fingermillet, pigeonpea, maize, groundnut
- Double cropping: Fodder maize, fodder sorghum, fodder pearlmillet, cowpea

Second fortnight of June
- Monocropping: Long duration finger millet, pigeonpea, maize and groundnut
- Double cropping: Sowing of chilli nursery

First fortnight of July
- Monocropping: Groundnut, long duration fingermillet
- Double cropping: Sowing of chilli nursery

Second fortnight of July
- Monocropping: Groundnut, long/ medium duration fingermillet
- Double cropping: Sowing of chilli nursery

First fortnight of August
- Monocropping: Cowpea, Horsegram, short duration finger millet, transplanting chilli
- Double cropping: Cowpea, Horsegram, short duration finger millet, transplanting chilli. Sowing of chilli nursery and short duration finger millet.

Second fortnight of August
- Monocropping: Short duration finger millet, transplanting of medium and long duration finger millet. Transplanting chilli. cowpea, horsegram
- Double cropping: Short duration fingermillet, transplanting of medium and long duration finger millet, transplanting chilli. Cowpea, horsegram. Also, fodder crops (maize-pearlmillet, sorghum)

First fortnight of September

- Monocropping: Horsegram, transplanting of short duration fingermillet and chilli (with protective irrigation)
- Double cropping: Horsegram, transplanting of short duration fingermillet and chilli (with protective irrigation)
- Following are practiced for contingency plans
  - Even if inter cropping systems recommended under item No.2.3 are to be followed (whether under mono-cropping or double cropping), the sowing/ transplanting period have to be as shown in the table for the respective crops.
  - Dry sowing in finger millet, sorghum, maize, pigeonpea, groundnut and castor when monsoon is delayed. For crops with big seeds and less seed rate, like pigeonpea, pelletisation of seed is to be done before dry sowing.
  - Maintain optimum plant population by thinning.
  - Repeated intercultivation coupled with weeding and weed mulching.
  - Preventive measures against pests and diseases.
  - Double split top dressing for security against storm.
  - Controlled grazing by animals to reduce excess vegetative growth to prevent transpiration in fingermillet and horsegram

11. Other supportive practices

- Deep red soils can be leveled into graded border strips without deleterious effects on productivity when cutting will not be more than 15 cm. With such a land development, the runoff loss is reduced to about 17% of the seasonal rainfall instead of the normal 36% on a land slope of 2.5%. Graded border strips can be of 100 to 200 m long, 10 to 15 m wide with a gradient of 0.2 to 0.3% along the length of the strip.
- Fall ploughing summer tillage help in conservation of rain water and increasing yield levels. One ploughing with mould board plough in addition to two wooden ploughings during pre-monsoon increases the yield of fingermillet. Deep tillage upto 30 cm for crops like maize and pigeonpea is highly beneficial. Similarly soil inversion upto 30 cm depth was found to be promising practice.
- Sowing of crops parallel to the bunds on a gradient and ridging up later in widely spaced crops like maize reduces the run off by about 40% and increases crop yield.
- Agroforestry system with *Faitherbia albida*/ *Casuarina*/ silver oak on contour bunds on east-west direction was found to generate sizable biomass with less affect on crop yields in adjacent rows.
- For more effective control of seepage, low density polyethylene (LDPE) sheet (600 gauge) overlaid with bricks or soil filled in brick framework can be used. However, this will be about four times costlier than soil + cement lining
- For every hectare of catchment, the required capacity of the pond is 250 cubic meters and the cost of excavation of such a pond works out to about Rs. 3000 at 1987 rates without lining, but including the cost of construction of inlet and outlet structures.
- With bimodal pattern of rainfall, double cropping has been a feasible proposition in years with favorable rainfall in May. The first crop of cowpea for grain or for fodder grown with maize should be sown in May only when the 30 cm depth of surface soil is wet. This should be followed either by drilled or transplanted fingermillet in August.
- Fodder maize as early crop followed by chillies as second crop with protective irrigation and organic mulching was found to be promising.
- An intercropping system of groundnut + pigeonpea in 4:1 or 8:2 proportion was better than growing of groundnut as an entire crop.
- When season is delayed and availability of fodder becomes a crucial issue, sowing of certain annual grasses like Deenanath grass (*Pennisetum pedicellatum*) or fodder sorghum Hybrid can provide 30-35 tones of green fodder per hectare in a short span of about 90 days.
- Early sown pigeonpea in wider rows can accommodate intercrops like fodder maize or grain cowpea and bring higher returns than a sole crop of pigeonpea.

- For establishing fingermillet crop in July, drilling the seeds is convenient, but for late establishment, transplanting the seedling is essential to maintain the yield levels. Dry seeding of fingermillet was also possible when the rains are delayed till the end of July and the seedbed is ready.
- When rains were delayed and early sowing of cowpea for grain purpose is not possible, there was still scope to take an early green fodder crop before the main season.
- Traditional intercrops like fodder sorghum, field bean and niger in fingermillet can be adopted only when the fertility level of the soil is low. With improved fertility levels, an entire crop of fingermillet is to be preferred.
- An intercropping system with paired rows of pigeonpea planted in May with 3.3 m between pairs, where fingermillet is drilled in July or transplanted in August is identified as a profitable cropping system. By opening furrows between pigeonpea rows, better moisture conservation was achieved. Similar system is recommended for groundnut with 8 rows followed by two rows of pigeonpea.
- Maize and pigeonpea can be grown in alternate rows of 37.5 cm. The system is well suited for contingent crop planning, when maize is harvested for fodder at 60-75 days, if a dry spell persists and pigeonpea continued to full maturity.
- The formation of soil crust after rains and subsequent drying is very common in red soils. The crust strength was reduced with the addition of 10 t FYM/ha, Maize residue 5t /ha or 25 t/ha sand. This has reduced crust strength and increased the sealing emergence and yield.
- The red soils are characterized with coarse surface soils and fine sub-soil. By inverting the soil profile to 30 cm depth, the clay content at surface was increased leading to improvement in water retention and crop yield and fertilizer use efficiency.
- Application of fertilizer in bands was superior to broadcasting. Sand placement was made through seed cum fertilizer drill
- Continuous application of only fertilizers gradually reduced the grain yield of fingermillet. However, integration of NPK with FYM 10 t/ha stabilized the productivity of fingermillet. Crop rotation fingermillet – groundnut, increased the grain yield by 30 percent. Groundnut yield was maximum with FYM 10 t/ha compared to NPK only or FYM + NPK.
- Green leaf manure was found to be a good substitute for farm yard manure in integrated nutrient management. Application of 50 percent N through green leaf manure and 50 percent NPK gave similar yield to full inorganic fertilizers.
- Red soils are usually acidic in pH and low in bases. Application of lime increases the crop yields of oil seed and pulses.
- Application of Sulphur 10 kg /ha for pulses and 20 kg/ha for oil seed crops increases the crop yields.
- Zinc sulphate at 10 kg/ha improves the yield of maize
- The red soils contain around 500 ppm of non- exchangeable potassium and crop does not respond to potassium. Continuous application of only N and P depleted the potassium to 260 ppm in 5 to 6 years.
- Application of green leaf manure 3 weeks before sowing was found to be feasible under dryland situation.

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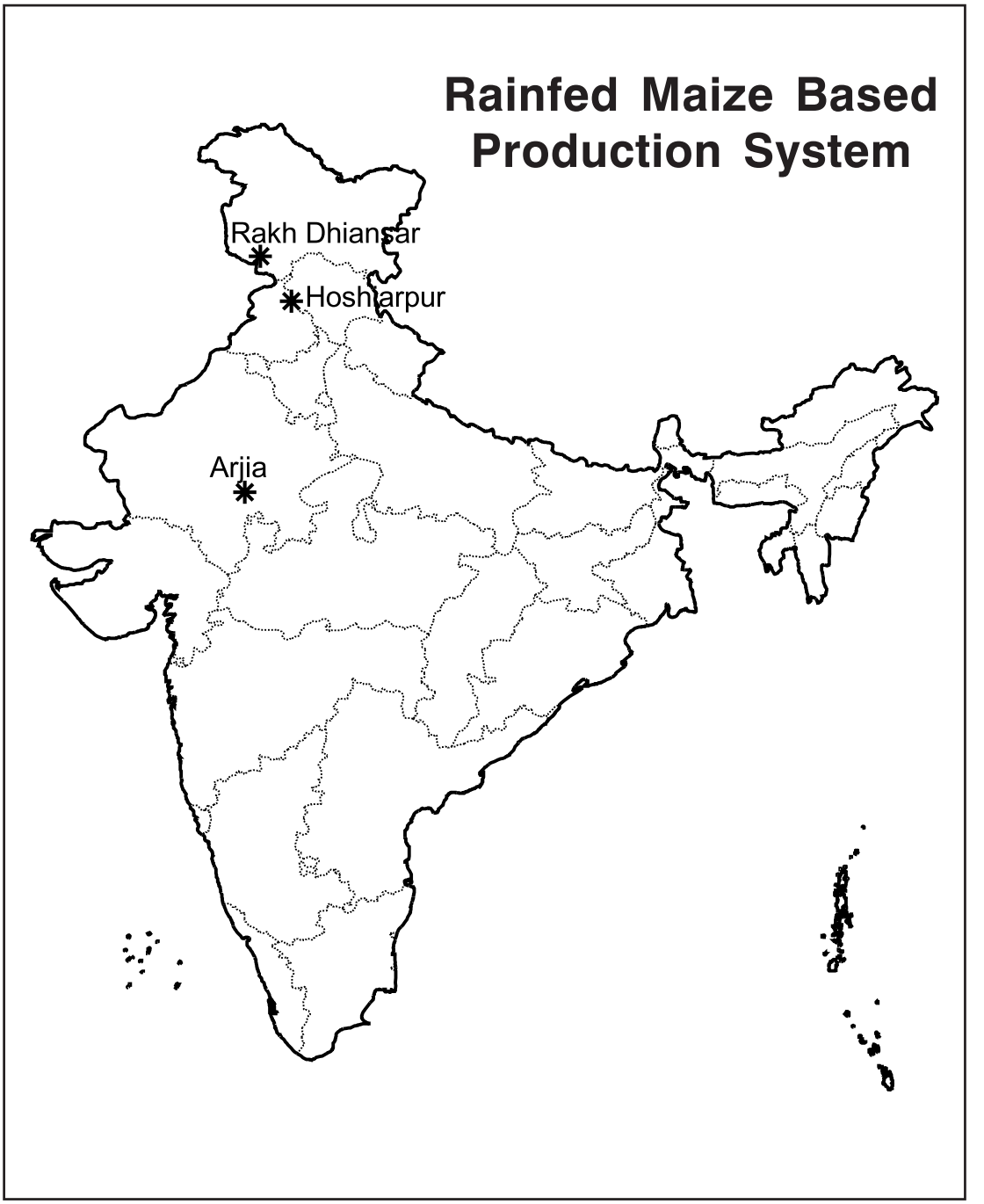
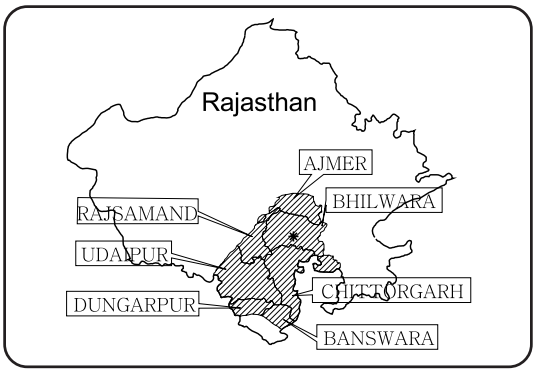

Rainfed Maize Based Production System
Rakh Dhiansar
Hoshiarpur
Arjia



ARJIA

Maize based Production System in *Kharif* Semi Arid Shallow to Deep Vertisols

1. Region

Districts of Udaipur, Chittorgarh, Bhilwara, Rajsamand and parts of Ajmer, Banswara and Dungarpur districts of Rajasthan

2. Climate

Semi-arid, mean annual rainfall is 656 mm (1960-2001) from June to end of September out of which above 90 % percent is received during July-August

3. Soils

Soils are medium black loams, moderately retentive and calcareous. *Kharif* crops are taken on light soils and *rabi* crops on the black soils.

4. Crops and varieties

Crops	Varieties/ hybrids/ composites	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Maize	Navjot	4.0	45	80-85		—
	Surya	3.5	40	70-75		
	PEHM-2	4.0	45	75-80		
Sorghum	SPV-245	3.5	70	95-110	Susceptible to shoot fly and shoot borer	
	CSH-6	3.5	55	85-90	-do-	
	CSH-14	4.5	55	85-90	-do-	
	GSH-1	—	—	—	—	—
	CSH-5					
	CSH-6					
	CSH-1					
	GJ-36					
	GJ-37					
	GJ-38					
	GJ-39					
	Fodder: GFS-4					
Pigeonpea	ICPL-87	1.2-1.5	85	135-140	—	Suitable for intercropping
	ICPL-151	1.2-1.5	80	130-135		-do-
	BDN – 2,	—	—	—	—	-do-
	G. Tur – 100					-do-
	ICPI –87119					-do-

Crops	Varieties/ hybrids/ composites	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Greengram	K-851	0.8-1.0	38	60-70		Suitable for intercropping and double cropping
	RMG-62	1.0-1.2	40	65-70	—	-do-
	GM-1	—	—	—	—	-do-
	GM-2					-do-
	GM-3					-do-
Groundnut	JI-24-	1.2-1.5	40	120-130	Susceptible to bud necrosis	Suitable for intercropping
	Spreading:					
	GAUG – 10	—	—	—	—	-do-
	GG-12	—	—	—		
	GG – 11 GG – 13					
	Bunch: GAUG – 1,					
	GG – 2, GG - 5					
	Semispreading:					
	GG – 20					
Blackgram	T-9	0.8-1.0	34	70-75	—	—
	RBU-38	1.0-1.2	38	75-80	—	—
	TVU-4					
Cowpea	C-152	1.0-1.2	40	70-80		
	Pusa Phalguni,					
	GC – 1, GC – 2,					
	GC – 3, GC – 4					
Horsegram	AK-21	1.0-1.2	55-60	90-95	—	—
Soybean	JS-71-05	1.2-1.5	35-40	90-100		
	JS-335	1.2-1.5	35-40	95-105		
	G.Soybean – 1					
	G. Soybean – 2					
Clusterbean	RGC-986	1.0-1.2	35-40	115-120	—	—
	RGC-936	0.8-1.0	30-35	90-100		
	HG – 75,					
	G.Guar – 1					
Sesame	RT-46	0.8-0.9	30-35	70-80	—	—
	RT-125	0.8-1.0	30-35	70-75		
	G.Til – 1					
	G.Til – 2					
	Semi *Rabi*:					
	Purva – 1					
Mustard	T-59	1.5-1.6	60-70	115-120	—	—
	BIO-902	1.8-2.0	65-70	110-115	—	—
Barley	RD-31	3.0-3.5	70	120-130		
	RDB-1	3.0-3.5	70	120-130		
	RD-2052	3.5-4.0	70	120-130	—	—
Chickpea	Dohad Yellow	1.2-1.4	65-70	105-115	—	—
	RSG-2	1.4-1.6	75-80	145-150		
	RSG-44	1.4-1.6	70-75	140-145		
Wheat	LOK-1	3.5-4.0	65	100-110		
	Raj-3077	4.0-4.5	70	115-120		

Crops	Varieties/ hybrids/ composites	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to disease and pest	Remarks
Taramira	T-27	1.2-1.4	40-45	45-120	—	—
Mothbean	Bileshvar, G. Guar – 1				—	—
Cotton	G.Cot – 10 CJ – 73 V-797 G.Cot – 13 G.Cot – 15				—	—
Sunflower	G. Sunflower – 1 EC – 68414, Morden	—	—	—	—	—
Castor	GAUC – 1 GAUCH – 1, GCH – 2, GCH – 4	—	—	—	—	—
Pearlmillet	GHB-27 GHB-30, GHB-32, GHB-235, GHB-181, GHB-15	—	—	—	—	—

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm) Inter row
Sorghum	10	45
Maize	25	60
Pigeonpea	10	75
Clusterbean	25	30
Greengram	16	30
Blackgram	16	30
Wheat	100	22
Barley	100	25
Mustard	5	30
Chickpea	80	30
Pearlmillet	3.75	60
Fodder sorghum	40 to 50	30
Groundnut	80 to 100	60
Spreading	120	45
Bunch	100	45
Castor	10	90
Sesame	3	45
Sunflower	10 to 12	60
Soybean	50 to 60	45
Cotton	12 to15	60-90
Mothbean	20	30
Cowpea	20	45

6. Nutrient management

Crop	Nutrients (kg/ha) N	P_2O_5	Mode of application
Maize	50	30	N in 2 splits + as basal and + at knee high stage
Sorghum	50	30	
Greengram/ blackgram/ cowpea	15	30	All drilled at sowing
Wheat/barley/ safflower/ mustard	30	15	
Chickpea/ lentil	15	30	
Pearlmillet	80	40	At sowing 20 kg N, 40 kg N at 25 to 30 days after sowing, 20 kg N at 45 to 50 days after sowing
Groundnut	12.5	25	At sowing
Castor	15.0	30	
Sesame	25.0	25	Half dose of N at sowing and full dose of P_2O_5. Remaining half dose at 30 to 40 days after sowing
Semi *rabi*: Purva-1	12.5	12.5	At sowing
Sunflower	60.0	60	Full dose of P_2O_5 and half dose of N at sowing and remaining half dose at 30 to 45 days
Soybean	30.0	60	At sowing
Cotton	25	40	Half of N at sowing time and remaining half at 50 to 55 days. If 25 kg of N it is applied at sowing time
Mothbean	20	40	At sowing time
Clusterbean	20	40	
Pigeonpea	20	40	

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ implements to be used	Times of operation
Maize	Deep tillage + Rotavator	Summer
Maize	Summer ploughing by *desi* plough followed by harrowing	Summer
Sorghum	Bullock drawn blade harrow	Summer

Weed management – chemical

Crop	Herbicide	Dose kg (a.i.) ha	Method of application
Maize	Atrazine	0.5 kg/ha	Preemergence
Groundnut+sesame	Pendimethalin	0.5 kg/ha	Preemergence

Insect pest management

Crop	Pest	Control measures
Pulses	Pod borer	Endosulfan 1250 ml/ha
Mustard	Pented bug	Methial Parathion 25 kg/ha dusting
Maize	Stem borer	Endosulfan 1250 ml/ha

Disease management

Crop	Disease	Control measures
Maize	Downy mildew	Seed treatment with Ridomyl MZ 4 g/g or Apron 35 WS 4 g/kg Spray of Mancozeb 0.2%. Repeat it after 10-15 days interval
Groundnut	Tikka Yellowing of leaves	Spray of Bavistin 0.5 g/l water or Mencozeb 1.5 kg/ha Spray of Sulfuric acid 0.1% at flowering stage
Sesame	Bacterial blight Powdery mildew	Spray Mancozeb 1.5 kg or Captan 2.5 kg Dusting of Sulphur powder 20 kg/ha or 200 g Bavistin/ha
Pulses	Powdery mildew Black Blight	Spray bavistin 0.5 g to 1.0 g/ l water As appearance of disease spray of Streptocycline 200 ppm or 2 kg copper fungicide per ha
	Yellow vein mosaic virus	Spray of Dimethoil 80 EC 1 l/ha repeat after 15 days interval

8. Suitable cropping systems

Sequence cropping on heavy soils with good rainfall

- Sorghum/ maize – mustard
- Blackgram/ greengram/ cowpea/ sorghum fodder - mustard
- Sorghum (fodder) – mustard
- Sorghum – safflower

Intercropping

- Maize + blackgram (2:2 row ratio in paired planting 37 cm.)
- Maize + pigeonpea (alternate rows at 30 cm.)
- Maize + castor (1: 1 row ratio)
- Groundnut + sesame (6:2 row ratio at 30 cm apart)
- Chickpea + mustard (4:1 row ratio at 30 cm apart)
- Chickpea + safflower (2:1 row ratio at 30 cm apart)
- Cotton + blackgram
- Pigeonpea + groundnut
- Castor + greengram (2:1)
- Groundnut + sesame (6:1)
- Sorghum/ pearlmillet + cowpea (fodder)
- Groundnut + pigeonpea (3:1)
- Groundnut + castor (3:1)
- Groundnut + sesame (6:3)
- Cotton + groundnut (1:2)
- Pearlmillet + pigeonpea (2:1)

9. Farm implements / Tools

Tool/ implements	Cost unit in Rs.	Operation
Arjia Pora	100/-	Placement of seed and fertilizer at proper depth
Multipurpose tool bar	2000/-	Ridge making, interculture, blade harrowing and seed and fertilizer drilling
Seeding attachment for ridge sowing	300/-	Ridge sowing of maize

Tool/ implements	Cost unit in Rs.	Operation
Dryland weeder	500/-	Intercultural operations
Rotavator-L-Series	60000/-	The operations like ploughing, Harrowing, Clod crushing, Leveling are done simultaneously
Two Row Seed Drill	1500/-	Two row sowing at a time
Plough Planter	1500/-	Placement of seed
Post hold digger	40000/-	Digging of pits for planting tree species

10. Contingent crop planning

Good and normal rainfall

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

Normal onset followed by long gaps

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

Delayed onset of monsoon

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

Early withdrawal of monsoon

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

11. Other supportive practices

- Sowing of maize with compartmental bunding helps for *in-situ* soil moisture coservation
- Create dust mulch (soil stirring) as when there is dry spell
- Sowing of maize in ridges is good practice during drought as well as excess rainfall
- Deep tillage during summer increases water retention
- Grow *Acacia tartilis* on marginal lands
- Alley cropping of Jatropha spp + Greengram land capacity class (LCC) III lands
- *Silvipastoral system* with *Prosopis cinerasia* + *Cenchrus* land capacity class (LCC) IV lands
- Horti – pastoral system with ber + C*enchrus setigerus*

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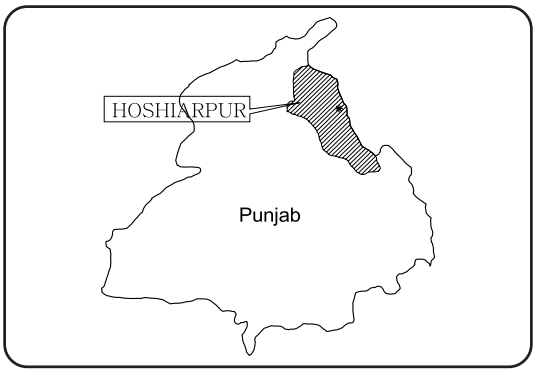

HOSHIARPUR

Maize based Production System in *Kharif – Rabi* Semi Arid Inceptisols

1. Region

Kandi, area of Punjab, located along the north - eastern border of the state, is a sub-montane undulating region and comprises about 10% of total area of the state. The height of this region varies between 300 and 550 m above mean sea level. This region is badly dissected by innumerable streams, which meander a lot and cause flash floods during rainy season. Underground water is inadequate and inaccessible because of poor water bearing aquifers.

2. Climate

This region belongs to sub-humid type of climate with annual rainfall of about 1000 mm, 80 percent of which is received during late June to mid September. Mean monthly rainfall is the highest in July and lowest in April Rainfall is relatively more erratic during sowing time of *kharif* crops and is erratic as well as low during sowing of *rabi* crops. Runoff varies from 20-45 percent during monsoon period. Generally, summers are hot and winters are cool. The maximum temperature is generally recorded in the month of May-June (upto 41^0C) and the minimum in the month of January (up to 3^0C).

3. Soils

Soils of the region have three distinct physiographic units – hilly, gently to moderately sloppy agricultural land and stream affected marginal lands. Soils are neutral in reaction and low in organic matter content. These are deficient in nitrogen, low in available phosphorus and medium in available potassium. Soils are generally light in texture with loamy sand and sandy loam. North-western part of the region has medium to heavy textured soils.

4. Crops and varieties

Crops	Varieties/	Yield potential (t/ha)	Duration from seed to seed (days)	Disease and pest reaction	Remarks
Kharif					
Maize - grain crop	JH-3459 (hybrid)	4.8	84	Moderately resistant to bacterial stalk rot	Drought tolerance
	Prakash (hybrid)	4.5	84	—	
	Megha (Composite)	3.0	80-83	—	
Pearlmillet - grain crop	PCB-138 (composite)	2.0	74-78	Resistant to downy mildew. Escape ergot due to earliness	Terminal drought

Crops	Varieties/	Yield potential (t/ha)	Duration from seed to seed (days)	Disease and pest reaction	Remarks
Greengram	ML-613	1.25	85	Resistant to yellow mosaic virus, cercospora leaf spot and bacterial leaf diseases. Tolerant to jassids and white files	Grains are bold and staining with good cooking quality. Determinate growth habit
	ML-267	1.45	85	Resistant to yellow mosaic virus	Determinate growth habit. Grains with good cooking quality
Blackgram	Mash 48	0.75	115	Susceptible to yellow mosaic virus in humid areas	Indeterminate growth habit
	Mash 338	0.87	90	Resistant to yellow mosaic virus, bacgterial leaf spot and cercespora leaf spot diseases. Tolerant to jassids and white flies	Determinate growth habit
	Mash 1-1	0.87	115	Resistant to fungal and viral diseases	Indeterminate growth habit
Groundnut	M 37	1.62	120	—	—
Sesame	TC 289	0.52	80	—	—
	Punjab Til No. 1	0.50	80	—	—
Fodder-Maize	J 1006	41.2	—	Moderately resistant to maydis leaf blight and brown strips downy mildew diseases	—
Fodder-Sorghum	SL 44	60.0	—	—	—
Fodder-Pearlmillet	PCB 141	60.0	—	Dual purpose variety Highly resistant to downy mildew	—
	PCB 15	57.5	—	Dual purpose composity Highly resistant to downy mildew disease	—
Fodder-Clusterbean	Guar 80	31.0	—	Late maturing variety Resistant to clusterbean leaf blight and stem breakage	—
Fodder-Cowpea	Cowpea 88	27.5	—	Dual purpose variety Highly resistant to yellow mosaic virus and Anthracnose disease	—

Crops	Varieties/	Yield potential (t/ha)	Duration from seed to seed (days)	Disease and pest reaction	Remarks
Rabi					
Wheat	PBW 396 (Double dwarf variety)	3.6	150	Resistant to yellow and brown rusts. Susceptible to Karnal bunt and loose smut	Recommended for timely sown conditions (End Oct.- end Nov.)
	PBW 175 (Single dwarf variety)	3.62	165	Highly resistant to yellow and brown rusts and Karnal bunt.	
	PBW 299 (Double dwarf variety)	3.62	165	Resistant to yellow and brown rusts and Karnal bunt. Susceptible to loose smut.	
	PBW 373 (Double dwarf variety)	3.75	140	Highly resistant to . yellow and brown Susceptible to loose smut rusts	Recommended for late sown conditions (from end Nov. onwards)
	PBW 138 (Double dwarf variety)	3.75	140	Resistant to loose smut and flag smut. Susceptible to yellow and brown rusts	
Triticale	TL 1210 (Single dwarf variety)	4.5	135	Resistant to yellow and brown rusts. Karnal bunt, loose smut,flag smut and powdry mildew	Suitable as poultry feed
Barley	PL 419 (Six row variety)	4.0	130	Resistant to yellow rust, loose and covered smuts. Moderately susceptible to stripe disease	Throughout the state
Chickpea	PBG 1	1.6	160	Highly resistant to chickpea blight and wilt complex	Bold seeds
	C 235	1.25	165	Fairly resistant to chickpea blight	Medium sized seeds
Lentil	LL 699	1.42	145	Moderately resistant to rusts and blight Tolerant to pod borer	Early in flowering
	LL 147	1.37	150	—	
	LL 56	1.29	155	—	—
	Mansar 9-12	1.0	155	—	—
Mustard (raya)	PBR 97	1.34	136	—	Medium bold seeds with oil content 40.0%

Crops	Varieties/	Yield potential (t/ha)	Duration from seed to seed (days)	disease and pest reaction	Remark
	RLM 619	1.5	143	Greater resistant to white rust, *Alternaria* blight and downy mildew	—
Taramira	TMLC 2	0.72	150	—	Oil content 36.6%
Linseed	LC 2023	1.24	158	Resistant to wilt, rust *Alternaria* blight and moderately resistant to powdery mildew	Oil content, 40% Bears blue flowers and brown seeds of medium size
	LC 54	1.25	170	Fairly resistant to wilt, rust and powdery mildew	Oil content 46% Bears white flowers and brown seeds

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Maize	20	40-50	20-25
Pearlmillet	3.75	60	15
Greengram	20	30	10
Blackgram	15-20	30	—
Groundnut	65	30	22.5
Sesame	2.5	30	15
Rabi Wheat	100	22-25	—
If soil moisture is low		30	—
Barley	112	18-20	—
Chickpea	40-45	30	—
Lentil	30-37.5	22.5	
Mustard	3.75	30	10-15
Taramira	3.75	30	15
Linseed	37.5	23	7.10
Fodder			
Maize	75	30	—
Sorghum	50-60	22	—
Pearlmillet	15-20	22	—
Clusterbean	45-50	30	—
Cowpea	50-60	30	—

6. Nutrient management

Crop	Nutrients (kg/ha)			Mode of application
	N	P_2O_5	K_2O	
Kharif				
Maize				
Sandy loam to clay loam	80	40	20	Apply half N and all P_2O_5 as well as K_2O at sowing and top dress remaining half N one month after sowing

Crop	Nutrients (kg/ha)			Mode of application
	N	P_2O_5	K_2O	
Loamy sand to sandy	40	20	10	Apply potassium on soil test basis and if soils show deficiency
Pearlmillet	62.5	30	—	Apply half N and full dose of P_2O_5 with last ploughing and remaining half N about one month after sowing with a shower of rain
Greengram	12.5	40	—	Drill all nutrients at sowing
Blackgram	12.5	25	—	
Groundnut	15	20	25	Drill all nutrients at sowing. Prefer phosphorus from single superphosphate. Apply potassium only when soil test indicates its deficiency.
Sesame	35	—	—	Drill at sowing
Rabi Wheat				
Sandy loam to clay loam	80	40	25	Drill half N and full P_2O_5 fertilizer at sowing at broadcast remaining half N at winter rains
Loamy sand to sandy loam	40	20	15	
Barley	40	30	15	Drill fertilizer at sowing
Chickpea	15	20	—	
Lentil	12.5	20	—	
Mustard	37.5	20	—	Drill the fertilizer before sowing, Prefer phosphorus from single super phosphate.
Taramira	30	—	—	Drill the fertilizer before sowing. Prefer single super phosphate as source of phosphorus.
Linseed	62.5	40	—	Drill all fertilizer before sowing. Prefer single super phosphate as source of phosphorus.
Fodder				
Maize 25	—	—	—	
Sorghum —	50	20	—	Drill all fertilizer at field preparations
Pearlmillet 25	50	—	—	Half at sowing and remaining half 3 weeks after sowing
Clusterbean 20-25	—	—	—	
Cowpea —	18	55	—	Drill all fertilizer at sowing

7. Pest and disease management

Weed management – mechanical

Crop	Operation
Pearlmillet	Interculture 3-5 weeks after sowing
Greengram	First hoeing 4 weeks after sowing and second if needed two weeks later
Blackgram	Hoeing at about one month after sowing

Crop	Operation
Groundnut	Two hoeings at 3 and 6 weeks after sowing
Sesame	One hoeing 3 weeks after sowing
Wheat	Two hoeings preferably with improved wheel hand hoe
Chickpea	One or two hand hoeings preferably with improved wheel hand hoe at 30 and 60 days after sowing
Lentil	One or two hoeings preferably with improved wheel hand hoe at 30 and 60 days after sowing
Mustard	-do-
Taramira	-do-
Linseed	Two hoeings with improved hand hoe at three and six weeks after sowing

Weed management – chemical

Crop	Herbicide	Dose kg a.i./ha	Time of application
Maize	Atrazine or Simazine	1.0 kg/ha in medium to heavy textured soils and 0.625 kg/ha in light soils	Within 2 days of sowing
	Alachlor	2.5 l/ha	Preemergence (within 2 days of sowing)
Pearlmillet	Atrazine or Simazine	0.25 kg/ha	Preemergence
Greengram	Fluchloralin	0.675 l/ha	Pre-plant incorporation
	Pendimethalin	0.75 l/ha	Preemergence
Groundnut	Alachlor	2.5 l/ha	Preemergence
	Fluchloralin	0.675 l/ha	Pre-plant incorporation
Wheat / barley	As in case of irrigated wheat		
Fodder/ maize	Similar to grain crop of maize		
Sorghum	Atrazine or Simazine	0.5 kg/ha	Preemergence
Pearlmillet	Atrazine of Simazine	0.25 kg/ha	Preemergence
Cowpea	Pendimethalin	0.562 l/ha	Preemergence

8. Suitable cropping systems

- Sandy loam – clay loam (Medium to heavy textured) soils with high moisture retention capacity:
  - Maize – wheat
  - Maize – mustard (raya)
  - Maize – chickpea
  - Pearlmillet – wheat/ barley
  - Fallow – chickpea
  - Fallow – wheat + chickpea
- Loamy sand to sandy (Light to medium textured) soils with low moisture storage capacity:
  - Fallow – wheat
  - Fallow – wheat + raya
  - Sunhemp (green manure) – wheat + chickpea
  - Sunhemp (green manure) – wheat + chickpea + raya
  - Cowpea (fodder) – wheat + chickpea
  - Cowpea (fodder) – wheat + chickpea + raya
  - Fallow – wheat + chickpea/ barley/ raya/ taramira
  - Pearlmillet – chickpea

9. Other supportive practices

- Agro-climatic conditions of Kandi area are quite suitable for raising variety of fruit crops namely, amla, guava, ber, citrus and mango. Technology for their successful cultivation has been generated at the Punjab Agricultural University Zonal Research Station for Kandi Area, Ballowal Saunkhri. The important varieties along with their features are listed in Table. Some important points for successful raising of fruit plants are as under

Crop	Variety	Yield	Remarks (kg/tree)	Ripening period	Spacing (m)	No. of plants/ha
Guava	Allahabad Safeda	35	White flesh, TSSI 13% Vit. C, 280 mg/ 100 g of pulp	January	6.5 x 3.5	236
	Sardar Guava (L-49)	22	Tolerant to guava wilt TSS 14% Vit. C 360 mg/100 g of pulp	January	6.5 x 3.5	236
Ber	Sanaur No.2	37	Fairly resistant to powdery mildew TSS 19% Acidity 0.39%	Second fortnight of March	7.5 x 7.5	178
Amla	Chakaiya	90	TSS 11% Acidity 2.1% Vit. 640 mg/100 g pulp	Mid December to mid January	7.5 x 7.5	178
	Banarasi seedling	50	TSS 12% Acidity 2.3% Vit.C 580 mg/100 g pulp	Mid November to mid December	7.5 x 7.5	178
Citrus	Galgal (Hill lemon)	19		Nov.–Dec.	6.0 x 6.0	275
Mango	Dushehri	—	Flesh firm, fiberless, pleasantly sweet, stone small and thin	July	9.0 x 9.0 (grafted)	123
					10.0 x 10.0 (seedling)	100

- The soils for an orchard should be deep and fertile free from hard pan or any concretion upto a depth of 2 metres. These should not contain more than 5 percent calcium carbonate and more than 10 percent lime.
- Planting in the sub-montane Kandi area should be taken up during early part of monsoon i.e. July. The spring season (February-March) is not suitable for plantation in this area. The planting should preferably be done when it is drizzling. During the initial two – three years of planting, limited irrigations are required for proper establishment of the plants.
- In Kandi area, water is the limiting factor for establishment of fruit plants. To make best use of limited water, water conservation techniques should be adopted especially in the sloppy areas. Staggered or continuous contour V-trenches made at suitable vertical intervals are useful. These trenches conserve rainwater in the root zone of plants besides checking soil erosion. Vegetative barriers such as Vetiver (*Vetiver zizanoides*), bhabbar grass (*Eulaliopsis binata*) and napier hybrid pearlmillet (*Pennisetum purpureum*), Kana (*Saccharum munja*) and Kahi (*Imperata cylindrical*) are also effective in checking soil erosion.
- Before planting, the orchard site be well laid out according to the recommended spacing of fruit plants to be planted. One month before planting, pits of 1m x 1m x 1m should be dug and filled with a mixture of top soil, silt and farm yard manure in equal parts.

Contributors

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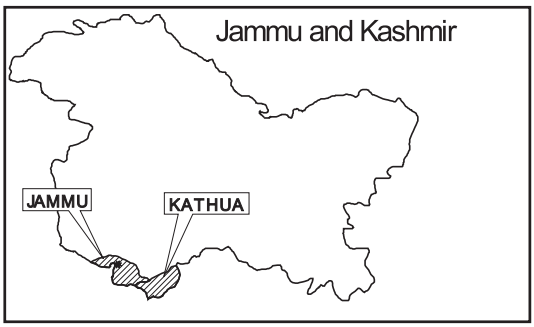
Adderss: AICRP for Dryland Agriculture, Regional Research Station for Kandi Area, Punjab Agricultural University, Ballowal Saunkhri, P.O. Takaria, Via. Balachaur, Dist. Hoshiarpur, Punjab-144521



RAKH DHIANSAR

Maize based Production System in *Kharif* and *Rabi* Sub-Humid Deep Inceptisols

1. Region

Comprise parts of districts of Jammu and Kathua of Jammu and Kashmir.

2. Climate

Sub–montane, dry sub–humid, Mean annual rainfall is 1180 mm of which 60 percent is received during July-August. Winter rains account for 225 mm.

3. Soils

Soils are medium deep sandy loam to loamy. This region is low in nitrogen and phosphorus and low to medium in potassium.

4. Crops and varieties

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Maize	GS-2 Mansar C – 5	2.0-2.5 1.8-2.2 1.8-2.2	65-70 55-60 55-60	100-105 90-95 90-95	Partially susceptible to stem borer	Suitable for mono and intercropping systems
Pearlmillet	WCC-175 MHB-110 MHB-179	1.4-1.6 1.8-2.0 1.8-2.0	70-75 70-75 70-75	100-105 105-110 105-110	Partially susceptible to downy mildew	Suitable for mono cropping system
Greengram	PDM-54 ML -13168	0.6-0.8 0.6-0.8	50-55 50-55	80-85 80-85	Partially resistant to yellow mosaic	Suitable for mono and intercropping systems
Cowpea	C-152 PS-42	0.7-0.9 0.7-0.9	45-50 45-50	70-75 70-75	Partially resistant to yellow mosaic	Suitable for mono and intercropping
Blackgram	Plant-U-19	0.6-0.7	60-65	110-115	Resistant to yellow mosaic	Suitable for mono cropping
Wheat	PBW-396 RDP-81	2.5-3.0 2.0-2.5	110-115 125-130	155-160 175-180	Partially resistant to loose smut and yellow rust	Suitable for mono cropping
Chickpea	C-35 PBG-1	0.8-1.0 1.0-1.2	90-95 95-100	135-140 150-155	Partially resistant to bacterial wilt and pod borer	Suitable for mono cropping

Crops	Varieties/ Hybrids	Yield potential (t/ha)	Days to 50% flowering	Duration from seed to seed (days)	Reaction to diseases and pests	Remarks
Lentil	L-9/12	0.5-0.6	105-110	155-160	—	Suitable for mono cropping
	PL-406	0.5-0.6	105-110	155-160	—	
Peas	T-163	1.0-1.2	90-95	140-150	Partially resistant to powdery mildew and root rot	Suitable for mono cropping
	Rachna	1.2-1.5			Powdery mildew and root rot	—
Mustard	RLM-619	1.0-1.2	90-95	130-135	Partially resistant to aphids and white rust	Suitable for mono cropping
	Pusa Bahar	1.0-1.2		120-125	—	—

5. Seed rate and planting pattern

Crop	Seed rate (kg/ha)	Planting pattern (cm)	
		Inter row	Intra row
Wheat	100	25	Thick sowing
Barley	100	25	Thick sowing
Maize	20	60	30
Pearlmillet	5	45	20
Greengram	15-20	30	15
Blackgram	15-20	30	15
Cowpea	20-25	30	15
Chickpea	—	30	15
Mustard	—	30	15

6. Nutrient management

Crop	Nutrients (kg/ha)			Method of application
	N	P_2O_5	K_2O	
Maize	60	40	20	P_2O_5 + K_2O +2/3rd of N as basal, remaining N though urea in 2 splits doses 1st at knee high stage and 2nd before tassel formation stage
Pearlmillet	50	30	15	P_2O_5 + K_2O + 1/2 N as basal, remaining N though urea after 30 to 40 days of sowing
Wheat	60	30	20	Full diammonium phosphate + muriate of potash + 2/3rd urea should be applied as basal. Remaining 1/3rd urea should be top dressed on receipt of rains
Barley	40	20	20	All N, P_2O_5 and K_2O
Greengram/ Blackgram	16	40	0	-do-
Cowpea	16	40	0	-do-
Mustard	60	30	15	Full P_2O_5 + K_2O +1/2 N as basal, remaining N through urea should be top dressed when first rain is received
Chickpea	15	40	—	All N, P_2O_5 and K_2O

7. Pest and disease management

Weed management – mechanical

Crop	Tool/ Implement to be used	Time of operation
Maize	Trapheli or 5 tyned hoe or *Khurpa*	Two hoeings one at 15 days and other at 30 days after sowing
Pearlmillet	Hand blade hoe or *Khurpa*	Interculture after 3 to 5 weeks of sowing
Wheat	Hand blade hoe or harrow	One hoeing should be given about a month after sowing
Mustard	Hand blade hoe or *Khurpa*	One weeding is important. Blade 35 days after sowing
Chickpea	Hand blade hoe or *Khurpa*	Weed control up to 4-5 weeks after sowing is essential

Weed management – chemical

Crop	Herbicide	Dosage kg (a.i.)/ha	Method of application
Maize	Atrazine	1.01	In 800 to 1000 l/ha of water/ha to be sprayed on the surface of soil just after sowing as preemergence
Wheat	2,4-D amine 2,4-D ester	0.75 0.50	For broad leaf weeds in 500 – 600 l/ha water at 25-35 days after sowing.
	Isoproturon	0.75	For chemical control of sitti (*Phalaris miner*) in 500-600 l/ha water in high volume spray pump 30-35 days after sowing
	Isoproturon + 2,4 – D	0.75 500 ml	For chemical control of both types of weeds in + 500-600 l/ha water in high volume spray pump 30-50 days after sowing
Mustard	Fluchloralin	0.70	As preplant incorporation
	Pendimethalin	1.00	As preemergence in 500-600 l/ha water

Insect pest management

Crop	Pest / disease	Control measures
Maize	Stem borer Aphids Hairy caterpillar	Spray with Endosulfan 35 EC 500 ml / ha Spray the crop with Dimecron 100 EC 25 ml/ ha
Pearlmillet	Leaf cutting caterpillar and grass hopper	Dust the crop with Chlorpyriphos 1.5% dust 25 kg/ ha or Lindane 1.3% dust 25 kg/ ha
Greengram, Blackgram and Cowpea	Hairy caterpillar and whitefly	Dust the crop with BHC 10% 25 kg/ha or spray Endosulfan 35 EC 1.5 l/ha for white fly spray the crop with Malathion 50EC 1ml/l of water
Wheat	Termites	Use 450 ml chlorpyriphos 20 EC or 686 ml of endosulfan 35 EC for seed treatment. Mix the desired insecticide in 5 l of water. Sprinkle this solution over a heap of one quintal of wheat seed and mix thoughly. Keep the treated seed in thin layer over night and sow it next morning.

Crop	Pest / disease	Control measures
		Treat soil with Lindane 1.5% dust 25 kg/ha after the last ploughing and before planking in areas where termite attack is recurrent and seed treatment could not be done. For example control in standing crop, dilute 4.L of Chlorpyriphos 20 EC or 2.286 L of Endosulfan 35 EC 5 l of water and mix in 50 kg of sand thoroughly. Broad cost this treated soil in the infested area.
		Never use raw farm yard manure
		Destroy termatoria in and around field
	Sucking insects	Spray the crop with Rogor 30 EC 750 ml in 800 l/ha water
	Field and house rats	Use Zinc Phosphide in poison baits
Peas	Leaf miner	Spray the crop with 0.03 % Phosphamidon 100 EC 240 ml in 750 l/ha water at pod formation stage.
Chickpea	Cutworm	Mix Lindane 20 kg or 2 l of Chlorpyriphos 20 EC in 25 kg of sand /ha in rows of the plants at sowing time.
	Pod borer	Spray the crop with Endosulfan (0.07%) 1200 g in 800 l of water at pod initiation stage and repeat the spray after 15 days
Lentil	Pod borer	Spray the crop with Endosulfan 35 EC 1.5 l in 750 l/ha water
Mustard	Aphids	Early sowing of mustard crop preferably by first fortnight of October be done
		Spray Chlorpyriphos 20 EC (0.025%) or Monocrotophos 40 WSL (0.035 %)
		For economical control apply Phorate 10 G 10 kg/ha at flower initiation stage. Broadcast granules and give light irrigation
	Sawfly Flea beetle	Spray the crop with Carbaryl 50 WP 1.5 kg/ha or spray the crop with Endosulfan 35 EC 1.5 l/ha

Disease management

Crop	Disease	Control measures
Maize	Leaf blight	Spray the crop with Zineb 0.2 % at the appearance of the disease.
		Clean cultivation always helps to reduce the disease to attack
Pearlmillet	Green ear disease or downy mildew and leaf blight	Rogue out the infected plants in the season to prevent secondary infection. Affected plants should be burnt Treat the seed with Apran 35 SD 5 g/kg. Fallow 3 to 4 Annual rotation with other crops
		Spray the crop 30-50 days after germination with Ridomil 0.01%
		For leaf blight spray the crop with Dithane Z-78 1.5 kg/ ha at the appearance of the disease
	Ergot	Affected plants should be removed and burnt
		Spray the crop with Cuman 375 g and 500 g of Dithane Z-78 in 500 l/ha water

Crop	Disease	Control measures
Greengram, blackgram and cowpea	Leaf spot	Spray the crop with Dithane Z-78 1.25 to 2.00 kg/ ha in 500-600 l of water
	Virus	Remove the infected plants and burn
Wheat	Loose smut	Treat the seeds with Carboxin or Carbendazim 2 g/kg of seed
	Yellow and brown rust	Spray the crop with Zineb 2 kg/ha or Bayleton 200 750 ml or Mancozeb 0.2 %.
Peas	Powdery mildew	Spray the crop with wettable sulphur 2.25 kg/ha or Karathane 1 kg in 200 l of water Seed treatment with Carbendazim +Thinram- (1.2) 2 g/kg of seed followed by two sprays of Mancozeb 0.25 % (75 days and 105 days after sowing)
	Wilt and root rot	Before sowing, treat the seeds with Thiram or Captan 2.5 g /kg of seeds or *Trichoderma viridae* 5 g/kg of seed
Chickpea	Wilt	Clean cultivation Uproot affected plants, as when observed in the fields Seed treatment with Carbendazim 50 WP 2 g/kg or *Trichoderma Viridae* 5 g/kg of seed.
Lentil	Wilt	Seed treatment with Captan or Thiram or Carbendazim 2 g/kg of seed.
Mustard	Aphids	Early sowing of musterd crop preferably by first fortnight of October be done Spray Chlorpyriphos 20 EC (0.025%) or Monocrotophos 40 WSL (0.035 %) For economical control apply Phorate 10 G 10 kg/ha at flower initiation stage. Broadcast granules and give light irrigation
Mustard	*Alternaria* blight	For *Alternaria* blight treat the seed before sowing with Thiram or Captan 2.5 kg/ of seed spray the crop with Mancozeb 0.2 %

8. Suitable cropping systems

Sequence cropping

- Maize – wheat
- Maize – barley
- Maize – rapeseed
- Maize – chickpea/ lentil/ pea
- Pearlmillet – wheat
- Greengram – wheat
- Blackgram – wheat
- Blackgram – rapeseed
- Cowpea/ greengram/ blackgram – pea
- Maize – toria (local) – wheat

Intercropping

- *Kharif*
  - Two rows of cowpea + blackgram + one row of maize each at 30cm
  - Maize + okra (1:1 row ratio at 30 cm each)

- *Rabi*
  - Barley + peas (2:1)
  - Wheat + chickpea (4:2)
  - Wheat + rapeseed (8:1)
  - Chickpea + mustard (4:1)

9. Farm implements /Tools

Tool/Implements	Cost/unit (Rs.)	Operation
Off set disc plough	14000/-	Land preparation
Tawi Multi crop thresher 3 H.P.	14000/-	For post harvest operation in wheat
Seed drill	13500/-	For sowing of mustard/ wheat
Cultivator	9000/-	Land preparation
Wheel hand hoe	500/-	Weeding in maize
Pora (Hill plough)	280/-	Line sowing of chickpea/ wheat/ maize
Maize sheller (Hand operated)	290/-	Shelling of maize (removal of seed from cobs)
Tawi power operated Maize sheller 2 H.P.	7500/-	Shelling of maize (removal of seed from cobs)
Winnowing Fan	1680/-	For winnowing operations

10. Contingent crop planning

Normal season

- *Kharif*
  - Maize: Ganga safed-2 (up to 600m altitude)
  - Maize: C-8, C-5, Mansar (for intermediate zone)
  - Maize: Him-123, Vijay (for hilly areas)
  - Pearlmillet: W.C.C-75, I-C M.S-7703, MHB-110 MH-179
  - Sorghum: CSH-6, CSH-9
  - Greengram: PDM-54, M2-131, PS-16, PS-7
  - Blackgram: PANT U-19
  - Cowpea: C-152, PS-42, Cullure-1
  - Sesame: Punjab Sesame-1
- *Rabi:*
  - Wheat:

  Normal Sown
    - PBW-396 and PBW -175 (25th October to 30th November)
    - IWP-72 and RSP-81 (15th October to 30th October)

  Late Sown
    - HD-1553 (1st to 25th December)
    - HD-2285, Raj 3077 and PBW -226 (25th November to 25th December)
  - Barley:
    - Ratna, Jyoti, Sonu
    - Local (For hilly region)
  - Mustard:
    - RLM-198, Pusa Bold (2nd fortnight of October)

  - RLM- 514, RLM-619 (1st week of October to last week of November)
  - Kranti, Pusa Basaut, Pusa Bahar, RH-30
  - RL-1359, Varuna (1st week of November)
- Gobhi Mustard: GSL-1, GSL-2, DGS-1
- Toria: Local
- Chickpea: C-235, K-468, Gaurav, PBG-1
- Peas: T-163, PG-2, Rachna
- Lentil: L-9/12, PL-406

Normal onset of monsoon followed by long gaps

- In case of normal onset of monsoon, follow the normal schedule of work
- Under abnormal weather conditions after sowing the crops the following practices should be undertaken to save the crops from drought.
- Clean cultivation (weed control): To check the moisture loss through transpiration of weeds
- Laying of soil mulch: to check the evaporation from the soil surface and also use locally available plant material as mulch.
- Reduction of plant population (thinning of crop): To check the moisture loss through transpiration of thick sown crops.
- Foliar spray of urea (3%): During the dry spell spraying of urea (3%) is beneficial.
- Inter-row water harvesting: Ridges and furrows enable the plant roots to derive moisture from the stored moisture within the furrows.
- Collect runoff and utilize some for *kharif* crop when there is scarcity of water during any dry spell

Delayed onset of monsoon

- Onset of monsoon as late as second week of July: Cultivation of short duration varieties of normally sown crops.
- Dry sowing of seed: Maize should be sown dry which will germinate just after the rains and thereby save the time in preparation of land.
- Transplanting of pearlmillet: Sow the nursery which can very easily be transplanted when the rains come.
- Minimum tillage: Sow the seed with the first ploughing to use the available moisture for germination of the *kharif* crop followed by weeding and earthing up.
- Onset of monsoon as late as 1st week of August: The cultivation of pearlmillet, greengram, and cowpea for fodder purpose can be taken up.
- Mid-season correction: When the monsoon is as late as the 3rd week of August the cultivation of local Toria (crop of 60-65 days) is the only answer which can be followed by normal *rabi* crops.

Early receding of monsoon

- Life saving irrigation from stored water
- Spraying of 3% urea
- Maize should be harvested green
- Harvest at intervals as the plants show physiological maturity
- Thinning of crop plants

Rabi

- When there is no moisture in the soil during October- November and December then dry sowing of wheat and mustard is done, so that whenever small shower of rain is received, it will be helpful in the germination of crop sown.
- Minimum tillage operation be adopted (sowing of seed with *kera* and application of fertilizer by *pora* method) to save the moisture loss from the soil and time. Direct sowings may be done without ploughing when moisture is available in the soil. It will help in the early germination.

11. Other supportive practices

- Prepare the land for seeding maize and wheat by ploughing with mould board plough once followed by disc harrowing twice or ploughing with soil stirring plough
- Sow maize, pearlmillet and sorghum on ridges
- Use Pora method or seed-cum fertilizer drill for seeding wheat
- For *rabi* season (wheat sowing) if the sowing is delayed, direct sowing can also be done on receipt of first shower of rains
- During *kharif* low fertility status lands are to be green manured
- Use sprinkler system for efficient utilization of harvested rain water
- As for as possible *Kharif* crops should be harvested at the time of physiological maturity
- Alternate land use /diversification of farming is a security against drought

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Annexure I

Varieties/ Hybrids Released during 1996-2002

The information on varieties/ hybrids released during 1996-2002 from the Annual Report(s), Department of Agricultural Research and Education, Ministry of Agriculture, Government of India, and Indian Council of Agriculture Research, New Delhi are summarised below. Apart from the rainfed region, information is also included on dry irrigated regions. This information may be read in conjunction with the recommendation of the centers for rainfed rice, oilseeds, pulses, cotton, coarse cereals and forages. The details follow.

Rainfed rice

Following are cultivars released for rainfed upland, medium to low land and deep water rice growing regions.

Cultivar	Recommended region	Salient features (Year of release)
	Upland	
Lalithagiri	Orissa	Medium bold, 3.2-6.7 t/ha, maturity 90-95 days (1999-2000)
Danteshwari	Direct-seeded uplands of Madhya Pradesh	Grain Long slender, Moderately resistant to Blast (2001-2002)
KHP 5	Direct-sowing situation of hill zone of Karnataka	Grain Medium bold, Moderately resistant to Blast (2001-2002)
Bhagdh dhan	Rajasthan	Long bold, 4-5 t/ha, maturity 90-100 days (1999-2000)
	Medium to low land	
Krishnahamsa	Jharkhand and Bihar	Grain Long slender, Resistant to Blast, cold (2001-2002)
Jawahar Rice 3-45	Madhya Pradesh, Uttar Pradesh, Chattisgarh and Orissa	(1997-98)
Shyamla	Madhya Pradesh, Chattisgarh	(1996 –97)
Pooja	Madhya Pradesh, Chattisgarh, Orissa	Medium bold, 4-5 t/ha, maturity 150-155 days, Gallmidge tolerant (1999-2000)
Mahanadi, Indravati, Prachi, Ramchandi	Orissa	Medium bold, 4.2-6 t/ha, maturity 150-155 days (1999-2000)
PMK 2, TPS 3, Poornima, CORH 1	Tamil Nadu	(1996-97)
Hemavati Durga	With temporary sub-mergence problem in hill zone of Karnataka	Grain Medium slender, Resistant to Blast (2001 – 2002)
	Deep water	
Neeraja	Uttar Pradesh (up to 1 m depth)	Grains long slender, maturity 180 days, tolerant to sheath blight, sheath rot and blast (1998-99)

Oilseeds

Following are the varieties/hybrids released in groundnut, rapeseed mustard, linseed, soybean, sunflower, castor and sesame crops.

Cultivar	Recommended region	Salient features (Year of release)
	Groundnut	
CSMG 884	Uttar Pradesh, Punjab Rajasthan	Semi-spreading Virginia, bold pods with prominent reticulation, moderately resistant to early leaf diseases and late leaf-spot (1998-99)
HNG 10	North-Western plains India	Semi-spreading Virginia, medium bold pods, tan seed-coat (1998-99)
LNG 2	Punjab, Uttar Pradesh, Rajasthan, Gujarat	Early maturing (1998-99)
LGN 2	Maharashtra	Yield 1.5-2.0 t/ha, Virginia bunch, tolerant to leaf diseases (2000-2001)
	Rapeseed Mustard	
VSL	Uttar Pradesh, Madhya Pradesh, Chattisgarh, Rajasthan	Early maturing than Varuna (1998-99)
RN 393	Punjab, Haryana, parts of Uttar Pradesh, Rajasthan	(1998-99)
Ragini (Yellow sarson)	Eastern Uttar Pradesh, Bihar and Jharkahand	1.6 t/ha, bold seed and high oil (2000-2001)
Pusa Agrani	Bihar, Orissa, Jharkahand	1.0 t/ha (2000-2001)
	Linseed	
LCK 9211	Punjab, Jammu and Kashmir	Resistant to rust and tolerant to powdery mildew (1998-99)
LCK 9313	Uttar Pradesh, Bihar, Jharkhand and Rajasthan	Resistant to powdery mildew, tolerant to rust and wilt (1998-99)
RL 993	-do-	Moderately resistant to *Alternaria* blight (1998-99)
Sheela (LCK 9211)	Punjab, Haryana and Jammu	Yield 1.4 t/ha, resistant to rust, wilt and moderately resistant to *Alternaria* blight and linseed budfly (2000-2001)
Shekhar (LCK)	Uttar Pradesh exluding Bundelkhand, Bihar, Jharkhand	0.9 t/ha, maturity 135-140 days, resistant to powdery mildew, rust and wilt. Oil content is 43% (2001-2002)
	Soybean	
Ahilya 1 (NRC 2)	Uttarnchal, Madhya Pradesh, Chattisgarh, Bundelkhand region of Uttar Pradesh, Rajasthan, Gujarat and northern Orissa	Determinate, good germinability, resistant to *Rhizoctonia*, pod blight, green mosaic virus, bacterial blight and tolerant to *Cercospora* leaf spot and anthracnose (1997-98)
Ahilya 2 (NRC 2)	Madhya Pradesh, Bundelkhand region of Uttar Pradesh, Rajasthan, Gujarat and northern Orissa	Determinate, resistant to bacterial pustules, *Myrothecium* leaf spot, bacterial blight, yellow mosaic virus, *Rhizoctania*, aerial blight and tolerant to defoliators, stem fly and girdle beetle (1997-98)

Cultivar	Recommended region	Salient features (Year of release)
Ahilya 3 (NRC 7)	Madhya Pradesh, Chattisgarh	Determinate, high oil content, resistant to pod-shattering, shows resistance to bacterial blight, green mosaic virus, bacterial pustules, phyllody, soybean mosaic, *Myrothecium* and *Cercospora* leaf spots and tolerance to stem fly, girdle beetle, green and grey semiloopers, leaf miner and defoliators (1997-98)
Pooja (MAUS 2)	Maharashtra	Semi-determinate, resistant to pod-shattering, resistant to green mosaic, bacterial pustules, rust and leaf spots and moderately resistant to leaf miner, stem fly and blue beetle (1997-98)
MACS 450	Andhra Pradesh, Karnataka, Tamil Nadu, parts of Maharashtra	Resistant to yellow mosaic virus and tolerant to stem-fly and defoliators (1998-99)
	Sunflower	
LS 11	Maharashtra, Andhra Pradesh	Early maturing (1998-1999)
	Castor	
DCH 177 (Hybrid)	Andhra Pradesh, Tamil Nadu, Karnataka, Rajasthan	High-yielding, resistant to wilt (1998-99)
DCH 177	Andhra Pradesh, Tamil Nadu	1.5 t/ha, resistant to wilt (2000-2001)
PCH 1	Andhra Pradesh	1.6-1.9 t/ha, early, dwarf (2000-2001)
	Sesame	
TKG 55	Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, Jharkhand	Resistant to *Phytophthora* blight (1998-99)

Pulses

Following are the varieties/hybrids released for pigeonpea, chickpea, greengram, clusterbean, horsegram, lobia and mothbean.

Cultivar	Recommended region	Salient features
	Pigeonpea	
AKPH 2022 (Hybrid) Pigeonpea	Maharashtra (Vidarbha region)	First hybrid of medium duration (1998-1999)
AKT 8811	Maharashtra	Yield 1.1-1.3 t/ha, maturity 140-150 days, tolerant to Fusarium wilt (2001-2002)
Durga	Andhra Pradesh	1.8-2 t/ha, Extra early duration (1999-2000)
Laxmi (ICPL 85063)	-do-	Yield 1.8-2.0 t/ha, maturity 175-180 days, resistant to sterility mosaic disease and tolerant to wilt disease (2001-2002)
	Chickpea	
BGD 72	Uttar Pradesh, Madhya Pradesh, Chattisgarh	Bold-seeded, desi type, moderately resistant to wilt and root-rot (1998-1999)

Cultivar	Recommended region	Salient features
GCP 105	Eastern Uttar Pradesh, Bihar and Jharkhand	Desi resistant to wilt 1.8 t/ha (2000-2001)
WCG 10	Western Uttar Pradesh	Desi resistant to wilt 2.10 t/ha (2000-2001)
BG 1053	Haryana, Punjab, Rajasthan and Western Uttar Pradesh	Kabuli bold seeded 1.7 t/ha (2000-2001)
KAK 2	Madhya Pradesh, Gujarat, Maharashtra, Chattisgarh and parts of Uttar Pradesh	Kabuli extra bold seeded 1.7 t/ha (2000-2001)
SAKI 9516	-do-	Desi resistant to wilt 1.9 t/ha (2000-2001)
Gulak 1	Maharashtra	Gulabi, Chana, bold seeded tolerant to wilt 2.0 t/ha (2000-2001)
Kranti (ICC 37)	Andhra Pradesh	Desi short maturity 90-100 days, 1.6-2.0 t/ha (2000-2001)
	Greengram	
Pusa bold 1	Haryana, Punjab, Rajasthan and parts of Uttar Pradesh	Resistant to YMV, bold seed size, suitable for summer, 1.3-1.4 t/ha (2000-2001)
PBM 1	Punjab	*Kharif*, resistant to YMV, 1.00 t/ha (2000-2001)
RMG 344 (Dhanu)	Rajasthan	*Kharif*/ summer, 0.7-5.9 t/ha (2000-2001)
PKV 880 Mung	Maharashtra	*Kharif*, resistant to powdery mildew, 1.20 t/ha (2000-2001)
Pusa 9531	Uttar Pradesh, Madhya Pradesh, Chattisgarh	Resistant to yellow mosaic virus, suitable for summer (1998-1999)
	Clusterbean	
RGC 1003, HGS 563	Arid tracts of all India	0.7 t/ha, maturity 90-100 days, 29.7% gum (1999-2000)
HG 5563	Rainfed areas of Haryana, Rajasthan and Gujarat	Synchrony in maturity, high gum content (1998-1999)
	Horsegram	
AK 21	Arid tracts of all India	Semi-spreading with waxy coat on leaves, tolerant to yellow mosaic virus (1998-1999)
AK 21	-do-	0.9 t/ha, maturity 60 to 105 days, tolerance to anthrocnose, 22.5% protein (1999-2000)
PHG 9	-do-	0.9 t/ha, maturity 100-105 days, light seeded, 21.5% protein and less spreading (1999-2000)
	Lobia	
V 585	Arid tracts of all India	0.86 t/ha, maturity 90-100 days, tolerance to lodging, long wide bold (1999-2000)
GC 3		1 t/ha, maturity 65-70 days, early maturity, wide seeded, 21% protein (1999-2000)
	Mothbean	
RMO 257	Arid lands of all India	0.6 t/ha, maturity 62-65 days, many part spreading and high fodder quantity (1999-2000)

Cotton

Following are the varieties/hybrids of cotton released for rainfed areas.

Cultivar	Recommended region	Salient features (Year of release)
AAH 1	Rajasthan	Intra-arboreum hybrid. First genetic male sterility based desi hybrid (1998-99)
AKA 7	Vidarbha region of Maharashtra	Arboreum. Medium staple (1998-99)
G.Cot 19	Mathio cotton area of Gujarat	Arboreum. Medium staple variety with resistance to bacterial blight, grey mildew and *Alternaria* leaf spot (1998-99)
G.Cot.18	Saurashtra region of Gujarat	Long staple, 2.5-3t/ha, maturity 160 days (1999-2000)
Jawahar Tapti	Madhya Pradesh, Chattisgarh	(1997-98)
JKHY 2	Madhya Pradesh, Chattisgarh	Intra hirsutum hybrid (1997-98)
WHH 09	Central Zone	Intra hirsutum hybrid (1997-98)
KC 2	Southern districts of Tami Nadu	Gossypium hirsutum (1997-98)
Sruthi	Coastal rice fallows tracts of South Zone	Interspecific hybrids (G. hirsutum x G.Arboreum) (1997-98)
K11	Southern Tamil Nadu	Gossypium arboreum (1997-98)
L 603	Andhra Pradesh	Gossypium hirsutum. Medium staple with resistance to jassids (1998-99)
L 604	Andhra Pradesh	Gossypium hirsutum. Medium staple with moderate resistance to jassids (1998-99)
LAHH 4	Andhra Pradesh	Intra hirsutum hybrid. Medium staple (1998-99)

Coarse cereals

Following are the varieties/hybrids released in *kharif*/*rabi* sorghum, pearlmillet,maize, fingermillet and other minor millets.

Cultivar	Recommended region	Salient features
	***Kharif* Sorghum**	
HC 6	All India	Foliar diseases tolerance (1995)
CSH-16	All India	Timely sown (1997-1998)
CSH 13	Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka, Uttar Pradesh, Rajasthan and Haryana	Timely sown (1997-1998)
MLSH 14	Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Rajasthan	Timely sown (1997-1998)
ICI 501	-do-	Medium to low rainfall (1997-1998)
JJ 938	Madhya Pradesh, Chattisgarh	Dual purpose (1995)
DSV 3	Karnataka (midge-endemic areas)	Midge resistant (1995)

Cultivar	Recommended region	Salient features
	***Rabi* Sorghum**	
Sel 3	Maharashtra (shallow soils),	Early and drought resistant 1 (1995)
CSH 15R	Maharashtra, south-eastern Karnataka, adjacent parts of Andhra Pradesh	Bold grain, shootfly tolerance and improved yield potential (1995)
CSH 15R	Northeast plain zone	Timely sown (1996-1997)
	Pearlmillet	
MLBH 285	Rajasthan, Haryana, Gujarat, Uttar Pradesh, Madhya Pradesh, Chattisgarh, Delhi and Punjab	Medium maturity 80-85 days, downy mildew resistant, bold seeded (1997-1998)
JKBH 26	-do-	Medium maturity 80-85 days, downy mildew resistant (1997-1998)
PB 106	All India	Yield 2.8 t/ha, maturity 77-79 days, resistant to downy mildew and smut (2000-2001)
RHB 121	Rajasthan, Haryana, Punjab, Gujarat, Uttar Pradesh, Madhya Pradesh, Chattisgarh and Delhi	Yield 2.73 t/ha, maturity 75-78 days, suitable for rainfed areas, presence of bristles (2001-2002)
Pusa Composite 383	-do-	Yield 2.17 t/ha, maturity 76-78 days, suitable for rainfed/areas (2001-2002)
GHB 316	Rajasthan, Haryana, Gujarat, Madhya Pradesh, Uttar Pradesh, Chattisgarh, Punjab and Delhi	Medium maturity and downy mildew resistant (1997-1998)
7685 (MH 643, XM 631)	-do-	Medium maturity and downy mildew resistant (1997-1998)
7688	Rajasthan, Haryana, Gujarat, Uttar Pradesh, Madhya Pradesh and Chattisgarh	Yield 2.5 t/ha, maturity 78-80 days, resistant to downy mildew (2000-2001)
MP 363	-do-	Yield 2.5 t/ha, medium maturing, resistant to downy mildew (2000-2001)
RHRBH 8924 (Saburi)	Maharashtra	Early maturity, bold seeded, downy mildew resistant (1997-1998)
RHB 90	Rajasthan	Yield 2.2 t/ha, drought tolerant, maturity 75-78 days (2000-2001)
HHB 94	Haryana	Yield 3.0 t/ha, medium early maturity, synchronous tillering and maturity (2000-2001)
HC 10	-do-	Yield 2.1 t/ha, maturity 75-80 days, dual purpose, resistant to downy mildew (2000-2001)
Nandi 30	Maharashtra, Andhra Pradesh	Medium maturity, downy mildew resistant (1997-1998)
X 7	Tamil Nadu	Late maturing, high tillering, downy mildew resistant (1997-1998)

Cultivar	Recommended region	Salient features
PAC 303 (ICI 903, MH 552)	Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka	Medium maturity, drought and downy-mildew resistant (1997-1998)
GK 1004 (MH 662)	-do-	Medium maturity, drought and downy-mildew resistant (1997-1998)
Nandi 35	-do-	Yield 3.01 t/ha, maturity 80-83 days, suitable for both rainfed and irrigated areas
	Maize	
Pusa Early Hybrid Makka 1	Rajasthan, Madhya Pradesh, Chattisgarh, Gujarat, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu	Early maturity (1997-1998)
Pusa Early Hybrid Makka 2	-do-	Early maturity (1997-1998)
Him 129	Rajasthan, Gujarat, Madhya Pradesh, Chattisgarh, eastern Uttar Pradesh, Bihar, Jharkhand, Orissa, Maharashtra, Kerala, Andhra Pradesh and Tamil Nadu	Early maturity (1997-1998)
PRO 311	Across the country, excepting Himalayan region	Maturity full season (1997-1998)
MMH 69	Punjab, Haryana, Uttar Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu	Medium maturity (1997-1998)
KH 9451	-do-	Medium Maturity (1997-1998)
Prakash (JH 3189)	Across the country	Early, orange-yellow (1998-1999)
Amar (D 941) composite	Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Rajasthan, Madhya Pradesh, Gujarat, Chattisgarh	(2000-2001)
Composite Gaurav	Central and west Uttar Pradesh, Haryana and Punjab	(1999-2000)
Aravali Makka 1	Punjab, Haryana, Delhi, western Uttar Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Chattisgarh	(2000-2001)
D 931 (composite)	Central and western Uttar Pradesh, Delhi, Haryana, Punjab	Early, orange-yellow (1998-1999)
FH 3049	Rajasthan, Madhya Pradesh, Chattisgarh, Gujarat	Extra early, orange-yellow (1998-1999)
Vivek Hybrid 4	-do-	Orange, Yellow, 3-4.5 t/ha, maturity 75-80 days (1999-2000)
KHMH 175	Rajasthan, Gujarat, Madhya Pradesh, Chattisgarh for *kharif* season	(2000-2001)

Cultivar	Recommended region	Salient features
JK 2492	Andhra Pradesh, Karnataka and Maharashtra	Early Maturity (1997-1998)
JH 3459	-do-	(2000-2001)
Pusa Early Hybrid Makka 3 (AH 58)	Andhra Pradesh, Maharashtra, Karnataka, and Tamil Nadu	(2000-2001)
Vivek Maize Hybrid 9	-do-	(2000-2001)
Kohinoor	Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, Rajasthan, Gujarat, Madhya Pradesh, Chattisgarh	(2000-2001)
	Fingermillet	
Fingermillet RR 230 (Maruthi)	Andhra Pradesh	2.5-3.0 t/ha, maturity 90-100 days (2000-2001)
Fingermillet BM 9-1 (Bhairabi)	Karnataka, Andhra Pradesh, Maharashtra	3.0-3.5 t/ha, maturity 103-105 days, moderately resistant to blast and brown spot (2000-2001)
Chilka	Orissa, Madhya Pradesh, Gujarat, Andhra Pradesh, Chattisgarh	Yield 2.5-30 t/ha, maturity 105-115 days, it is moderately resistant to finger and neck blast and is suitable for early sowing (2001-2002)
GPU 45	Tamil Nadu, Gujarat, Karnataka, Madhya Pradesh, Jharkhand, Maharashtra, Chattisgarh	Yield 2.7-2.9 t/ha, maturity 104-109 days, it is suitable for normal and late planting (2001-2002)
GPU 26	Karnataka	Yield 3.0-4.0 t/ha, maturity 95-100 days, it is moderately resistant to finger and neck blast and is suitable for late sown conditions (2001-2002)
	Foxtail millet	
SR 16 (Meera)	Rajasthan	Yield 1.5-1.7 t/ha, maturity 75 days, it is suitable for sub marginal, undulating and sloppy lands. It has superior stover quality and has stay-green character at maturity (2001-2002)
	Proso millet	
GPUP 8 (DHPM 1)	Karnataka	Yield 2.5-2.8 t/ha, maturity 85 days, it is suitable for double cropping and is resistant to brown spot (2001-2002)
	Little millet	
KOLAB Paiyur 2	Madhya Pradesh, Orissa, Chattisgarh, Bihar, Karnataka, Gujarat, Jharkhand	Yield 1.5-1.7 t/ha, maturity 75 days, it is suitable for early and late planting (2001-2002)
Paiyur 2	Tamil Nadu	Yield 0.7-0.8 t/ha, maturity 80-85 days, it shows field tolerance to grain smut and is adapted to poor fertility soils (2001-2002)

Cultivar	Recommended region	Salient features
Tarini	Karnataka, Andhra Pradesh, Orissa, Bihar, Jharkhand, Tamil Nadu	1.2-1.5 t/ha, maturity 100-105 days (2000-2001)
	Kodo millet	
Jawahar Kodo 48	Andhra Pradesh, Karnataka, Chattisgarh, Gujarat, Madhya Pradesh	Yield 2.0-2.5 t/ha, maturity 90-98 days, it is suitable for timely sowing (2001-2002)
Jawahar Kodo 155	Karnataka	2.1-2.2 t/ha, maturity 90-100 days (2000-2001)
	Barnyard millet	
VL Madira 181	Bihar, Karnataka, Madhya Pradesh, Tamil Nadu, Chattisgarh, Jharkhand	Yield 1.5-1.8 t/ha, maturity 80-90 days, it is moderately resistant to grain smut (2001-2002)
VL 172	Uttar Pradesh, Gujarat, Karnataka	2.1-2.3 t/ha, maturity 90-95 days, tolerance to grain smut (2000-2001)

Forage crops

Following are cultivars released in sorghum, pearlmillet, maize, cowpea, clusterbean, shaftal, ghobi sarson, teosinte, and dinanath grass for rainfed region.

Cultivar	Recommended region	Salient features (Year of release)
	Sorghum	
HC 308	All India	Resistant to leaf diseases and tolerant to major insects pests. Yields 40-55 t/ha of green forage/ha in a single cut (1996-1997)
CSH 13R	All India	Primarily released for *rabi* but promising for *kharif* also as a dual-purpose. It is a tall hybrid, fairly resistant to foliar diseases and yielded 50-55 t/ha of forage and 1.8-2.5 t/ha of grains (1996-1997)
SPV 946 (CSV 15)	All India	Dual-purpose, tall variety, yielding 3.0 to 3.6 t/ha of grains and 110-120 t/ha of dry forage (1996-1997)
Pusa chari Hybrid 106 (PCH 106)	Entire fodder sorghum-growing areas	10-12% higher forage yield 3-4 cuts. It is resistant to leaf diseases (1997-1998)
Pant Chari 4 (UPFS 23)	Uttar Pradesh	It is a good single-cut variety, yielding 30-40 t/ha of green forage (1997-1998)
GJ 40	Gujarat	It is a good dual-purpose variety, gives 3 t/ha of grainha and 7-8 t/ha of dry forage (1997 – 1998)
FS 92079	Uttar Pradesh	Multicut hybrid with high yield (1998-1999)
	Pearl millet	
Pro-agro No.1	All India	This is the first fodder pearlmillet hybrid and also the first multicut fodder pearlmillet; gives 10-15% more yield (1997-1998)

Cultivar	Recommended region	Salient features (Year of release)
Co 3 (Napier pearlmillet hybrid)	Tamil Nadu	It shows high leaf-stem ratio with good herbage quality, free from diseases, gives 130-170 t/ha/yr of green forage in 8-9 cuts (1997-1998)
FMH 3	Uttar Pradesh	Multicut forage hybrid having high forage productivity and resistance to downy mildew (1998-1999)
DRSB 2	Rajasthan, Gujarat	High forage yield, responsive to agronomical inputs (1998-1999)
	Maize	
J 1006	Punjab	Yields 35-45 t/ha of green forage, and is resistant to maydis blight and brown strip and downy-mildew disease (1996-1997)
APFM 8	Andhra Pradesh	It yields at a par with the best check African Tall, with added advantage of earliness by 10-12 days. It is yellow seeded, and is much better in seed viability than white-seeded types as is African Tall (1997-1998)
	Cowpea	
UPC 8705	All India	Resistant to root-rot and collar-rot, yield 30-42 t/ha of green forage in 60 days (1996-1997)
Haryana Lobia 88 (CS 88)	Haryana	It is erect, suitable for intercropping with sorghum, pearlmillet and maize and is resistant to yellow mosaic virus and yields 30 t/ha of green forage (1997-1998)
UPC 9202	Uttar Pradesh	It gives 10% higher yield than check Nundel Lobia 1 in the Central Zone, and is fairly resistant to root and collar rot (1997-1998)
Konkan (DFC 1)	Maharashtra	It is most sutiable for high rainfall areas of Maharashtra; gives 30 tonnes of green forage/ha. This is fairly resistant to root rot (1997-1998)
UPC 9202	Uttar Pradesh	Suitable for Central Zone of the country, shows 10% higher forage productivity and crude protein than check (1998-1999)
	Clusterbean	
IGFRI 2395 2	Uttar Pradesh (Bundelgurar 2)	Resistant to *Xanthomonas* and *Alternaria*, and its green forage yield is 25-45 t/ha (1996-1997)
Guara 80	Punjab	Moderately resistant to bacterial leaf blight, and yields 35-40 t/ha (1996-1997)
IGFRI 1091-1	Uttar Pradesh	It gives 15% higher yield than check HFG 119, gives higher seed yield and is resistant to bacterial wilt (1997-1998)

Cultivar	Recommended region	Salient features (Year of release)
Bundel Guar 3	Arid, semi-arid zones (relatively drier areas with low to medium rainfall)	Fodder 50-55 days, green fodder 26.2-30.0 t/ha, dry matter 5.9-6.0 t/ha, seed 125-135 days, seed yield 0.8-1.0 t/ha, fodder-cum-grain type, resistant to lodging, free from pod shattering, highly responsive to fertilizers, moderately tolerant to drought, bacterial blight, and powdery mildew (2000-2001)
	Shaftal	
SH 69	Punjab	Almost free from major diseases and pests, is suitable for high rainfall areas, acid soil, hilly sub-temperate areas. It yields 80-105 t/ha of green forage (1996-1997)
	Gobhi sarson	
GSL 1	Punjab	Primarily released as grain material but is also suitable for fodder (20-35 t/ha of green forage/ha) and is comparatively free from foliar diseases (1996-1997)
	Teosinte	
TL 1	Punjab	Yields 38-50 t/ha of green forage/ha, and is tolerant to major diseases and pests (1996-1997)
	Dinanath grass	
Coimbatore Dinanath 1 (TNDN 1)	Tamil Nadu	It is suitable for 1-2 cuts and yields about 40-60 t/ha of green forage, and is also suitable for wastelands and degraded forest area (1997-1998)

Annexure II

Basic Concepts and Practices

In addition to the region-specific recommendations made in this bulletin, some basic concepts and practices are of universal application for raising crops on the drylands. These are :

i. Conserve the basic resources of soil and water;

ii. Make the best use of the conserved resources for crop production;

iii. Evolve contingency plans to meet seasonal aberrations.

A. Soil and Water Management

1. **Soil and water conservation:** Prevention of soil erosion and retention of more rain water where it falls are utmost importance in dryland agriculture. Basic practices of soil and water conservation like graded bunds, land leveling and /or smoothening must be adopted.
2. **Management of deep black soils:** In the low rainfall region (Deccan), advancing sowing date and choice of short duration crops are important to mature *rabi* crops by mid January.
3. **Management of red soils:** Soil crusting is a serious problem in these soils leading to considerable runoff. Off-season tillage should be taken up to work the soil with a blade harrow to keep the soils open for increasing infiltration and reducing run-off.
4. **Management of sloppy lands:** In Bhubaneswar and Chotanagar regions toposequences are common with gravelly skeletal soils at the highest level of topography followed by loamy sand and sandy loams at intermediate level and sandy clays at the lowest element. The crop choice should vary with toposequence. Crops with low water requirement (sorghum and fingermillet) alone can grow well in higher elements of topography while rice will be the successful crop at the lowest regions. In between, crops like maize will be suitable.
5. **Soil amendments:** In the lateritic red soils of Bangalore, Bhubaneswar and Ranchi, 2-4 quintal/ha of lime need be added for neutralizing exchange acidity. Further, in those soils, the phosphatic fertilizers, when used, need be band placed. In these soils gypsum application @ 4 –5 quintal/ha would be beneficial for increasing yields of groundnut.

B. Crop Management

1. **Seed :** Good quality seed and choice of suitable varieties is essential for obtaining higher yields. Uniform seed size is also important, particularly for bold seeded crops like groundnut. Certified seed from recognized agencies alone need be used for obtaining good plant stands. For a given area (village) it is necessary to use one kind of seed (hybrid or variety) of a crop to reduce bird damage, incidence of pests and diseases and also to preserve purity of cross pollinated crops like redgram and castor.
2. **Sowing time:** Early sowing of *kharif* crops is important to obtain vigorous seedlings, avoid incidence of pests and diseases like shootfly on sorghum and downy mildew /ergot on pearlmillet and to vacate land early for a second crop in regions like Indore and Akola. This can be achieved by preparing seed bed during the off- season, widening of row distances but maintaining full population and by resorting to dry seeding in some areas where rains can be expected with some certainty (cotton in Indore; rice in Ranchi and pearlmillet in Hisar).
3. **Population:** The new high yielding varieties of crops, as also the hybrids, yield better with higher population levels than local varieties. To obtain good plant stands, higher seed rate, quality seed and method of seeding become important. Normally seed drills give better stands.

4. **Fertilizer use:** The two main constraints in crop production in drylands are the moisture and nutrient supply. Fertilizer use at low to medium level pays in these lands. Fertilizer use pays best when other inputs are also well managed. Perse its efficiency can be enhanced by deep drilling. While phosphates need be basally applied, nitrogen should be applied in 2-3 splits in *kharif*. However, in *rabi* it has also to be deep placed along with phosphates.
5. **Weed control:** The importance of weeding cannot be over emphasized. Timely weed control is important for *kharif* crops. By 3-4 weeks the first weeding by whatever means possible manually, culturally or chemically must be attempted. Year-round tillage minimizes weed population. Widening the inter-row distance helps in quicker and timely weeding by interculture using bullock drawn blade harrows or sweeps.

Explanatory Notes

The practices recommended for different regions in this bulletin are not exhaustive. They mention only what has been recently found to beneficial for increasing and stabilizing dryland crop yields. More information is assumed to be available from the Department of Agriculture, State Agricultural Universities, Private sector, etc., for respective areas. This information should be used wherever available.

1. **Varieties** : Varieties or hybrids of crops listed in this bulletin are not necessarily those released by the concerned Department of Agriculture. The hybrids and varieties enlisted are those which have consistently performed well at the respective locations.
2. **Fertilizers:** in some cases fertilizer use has been recommended only for a few crops. For other crops the recommendations of the Department of Agriculture/Agricultural University hold good.
3. **Weeding :** Specific recommendations have been made for only a few crops. These are based on recent findings of research at respective centers. For all crops weeds have to be effectively controlled using one method or the other. Hand weeding and intercultural of crops should not slow down only because some chemical herbicide has been recommended for a particular crop.
4. **Crop sequence:** Some of the crop sequences are only of contingent nature depending on weather conditions. In areas of low rainfall with deep retentive soils two crops are feasible if the monsoon rains continue beyond the normal data of withdrawal. In other seasons only one crop a year is possible, wither a *kharif* crop or a *rabi* crop, with soil moisture conserved from the preceding rains.
5. **Water harvesting:** Water should be harvested in farm ponds wherever there is runoff. Asphalt coating of the sides and bottom of ponds has been found effective in reducing seepage losses and storing water for 30-45 days.

Annexure III

Some Popular and Botanical Names

Arhar (Redgram, Tur, Pigeonpea)	*Cajanus cajan* (L.) Millsp.
Bajra (Pearlmillet)	*Pennisetum americanum* (L.) Leeke
Barley	*Hordeum vulgare* L.
Bengalgram (Gram, Chickpea)	*Cicer arietinum* L.
Blackgram (Urd, Mash)	*Vigna mungo* (L.) Hepper
Blue panic	*Panicum antidotale*
Castor	*Ricinus communis* L.
Chilli (Chillies)	*Capsicum frustescens* L.
Clusterbean (Guar)	*Cyamopsis tetragonolobus* (L.) Taub
Coriander	*Coriandrum sativum* L.
Cowpea	*Vigna unguiculata* (L.) Walp
Fingermillet (Ragi)	*Eleusine coracana* (L.) Gaertn
Foxtail millet (Setaria, Italian millet)	*Setaria italica* Beauv
Gingelly (Sesamum, Sesame, Til)	*Sesamum indicum* L.
	Sesamum orientale L.
Gram (Bengalgram, Chickpea)	*Cicer arietinum* L.
Greengram (Moong)	*Vigna radiata* (L.) Wilczek
Groundnut (Peanut)	*Arachis hypogea* L.
Guar (Cluster bean)	*Cyamopsis tetragonolobus* (L.) Tabu
Horsegram	*Macrotyloma uniflorum* (Lam.) Verdc
Hybrid Napier	*(Pennisetum purpureum x P. typhoides)* F1
Indian bean (Lablab)	*Lablab purpureus* (L) Sweet
Indian rape (Toria)	*Brassica campestris* L.
Indian squash melon (Tinda)	*Citrulus fistulosus*
Italian millet (Foxtail millet, Setaria)	*Setaria italica* Beauv
Jowar (Sorghum)	*Sorghum bicolor* (L.) Moench
Jute	*Corchorus capsularis* L.
Kabuli gram	*Cicer arietinum* L.
Lentil (Masoor)	*Lens culinaris* Medic
Maize	*Zea mays* L.
Mash	Vigna mango
Mesta (Rozella)	*Hibiscus Sabdariffa* L.
Moth (dew gram)	*Vigna aconitifolia* (Jacq.) Marechal
Mustard (Raya)	*Brassica juncea* Coss.
Napier Grass	*Pennisetum purpureum*
Niger	*Guizotia abyssinica* (L.f.) Cass
Paddy (Rice)	*Oryza sativa* L.

Peanut (Groundnut)	*Arachis hypogaea* L.
Pearlmillet (Bajra)	*Pennisetum americanum* (L.) Leeke
Peas	*Pisum Sativum* L.
Pigeonpea (Arhar, Redgram, Tur)	*Cajanus cajan* (L.) Millsp.
Potato	*Solanum tuberosum* L.
Proso millet	*Panicum miliaceum* L.
Ragi (Fingermillet)	*Eleusine coracane* (L.) Gaertn
Rapeseed (Sarson)	*Brasica campestris* L. var. Sarson Prain
Raya (Mustard)	*Brassica juncea* (L.) Czern. & Coss
Redgram (Pigeonpea, Arhar, Tur)	*Cajanus cajan* (L.) Millsp
Rice (Paddy)	*Oryza sativa* L.
Rozella (Mesta)	*Hibiscus sabdariffa* L.
Safflower	*Carthamus tinctorius* L.
Sarson (Rapeseed)	*Brassica campestris* L. var. Sarson Prain
Sesame (Sesamum, Gingelly, Til)	*Sesamum indicum* L.
Setaria (Foxtail millet, Italian millet)	*Setaria italica* Beauv
Siratro	*Macroptilium purpureum* L.
Sorghum	*Sorghum bicolor* (L.) Moench
Soyabean or Soybean	*Glycine max* (L.) Merr
Sunflower	*Helianthus annuus* L.
Sweet Potato	*Ipomea batatas* (L.) Lam
Taramira (Rocket salad)	*Eruca sativa* Mill
Til (Gingelly, Sesamum, Sesame)	*Sesamum indicum* L. *Sesamum orientale* L.
Tinda (Indian Squash Melon)	*Citrulus fistulosus*
Tobacco	*Nicotiana tabacum* L.
Toria (Indian rape)	*Brassica campestris* var toria Duthie & Fuller
Tur (Redgram, Pigeonpea, Arhar)	*Cajanus cajan* (L.) Millsp.
Triticale	*Triticale officinale*
Urd (Blackgram)	*Vigna mungo* (L.) Hepper
Ber	*Zizyphus sp.*
Guava	*Psidium guajava*
Mango	*Mangifera indica*
Neem	*Azadirachta indica*
Amla (Aonla)	*Emblica offcinalis*
Citrus	*Citrus limon*
Cassia	*Cassia siamea*
Leucaena (Leucaena)	*Leucaena lecocephala*
Glyricidia (Gliricidia)	*Glyricidia sp.*
Karingado (Water melon)	*Citrullus vulgaris*

Annexure IV

Acronyms

a.i.	-	active ingredient
cc	-	cubic centimeter
cm	-	centimeter
DAG	-	days after germination
DAP	-	days after planting
DAS	-	days after sowing
D	-	dust
EC	-	emulsfiable concentrate
ETL	-	economic threshold level
FYM	-	farm yard manure
g	-	grams
G	-	granules
ha	-	hectare
HNVP	-	*Heliothis* Nuclear Virus Production
K_2O	-	pottasium
Kg	-	kilogram
LE	-	larval equivalent
l	-	litre
ml	-	millilitre
m	-	metre
N	-	nitrogen
O.C	-	organic carbon
P_2O_5	-	phosphate
ppm	-	parts per million
SP	-	soluble powder
SP	-	soluble powder
S	-	sulphur
t	-	tonnes
WP	-	wettable powder
WS	-	wettable sulphur
YMV	-	yellow mosaic virus

Annexure V

Some Generic & Brand Names of Insecticides

ALDICARB: Temic 10G (Rhone Poulenc)

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

CARBOFURAN 3G, 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 20EC, 10G, 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 Incesticides), Tagban 20 EC (Tropical Agro), Cyphos (ICI-Zenica), Tarkash (BASF), Force (NFCL), Pyrivol (Voltas), Hexaban (Parry Chemicals), Agro-Chlore (Gujarat Agro), Chlorguard (Gharda), Tafaban (Rallis), Strike (Wockhardt), Robust (Sabero)

CYPERMETHRIN 10EC: Ralothrin (Rallis), Ankush (BASF), Simper (ICI-Zeneca), Hi-Power (Sulphur Mills), Spec Cyperin (Southern Pesticides), Hycyper (Hyderbad Chemicals), Cyper Top (Thakar Chemicals), Lacer (Searle India), Agro-Cyper (Gujarat Agro), Jawa (Dupont), Cypercin (IOCL), Super Killer (Dhanuka), Cypermil (Montari), Polytrin (Novartis), Cyproid (AIMCO), Challanger (Tripical 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), Cypercin (IOCL), Challanger (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 20EC, 10% Gr: Basudin (Novartis), Tik-20 (Rallis)

DICHLOROVOS 76EC: 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 35EC & 4% D, 2% D: Thiodan (Agro Evo), Endocel (Excel), Endosul (Sulphur Mills), Endostar (Shaw Wallance), Dawn (Southern Pesticides), Hysulfan (Hyderabad Chemicals), Top Sulfan (Thakar Chemicals), Endocin (IOCL), Parry Sulfan (E.I.D. Parry), Endodhan (Dhanuka), Endonil (Montari), Endosol (AIMCO), Thiokill (United Phosphorous), Lusulfan (Lupin), Agro Sulfan (Gujarat Agro), Hildan (Hindustan Insecticides), Tagsulfan (Tropical Agro), Hexasulfan (Parry Chemicals), Endotaf (Rallis), Speed (NFCL), Devigor (Devi Dayal)

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

FENVALERATE 20EC 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), Agrofen (Gujarat Agro), Bhaskarfen (Bhaskar Agro), Newfen (Gharda), Fenkem (New Chemi), Anchor (ICI-Zeneca), Fenny (NFCL), Viper (SPEC), Milfen (Montari), Tatafen (Rallis), Fennock 20 (De'Nocil), Bhasma (Wockhardt)

FIPRONIL 0.3% Gr, 5% SC: Regent (Rhoune – Poulnec), Tempo (Agr Evo)

FORMOTHION 25%: Anthio (Novartis)

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

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

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

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

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

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

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

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

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

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

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

THIODICARB 75% WP: Larvin (Rhoune-Poulnec)

II. 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 (Agro 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 (Navartis)

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

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

III. HERBICIDES/ WEEDICIDES

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

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

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

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

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

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

FLUCHLORALIN 45%: Basalin (BASF)

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

METALACHLOR 50% EC: Duel (Novartis)

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

OXADIAZON 25% EC: Ronstar (Rhone-Poulnec)

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).

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