Decadal Research Achievements in Dryland Farming for Marathwada Region

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A.K. Gore, M.S. Pendke, G.K. Gaikwad

All India Coordinated Research Project for Dryland Agriculture
VNMKV, Parbhani
&
ICAR-Central Research Institute for Dryland Agriculture,
Hyderabad

VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH
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FOREWORD

Indian agriculture is dominated by rainfed farming which forms 60 per cent of the cultivated area. Rainfed agriculture is highly influenced by weather aberretations. Unfavourable weather condition like delayed monsoon, intermittent dryspells, extreme events impact crop production and farmers livelihoods. Timely onset and uniform distribution of rainfall are critical for achieving optimum crop yields by farmers, particularly during *kharif* season along with other factors like input, labour and technology. Therefore location specific technologies are essential to attain sustainability in rainfed agriculture.

Marathwada region comprises eight districts viz. Aurangabad, Jalna, Parbhani, Nanded, Hingoli, Latur, Osmanabad and Beed with cultivated area of 5.6 M ha which is traditionally a drought prone. Between 1961-2014, the region experienced 1 severe, 6 moderate and 25 mild droughts. Continuous droughts during 2014 and 2015 have caused severe distress among farmers.

All India Coordinated Research Project for Dryland Agriculture was initiated in the year 2005 at Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani for finding solutions to make rainfed farming more viable and sustainable for small and marginal farmers. In the last decade, many technologies were recommended for rainfed farming by this centre. A technical document comprising research achievements and technologies for Marathwada region has been brought out by the scientist's of the All India Coordinated Research Project for Dryland Agriculture, Parbhani. I am sure that this publication will be useful to all agricultural officials of the state, progressive farmers and policy makers to promote rainfed farming in the region

I compliment Dr. B.V. Asewar and his team for bringing out this publication.

B. Venkateswarlu

B. Venkateswarlu

Dr. D.P. Waskar
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MESSAGE

Changing and increasingly variable climate is among the major challenges to ensure food and livelihood security of increasing population. The agriculture sector is bestowed with number of challenges. About more than 85 per cent of the cultivated area in Marathwada region of Maharashtra state is under dryland agriculture. Drylandarea need to play crucial role in meeting the challenges of future food and water demand. Accordingly, the productivity of dryland agriculture need to be increased. Improving productivity and profitability of dryland crops require adoption of combination of technologies in sequel at different stages of crop growth to harness the synergies.

By reviewing the issues of rainfed farming of the Marathwada region, the research work was conducted through AICRPDA on many aspects such as, rainwater management, crops and cropping systems, nutrient and energy management, alternate land use, soil & water conservation, crop improvement etc. and many location specific technologies were evolved during last decade to make rainfed agriculture of this region more sustainable.

This document is an outcome of the dedicated efforts of the scientists of AICRPDA, VNMKV, Parbhani in the multidisciplinary research work conducted under rainfed farming to solve the practical problems of small and marginal farmers of the region. I am sure this technical document will be useful to all extension officials of the state Department of agriculture, extension officials, KVK Incharge for guiding the rainfed farmers of the region to enhance the water and food productivity. I compliment Dr. B.V. Asewar and his team for bringing out this valuable publication.

D.P. Waskar

PREFACE

Rainfed systems are characterized by low and unstable crop yields, vulnerable to erratic rainfall, occurrence of frequent droughts, declining of natural resources etc. Marathwada region of Maharashtra state is broadly classified in to three agro-climatic zones i.e. high rainfall zone, assured rainfall zone and rain scarcity & shadow zone (low rainfall zone). The productivity of the rainfed / dryland agriculture of the region is unstable due to weather aberrations. Thus to suggest the location specific dryland technologies, All India Coordinated Research project for Dryland Agriculture at VNMKV, Parbhani was launched in the year 2005 to cater the needs of the small and marginal rainfed farmers of the region.

Since last decade, the multidisciplinary research work was conducted at this centre and evolved various technologies such as rain water harvesting and its recycling through farm pond for improving the productivity, well recharging, *insitu* moisture conservation technologies, stress management practices, crop and cropping systems, tillage practices, energy & nutrient management, alternate land use and integrated farming system approach. Combination of these one or more technologies will be helpful to sustain and stable the water and crop productivity under dryland condition. Various technologies such as reducing evaporation losses from farm pond, mechanization, strip cropping, sub-soiling and soil health improvement are in pipeline.

We profusely thank to Dr.B.Venkateswarlu, Hon. Vice chancellor and Dr. D. P. waskar, Director of Research, VNMKV, Parbhani for their keen interest, guidance and support in conducting the research work. We sincerely acknowledge the support and encouragement received from Director, CRIDA and Dr. G. Ravindra Chary, Project Co-ordinator, AICRPDA, CRIDA, Hyderabad. We place on record our sincere thanks to all supporting staff of this research centre for conducting various research experiment and collection of data base.

The bulletin entitled," Decadal Research Achievement in Dryland Farming for Marathwada Region" containing the zest of various dryland technologies will be very useful to extension officials, KVK officials and progressive farmers of the region in understanding the technologies which are suited to rainfed condition and cause for further upscaling.

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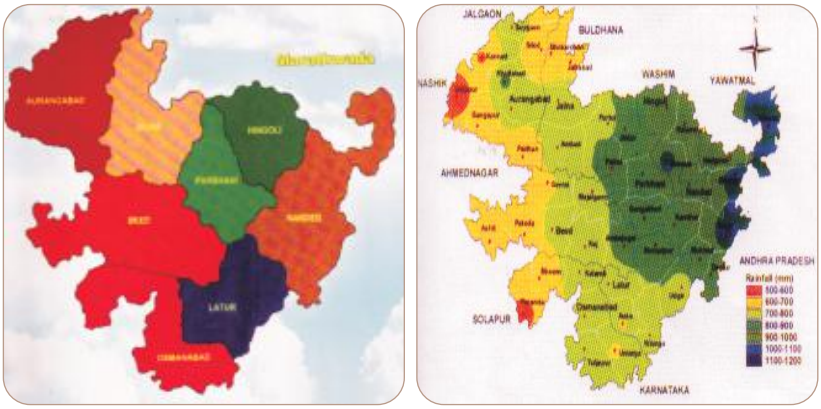
Preamble

Marathwada region is one of the four regions of Maharashtra state, comprising eight districts with cultivable area of 5.6 Mha and 85 per cent of cultivated land is rain dependent. South-west monsoon is the chief source of rainfall in the region, receiving about 90 percent of annual rainfall. The climate of Marathwada experiences wide inter districts and intra districts variability. Long dryspells which are fairly common during the months of monsoon, which affects on the production of crops. Extent of degraded land is also a matter of serious concern.

History of establishment of the centre

All India Co-ordinated Research Project for Dryland Agriculture has been commissioned at Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani since January, 2005. Indian Council of Agriculture Research (ICAR) New Delhi and Central Research Institute for Dryland Agriculture, (CRIDA) Hyderabad has identified this centre as one of the centre for implementation of a project on National Initiative on Climate Resilient Agriculture (NICRA) since February 2011. The centre is located at head quarter of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra). Geographically, it is located at 19°16' N latitude and 76°47' E Longitude at 409 m MSL.



Map of the centre for domain district – Marathwada Region

Mandate

1. Research on production technology for important dryland crop and cropping systems.
2. To evolve suitable alternate land use and farming system to match weather aberrations.
3. To develop suitable soil and water conservation technologies (both *insitu* and *exsitu*) water harvesting and recycling.
4. Development of optimum nutrient management technologies.
5. Screening of crop varieties for moisture stress and drought resistant.
6. To develop energy efficient technology.

Visioning and strategies

All India Co-ordinated Research Project for Dryland Agriculture was established at Parbhani centre of Marathwada region to cater the needs of the dryland farmers as 85 % area in under dryland cultivation. The research work conducted at this centre is as per the vision to increase the production level of dryland farmers, similarly to boost up the socio economic condition of the farmers.The major strategy of conducting the research is rainwater management and recycling, resource conservation, crops and cropping systems, alternate land use, integrated pest and diseases management, energy management and evaluation of drought tolerance varieties sustainable in climate change situation.The centre in concentrating to on-farm demonstration of various technologies for testing their feasibility on farmers field.

Centre emerged as focal point/ visibility in droughts and addressing local issue

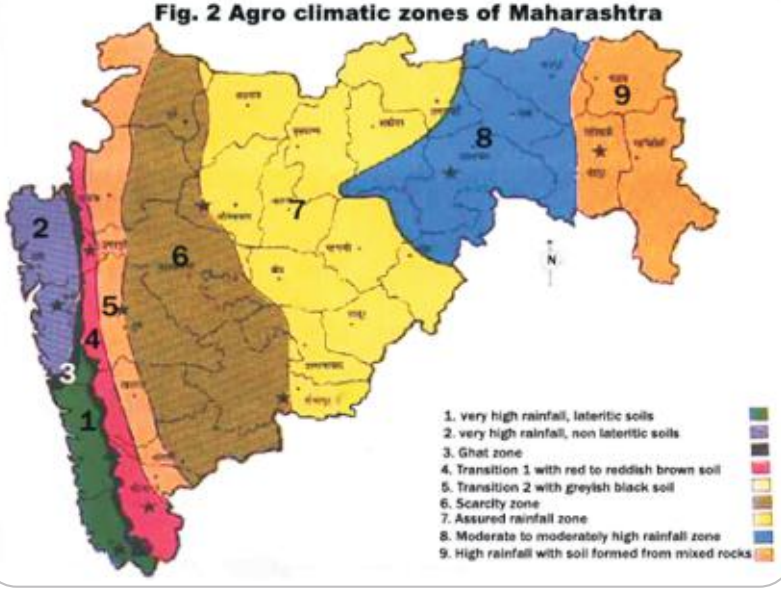
The centre is making all efforts to generate the technology suitable for dryland areas of the region.The research work is initiated to address the issue of climate change particularly the occurrence of frequent drought. Centre has given wide publicity through daily Newspapers, All India Radio (AIR), Television, interviews to mitigate the drought situation. Director of Research, MAU, Parbhani presented the strategy for drought situation to Agril. Minister of State.The guidance to

farmers through Rural Agricultural Work Experience (RAWE) programme was done to uplift the livelihood of the village where the programme was implemented.

Brief details of the Agro-climatic Zones

The region is broadly classified into three rainfall zones i.e. assured rainfall zone (700 -900 mm), moderately high rainfall zone (900-1100 mm) and scarcity zone (less than 700 mm).

Fig. 2 Agro climatic zones of Maharashtra



Particulars	Scarcity Zone	Assured Rainfall Zone	High rainfall zone)
Jurisdiction	Aurangabad (7 taluks) Beed (3 taluks) Osmanabad (4 taluks)	Aurangabad (3 taluks) jalna 3 taluks) Beed (4 taluks) osmanabad (3taluks) Latur (4) Parbhani (6) Nanded (4) Hingoli (2)	Hingoli (3taluks) Nanded (5 taluks)
Geographical location Latitude longitude	$74^0.40'$to $76^0.20'$ $19^0.40'$ to $20^0.40'$	$76^0.20'$to $77^0.30'$ $18^0.20'$ to $20^0.40'$	$77^0.30'$to $78^0.16'$ $18^0.20'$ to $19^0.40'$
Mean annual rainfall	500 to 700 mm	700-900 mm	900-1250 mm
Distribution of rainfall and soils	Bi-modal distribution of rain-June-Sept, monsoon and Oct-Dec, post monsoon Deep black (11%) Medium black (65%) Shallow/coarse textured (24%)	Bi-modal distribution of rain-June-Sept,monsoon & Oct-Dec, post monsoon Deep black (23%) Medium black (60%) Shallow/coarse textured (17%)	Bi-modal distribution of rain-June-Sept, monsoon and Oct-Dec, post monsoon Deep black (24%) Medium black (48%) Shallow/coarse textured (28%)
Major dry land crops	Field crops: Bajra, Maize, Cotton, Sunflower, Sorghum, Soybean, Pigeonpea,Greengram, Blackgram, Moth bean. Fruit crops: Mango, Citrus, Guava, tamarind, Anola, Custard apple and Papaya,Pomogranate Vegetables: Tomato, Potato, Brinjal. Beans, Leafy vegetables	Field crops: Cotton, Soybean, K. sorghum, pigeonpea, Greengram, Blackgram, Groundnut, Chick pea, safflower Fruit crops: Mango, Grapes, Guava, Citrus,Sapota,Anola,Custardapple, Vegetables: Tomato, Potato, Chilli, Bhendi, Brinjal. Beans, Leafy vegetables	Field crops: Cotton, Soybean, K. sorghum, pigeonpea, Greengram, Blackgram, Paddy, Chick pea, Safflower, R.sorghum. Fruit crops: Mango, Banana, Guava, Vegetables: Tomato, Potato, Brinjal, Beans, Leafy vegetables.

Climate

Marathwada region comes under assured rainfall zone. The monsoon commences from June and terminates by September end. Around 80 percent of annual rainfall is concentrated in these months. Marathwada region is one of the four regions of Maharashtra state, comprising eight districts with cultivable area of 5.6 Mha and 85 per cent of cultivated land is rain dependent. South-west monsoon is the chief source of rainfall in the region, receiving about 90 percent of annual rainfall. The region receives annual rainfall in the range of 500 to 1100 mm and comes under assured rainfall zone (60%), moderately high rainfall zone (20%) and scarcity zone (20%).

Soils in the domain

The soils in the region are deep black, medium black, coarse and shallow. The predominant soil in the region is vertisol (Black cotton soil) with low to medium in N and P_2O_5, generally rich in K_2O and low in organic carbon. The soils are characterized by black colour dominated by montmorillonate clay with high coefficient of expansion and shrinkage lead to deep cracking. The soils are formed from basaltic material. According to 7th approximation the soils are classified as TYPIC Haplusterts. Soil is fine, smectitic (calcareous), Iso-hperthermic TYPIC Haplusters. It is slightly alkaline in reaction, safe in soluble salt concentration and medium in organic carbon content and calcium carbonate content. Exchangeable Ca and Mg status were 27.30 and 16.30 cmolP^+ kg/ha. While the micronutrient status like zinc, iron, manganese and cuppor rated as low in Zn and Fe and high in Mn and Cu.

pH	:	8.2
Bulk density	:	1.29 g/cm^3
Field capacity	:	32 to 33 percent
AWC	:	110-125 mm/ 60 cm depth
Permanent wilting point	:	17 to 18 percent
Textural class	:	Clayey
Depth	:	70 cm to 100 cm
Nutrient status	:	Nitrogen and phosphorus low to medium, Potassium rich.

The soils of the region are predominantly black cotton soils. Out of this nearly 65 per cent fall under medium to deep heavy category. The details are as below

Soil Type	Percentage
Deep black cotton soils (90 cm and more deep)	65
Medium black cotton soils (20 to 90 cm deep)	
Light soils (20 cm and less deep)	35

The soil analysis report showed that near about 40 per cent soils were found deficient in zinc, 42 per cent soil were found deficient in iron, whereas 30-35 per cent soils in boron and 40 per cent in sulphur. The pH ranges in between 7 to 8.5, electrical conductivity 0.1 to 0.35 dsm^{-1}, organic carbon 0.3 to 0.7 per cent.

Crops and Cropping systems

Major *kharif* crops of the region are cotton, soybean, pigeonpea, greengram blackgram, sorghum and pearlmillet and whereas major *rabi* rainfed crops are *rabi* sorghum, safflower, chickpea and sunflower. The prominent cropping systems adopted in the region are, *kharif* sorghum+ pigeonpea, soybean + pigeonpea, pearlmillet+ pigeonpea, cotton+ pigeonpea and cotton+ greengram/ blackgram/ soybean, *rabi* sorghum + safflower. Latur district is dominating for sorghum + pigeonpea, Aurangabad and Beed for pearlmillet+ pigeonpea whereas Parbhani, Nanded, Hingoli and Jalna districts are dominating for soybean + pigeonpea, cotton + pigeonpea intercropping /strip cropping system.

Major rainfed crops and cropping/farming systems (area '000' ha)

Districts	Net Cultivated Area	Net rainfed area	% Net Rainfed Area
Aurangabad	654.0	490.7	75.03
Jalna	568.0	412.52	72.62
Beed	876.0	738.3	84.28
Osmanabad	584	461.1	78.95
Latur	609	509	83.57
Nanded	703.84	599	85.10
Hingoli	382	293.2	76.67
Parbhani	510.4	387.01	75.82

Natural vegetation (including area under horticulture)

The coverage under natural vegetation is about 20 to 22 percent, which includes natural vegetation under cultivable area and forest. Under forest timber trees viz. teak, acacia species, Neem, Anjan etc. are widely occurred. Besides the timber trees, some shrubs, herbs, wild grass and thorny bushes are commonly found under natural vegetation. In cultivated areas besides the species under forest, many other fruit trees viz. mango, ber, tamarind, Jamun, custardapple, marking nut, Charoli, Aonla, wood apple etc are widely grown on fallow lands and bunds.

Rainfed Area Statistics of state and domain districts of the centre

a. Total Area of the state (lakh ha) : **307.58**

b. Rainfed Area of the state (lakh ha) : **181.00** (59% of total area)

c. **Particulars Marathwada and Maharashtra**

Total geographical area (lakh ha)	64.00	307.58
Gross cropped area (lakh ha)	57.00	225.56
Net cropped area (lakh ha)	49.56	174.73
Cropping intensity	1.15	1.26
Rainfed area (lakh ha)	49.00	181.00
Rainfall (mm)	630	940

Domain districts of the centre: Parbhani, Hingoli, Nanded, Beed, Latur, Osmanabad, Aurangabad, Jalna.

particulars	Maharashtra	Marathwada
Geo. Area Lakh ha.	308	68
Cultivable area lakh ha	225	57
Area under irrigation lakh ha	40.58 (18%)	8.1 (14%)
Dryland area lakh ha	184.42 (82%)	48.9 (86%)

Socio – Economic details with the secondary data of last 5 years

Land Holding Class	No.of holders	Area in ha.	% of land holders
1. Marginal (upto 1 ha.)	895758	425664	32.4
2. Small (1 to 2 ha.)	1002788	1246684	36.3
3. Medium (2 to 4)	642880	1704617	23.3
4. Large (> 4 ha)	222067	1401670	8.0
Total	**2763493**	**4778635**	**100.0**

Transport : Poor transport facilities in rural areas due to kachha road condtions.

Constraints :

1) Fragmentation of land (as presented above)
2) Higher percentage of marginal and small farmers.
3) Poor socio economic status of dryland farmers.
4) Poor irrigation facilities to the extent of 14% and electric load shading
5) Poor mechanization of dryland farming.
6) Low procurement prices of agriculture commodity not based on cost of cultivation.
7) Unstable and poor marketing facilities.
8) High input costs and unavailability of labourers during peak period.

Rainfall – Dryspells in the domain districts

The productivity of all crops decreases with either deficiency of rainfall and its distribution or due to moisture stress in critical growth period due to dry spells occurred in July and August. Dryspell analysis conducted for this region indicated that the onset of effective monsoon at Marathwada region showed that the first critical dryspell (CD) occurred from July 7 with 19 days. Second CDs starts from August 1 with 26 daysand the third CDs starts from August 29 with a length of 35 days. Thus the crop suffers with the moisture stress and ultimately the crop productivity lowered by 30 to 40 per cent.

Locations	OEM	With drawl	Rainy days	Rainfall (mm)	Monsoon duration		CDS		
					Weeks	Days	I	II	III
Parbhani	June, 22	Oct,7	41.6	872.5	18	108	July,6 (18.8)	Aug,11 (18.33)	Sept,7 (24.83)
Latur	June,17	Oct,10	43.48	804.9	16.32	127.7	July,4 (19.23)	Aug,13 (19.8)	Sept,5 (25.15)
Nanded	June,21	Oct,13	42.45	806.3	15.78	109.8	July,7 (17.38)	Aug,11 (17.5)	Sept,18 (25.16)
Hingoli	June,13	Oct,13	45.41	987.1	17.35	123.20	July,9 (17.5)	Aug,23 (20.16)	Sept,14 (20.63)

Water balance (based on 30 years data)

Rainfall (mm)	Interception (mm)	Surface runoff (mm)	Soil evaporation (mm)	Transpiration (mm)	Recharge (mm)
975.96	14.21	293.09	148.23	386.66	125.32

Rainfall – Runoff relationship (averages based on 30 years data)

Month	Duration	Rainfall, (mm)	Runoff, (mm)
June	7-15	56.22	23.6
	16-30	73.32	31.38
July	1-15	59.40	25.34
	16-31	141.0	55.51
Aug.	1-15	64.78	30.15
	16-31	103.6	54.39
Sept.	1-15	69.1	33.33
	16-30	44.30	18.04
Oct.	1-15	56.85	26.08
	15-31	22.40	10.87

Theme

Rain Water Management

Farm pond technology for Marathwada region of Maharashtra state

Based on the 30 years rainfall-runoff-catchment relationship, the farm pond sizes for assured rainfall zone of Marathwada region were standardized. Similarly, the area occupied by farm pond and the area covered under protective irrigation were analyzed.

Catchment area, ha	Dimensions, M (Lx W x D)	Side slope	Storage volume, (Cubic m)	Area covered by farm pond (%)	Area under one protective irrigation, (ha)
1	20 x 20 x 3	1.5:1	740	4.0	0.75
2	25 x 25 x 3	1.5:1	1280	3.13	1.05
3	30 x 30 x 3	1.5:1	1970	3.0	2.25

Protective irrigation of depth 5 cm be applied with 4 nozzle operated sprinkler system using minimum 1.5 hp diesel pump set.

Table : Increase in soybean / safflower grain yield due to protective irrigation

Treatments	Soybean seed yield, Kg/ha	Increase in yield %	Safflower seed yield, kg/ha	Increase in yield %
T_1-One protective irrigation (sensitive stage)	1837	**43.06**	922	34.45
T_2 – Control i.e. without any protective irrigation	1284	--	686	--

Performance : Application of one protective irrigation through harvested water from farm pond resulted in increase in soybean yield by 43.06 per cent. Similarly, application of one or two protective irrigation at branching and flowering stage resulted in increase in safflower yield in the tune of 34 to 37.80 percent.

Open wells Recharge Technique

Open well recharge technology comprises of a filtration unit (fig.1) for artificial recharging of open wells. The filtration unit consists of three blocks viz; primary filter unit, silt trapping unit and main filtration tank.

Block 1 : It consists of primary filter with dimension of 0.6 x 0.6 m which is combines layer of stones, sand and metals.

Block 2 : The primary filter is joined with 4" diameter pipe to silt trapping unit / energy dissipation unit (1.1 m x 1 m x 1.5 m) having a rectangular notch opening in main filter unit.

Block 3 : It consists of main filtration tank with dimensions as 2 m x 2 m x 2 m having three layers of different filter material such as 30 cm sand, 30 cm metal and 30 cm stones which act as filter material.

The main filter unit is joined to open well by the 4"diameter PVC pipe.

Artificial well recharging system model

Performance : This model has the filtration efficiency of 92 to 95%. In case of Marathwada region, the 25 to 35% runoff is generated from the seasonal rainfall which is normally available for open well recharge that helps to enhance the ground water level up to 3.5 m. The life of the structure is 15 years, however the cleaning of the filter material should be carried out every after 2 to 3 years.

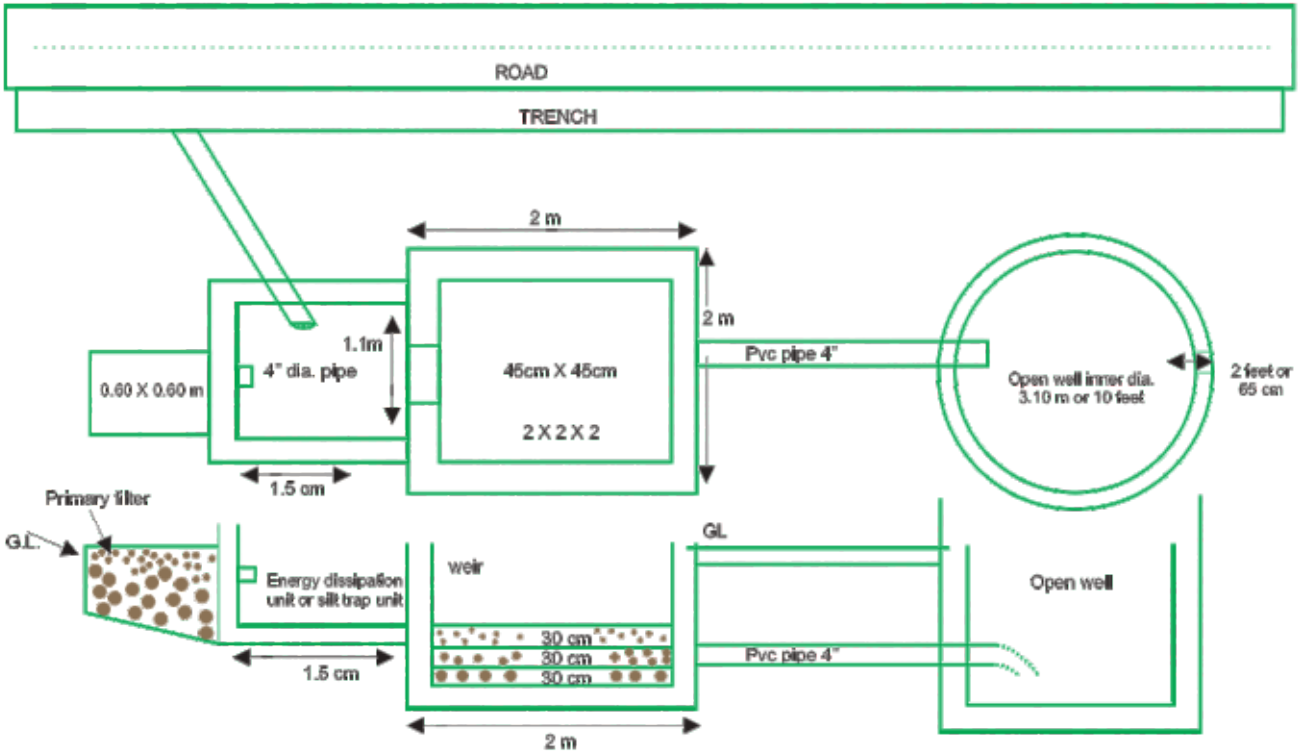


Fig.1 : Artificial Well Recharging System

Table : Filtration efficiency (2011-13)

Test Sample No.	Filtration Efficiency (%)		
	2011	**2012**	**2013**
1	92.85	93.10	94.80
2	93.92	93.54	93.10
3	93.3	96.47	90.90
4	91.42	95.45	93.33
5	94.10	93.18	92.85
6	90.10	94.78	91.25
	Average 92.58	**94.61**	**92.70**

Table : Water level fluctuation due to recharging of well (M.S.L.)

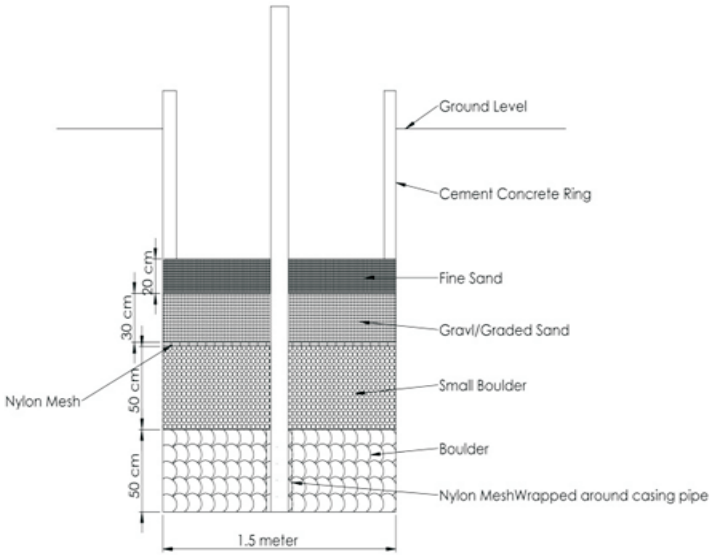
Month	2011	2012	2013	Increase in water level in 2013 compared to 2011
January	404.8	405.0	405.6	0.8
February	404.6	404.5	405.2	0.6
March	404.6	404.1	404.8	0.2
April	404.0	403.9	404.4	0.4
May	403.9	403.3	404.2	0.3
June	404.0	404.6	407.4	3.4
July	405.0	405.5	407.7	2.7
August	405.2	406.1	407.7	2.5
September	406.7	406.2	407.7	1.0
October	406.3	406.2	407.6	1.3
November	406.8	406.9	407.7	0.9
December	406.7	406.5	407.5	0.8

Bore-well recharge technique for Marathwada region

A borewell recharge technique for basaltic terrain of Marathwada region was developed considering the aquifer characteristics i.e. well yield, specific yield and transmissivity. A specific filter system was developed for filtration of runoff water for its insertion in the borewell. The construction cost of the model is Rs. 7500/unit.

Working principle of Bore well recharging system

Runoff water allows entering in primary filter unit wherein the major sediments were arrested and water flows to the secondary filter unit. Secondary filter unit consist of excavation of soil around the bore well casing pipe by 2.5 m depth and 1.5 dia. From the bottom, up to 50 cm height, small holes are made with pointer at a spacing of 5 cm and later the casing pipe is wrapped with nylon mesh. The excavated pit is filled with 4 layers of big stone, metal, gravel sand and fine sand one above each. On the top, the unit is covered with cement ring for not allowing the sediment from the flowing water.



Schematic View of Borewell Discharge

Table : Water levels and ground water recharge in Bore wells

Well number	Water level from GL in May 2015 (Pre-monsoon)	Water level from GL in Nov. 2015 (Post Monsoon)	Water level fluctuation, m	Ground water recharge, cm	Ground water recharge %
Recharged bore wells					
1	31.45	23.20	8.25	11.055	27.16
2	17.27	10.05	7.22	09.675	23.77
3	18.55	12.23	6.32	08.468	20.80
4	32.69	23.85	8.84	11.845	29.10
5	33.12	24.51	8.61	11.537	28.34
6	14.34	8.33	6.01	8.053	19.78
7	21.72	15.09	6.63	8.884	21.82
8	15.85	9.72	6.13	8.214	20.18
9	19.20	12.35	6.85	9.179	22.55
10	72.25	66.23	6.02	8.066	19.81
11	40.60	34.70	5.90	7.906	22.26
12	26.85	19.60	7.25	9.715	23.86
Average					**23.28**
Un-recharged bore wells					
13	74.50	71.18	3.32	4.44	05.94
14	29.50	26.61	2.89	3.87	05.18
Average					**05.56**

Table : Comparison of water levels in May 2015 and May 2016

Location	Water level from GL in May 2015	Water level from GL in May 2016	Rise in Water level, m
Recharged bore wells			
1	31.45	29.05	**2.40**
2	17.27	15.22	**2.05**
3	18.55	16.30	**2.25**
4	32.69	30.15	**2.54**
5	33.12	30.55	**2.57**
6	14.34	12.43	**1.91**
7	21.72	19.85	**1.87**
8	15.85	13.75	**2.10**
9	19.20	16.50	**2.70**
10	72.25	70.10	**2.15**
11	40.60	37.30	**3.30**
12	26.85	24.25	**2.60**
		Average	**2.37**
Un - recharged bore well			
1	74.50	75.90	**-0.40**
2	29.50	30.34	**-0.84**
		Average	**-0.62**

Performance:

The filtration efficiency of the designed filter was found to be 93 to 96 %.The water level fluctuation in pre monsoon and post monsoon season in recharged bore are found to be in the range of 5.90 to 8.84 m. The ground water recharge in treated bore well was found to be 23.28 per cent of annual rainfall as against 5.56 per cent in untreated bore wells.The rise in water level in recharged bore well is found to be 2.37 m as compared to fall of 0.62 m water level in un-recharged bore well during May 2015 to May 2016.

Conservation furrow in cotton and soybean based intercropping systems

A conservation furrow of width 30-45 cm and depth about 20-30 cm is openedat 2.7 m distance in soybean + pigeonpea intercropping sown at 45 cm spacing with Bullock drawn ridger or Baliram plough at 30 to 40 days after sowing (or last week of July or first week of August). The furrows should be opened generally after intercultural operations.

In soybean + pigeonpea (4:2) intercropping system (spaced at 45 cm), the furrow is opened between two rows of pigeonpea at every twelve rows

Table : Comparative performance of furrow opening in intercropping system

Treatment	Soybean (kg/ha)	Pigeonpea (kg/ha)
Furrow opening	1266	730
No furrow opening	939	536
Yield increase (%)	25.77	26.57
Mean	**1102**	**633**

In cotton + soybean (1:1) intercropping system (90 cm spacing in between two cotton rows). The furrow is opened after every six rows of cotton i.e. at 2.7 m distance.

This practice helps in increase in system productivity up to 20% and mitigating dry spells during crop season as compared to without conservation furrow

Opening furrow in sole Soybean in medium to deep black soils of Marathwada region

In medium to deep black soils for sole soybean crop, a shallow furrow of 20 cm width and 10-15 cm depth is opened at 30 to 40 days after sowing (or last week of July or first week of August) with the help of bullock drawn ridger or Baliram plough after every 4 rows. Generally, the furrow is opened after intercultural operations

Table : Soybean crop yield, GMR.NMR, B.C.ratio and RWUE as affected by various insitu rain water conservation treatment

Treatment	Soybean yield (kg)	GMR, Rs	NMR, Rs	B.C. Ratio	RWUE Kg/mm/ha
T1: Opening of furrow after every 4 rows	1389	48615	24242	1.99	1.47
T2: Dead furrow after 10 m	1137	39795	15422	1.63	1.20
T3: Tied ridging after every 4 rows	1236	43260	18887	1.77	1.30
T4: Conservation furrow at 2.7 m distance	1312	45920	21547	1.88	1.39
T5: Flat bed	895	31325	6952	1.28	0.94
SE	32	912	970	0.04	
CD	98	2739	2914	0.12	
Cv %	08	09	08	07	

Table :Monthly soil moisture status as influenced by various treatments

Month	Soil moisture %				
	Opening of furrow after every 4 rows, (T_1)	Dead furrow after 10 m, (T_2)	Tied ridging after every 4 rows, (T_3)	Conservation furrow at 2.7 m distance, (T_4)	Flat bed (T_5)
June	28	26	29	26	22
July	30	29	30	27	22
August	29	28	29	26	21
Sept	28	26	28	25	21
Oct	27	25	27	24	20

This practice increases moisture conservation upto 30% and enhances productivity of soybean crop upto 20% as compared to without furrow opening.

Tied ridging for moisture conservation in Pigeonpea:

Land layout of tied ridging in every row of pigeonpea (90 cm row spacing) is recommended in first fortnight of August to prevent soil loss, minimise runoff and conservation of rainwater for enhancing productivity of pigeonpea under rainfed condition. The ridges and furrow should be opened by bullock drawn ridger or baliram plough and the furrows should be tied at every 10 m distance by manually.

Performance:

Tied ridging in pigeonpea resulted in increase in crop yield by 20 per cent and reduces runoff by 25 per cent. The practice of tied ridging increases moisture availability by more than 20 per cent and thus crop sustain good even under long dryspell condition.

Theme

Crops and Cropping Systems

Contingency Crop Planning

The contingency cropping ensures sowing upto first fortnight of August during *kharif* with higher productivity and income.The following crops/varieties and intercropping systems are suggested for late / delayed sowings.

Sowing date	Crops/cropping systems to be adopted
Up to 30 June (Normal sowing)	All kharif crops. Cotton+Soybean,Soybean+Pigeonpea, Sorghum+Pigoenpa, Castor+Soybean, Bajra + Pigeonpea, Greengram, Blackgram, Sorghum, Pearlmillet, Cotton and Soybean
Up to & 7th July	All kharif crops. Cotton+Soybean,Soybean+Pigeonpea, Sorghum+ Pigoenpa, Castor+ Soybean, Bajra + Pigeonpea, Greengram, Blackgram, Sorghu m, Pearlmillet, Cotton and Soybean
30 June to 15 July	Cotton. Soybean, Pigeon pea, Pearl millet, Cotton+Soybean, Soybean+Pigeonpea, Castor+Soybean and Bajra + Pigeonpea,
16 July to 30 July	Pigeon pea, Pearl millet, Castor, Soybean+Pigeonpea, Bajra + Pigeonpea and Castor+Soybean
1 August to 15 August	Pigeon pea, Castor, Sunflower, Corinder, Soybean+Pigeonpea, Bajra + Pigeonpea and Castor+Soybean (exceptional situation)

Name of the crops	Prominent Varieties
Soybean	JS-335, MAUS-47, MAUS-71, MAUS-81, MAUS 158, MAUS-162,
Cotton	NH-545, NHH-44, PH-316, NH-250, NH-615, NH-635
Kharif Sorghum	CSH-25 (ParbhaniSainath), PVK-801 (ParbhaniSweta), PVK 809,
Pearlmillet	Shradha, Saburi, Samruddhi, Parbhanisampada, ABPC -4-3,
Pigeonpea	BSMR-736, BSMR-853, BDN-711,
Green gram	BPMR-145, BM-2002-1, BM-2003-2,
Black Gram	TAU-1, BDU-1
Sunflower	LS-8, LS-11, LSFH-35, LSFH-171, KBSH-45
Sesamum	JLT-7 (Tapi), Phule-1, Punjab-1, AKT-64,
Niger	IGP-76, PNS-6,
Caster	DCH-32, DCH-177, DCH-519, GCH-6
Rabi Sorghum	M-35-1 (Maldandi), SPV-502 (Swati), SPV-1411 (Parbhanimoti), SPV-1515 (ParbhaniJyoti),
Chickpea	BDN-797 (Akash), Vijay, Digvijay, Vishal,
Safflower	Sharda, PBNS-12 (ParbhaniKusum), PBNS-40 (Spineless), Phulekusum,
Linseed	S-36, /rkc-4 (Jagdamba), NL-97

Profitable Maize based intercropping systems for Marathwada region

Maize + soybean (2:2) intercropping is done in paired rows of maize and soybean at 45/75 cm with the help of tractor drawn seed drill.

Treatments	Pooled mean Maizeyield, Kg/ha	Pooled Mean intercrop yield, kg/ha	Mean land equivalent ratio (LER)	RWUE, Kg/mm/ha
T_1 - Sole maizeat60cm	3038		1.00	5.44
T_2 - Maize + Blackgram 60 cm (1:1)	2641	256	1.15	5.26
T_3 - Maize+ Greengram 60 cm (1:1)	2843	278	1.23	5.16
T_4 - Maize + soybean 60 cm (1:1)	2685	611	1.17	5.26
T_5 - Maize + Cowpea 60 cm (1:1)	2587	270	1.14	5.83
T_6 - Sole maizeat 45/75cmpairing	3323		1.00	5.91
T_7 - Maize + blackgram 45/75 cm (2:2)	2746	305	1.30	5.88
T_8 - Maize+Greengram 45/75 cm (2:2)	2846	317	1.24	5.70
T_9 - Maize + Soybean 45/75 cm (2:2)	2849	647	1.25	6.93
T_{10} -Maize + Cowpea 45/75 cm (2:2)	2648	303	1.20	5.85
S.E.±	146	-	**0.17**	-
CD at 5%	437	-	**0.49**	-
Mean	2821	-	-	-

Maize + greengram (1:1) intercropping at 45/75 cm (2:2) as paired row and intercropping of Maize + Soybean is done at 60 cm (1:1) The systems to minimize risk, stabilize crop yields and give higher monetary returns under dry land situations in Marathwada region.

Performance : The intercropping systems gave higher equivalent yields of Maize (5290 kg/ha) in Maize + Soybean at 45/75cm (2:2), 5156 kg/ha in Maize + Soybean at 60 cm (1:1) and 5058 kg/ha in Maize + Green gram at 45/75cm (2:2)) and more net monetary returns (Rs. 27627/ha in Maize + Soybean, Rs. 26691/ha in Maize + Soybean and Rs.28412/ha in Maize + Green gram) over sole cropping of Maize.

Management practices in *Bt.* Cotton in Marathwada region

Under rainfed condition, with suitable Bt. cotton hybrid, the sowing is done at 90 x 60 cm spacing. Application of FYM @ 5 t/ha at the time of land preparation and application of 75 % RDF (RDF is 100:50:50 NPK kg/ha) i.e. basal application of 37.5 kg NPK/ha and 37.5 kg N as top dressing at 30 days after sowing. It gives 20% more seed cotton yield as compared to other spacings and RDF application.

Broad Bed and Furrow Technique- A Climate Smart Technology for Rainfed Soybean of Marathwada region

Soybean is a major crop cultivated in the domain districts of the region. The monsoon behavior has become very erratic during recent past.The rainfall and its uneven distribution and prolonged dry spells are affecting the crop yields during last two to three years particularly in Marathwada region. Therefore in order to conserve the as much as received rainfall and its conservation for crop use and management of crops during dry spells are the key points in rainfed agriculture for sustainable crop yields. Land configuration and stress management practices have become necessary to cope with drought situation for obtaining assured crop yields. Similarly nutrient management is also important for better productivity under dryland condition.

The objective were to find out the effect of various land configurations on growth and yield of Soybean, to evaluate the effect of nutrient cum stress management practices on growth and yield of soybean and to assess the combined effect of land configurations, nutrient and stress.

Conclusion/ recommendations

For higher seed yield and net monetary returns of soybean, it is recommended to undertake sowing of soybean on broad bed furrow in medium to deep black soils with the application of RDF (30:60:30 NPK Kg/ha) and during dry spell two sprays of potassium nitrate (KNO_3) (@ 1.0 & 2.0 %) OR two sprays of 19:19:19 (@ 0.5%) at 30-35 days and at 60-65 days after sowing respectively.

Soybean seed yield (kg ha^{-1}), GMR, NMR, BC ratio and RWUE as influenced by different treatments (2014-2016)

reatmeñts	Pooled Mean				
	Soybean Yield kg ha^{-1}	GMR, Rs ha^{-1}.	NMR, Rs.ha^{-1}	BC ratio	RWUE
Main Plots: Land Configurations : (03)					
L_1 : Flat Bed	1148	34782	9263	1.36	2.77
L_2 : BBF	1460	44191	18587	1.72	3.50
L_3 : Ridges & Furrow	1321	39984	14232	1.54	3.16
SE ±	**45.46**	**1145**	**341.6**	-	-
CD at 5%	**125.8**	**3168**	**976.4**	-	-
Fertilizer cum Stress Management Practices : (08)					
F_1: RDF (30:60:30 NPK Kg/ha)	1140	34670	11457	1.48	2.81
F_2 :RDF + KNO3 @ 1 % & 2 % (two sprays)	1421	42954	17545	1.68	3.35
F_3: RDF + (19:19:19) @ 0.5%	1384	41884	16448	1.64	3.31
F_4: RDF + MoP @ 1 % & 2 %	1290	39099	14386	1.57	3.11
F_5: RDF + Micronutrients Mixture @ 0.5 %	1440	43329	17624	1.68	3.34
F_6: RDF + Straw Mulch @ 3 t/ha	1348	40738	13958	1.05	3.21
F_7: RDF + Anti-transparent Kaolin @ 7%	1224	37735	9105	1.31	2.98
F_8: RDF + Water sprays	1211	36797	12570	-	2.98
SE ±	**37.75**	**1298**	**856.3**	-	-
CD at 5%	**104.4**	**3592**	**2401.6**	-	-
Interaction SE ±	**65.39**	**2248**	**1031.5**	-	-
CD at 5%	**180.9**	**6223**	**1698.5**	-	-

Dry spell management in rainfed *Bt* cotton through various stress management practices

Cotton is a major crop cultivated in Marathwada region. The average area under cotton cultivation is 15 lakh ha. The monsoon behavior has become very erratic during recent past years. Weather aberrations are common during *kharif* season; hence need to take up real time contingency measures for stress management like foliar sprays with chemical or nutrients in rainfed crop like *Bt*-cotton to sustain growth and production. The objectives were to find out the effect of various stress management practices on growth and yield of *Bt* cotton and to find out the economics of various stress management practices in *Bt*cotton.

Table: Bt-Cotton seed yield, GMR, NMR, B:C Ratio and RWUE influenced by different treatments (2014-16)

Treatments	Pooled Mean				
	Seed Cotton Yield (Kg ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs.ha^{-1})	B:C Ratio	RWUE (kg/ha/ mm)
T_1 : RDF	1099	54119	21407	1.58	2.51
T_2 : RDF + Straw mulch	1274	61875	25284	1.63	3.06
T_3 : RDF + Kaolin (two sprays)	1208	58758	21335	1.51	2.87
T_4 : RDF + KNO_3 (two sprays)	1384	66936	29622	1.73	3.37
T_5 : RDF + 19:19:19 (two sprays)	1383	67299	30950	1.79	3.29
T_6 : RDF + MOP (two sprays)	1242	60396	25351	1.65	2.96
T_7 : RDF + Thiourea (two sprays)	1142	56108	21876	1.56	2.64
T_8 : RDF + Water sprays (two sprays)	1156	55109	21663	1.56	2.57
T_9 : 75% RDF + 25% through FYM	1199	58769	22798	1.57	2.75
T_{10} : 75% RDF + KNO_3 (two sprays)	1188	59107	21427	1.55	3.00
SE +	**30.90**	**1168**	**918**	--	--
CD at 5%	**90.8**	**3504**	**24171**	--	--
Mean	**1228**	**59848**	**24172**	--	--

Conclusion/ recommendations:

To cope with dryspells and to attain stable rainfed *Bt* cotton yield it is recommended to apply two sprays of 19:19:19 @ 0.5 % at 35 days and at 75 days after sowing respectively OR potassium nitrate (KNO_3) at 35 days (@ 1.0 %) and at 75 days after sowing (@ 2.0 %) respectively alongwith recommended dose of fertilizers (120:60:60 NPK kg/ha) in medium to deep black soils.

Evaluation of land configurations and nutrient cum stress management practices in *Bt* Cotton under rainfed condition

Cotton is major crop cultivated in Marathwada region. Due to erratic nature of monsoon there are long dry spells in growing season which affects the growth and productivity of cotton. Under such situation preparedness and real time contingency is very essential to save the crop and sustain the productivity of *Bt* cotton.

Treatments	Pooled Mean				
	Seed Cotton Yield (Kg ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C Ratio	RWUE (kg/ha/ mm)
Main Plots: Land Configurations : (03)					
L_1 : Flat Bed	1166	57091	21728	1.56	2.22
L_2 : BBF	1476	72303	32848	1.71	2.74
L_3 : Ridges & Furrow	1339	65548	26942	1.60	2.51
SE ±	**19**	**267**	**582**	-	-
CD at 5%	**58**	**801**	**1678**	-	-
Fertilizer cum Stress Management Practices : (07)					
F_1 :RDF	1127	54820	19410	1.46	2.22
F_2 :RDF + Foliar application of KNO_3 (2 sprays)	1306	63574	24742	1.52	2.51
F_3 :RDF + Foliar application micro-nutrient mixture Grade II (two sprays)	1310	63986	25843	1.51	2.36
F_4 : 75% RDF + 25% N through FYM + KNO_3	1355	66581	27568	1.10	2.47
F_5 : RDF + 25% N through FYM + Micro-nutrient mixture Grade-II (two sprays)	1329	65375	23218	1.05	2.38
F_6 :75% RDF + Green Manuring + KNO_3 (two sprays)	1462	71825	32664	1.19	2.82
F_7 :75% RDF + Green Manuring + Micro-nutrient mixture	1400	68771	29042	1.23	2.66
SE ±	**27**	**1763**	**873**	-	-
CD at 5%	**81**	**5291**	**2437**	-	-
Interaction (L X F) SE ±	**39**	**962**	**990**	-	-
CD at 5%	**117**	**2886**	**2970**	-	-

Conclusion/ recommendations

For higher seed cotton yield and net monetary returns of rainfed *Bt* cotton, it is recommended to plant rainfed *B*t cotton on broad bed furrow in medium to deep black soils with *in-situ* green manuring (at 50 % flowering / at 45 DAS) of *sunhemp* as a inter crop OR apply 5 t/ha of FYM with the application of 75 % RDF (90:45:45 NPK Kg/ha) + two sprays of potassium nitrate (KNO_3) at 35 days (1.0 %) and at 75 days (2.0 %) after planting respectively OR two sprays of micronutrient mixture (grade – II) (@ 0.5 % each) at 35 days and at 75 days after planting respectively.

Theme

Energy Management

Performance of Prominent Cropping Systems under various Tillage Practices in Vertisols of Marathwada region

The experiment was laid out in factorial randomized block design with three replication with three prominent cropping systems i.e. Sorghum + Pigeonpea (4:2), Soybean + Pigeonpea (4:2) and Cotton + soybean (1:1) and five tillage practices shallow tillage with bullock drawn implements, conventional tillage with bullock drawn implements, shallow tillage with tractor drawn implements, conventional tillage with tractor drawn implements and tillage with rotary tillers.

Pooled Data on Crop yield, seed cotton equivalent yield, gross monetary returns, net monetary returns and B:C ratio as influenced by cropping systems and tillage practices during 2011-2016 is presented in Table.

Performance of cropping systems and tillage practices during 2011-2016.

Treatments	Seed cotton equivalent yield (kg/ha)	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	B:C ratio
Cropping systems				
C_1-Sorghum +Pigeonpea	1700	76526	51950	3.11
C_2-Soybean+ Pigeonpea	1905	85746	58170	3.10
C_3-Cotton+Soybean	2120	95391	67543	3.42
SE $\pm$	69	2546	1927	0.09
CD (P=0.05)	207	7639	5781	0.27
Tillage practices				
T_1- Shallow tillage with Bullock drawn implements.	2031	91387	64811	3.43
T_2- Conventional tillage withbullock drawn implements.	1880	84640	56064	2.96
T_3- Shallow tillage with Tractor drawn implements	2067	93031	65455	3.37
T_4- Conventional tillage with tractor drawn implements	1678	75515	45939	2.55
T_5-Tillage with rotary tillers	1624	73092	45516	2.65
SE $\pm$	36	515	337	0.05
CD (P=0.05)	108	1545	1012	0.15
Interaction (C x T)				
SE $\pm$	61	2715	2125	0.05
CD (P=0.05)	183	8145	6375	0.15
Mean	2034	91534	63558	3.26
CV (%)	12	13	12	14

Soil moisture use (mm) and moisture use efficiency (Rs/mm-ha) as influenced by cropping systems and tillage practices during 2011-16.

Treatments	T_1	T_2	T_3	T_4	T_5	Mean
Soil moisture use, mm						
C_1- Sorghum + Pigeonpea	319	325	340	332	327	**329**
C_2- Soybean+ Pigeonpea	327	332	337	335	324	**331**
C_3-Cotton + Soybean	367	362	375	367	362	**367**
Mean	**338**	**340**	**351**	**345**	**338**	342
Moisture use efficiency, Rs/mm-ha						
C_1- Sorghum + Pigeonpea	263	248	249	229	229	**243**
C_2- Soybean+ Pigeonpea	271	256	265	240	245	**256**
C_3-Cotton + Soybean	254	249	251	233	233	**244**
Mean	**263**	**251**	**255**	**234**	**236**	248
Effective Rainfall (mm)	**285**					

Performance:

Cotton + soybean (1:1) intercropping system recorded significantly superior seed cotton equivalent yield than other cropping systems. Soybean +Pigeonpea (4:2) and Sorghum + Pigeonpea (4:2) recorded at par seed cotton equivalent yield. Among tillage practices, shallow tillage with tractor drawn implements recorded significantly higher SCEY than Conventional tillage with bullock drawn implement, conventional tillage with tractor drawn implements and tillage with rotary tillers and found to be at par with shallow tillage with bullock drawn and .Cotton + soybean in combination with shallow tillage with tractor drawn implement recorded significantly higher SCEY than other cropping system. GMR, NMR and B.C. ratio in Cotton + soybean in combination with shallow tillage with tractor drawn implement was found significant.

Tillage and nutrient management for resource conservation and improvement of soil quality in Soybean + Pigeonpea and Cotton + soybean biannual intercropping system

The experiment was laid with three tillage practices and five nutrient levels in Soybean + Pigeonpea and Cotton + soybean biannual intercropping systems since 2005-06 with a view to the improvement in infiltration rate of soil and other basic soil properties in long term.

Conventional tillage (T_1) treatment recorded significantly higher soybean grain equivalent yield than reduce tillage + herbicide (T_3) and reduce tillage + inter-culture (T_2).

Crop yield, Soybean grain equivalent yield, gross monetary returns, net monetary returns & B:C ratio as affected by tillage methods and nutrient sources.

Treatments	Soybean grain equ. yield (kg/ha)	GMR (Rs/ha)	Net monetary returns (Rs/kha)	B:C ratio	RWUE (kg/m m/ ha)
Tillage methods (T)					
T_1 - Conventional Tillage	2228	77980	53607	2.19	2.36
T_2 - Reduced tillage+ interculture	2040	71400	48027	2.05	2.16
T_3 - Reduced tillage + herbicide	1930	67550	43550	1.81	2.04
SE $\pm$	49	1295	1052	0.08	-
CD (P = 0.05)	148	3884	3159	0.25	-
Nutrient Sources (N)					
N_1 – FYM @ 5 t/ha	1928	67480	43107	2.76	2.04
N_2 - Vermicompost @ 3 t/ha	1671	58485	34112	2.39	1.77
N_3 - RDF (50%) + FYM (2.5 t/ha)	1916	67060	42687	2.75	2.03
N_4 - RDF (50%) + vermicompost (1.5 t/ha)	1844	64540	40167	2.64	1.95
N_5 – RDF	2320	81200	56827	3.33	2.46
SE $\pm$	72	1729	1686	0.14	-
CD (P=0.05)	218	5190	5060	0.42	-

Infiltration rate (cm/hr) and bulk density (g/cm^3) as affected by tillage methods and nutrient sources

Treatments	FYM	Vermi-compost	RDF+ FYM	RDF+ Vermi-compost	RDF	Mean
Infiltration rate, cm/hr						
Conventional tillage	13.0	9.6	8.6	5.3	6.0	8.5
Reduced tillage+ interculture	5.0	5.8	5.4	5.6	4.7	5.3
Reduced tillage + herbicide	7.0	8.4	8.6	9.7	4.6	7.66
Mean	8.33	7.93	7.53	6.86	5.1	7.15
Bulk density, g/cm^3						
Conventional tillage	1.24	1.38	1.33	1.21	1.40	1.312
Reduced tillage + interculture	1.21	1.38	1.37	1.39	1.28	1.326
Reduced tillage + herbicide	1.39	1.27	1.24	1.27	1.27	1.288
Mean	1.28	1.34	1.31	1.29	1.32	1.308

Soil moisture use (mm) and moisture use efficiency (Rs/mm-ha) as affected by tillage methods and nutrient sources.

Treatments	FYM	Vermi-compost	RDF+ FYM	RDF+ vermin-compost	RDF	Mean
Soil moisture use (mm)						
Conventional tillage	604	598	608	596	658	**613**
Reduced tillage+ interculture	592	587	590	586	648	**601**
Reduced tillage + herbicide	586	582	589	592	624	**595**
Mean	**594**	**589**	**596**	**591**	**643**	-
Moisture use efficiency, Rs/mm-ha						
Conventional tillage	77.06	72.29	76.29	75.50	84.32	**77.09**
Reduced tillage + interculture	73.57	68.80	77.35	72.01	80.84	**74.52**
Reduced tillage + herbicide	71.53	66.77	71.31	69.98	78.80	**71.68**
Mean	**74.05**	**69.28**	**74.98**	**72.49**	**81.32**	-

On an average maximum infiltration rate of 8.5 cm/hr was observed in conventional tillage whereas minimum of 5.3 cm/hr was observed in

reduced tillage + interculture. Among nutrient sources maximum infiltration rate of 8.33 cm/hr was observed in FYM, whereas minimum of 5.1 cm/hr was observed in RDF treatment. Among tillage methods, minimum bulk density of 1.288 g/cm^3 was observed in reduced tillage + herbicide treatment, whereas minimum bulk density of 1.28 g/cm^3 was recorded in FYM.

Among tillage methods, highest soil moisture use of 613 mm and moisture use efficiency of 77.09 Rs/mm/ha respectively was observed in conventional tillage. whereas the highest moisture use of 643 mm and moisture use efficiency of Rs 81.32 /mm-ha was observed in RDF

Chemical properties as influenced by various treatments

Tillage Method (T)	pH	Ec dsm^{-1}	OC (%)	$CaCO_3$ (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
T_1 conventional Tillage	7.97	0.28	0.37	3.0	165	8.15	408
T_2 Reduced tillage + interculture	7.98	0.33	0.40	3.6	199	10.04	525
T_3 Reduced tillage + herbicide	7.97	0.31	0.38	3.3	160	9.13	479
Mean	7.97	0.30	0.38	3.3	174	9.10	379
N_1 FYM @ 5 t/ha	7.98	0.31	0.40	3.0	197	9.19	511
N_2 Vermicompost @3 t/ha	8.00	0.38	0.45	3.2	203	11.73	533
N_3 RDF (50%) + FYM (2.5 t/ha)	8.01	0.40	0.49	3.2	204	12.13	619
N_4 RDF (50%) + vermicompost (1.5 t/ha)	8.01	0.39	0.55	3.8	219	13.05	603
N_5 RDF	797	0.29	0.41	3.5	212	10.13	525
Mean	7.99	0.37	0.46	3.34	207	11.24	558

Variety released Genetic enhancment

1. A promising Niger variety (PNS -6) for Marathwada region.

Released Niger variety PNS -6 for assured rainfall zone of Marathwada region for wide scale adoption as a contingent crop varietyhaving bold and shining seed, higher oil content (38%) and yield potential of 500-550 kg/ha.

Variety features

1.	Plant Height	:	140-160 cm
2.	Distinguishing morphological characters		
a)	Stem	:	Straight
b)	Stem colour	:	Dark Violet
c)	Stem base	:	Dark pink
d)	Primary branches	:	06-10
e)	Colour of primary branches:		Pale violet
f)	Angle of branching	:	30 to 35^0
g)	Leaves	:	Dark green
h)	Midrib	:	Pink on ventral and green on dorsal surface
i)	Margin	:	Serrated
j)	Ray florets	:	08 – 11
k)	Flower Colour	:	Yellow

3. Maturity (range in day from seed to seed) 90-93 days (60 days for 50% flowering
4. Test weight (g) : 3.73 g
5. Maturity group early/medium/late Early group
6. Reaction to major disease under Field and controller condition No disease incidence in field condition
7. Reaction of major pests under No major pests Field and controlled conditions Including stored pest

8.	Agronomic features (resistant to Lodging, shattering, fertilizer Responsive, suitable to early and early Sown condition, seed rate etc.	i) Responsive to fertiliser ii) Tolerant to lodging iii) Suitable for late and late sowing iv) Seed rate 2.5 – 3.0 kg/ha v) spacing : 30 x 15 cm^2 – light soil 45 x 15 cm^2 – heavy soil
9.	Quality of produce	: Good quality due to black shinning colour of seeds.

Visit of Dignitaries

Dr. V.M. Mayande, Former Vice-Chancellor, Dr.PDKV, Akola

Dr. S.D. Sawant, Director, ICAR-NRC Grapes, Pune

Dr. M.A. Shankar, Former Director of Research, UAS Dharwad
and Dr. M. Osman, Principal Scientist, CRIDA, Hyderabad

Stake Holder Consultation Meeting

State Level Contingency Planning Meeting, Pune

Inaugural Function of Model Training Course
on Drought Management in Agriculture

Valedictory Function of Model Training Course

Visit of Hon. Agriculture Minister (M.S.), MLA, Parbhani &
Dignitaries to Well Recharge Model in Exhibition Stall of DARC

Visit of Hon. Governor (M.S.), Hon. Vice-Chancellor, VNMKV, Parbhani, MP, Parbhani and Divisional Commissioner to Well Recharge Model

Release of District Agriculture Contingency Crop Planning Book During Joint AGRESCO - 2017

Technological Input to PoCRA Project Govt. of Maharashtra Aided by World Bank