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Performance Evaluation of Conservation Furrow and BBF Method of Sowing for Soybean under Varying Climate on Farmers Field in Marathwada Region of Maharashtra

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ABSTRACT: The impact of climate change and its variability in the Marathwada region on agricultural production is quite evident in the recent years. There is a need to develop appropriate strategies to deal with such eventualities. Soybean is grown on large area in Marathwada region of Maharashtra State and is a preferred crop in *kharif* season for the marginal and small rainfed farmers. The productivity of soybean, particularly in Marathwada region, is uncertain due to occurrence of frequent dry spells. Occurrence of 3 to 4 dry spells in July to September is a common feature of this region even though most of area falls under assured rainfall zone. Based on farmers need, technical interventions were taken up under NICRA (National Innovations in Climate Resilient Agriculture) project through preparedness and real time contingency measures. To cope with dry spells and to obtain sustainability in soybean production, measures like conservation furrow and BBF (Broad bed and furrow) method of sowing were advocated to the farmers for *in-situ* moisture conservation as real time climate resilient technologies. Research demonstrations were undertaken on farmers' fields since 2011 at village Babhulgaon in Parbhani district of Maharashtra State. Yield advantage in soybean crop was observed due to adoption of above techniques with increase in net returns and rain water use efficiency.

Key words: Broad bed & furrow, climate resilient, conservation furrow, dry spell

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Introduction

Rainfed agro-ecosystems occupy a significant place in Indian agriculture. In Marathwada region, out of total cultivated area of 57.94 lakh ha, 49.60 lakh ha is rainfed. The impact of climate change and its variability in the region on agricultural production is quite evident in the recent years. Climate change threatens the sustainability of present agriculture. Weather aberrations like drought and floods, extreme events like high intensity rainfall, etc., are recurrent during the crop growing periods. The south-west monsoon accounts for nearly 75% of the precipitation received and exerts a strong influence on the *kharif* food grain production and the economy in terms of agricultural output, farmers income and price stability. The onset of south west monsoon, the amount of rainfall and its distribution are crucial factors which influence the performance. The probability of erratic monsoon rains is about 40% which implies that 4 out of 10 years have adverse impact on crop production. There is a need to develop appropriate strategies to deal with such eventualities.

Marathwada region comprising of eight districts namely, Aurangabad, Beed, Hingoli, Jalna, Latur, Nanded, Osmanabad and Parbhani is a traditionally a drought-prone region. 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%). Major *kharif* crops of the region are soybean, cotton, pigeon pea, sorghum, green gram and black gram. Area of soybean in Maharashtra, particularly in Marathwada region is continuously increasing due to its dual utility as pulse as well as oil seed crop. It fetches better market price due to establishment of large number of soybean oil extraction plants and also from nutritional point of view (Havankar *et al*., 1992). Soybean is grown on 13 lakh ha area in Marathwada region and majority of the small and marginal farmers are preferring to grow soybean during *kharif* season. The average productivity of soybean varies depending of monsoon behavior. Rainfall is the key variable influencing crop productivity of soybean under rainfed condition. Intermittent and prolonged dry spells are the major cause of yield reduction. Based on the farmers need, technical interventions were taken up under NICRA (National Innovations in Climate Resilient Agriculture) project through preparedness and real time contingency measures.

Materials and Methods

Participatory trials were conducted on farmers' fields during 2011 to 2020 under the NICRA project which is in operation at village Babhulgaon in Parbhani District in Marathwada region of Maharashtra. The real time climate resilient technologies like opening of conservation furrow in soybean and preparedness like BBF method of sowing for soybean were demonstrated on farmers field for evaluating its performance. Demonstration fields were selected based on the willingness of the farmers to engage in participatory research mode to evaluate the science

based strategy. Major soils in the research area are medium black. The annual rainfall and crop seasonal rainfall during the study period (2011 to 2020) is presented in Table 1.

Table 1: Annual rainfall and crop seasonal rainfall during 2011 to 2020

Year	Annual rainfall, mm	Crop seasonal rainfall, mm	Year	Annual rainfall, mm	Crop seasonal rainfall, mm
2011	677.6	636	2016	1159.5	1130
2012	687.8	681.8	2017	995.7	886
2013	1216.1	1172.6	2018	812.1	802.4
2014	560.2	393.6	2019	964.2	859.7
2015	574.8	408.1	2020	1098.7	1004.5

The mean annual rainfall of the station is 880.9 mm. Out of the 10 years, above normal rainfall occurred during 5 years and below normal rainfall was observed in 5 years. The years 2014 and 2015 were recorded as dry years where 40 to 50 per cent less rainfall was observed. The dry spells were monitored during the study period. During the above period, almost every year, one or more dry spells occurred and had adverse effect on crop growth. The data is tabulated in Table 2.

Table 2: Dry spells during 2011 to 2020

Year	Number of dry spells	Duration	Period
2011	1	10	06/09/2011 to 15/09/2011
2012	1	09	12/08/2012 to 20/08/2012
2013	2	13	27/08/2013 to 08/09/2013
		10	22/09/2013 to 02/10/2013
2014	1	10	12/08/2014 to 21/08/2014
2015	1	45	20/06/2015 to 04/08/2015
2016	1	18	05/08/2016 to 22/08/2016
2017	4	16	25/06/2017 to 10/07/2017
		13	26/07/2017 to 07/08/2017
		09	31/08/2017 to 08/09/2017
		16	17/09/2017 to 02/10/2017
2018	2	25	22/07/2018 to 15/08/2018
		33	28/08/2018 to 30/09/2018
2019	4	10	01/07/2019 to 10/07/2019
		13	14/07/2019 to 26/07/2019
		16	15/08/2019 to 30/08/2019
		18	02/10/2019 to 19/10/2019
2020	4	09	17/06/2020 to 25/06/2020
		12	30/07/2020 to 10/08/2020
		10	28/08/2020 to 06/09/2020
		09	02/10/2020 to 10/10/2020

During the year 2015, a prolonged dry spell of 45 days was observed and it resulted in severe moisture stress and drastic yield reduction. During the year 2017, 2019 and 2020, 4 dry spells each were observed despite normal rainfall. During the year 2013 and 2018, two dry spells were observed and yield reduction was reflected. Data indicated that, most of the dry spells were observed during flowering and pod initiation stage or during grain filling stage in soybean which had created the moisture stress during crop growth.

Real time intervention: Opening of conservation furrow in sole soybean

Before introduction of this project, the farmers were cultivating sole soybean crop on flat bed without *in-situ* moisture conservation practice like opening of conservation furrow. However, yield reductions were observed due to moisture stress during dry spells. Under improved practice, opening of conservation furrow after every 4 rows in sole soybean after 30 to 35 days of sowing was adopted as a strategy for moisture conservation on farmer's field during 2011-2020.

Preparedness: Broad bed & furrow (BBF) method of sowing in soybean

Tractor drawn BBF planter was provided to farmers for sowing of soybean. Performance of BBF technique as preparedness for *in-situ* moisture conservation in soybean on farmers field was evaluated for 7 years during 2014 to 2020.

Results and Discussion

Adoption of conservation furrow technique in soybean

The effect of *in-situ* moisture conservation practice like conservation furrow in sole soybean was assessed and its effect on crop productivity (yield), net monetary returns, B:C ratio and RWUE was analyzed and the data is presented in Table 3. It indicated that, with conservation furrow, a sole soybean mean yield of 1409 kg ha^{-1} was obtained with a yield advantage of 300 kg ha^{-1} over the treatment without conservation furrow (1109 kg ha^{-1}). The net return of Rs. 22511 ha^{-1} was obtained due to adoption of conservation furrow technique and was higher than the net return of Rs. 15146 ha^{-1} in no furrow system. The B:C ratio under adoption of conservation furrow technique was found to be 2.1 as against B:C ratio of 1.68 with no furrow system. Similarly, the RWUE of 2.64 was found with conservation furrow as compared to RWUE of 2.08 in no furrow system. Pendke *et al*. (2000), Ramachandrapa *et al.* (2015), Ramachandrapa *et al*. (2016) found that all *in-situ* moisture conservation practices resulted in additional moisture conservation and resulted in increase in crop yield. Ranade *et al.* (2017) evaluated *in-situ* moisture conservation practices and assessed improved seeding implements to mitigate dry spells. Behera *et al*. (2016) studied the effect of *in-situ* moisture conservation methods on productivity.

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Table 3. Effect of conservation furrow on crop yield, net returns, B:C ratio and RWUE of soybean

Parameter	Intervention	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Mean
Yield (kg ha^{-1})	Conservation furrow	1850	2620	1750	834	643	1623	1742	952	872	1205	1409
	No furrow	1424	2146	1506	632	524	1076	1282	786	752	965	1109
Net returns (Rs. ha^{-1})	Conservation furrow	21017	30723	41250	9315	6280	26072	34571	15781	16351	23754	22511
	No furrow	16177	21546	32710	2851	1815	12030	22541	8670	14101	19020	15146
B:C ratio	Conservation furrow	1.52	2.53	3.06	1.53	1.35	2.40	2.86	1.7	2.02	2.03	2.1
	No furrow	1.16	2.07	2.63	1.16	1.10	1.68	2.36	1.5	1.53	1.64	1.68
RWUE (kg ha^{-1}mm^{-1})	Conservation furrow	4.14	5.50	1.78	2.95	2.25	2.06	2.74	1.7	1.53	1.74	2.64
	No furrow	3.19	4.5	1.53	2.24	1.84	1.37	2.01	1.4	1.32	1.39	2.08

Table 4: Comparison of BBF technique with farmers practice for soybean

Parameter	Intervention	2014	2015	2016	2017	2018	2019	2020	Mean
Yield (kg ha^{-1})	BBF	941	848	1709	1936	1336	1150	1332	1322
	Flatbed	632	524	1076	1282	786	892	952	878
Net returns (Rs. ha^{-1})	BBF	12739	13972	28437	40488	25316	24465	33181	25514
	Flatbed	5851	6815	12030	22541	8670	17093	23715	13816
B:C ratio	BBF	1.73	1.78	2.53	3.18	2.26	2.34	2.79	2.37
	Flatbed	1.16	1.10	1.68	2.36	1.50	2.06	1.32	1.59
RWUE (kg ha^{-1}mm^{-1})	BBF	3.32	2.97	2.17	3.04	2.40	2.01	1.92	2.54
	Flatbed	2.24	1.84	1.37	2.01	1.40	1.56	1.3	1.67

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Performance of broad bed & furrow (BBF) method of sowing in soybean as preparedness

The data on crop yield, net return, B:C ratio and RWUE under BBF technology as compared to farmers practice is presented in Table 4.

Data presented in Table 4 indicated that the mean soybean grain yield of 1322 kg ha^{-1} was obtained due to adoption of BBF sowing method as against the soybean yield of 878 kg ha^{-1} under normal sowing method (farmers practice). Similarly, the net returns, B:C ratio and RWUE were found to be higher due to adoption of BBF sowing technique as compared to farmers practice under variable climatic conditions over a period of 7 years (2014 to 2020). Thus, BBF technique was proved as climate resilient technique for *in-situ* moisture conservation and for enhancing crop yield under changing climate. Bheemappa *et al*. (1994) studied the effectiveness of broad bed and furrow method for groundnut cultivation on farmers field and found that BBF technology performed better for moisture conservation and higher yield. Singh *et al.* (2011) evaluated tractor drawn broad bed furrow planter to overcome moisture stress for soybean in Vertisols and found that BBF system conserved more moisture and resulted in higher soybean grain yield. Similar results were found in the present study.

Conclusions

The real time opening of conservation furrow in soybean crop was found effective for *in-situ* moisture conservation and enhancing soybean crop yield under changing climate and played an important role in dry spell mitigation. Preparedness by adoption of broad bed and furrow sowing technique (BBF) for soybean was found to be an efficient climate resilient technology under variable climatic conditions for sustaining crop productivity in Marathwada region of Maharashtra state.

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