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Farm Pond Technology for Crop Productivity Enhancement in Rainfed ecosystem of Marathwada Region of Maharashtra

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Abstract: Marathwada region is traditionally a drought-prone region. The region receives annual rainfall in the range of 500 to 1100 mm and major area comes under assured rainfall zone (60%). Rainfall in uncertain and erratic in this region and sometimes suffers from severe droughts. 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 dryspells occurred in July and August. Thus, protective irrigation to rain fed crops particularly during dryspells from harvested water in farm pond is important concept of dryland agriculture for assured crop production. Major crops of the region are soybean, cotton, pigeon pea, sorghum, green gram and black gram during *kharif* season. Similarly, gram, *rabi* sorghum and safflower are grown in *rabi* season. Based on the farmers need, technical interventions were taken up under NICRA (National Innovations in Climate Resilient Agriculture) action research project through preparedness. Farmers had constructed farm ponds through Government schemes on their field for harvesting runoff water. Similarly farmers procured sprinkler set from the Government government schemes. Farmers were advocated to apply farm pond water using sprinkler set during critical dryspells period in *kharif* and during critical growth period in *rabi* season. Optimum use of farm pond water to soybean and pigeonpea during *kharif* season resulted in increase in crop yield up to 50 per cent. Similarly, application of farm pond water to gram in *rabi* season resulted in productivity enhancement in gram.

Key words: *Dry spell, farm pond, protective irrigation, sprinkler irrigation*

Introduction

Rainfall is a basic resource for all the forms of water in semi-arid tropics. Several management options are available at farm level to increase rainwater use efficiency. Marathwada region is traditionally a drought-prone region. The region receives mean annual rainfall of 880 mm and major area comes under assured rainfall zone. In Marathwada region, out total cultivated area of 57.94 lakh ha, 49.60 lakh ha area is rain fed. The impact of climate change and variability in the region on agricultural production is quite evident in the recent years. Rainfall is the key variable influencing crop productivity of soybean under rain fed condition. Intermittent and prolonged dry spells are the major cause of yield reduction. Occurrence of frequent dry spells during critical crop growth period are common feature of the region which lowers the productivity of all crop due to moisture stress condition. The South-West monsoon account for nearly 75% of the precipitation 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 monsoon, the amount of rainfall and its distribution are crucial factors which influence the performance. The probability of erratic monsoon rains is about 40%. There is need to develop appropriate strategies to deal with such eventualities.

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Major *kharif* crops of the region are soybean, cotton, pigeon pea, sorghum, green gram and black gram. Based on the farmers need, technical interventions were taken up under NICRA action research project through preparedness and real time contingency measures. Water harvesting is one of the key component of successful rain fed farming in semi-arid regions. Harvesting surplus runoff in farm pond and recycling the same for providing protective/supplemental irrigation to *kharif* crops or supplemental irrigation to rabi crop in critical growth stages has proved at many places as successful technology for adoption. (Khan and Venkateswarlu 1993) mentioned that rainwater harvesting is necessary for increasing water availability in arid Rajasthan. (Goyal *et al.* 1995) conducted study evaluation of water harvesting pond under arid condition. (Vora *et al.* 2008) mentioned that farm pond technology is useful for enhancing crop productivity in Bhal area of Gujarat. Although the farm pond technology is well known in the country, its adoption has been low due to number of constraint. Technical interventions were taken up under NICRA action research project through preparedness. Considering the need and current emphasis on on-farm rainwater harvesting for enhancing the water productivity in rain fed region by Government, the present study on rainwater harvesting and recycling through farm pond technology for enhancing crop productivity in Marathwada region was taken up in last 5 years under NICRA component and farmers in the NICRA village were advocated and motivated for adoption of farm pond technology.

Materials and Methods

Participatory trials were conducted on farmers' fields during 2016-17 to 2020-21 under the project NICRA which is in operation at village Babhulgoan in Parbhani District in Marathwada region of Maharashtra.

Farmers had constructed farm ponds through Government schemes for harvesting runoff water. Similarly farmers procured sprinkler set. Farmers were advocated to apply farm pond water using sprinkler set during critical growth period and during critical dry spells period. Demonstration fields were selected based on the willingness of the farmers to engage in participatory research to evaluate the science based strategy. Major soils in the research area are medium black (vertisol).

More than 15 farm ponds were constructed in the NICRA village. Out of that, 3 farmers were selected for study of impact of application of farm pond water to soybean and pigeon pea in *kharif* during dry spell period and gram in *rabi* season during critical growth period. The farmers were advocated for application of farm pond water to various crops with respect to time of application and quantity of supplemental irrigation. (Freebairn *et al.*1986) studied the effect of catchment management on runoff, water quality and yield potential from vertisols. Similar procedure was adopted in the present study. The rainfall data was collected from the nearest rain gauge station. The duration of dryspells and number of dryspells were recorded every year. The runoff was estimated using SCS curve number method based on topography of the farmer's field, slope of land and land use for the year 2016 to 2020. The numbers of filling of farm pond were observed each year due to surplus runoff water. The data on crop yield in both the field i.e. irrigated and non-irrigated were recorded. Accordingly, the gross and net returns were worked out and thus the additional per cent increase in yield was analyzed.

Details of Farm Pond and micro irrigation on Farmers field

Size	:	20 m x 20 m x 3m
Storage capacity	:	746 Cubic metre.
Water lifting device	:	Diesel operated pumpset of 3.00 HP
Method of irrigation	:	Sprinkler Irrigation
Depth of irrigation	:	5 cm
Quantity of irrigation	:	500 cubic metre/ha (5 lakh litre/ ha)

Time of irrigation (Soybean and pigeon pea) : During dry spell every year

Gram: At branching every year December

Results and Discussion

The data on annual rainfall, crop seasonal rainfall, dryspell, duration and period during 2016-2020 is presented in Table 1.

Table 1. Annual, crop seasonal rainfall and dry spell details during 2016-2020

Year	Annual Rainfall, mm	Crop seasonal rainfall, mm	Number of	Duration (Number of days)	Dryspell period
2016	1159.5	1130	1	18	05/08/2016 to 22/08/2016
2017	995.7	886	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	812.1	802.4	2	25	22/07/2018 to 15/08/2018
				33	28/08/2018 to 30/09/2018
2019	964.2	859.7	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	1098.7	1004.5	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

The mean annual rainfall of the station is 880.9 mm. Out of the 5 years, above normal rainfall occurred during 4 years and below normal rainfall was observed in 1. However, the distribution of rainfall was different in every year. Out of the 5 years 3 years i.e. 2017, 2019 and 2020, 4 dryspells were observed every year which has resulted moisture stress during crop period.

Surplus runoff harvesting in farm pond

The data on annual rainfall, crop seasonal rainfall number of rain storm produced runoff, surplus runoff harvested in pond and number of fillings of farm pond per year is presented in table 2.

Table 2. Rainfall – runoff relationship related to water harvesting in farm pond

Year	Total Annual rainfall	Crop seasonal rainfall, mm	Number of rain storm produced runoff	Surplus runoff harvested in farm pond, mm	Number of filling of runoff water in farm pond
2016	1159.5	1130.0	10	330.1	4
2017	995.7	886.0	10	432.3	4
2018	812.1	802.4	08	265.4	3
2019	964.2	859.7	09	180.0	3
2020	1098.7	1004.5	08	314.4	4
Mean	**1006.04**	**936.52**	**09**	**304.44**	**3.6**
Per cent runoff				**32.50**	

Rainfall runoff relationship indicated that approximately 32.50 per cent runoff was produced from the crop seasonal rainfall. On an average 3 to 4 fillings of farm pond were observed every year thus, sufficient quantity of harvested water was available to provide supplemental irrigation to *kharif* and *rabi* crop.

The data on crop productivity, gross monetary returns, net returns and BC ratio due to application of farm pond water and without irrigation for soybean crop is presented in Table 3.

Table 3. Effect of Supplemental irrigation from harvested rainwater to *soybean*

Intervention	Seed/grain Yield (kg/ha)					Mean seed/grain yield, kg/ha	Gross Monetary Returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
	2016-17	2017-18	2018-19	2019-20	2020-21				
Farm pond water	1370	1545	1410	1395	1465	1437	48844	28344	2.38
Farmers practice	972	1140	842	832	1032	964	32766	14266	1.77

Data presented in Table indicated that due to application of farm pond water using sprinkler irrigation during dryspell, the mean soybean grain yield was recorded as 1437 kg/ha as against the soybean grain yield of 964 kg/ha in farmers practice. Further, it is observed that due to this intervention, additional 49 per cent soybean grain yield was recorded as against farmers' traditional practices. The net returns in soybean crop due to application of farm pond water during dryspell was recorded as Rs. 28344/h as against of Rs. 14266/ ha under farmers practice. The BC ratio of 2.38 was recorded under application of farm pond water as against BC ratio of 1.77 under farmers practice. (Narayanan *et al.* 1987) evaluated the impact of supplemental irrigation through farm pond on drylands, Similarly, (Rathore *et al.* 1996) conducted study on on-farm rainwater and crop management for improving productivity of rainfed areas. The results of this study confirms with the results of previous researchers.

The data on crop productivity, gross monetary returns, net returns and BC ratio due to application of farm pond water and without irrigation for pigeon pea crop on farmers field is presented in Table 4.

Table 4. Effect of supplemental irrigation

Intervention	Pigeonpea Seed/grain yield (kg/ha)					Mean seed/grain yield, kg/ha	Gross Monetary Returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
	2016-17	2017-18	2018-19	2019-20	2020-21				
Farm pond water	1172	1095	890	1180	1565	1180	66965	34965	2.09
Farmers practice	725	765	700	875	1052	823	46705	16705	1.55

Data on crop productivity and its economics for pigeonpea indicated that due to application of farm pond water using sprinkler irrigation during dry spell, the mean crop yield was recorded as 1180 kg/ha as against the crop yield of 823 kg/ha under farmers practice. The mean gross monetary returns (GMR) of Rs.

66965 /ha recorded as against the GMR of Rs. 46705 /ha under farmers practice. Further, it is observed that due to this intervention, additional 43 per cent GMR was recorded as against traditional practices. The net returns in pigeonpea crop due to application of farm pond water during dryspell was recorded as Rs. 34965/ha as against of Rs. 16705/ ha under farmers practice. The BC ratio of 2.09 was recorded under application of farm pond water as against BC ratio of 1.55 under farmers practice. (Narayanan *et.al*. 1987) conducted study on effect of supplemental irrigation through farm pond to enhance crop productivity and found yield enhancement. The results of this study confirms with the previous results.

The data on crop productivity, gross monetary returns, net returns and BC ratio due to application of farm pond water and without irrigation for gram in *rabi* season on farmers field is presented in Table 5.

Table 5. Effect of Supplemental irrigation from harvested rainwater to gram *(rabi)*

Intervention	Seed/grain yield (kg/ha)					Mean seed/grain yield, kg/ha	Gross Monetary Returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
	2016-17	2017-18	2018-19	2019-20	2020-21				
Farm pond water	895	765	640	842	869	802	37052	18552	2.00
Farmers' practice	492	486	430	590	545	509	23516	7016	1.42

Data on crop productivity and its economics indicated that due to application of farm pond water using sprinkler irrigation during branching stage, the mean gram yield was recorded as 802 kg/ha as against the mean gram yield of 509 kg/ha under farmers practice. The mean gross monetary returns (GMR) of Rs. 37052 /ha recorded as against the GMR of Rs. 23516/ha under farmers practice. Further, it is observed that due to this intervention, additional 57 per cent GMR was recorded as against farmer's traditional practice. The net returns in gram crop due to application of farm pond water during dryspell was recorded as Rs. 18552/ha as against of Rs. 7016/ ha under farmers practice. The BC ratio of 2.00 was recorded under application of farm pond water as against BC ratio of 1.42 under farmers practice. (Singh *et.al*. 2006) conducted experiment on eeconomics of rainwater harvesting and recycling for winter vegetable production in mid hills of Meghalaya and found yield increase of winter crop due to recycling of harvested water. The results of this study also confirms with the previous findings.

Conclusion

Protective irrigation from farm pond water during dryspell period to soybean and pigeon pea crop in *kharif* season resulted in increase in crop yield in the tune of 43 to 49 per cent and one supplemental irrigation to gram crop during critical growth stage in *rabi* season from farm pond using sprinkler irrigation resulted in yield enhancement of 57 per cent. The net returns in gram crop due to application of farm pond water during dryspell was recorded as Rs. 18552/ha as against of Rs. 7016/ ha under farmers practice. The BC ratio of 2.00 was recorded under application of farm pond water as against BC ratio of 1.42 under farmers practice.

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