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RESEARCH ARTICLE

Productivity, profitability and sustainability of wheat as influenced by water management practices in chambal command of Rajasthan

■ **R. S. NAROLIA, PRATAP SINGH, I. N. MATHUR and P. R. RAIGAR**

SUMMARY

On farm experiment was conducted at farmer's field of Kota and Bundi districts under operational research programme (ORP), Agricultural Research Station, Kota (Rajasthan) during five consecutive years (2005-06 to 2009-10) to assess the impact of improved water management practices for enhancing crop and water productivity of wheat crop in Chambal Command Area. Treatments comprised of irrigations scheduling at crown root initiation (CRI), late tillering, flowering and milk stages by border strip (6 m x 50 m) method using 80 per cent cut off ratio (improved water management technology) which was compared with farmer's practice *i.e.* wild flooding. Results revealed that improved water management technology gave higher and sustainable yield of wheat over the years. The mean grain yield recorded (47.3 q/ha) being 7.0 per cent higher as compared to the grain yield (44.25 q/ha) observed in farmers practice. Sustainability of wheat yield reflected by the higher pooled sustainability yield index and value index *i.e.* 0.803 and 0.675, respectively. Improved water management technology possess higher mean water expanse efficiency (139.0 kg/ha/cm) and incremental benefit cost ratio (5.0).

Key Words : Wheat, Sustainability yield index, Value index, Water management technology

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Wheat [*Triticum aestivum* (L.) Emend.Fiori and Paol.] occupies a predominant place as an important crop contributing 40 per cent in the total food grain production and grown on 21.24 lac ha area with an average productivity of 27.62 q/ha in Rajasthan. Yield of wheat crop is influenced by improved production technology and water management practices (Sharma *et al*., 2007). Irrigation scheduling, method and time of water application play an important role in enhancing the water productivity of wheat (Nadeem *et al*., 2007). Declining availability of irrigation water, needs sustainability in crop production and increasing demand of food can be achieved through adoption of improved water management and crop production technologies. Keeping this in view, field trials were conducted at farmer's field under operational research programme with the objective to enhance crop and water productivity at field level and to show the benefits of water management technology to them in real farm situatios.

MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
PRATAP SINGH, Department of Agronomy, AICRP on water management, Agricultural Research Station (M.P.U.A.&T.) Ummedganj, KOTA (RAJASTHAN) INDIA
Email: psd427@rediffmail.com, psdkd108@gmail.com

Address of the Co-authors:
R.S. NAROLIA, I.N. MATHUR AND P.R. RAIGAR, Department of Agronomy, AICRP on water management, Agricultural Research Station (M.P.U.A.& T.) Ummedganj, KOTA (RAJASTHAN) INDIA

MATERIALS AND METHODS

The study area comes under agro climatic zone V (Humid south eastern plain) of Rajasthan represents chambal command lies between 25^0 and 26^0 North latitude and 75^0-30' and 76^0-6' East longitude comprising part of Kota, Bundi and Baran districts. The soils of the chambal command are vertisols and inceptisols comprised mainly chambal series (62%) and Kota variant (23%). The bulk density, pH and cation exchange capacity of soils varies between 1.30-1.60 Mg/m^3, 7.75-8.50 and 30-40 Cmol/kg, respectively. The soils have a very low water intake rate 0.25 cm/hr on surface but are almost impermeable at 1.2 to 1.5 m depth. The potential moisture retention capacity is 120 mm of water in 1 m depth. The soils of the region are poor in organic carbon (0.45±0.08) and available nitrogen (275±5 kg/ha) but are low to medium in available P_2O_5 (24.2± 1.0 kg/ha) and medium to high in available K_2O (290 ± 6 kg/ha).

The field trials were conducted for five years (2005-06 to 2009-10) during *Rabi* season, at farmer's field under Operational Research Programme (ORP) of AICRP on water management to asses' economic feasibility and sustainability of improved water management technology in wheat crop. Every year eighteen field trials were conducted (three each at head, middle and tail reach) at left main canal (LMC) and right main canal (RMC) of chambal command, respectively.

Under improved water management technology *i.e.* four irrigation at CRI, late tillering, flowering and milk stages with 6 cm depth were applied by border strip method (6 m x 50 m) using 80 per cent cut off ratio. Beside, crop was raised with recommended package of practices *viz.*, high yielding varieties (Raj 3765 and 4037), seed treatment, recommended dose of fertilizer (120:40:30 kg/ha, NPK), weed management and seed rate (100 kg/ha) during every year. Each field trial was laid out in an area of 0.1 ha. For assessing impact of improved water management technology (IT), the adjoining field with similar area cultivated to wheat crop by the farmer himself was considered as control plot (Farmers practice). Improved water management technology was compared with farmer's practice (FP) *i.e.* flooding method of irrigation without any consideration of depth of irrigation (usually about 10 cm). In the test plots measurement of water was done by velocity-area method at field level. The field trials were sown during second week of November and harvested in third week of April of the respective year. Four irrigations were applied to the crop. In the improved water management technology only 34 cm water was applied in test block which resulted into saving of 16 cm water in comparison to farmers practice (50cm). Different parameters were determined as suggested by Prasad *et al.* (1993).

– Extension gap=Demonstration yield(Di)- Farmers practice yield (Fi)
– Technology gap= Potential yield(Pi)- Demonstration yield(Di)
– Technology index=(Pi-Di)/Pi x 100

Sustainability indices *i.e.* sustainability yield index (SYI) and sustainability value index (SVI) were calculated using the formula given by Singh *et al.* (1990).

$$\mathbf{SYI} = \frac{\textbf{Estimated average yield} - \textbf{Standard deviation}}{\textbf{Maximum yield}}$$

$$\mathbf{SVI} = \frac{\textbf{Estimated net return} - \textbf{Standard deviation}}{\textbf{Maximum net return}}$$

Data were also analyzed for parameters like standard deviation, co-efficient of variation as per standard procedure (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Grain yield :

The improved water management technology gave 47.3 q/ha mean grain yield of wheat, which was 7.0 per cent higher mean yield (44.25 q/ha) obtained under farmers practices (Table 2). Per cent increase in grain yield was 5.9 to 7.8 over farmers practice. The higher grain yield under demonstrations attributed to adoption of improved water management technology. Water expanse efficiency (139.0 kg/ha/cm) was also higher with improved water management technology. This was due to optimal depth of irrigation water applied and more yields obtained. Dhar *et al.* (2011) also reported the similar results.

Yield gap analysis :

Extension gap ranged from 2.52 to 3.48 q/ha with an average of 3.04 q/ha. This indicated gap between the improved technology and its adoption by the farmers (Table 2). Technology gap can be lowered down by strengthening the extension activities and further research to improve the package of practices. Technology index is depend up on technology gap and is expressed in per cent. Under the study, technology index varied from 12.9 - 25.0 per cent with mean of 21.0 per cent. The very low technology index (12.9) during the year 2007-08 ascribed to adoption of improved water management technology and favorable climatic conditions. High technology index shows a poor performance of package of practices and demonstrated technology. This was observed during 2008-09 (25.0 percent) and was mainly due to high temperature in the month of March resulted in force maturity of the crop. Such higher technology indices have also been reported in front line demonstrations in chickpea by Siag *et al.* (2002).

Economic analysis :

The year wise additional returns due to improved water management technology over farmer's practice varied from Rs 2520 to 3409 per hectare. The mean additional cost of inputs of the demonstrations was Rs. 620/ha (Table 3). This additional investment along with non-monitory management factors gave an additional mean return of Rs.2946/ha. The incremental benefit cost ratio (IBCR) was 5.0 under improved technology. The highest IBCR (5.4) was observed in 2007-08 and was due to higher grain yield and better market price.

Sustainability :

Higher standard deviation in yield was observed under farmer's practices over improved water management technology during all the years. Similarly co-efficient of variation was high in farmer's practices. This may be due to more variation in the yield from farmer to farmer and less in improved technology demonstrations. However, the sustainability yield index (SYI) and sustainability value index (SVI) were higher under improved technology than farmer's practices (Table 1). Improved water management practices resulted sustainability yield index of 0.903 - 0.921 and SVI was 0.880 - 0.899 with the pooled mean of 0.803 and 0.675, respectively. Under farmer's practice SYI was 0.845 -0.902 and SVI was 0.810 – 0.881 with the pooled mean of 0.788 and 0.653, respectively. Higher SYI and SVI showed that improved water management technology gave more sustainable and economical yields as compared to farmer's practice. Similar trend have also been reported by Billore *et al.* (2009)

Table 1: Variability of grain yield and net return of wheat under on farm trials

Particulars		Years											
		2005-06		2006-07		2007-08		2008-09		2009-10		Pooled	
		IT	FP	IT	FP	IT	FP	IT	FP	IT	FP	IT	FP
Grain yield (kg/ha)	H	4770	4530	4830	4760	5481	5200	4810	4750	5058	4825	4990	4813
	T	4280	3800	4270	3700	4810	4380	4280	3800	4525	4150	4433	3966
Mean yield (kg/ha)		4541	4214	4593	4266	5227	4879	4500	4248	4788	4519	4730	4425
S.D.		149.2	186.5	223.0	243.3	251.7	294.5	154.7	180.0	151.2	169.2	327.2	328.8
C.V. (%)		3.28	4.43	4.85	5.70	4.82	6.04	3.44	4.24	3.16	3.74	6.92	7.43
Net return (Rs./ha)	H	31945	30445	35686	35632	44794	42670	38800	38850	46650	44730	39575	37969
	T	27780	24240	30534	25880	38218	34634	33500	29350	40680	37170	34142	30849
Mean net return (Rs./ha)		29999	27760	33506	31083	42304	39525	35702	33832	43624	41307	37027	34707
S.D.		1267.8	1585.4	2051.4	2238.5	2466.7	2885.9	1547.0	1800.0	1693.1	1895.3	5528.3	5514.2
C.V. (%)		4.23	5.71	6.12	7.20	5.83	7.30	4.33	5.32	3.88	4.59	14.93	15.89
SYI		0.921	0.889	0.905	0.845	0.908	0.882	0.903	0.886	0.917	0.902	0.803	0.788
SVI		0.899	0.860	0.881	0.810	0.889	0.859	0.880	0.824	0.899	0.881	0.675	0.653

H= Maximum yield at head reach of canal, T= Minimum yield at tail reach of canal IT=Improved technology FP=Farmers practice S.D= Standard deviation

Table 2: Grain yield gap analysis and water expanse efficiency of wheat as influenced by water management practices

Year	Yield (kg/ha)		% increase over FP	WEE (kg/ha/cm)		Potential yield (q/ha)	Extension gap (kg/ha)	Technology gap (kg/ha)	Technology index (%)
	IT	FP		IT	FP				
2005-06	4541	4214	7.8	133.6	84.3	60.0	327	1459	24.3
2006-07	4593	4266	7.7	135.1	85.3	60.0	327	1407	23.4
2007-08	5227	4879	7.1	153.7	97.6	60.0	348	773	12.9
2008-09	4500	4250	5.9	132.4	85.0	60.0	252	1500	25.0
2009-10	4788	4519	5.9	140.8	90.4	60.0	269	1212	20.2
Average	4730	4425	7.0	139.0	89.0	60.0	304	1270	21.0

WEE=water expanse efficiency IT=Improved technology FP=Farmers practice

Table 3: Economic analysis of on farm trials of wheat

Year	Cost of cultivation(Rs./ha)		Additional cost in IT	Sale price (Rs/q.)	Total return((Rs./ha))		Additional return in IT (Rs/ha)	Effective gain (Rs/ha)	IBCR
	IT	FP			IT	FP			
2005-06	8600	8060	540	850	38599	35820	2779	2239	5.1
2006-07	8750	8160	590	920	42256	39243	3013	2423	5.1
2007-08	8920	8290	630	980	51224	47815	3409	2779	5.4
2008-09	9300	8650	650	1000	45002	42482	2520	1870	3.9
2009-10	10000	9310	690	1120	53624	50617	3008	2318	4.4
Average	9114	8494	620	974	46141	43195	2946	2326	5.0

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