Wheat water productivity in Bijori Water User Association (WUA) canal command area

DEEPAK CHOUHAN[1], RK NEMA[2], YK TIWARI[3] and KS KUSHWAHA[4]

[1]ICAR- Krishi Vigyan Kendra (JNKVV), Kalyanpur, Shahdol 484001 Madhya Pradesh, India
[2]O/o The Dean, [3]Department of Soil and Water Engineering
College of Agricultural Engineering
[4]Department of Mathematics and Statistics, College of Agriculture
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur 482004 Madhya Pradesh, India
Email for correspondence: deepakchouhan22@gmail.com

 Received: 22.02.2021/Accepted: 21.03.2021

ABSTRACT

The study was aimed at assessing the water productivity in wheat crop taken by Water User Association (WUA), Bijori canal command area in Jabalpur district, Madhya Pradesh. In the command area, among all the minors the highest discharge was obtained in Nunpur minor in case of head and tail reaches (0.443 and 0.096 m^3/s respectively) and lowest in Badayakheda minor in head, middle and tail reaches (0.025, 0.018 and 0.004 m^3/s respectively). However in middle reach the highest discharge was recorded in Piparia minor (0.209 m^3/s). The water productivity of wheat crop in Bijori WUA command area ranged from 0.25 to 0.71 kg/m^3 in head reach, 0.24 to 0.69 kg/m^3 in middle reach and 0.25 to 0.74 kg/m^3 in tail reach. Among the reaches highest water productivity was obtained in middle reach (0.51 kg/m^3) followed by tail (0.49 kg/m^3) and head (0.45 kg/m^3) reach whereas among farmers the highest water productivity was recorded in case of medium farmers (0.58 kg/m^3) and lowest in case of marginal (0.41 kg/m^3) farmers.

Keywords: Water productivity; wheat; WUA; command area; tail; reach

INTRODUCTION

Irrigated agriculture holds the key for increasing crop productivity for which a number of irrigation projects have been commissioned in India during the last fifty years. However it is seen that there is a wide gap between the irrigation potential created and that utilized under these projects. Water resources provide important benefits to humankind, both commodity benefits and environmental values. Because of the increasing scarcity of water for both its commodity and environmental benefits and scarcity of the resources required to develop water, economic consideration plays an increasingly important role in public decisions on water projects, reallocation proposals and other water policies. This has been mainly attributed to improper/inefficient water management in the command areas of irrigation projects resulting in wastage and inequitable water distribution among farmers both in terms of quantity as well as time. Farmers' contribution has been found to be regular maintenance of the canal water management (Chouhan et al 2015a, 2015c, Cheong 1971, Singh 1989). The level of education increases awareness of new technology among water user associations (WUAs) (Chouhan et al 2015b).

A WUA is a group of farmers along a lateral canal who establish their own cooperative non-profit organization with a set of rules to manage water deliveries within their area (Lohmar et al 2003). In WUA study out of 11 indicators 9 was acceptable range (Chouhan et al 2017).

Madhya Pradesh was second state to complete elections to 1470 WUAs in April 2000 and to 90 distributaries committees in February 2001 (http://www.bareactslive.com/MP/MP729.HTM). WUA's

main aim is to increase water productivity in command area development (http://www.forumfed.org/libdocs/Misc/0312-in-Rakesh-Hooja1.pdf).

Water productivity can be expressed in physical or economic terms. Physical productivity is quantity of product in kg per m^3 of water used and economic productivity is income in rupees derived by use of unit volume of water (m^3) (Molden et al 2003). WUAs constituted in the year 2008 in the state of Madhya Pradesh for different irrigation projects are working to achieve the productivity improvement of water applied.

METHODOLOGY

Study area

The study was conducted of Bijori WUA command area in Jabalpur district, Madhya Pradesh. This command area is a part of Left Bank Canal Network of Rani Awanti Bai Sagar Irrigation Project. The area lies between the 23°2'27" to 23°4'45" N latitude and 79°41'35" to 79°42'5" E longitude. The command area of Bijori WUA was 2,082 ha and there were nine minors in this WUA. The highest number of farmers in the area was of that of marginal (40%) followed by small (37%), medium (16%) and large (7%) farmers. However in case of area, largest area was with small farmers (46%) followed by large (22%), marginal (17%) and medium (15%) farmers (Fig 1).

Farmers' survey

Representative farmers were selected within the WUA command area as well as in the immediate vicinity from different categories namely marginal, small, medium and large. Selection of farmers was done using stratified random sampling technique and three farmers in each of four categories were selected in head, middle and tail reach of minors. Total 36 farmers were surveyed in each WUA area. The selected farmers were interviewed and the information on their agricultural practices, land use, crops grown, irrigation sources, irrigation practices etc were obtained.

Field observations

The discharge of minor and field channel was observed in different minors at different reaches. In minors, discharge was observed using estimates by velocity area method (Michael 2011). Cross sectional area, velocity of flow and depth of flow were measured in the minors and canal. The area of cross section, depth of flow and velocity in minors and field channel were obtained from the measurement along with the location (Table 1). Bottom width of minors was 0.30 m and side slope was 1:1.5. Depth of flow ranged from 0.29 to 0.38 m and thus the velocity was recorded as 0.27 to 0.99 m/s in the three minors.

Estimation of water productivity

This indicator relates to the performance of irrigated agriculture and performance of agricultural

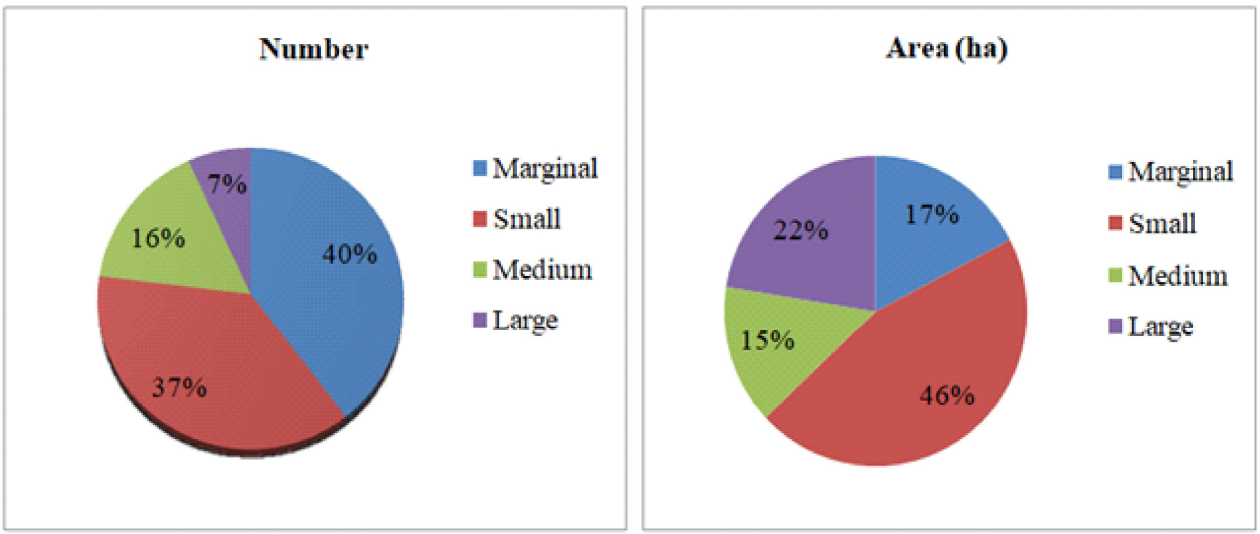

Fig 1. Total number of farmers and area in different categories

Table 1. Average cross section details, flow depth and velocity in minors

Bijori WUA	Bottom width (m)	side slope (H:V)	Top width (m)	Depth of flow (m)	Velocity of flow (m/s)
Head	0.30	1:1.5	1.06	0.38	0.99
Middle	0.30	1:1.5	1.05	0.33	0.56
Tail	0.30	1:1.5	0.91	0.29	0.27

economics of water productivity. Water productivity of WUAs is determined by quantity of water used and yield. Water productivity is quantity of product in kg/m³ of water used in field (Molden et al 2003).

$$\text{Water productivity} = \frac{Y}{Wq}$$

where Y= Yield per kg/ha as per survey, Wq= Quantity of water used per m^3/ha as per farmers survey and field observation

RESULTS and DISCUSSION

Discharge measurement: In the command area, among all the minors the highest discharge was obtained in Nunpur minor in case of head and tail reaches (0.443 and 0.096 m^3/s respectively) and lowest in Badayakheda minor in head, middle and tail reaches (0.025, 0.018 and 0.004 m^3/s respectively). However in middle reach the highest discharge was recorded in Piparia minor 0.209 m^3/s) (Table 2).

Water productivity: The water productivity of wheat crop in Bijori WUA command area ranged from 0.25 to 0.71 kg/m^3 in head reach, 0.24 to 0.69 kg/m^3 in middle reach and 0.25 to 0.74 kg/m^3 in tail reach as given in Table 3.

The highest water productivity was obtained in middle reach (0.51 kg/m^3) followed by tail (0.49 kg/m^3) and head (0.45 kg/m^3) reach whereas among farmers the harshest water productivity was recorded in case of medium farmers (0.58 kg/m^3) and lowest in case of marginal (0.41 kg/m^3) farmers as indicated in Table 4.

In Fig 2 the trend line shows that in head reach of canal, the yield level decreased as the water utilization increased. The reverse trend was observed in middle and tail reaches where it was found that the yield level was higher when water utilization was more. The water utilization in overall three reaches was minimum 2,094.80 m^3/ha in tail reach, 2,437.3 m^3/ha in middle reach and 2,521.06 m^3/ha in head reach which showed that among the three, head reach had over-utilization of water.

The yield in minimum water utilization in tail, middle and head reaches was 1,550, 1,600 and 1800 kg/ha respectively. It shows that though the yield was

Table 2. Field observations in different minors of Bijori WUA

Name of minor	Canal length (km)	Measured discharge (m^3/s) at different reaches		
		Head	Middle	Tail
Dabola	1.21	0.328	0.140	0.055
Bicuva	2.41	0.299	0.142	0.059
Nunpur	2.51	0.443	0.178	0.096
Chapra	1.22	0.200	0.144	0.083
Dulakheda	3.21	0.285	0.107	0.042
Pipariya	2.21	0.347	0.209	0.068
Jhanshi	2.18	0.287	0.139	0.060
Jamuniya	3.19	0.266	0.094	0.016
Badayakheda	2.32	0.025	0.018	0.004

Table 3. Wheat crop water productivity in the sample farmers' fields

Reach	Category of farmers	Water productivity (kg/m^3)		
		Farmer I	Farmer II	Farmer III
Head	Marginal	0.25	0.44	0.25
	Small	0.54	0.30	0.29
	Medium	0.60	0.71	0.45
	Large	0.48	0.66	0.40
Middle	Marginal	0.24	0.69	0.41
	Small	0.54	0.55	0.42
	Medium	0.62	0.66	0.63
	Large	0.45	0.48	0.39
Tail	Marginal	0.51	0.62	0.25
	Small	0.74	0.64	0.36
	Medium	0.58	0.39	0.59
	Large	0.49	0.34	0.35

Table 4. Mean water productivity of wheat

Category of farmers	Water productivity (kg/m^3) in reach			
	Head	Middle	Tail	Average
Marginal	0.31	0.45	0.46	0.41
Small	0.38	0.50	0.58	0.49
Medium	0.59	0.64	0.52	0.58
Large	0.51	0.44	0.39	0.45
Mean	0.45	0.51	0.49	

more in head reach but it was not able to compensate the head reach water productivity level due to higher water utilization with less increase in yield. Therefore it can be concluded that there was need to improve water management in head reach. Also improved water availability in tail end may further improve yield level and water productivity level to appreciable limit.

Analysis of variation of water productivity: Water productivity as obtained with wheat crop varied with respect to canal reach and also with the categories of farmers viz marginal, small, medium and large farmers. It also attained different values as per water management, canal management and water distribution works undertaken by canal reaches. Wheat productivity data were used to find out the impact of all these variations statistically.

The data given in Table 5 reveal that the calculated value of f for experimental error was 1.255 which was less than the corresponding table value of $f_{5\%(6,24)}$= 2.5082. It indicates that the experimental error of the data for Bijori WUA was found statistically non-significant. The calculated value of f for treatment fc for category (2.771) was found less than the corresponding tabulated value $F_{5\%(3,30)}$= (2.9223).

Therefore it can be concluded that the different reaches in four categories of farmers had statistically equal water productivity in WUA.

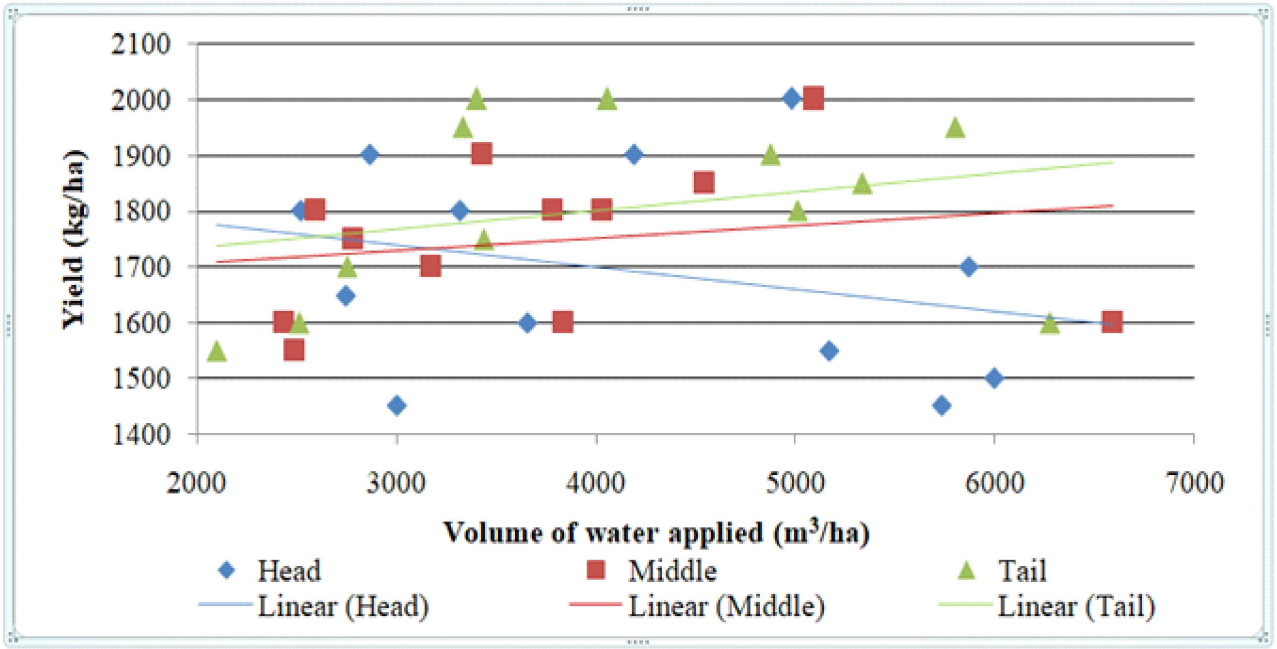

Fig 2. Variation of wheat yields with water utilization

Table 5. Analysis of variance for Bijori WUA command area

Source of variation	df	s s	ms	fc	$f_{5\%}$	Significance
Reach (r= 3)	2	0.02	0.01	0.552	19.46	NS
Category (t= 4)	3	0.15	0.05	2.771	2.9223	NS
Experimental error	6	0.128	0.022	1.255	2.5082	NS
Sampling error	24	0.425	0.017	-	-	-
Total number	35	0.723	-	-	-	-
Common error	-	-	0.0184	-	-	-

CONCLUSION

In Bijori WUA command area as the velocity decreased the discharge also decreased in head to tail reach in main canal and minors but mean of water productivity was lowest in head reach and highest in middle reach. The average of water productivity was more in case of medium farmers as compared to other farmer categories.

REFERENCES

Cheong CL 1971. Integrated farm water management. Bulletin Number 131, Ministry of Agriculture and Fisheries, Malaysia, Irrigation and Drainage Paper 10, Water Resources and Development Service, Land and Water Development Division, Rome.

Chouhan D, Nema RK and Awasthi MK 2015a. Contribution and importance of water user associations for increasing water productivity in command areas. Bhartiya Krishi Anusandhan Patrika **30(1):** 36-39.

Chouhan D, Nema RK and Awasthi MK 2015b. Working status of water user associations in command area. Ecology, Environment and Conservation **21(Aug Suppl Issue):** 177-181.

Chouhan D, Nema RK and Kushwah KS 2015c. Performance of water user associations in wheat zone of Madhya Pradesh, India. Ecology, Environment and Conservation **21(Dec Suppl Issue):** 45-50.

Chouhan D, Nema RK and Kushwah KS 2017. Physical performance in irrigation minors area under different WUAs. Journal of Agricultural Science and Technology **19(4):** 1197-1208

http://www.bareactslive.com/MP/MP729.HTM (Retrieved: 15.01.2021)

http://www.forumfed.org/libdocs/Misc/0312-in-Rakesh-Hooja1.pdf (Retrieved: 12.01.2021)

Lohmar B, Wang J, Rozelle S, Huang J and Dawe D 2003. China's agricultural water policy reforms: increasing investment, resolving conflicts and revising incentives. Agriculture Information Bulletin Number 782, Market and Trade Economics Division, Economic Research Service, United States Department of Agriculture, Washington, DC, USA.

Michael AM 2011. Measurement of irrigation water. In: Irrigation theory and practice, 2nd edn, Vikas Publishing House Pvt Ltd, New Delhi, India, pp 291-292.

Molden DJ, H. Murray-Rust H, R. Sakthivadivel R and Makin IW 2003. A water-productivity framework for understanding and action. In: Water productivity in agriculture: limits and opportunities for improvement (JW Kijne, R Barker and D Molden eds), CABI, Wallingford, UK.

Singh KK 1989. Irrigation management by farmers- the Indian experience. ASCI Journal of Management **18(2):** 93-119.