Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7137

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (6):** 439-448 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Comparative Study on Performance Evaluation of Selected Water User Association

Rohit Gupta*, Y. K. Tiwari and Satyendra Thakur

Department of Soil and Water Engineering, College of Agricultural Engineering JNKVV, Jabalpur, M.P. India

*Corresponding Author E-mail: rohitguptacae@gmail.com

Received: 7.10.2018 | Revised: 12.11.2018 | Accepted: 19.11.2018

ABSTRACT

A study was conducted on Comparative Study on Performance of Water User Associations (WUAs)". The main aim of the study was to evaluate the factors responsible for the functioning of selected Water User Association and performance evaluation of the command area of WUA's. In the present study out of the total eleven physical indicators evaluated for characterizing WUA's, nine are in acceptable range in all three WUA's and it was observed that physical indicators are found superior than other two indicators i.e. bio-economical indicator and social-organizational indicator. In terms of water productivity, Govindgarh WUA has shown highest performance in all reaches than the other WUAs. This is also indicated by farmer satisfaction and in which Tail end supply ratio was highest in Govindgarh which is in the acceptable limit and shows good availability of water in Govindgarh WUA. Bauchhar WUA has highest manpower number ratio of 0.06 followed by 0.0115 in Bijori and 0.01 in Govindgarh WUA. It proves the superiority of Govindgarh WUA among all three WUA's. Statistical analysis of data shows the Govindgarh WUA is the best among three WUA's. Farmer's categories with different canal reach are also responsible for significant variation in the crop as analyzed statistically. There is a significant variation in water productivity in head, middle and tail reach. Even higher water utilization at head reach of canal could not achieve higher water productivity as compared to tail reach.

Key words: *Water productivity, Water user association, Performance evaluation.*

INTRODUCTION

Water is the most important natural resource and universal asset. Proper planning, development, management and optimal utilization of it, is the main importance for socio- economic development of the country. Irrigated agriculture contributes much to food security and improved livelihoods of the rural population around the world. Occupying only 17% of the total cropland, irrigated agriculture produces more than 40% of the world's food. At the same time the development of the new water resources and land for irrigated agriculture in order to increase food production is increasingly less economically, environmentally and socially viable.

Cite this article: Gupta, R., Tiwari, Y. K. Thakur, S., Comparative Study on Performance Evaluation of Selected Water User Association, *Int. J. Pure App. Biosci.* **6(6):** 439-448 (2018). doi: http://dx.doi.org/10.18782/2320-7051.7137

Irrigation development in India is mainly from three sources *viz.* canals, wells and tanks as per demand for irrigation as well as technologies developed for storing, transporting and lifting of water. It is necessary to achieve maximum returns per unit of water used from cropping activities.

Command area development program (CADP) was launched exclusively to reduce the physical and time gap between irrigation potential created and its actual utilization through systematic land development, scientific water management and appropriate extension methods[8].

Water User Association

Canal irrigation is one of the principal method used for improving the crop productivity of India. In order to have the equal distribution of canal water and to reduce the dependability in canal repair and maintenance on governing bodies, the government has created their Water User Association (WUA). A Water User Association (WUA) is a co-operative association of individual water users who wish to undertake water – related activities for their mutual benefit along a lateral canal with a set of rules to manage water deliveries within their area[5]. Functions of WUA are to prepare and implement a warabandi schedule for each irrigation season, promote economy in the use of water allocation, monitor flow of irrigation, prepare and maintain an inventory of the irrigation system within the area of operation, raise resources and to conduct regular water budgeting along with periodical social audit. 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. WUA's main aim is to increase water productivity in command area[3].

Water Productivity

It is defined as the ratio of net benefits from crop, forestry, livestock, and mixed agricultural systems, to amount of water required to produce these benefits. Water productivity depends on several factors like crop genetic material, water management practices and agronomic practices. 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)[6].

MATERIAL AND METHODS

Performance assessment of a command area has been focused on internal processes of irrigation systems. The type of performance measures chosen depends on the purpose of the performance assessment activity. It is useful to consider an irrigation system in the context of nested systems to describe different types and uses of performance indicators. Many internal process indicators related to assess performance of any irrigation system were analyzed. The area selected for the present study is command area under three WUAs at their locations in Madhya Pradesh. They are Bijori WUA in Jabalpur district, Bauchhar WUA in Narsinghpur district and Govindgarh WUA in Rewa district . Bijori and Bauchhar WUAs are a part of Left Bank Canal of Rani Awanti bai Sagar Irrigation Project and Govindgarh WUA is under Govindgarh tank.

The major crops grown in the area during rabi season are Wheat, Gram, Lentil, Pea, Arhar and some Vegetables crops and in kharif season the main crop is paddy. The data collection was carried out with the help of water resources department, district revenue department and meteorological department of JNKVV, Jabalpur. Few farmers and WUA Presidents were consulted about the general condition of WUA's and irrigation project. Selected WUAs were surveyed and information was collected on Gross command area, cultivable command area, total number of structures, total number of damaged structures, water charges collection, expected water charges collection, total number of minors, total length of canal, total number of days water available in canal, total number of staff working in WUA, canal irrigated area, tube well irrigated area. This information was tabulated and analyzed characterizes the WUA. All the information was collected with the help of questionnaire of 36 farmers, 12 farmers from every reach *viz.* (head, middle and tail) from every WUA.

Performance Indicators

Performance indicators as proposed by Nelson[7] were used for evaluating the irrigation project commanded by WUA. These indicators are grouped into four categories namely, Water deliveries, Maintenance, Financial and Sustainability indicator.

Water Deliveries

Quality of water deliveries is evaluated in terms of tail-end supply ratio, area uniformity and delivery timeliness ratio.

1. Tail-end Supply Ratio (TSR)

TSR =Ns/Nt

Ns = the no. of days that sufficient water reached the end of canal system.

Nt = the total no. of days the canal system was delivering water.

2. Area Uniformity (AU)

AU = Dw/Davg

Dw = the water depth for the worst supplied area on the system (mm).

Davg= the average water depth supplied to the whole system during the same time period (mm).

3. Delivery Timeliness Ratio (DTR)

DTR = Nt/NT

Nt = the no. of orders where water was delivered within the target time

NT = the total no. of orders.

Maintenance

Maintenance work in WUA is evaluation through Carrying capacity ratio and Poor structure ratio.

1. Carrying Capacity Ratio (CCR)

CCR = Ca/Cd

Ca = the actual capacity for the selected canal(mm^3).

Cd = designed canal capacity for the selected canal(mm^3).

2. Poor Structure Ratio (PSR)

PSR = Np/NT

Np = no. of structures in poor condition.

NT = the total no. of structures on the system.

Financial: Financial indicators namely, Fee collection performance, Maintenance budget ratio, Personnel cost ratio and Manpower number ratio are used to evaluate financial status of WUA.

1. Fee collection performance(FCP) = Fc/Fa

Fc = annual irrigation fee collected (Rs).

Fa = total annual fees assessed (Rs).

2. Maintenance Budget Ratio

MBR = Em/Eo &m

Em = annual maintenance expenditures (Rs).

Eo & m= total operation & maintenance expenditure (Rs).

3. Personnel Cost Ratio

$$\text{Personnel Cost Ratio} = \frac{Ep}{Et}$$

Ep = annual expenditures on personnel (wages, fringe benefits, training, etc.) as per WUA records(Rs)

Et = total annual expenditures as per WUA records (Rs).

4. Manpower Numbers Ratio

Manpower Number Ratio = Ns/At

Ns = is number of staff.

At = is total irrigated area (ha).

Sustainability

Sustainability indicators are sustainability of area and Area/ Infrastructure ratio.

1. Sustainability of Irrigated Area

SIA = Ac/Ai

Ac = current irrigated area (ha).

Ai = initial irrigated area when the system was first full Developed (ha).

2. Area/ Infrastructure Ratio

AIR = At/Lc

At= irrigated area (ha).

Lc = total length of canal & laterals on the system (km).

Bio-economical Indicator

Water productivity is quantity of product in kg per m^3 of water used in field.

Water Productivity = Y / Wq

Y = Yield per ha ,kg as per surveyed

Wq = Quantity of water use per ha,m^3 as per farmers survey and field observation.

RESULTS AND DISCUSSION

Various performance indicators were evaluated for project performance assessment, which has already been discussed. Table presents the computed values of performance indicators for WUAs . There are nine minors

under the jurisdiction of this WUA. Average value of indicators are presented in Table and reference values as found in literature are also presented as reference range. Water delivery indicators namely Tail-end supply ratio (0.50), area uniformity ratio (0.73) and delivery timeliness ratio (1) are within the reference range, hence this can be said satisfactory in Bijori (WUA1), Sustainability indicators are also found satisfactory. However poor structure ratio was found very high as 0.65 and manpower number ratio was also observed as 0.0115 which seems to be very high as compared to reference range.

Similar trend of values in indicators was found in case of Bauchhar (WUA 2) and Govindgarh (WUA 3). Poor structure ratio of 0.85 and 0.46 indicate the poor condition of structure and high man power number ratio and 0.04, 0.01 shows engagement of more staff then optimum.

Performance of Water User Association

Parameters	Performance indicator	Basic Input	Input Value			Value			Reference range
			WUA1	WUA2	WUA3	WUA1	WUA2	WUA3	
Water Deliveries	Tail-end Supply Ratio	Ns Nt	61 120	57 120	73 120	0.50	0.47	0.61	0.50-0.70
	Area uniformity Ratio	Dw DAvg	6356 8751	5140 7016	2456 5398	0.73	0.73	0.45	0.50-0.90
	Delivery Timeliness Ratio	Nt *Nt*	4 4	3 4	4 4	1	0.75	1	0.72-0.90
Maintenance	Carrying Capacity Ratio	Ca Cd	265 307	257 299	365 371	0.86	0.86	0.98	0.60-1.0
	Poor Structure Ratio	Np Nt	250 382	161 189	117 257	0.65	0.85	0.46	0.01-0.20
Financial	Fee Collection Performance	Fc Fa	314333 417478	45552 69480	299031 356850	0.75	0.66	0.84	0.62-1.0
	Maintenance Budget Ratio	Em Em&om	54461 90875	27952 58238	43190 72076	0.60	0.48	0.60	0.40- 0.70
	Personnel Cost Ratio	Ep Et	46393 86168	31938 59780	43011 72283	0.54	0.53	0.60	0.50-0.60
	Manpower Numbers Ratio	Ns At	23 1992	16 363	17 1535	0.0115	0.04	0.01	0.0004-0.001
Sustainability	Sustainability of Irrigated Area	Ac *Ai*	1992 2080	363 838	1535 1722	0.96	0.43	0.89	0.50-1.0
	Area/Infrastructure Ratio	At Lc	1850 20.46	363 14	1535 13	97.38	26.45	122.80	

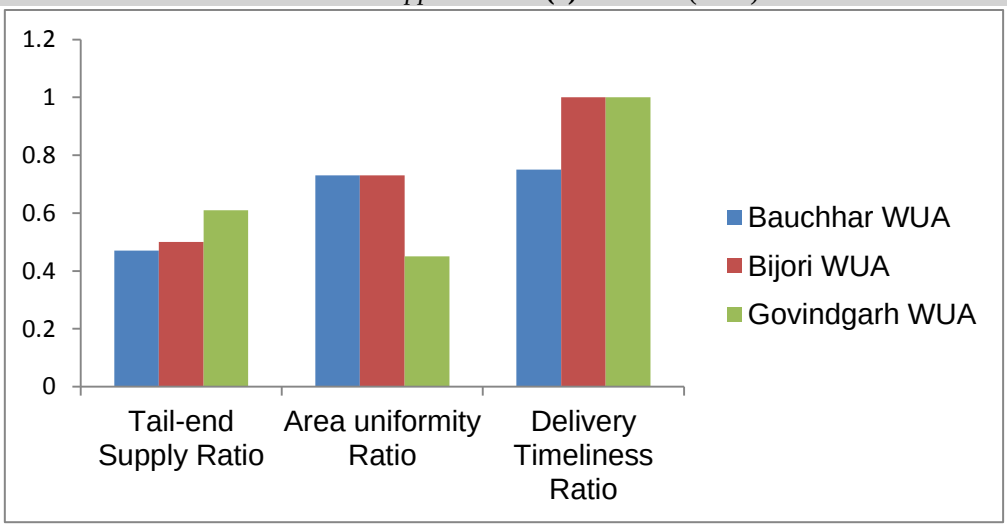

Fig. Water Deliveries performance indicator in different WUAs

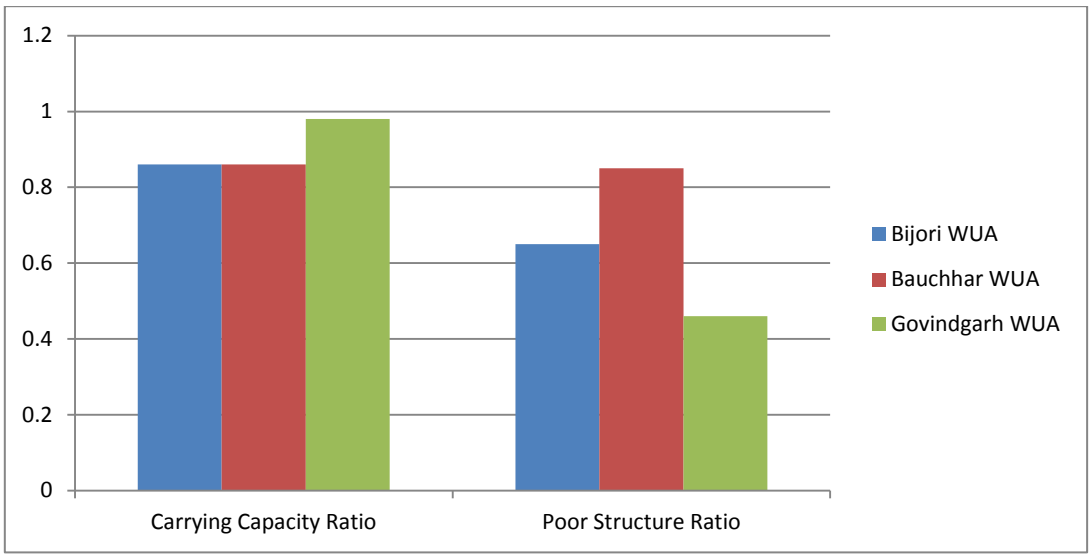

Fig. Maintenance performance indicator in different WUAs

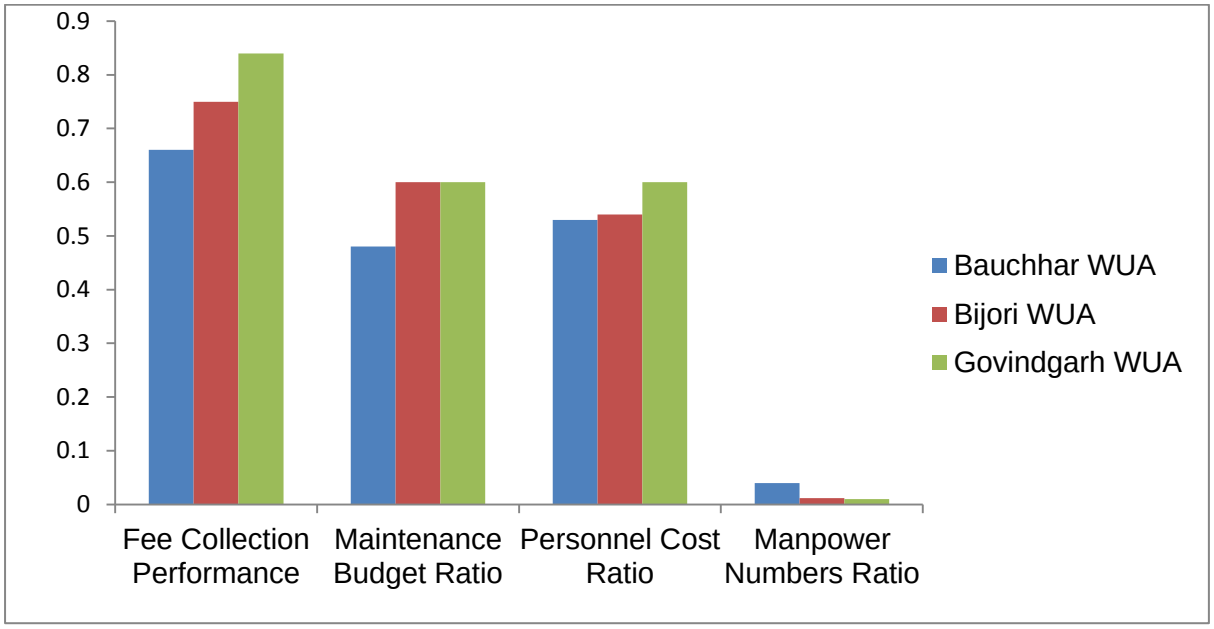

Fig. Financial performance indicator in different WUAs

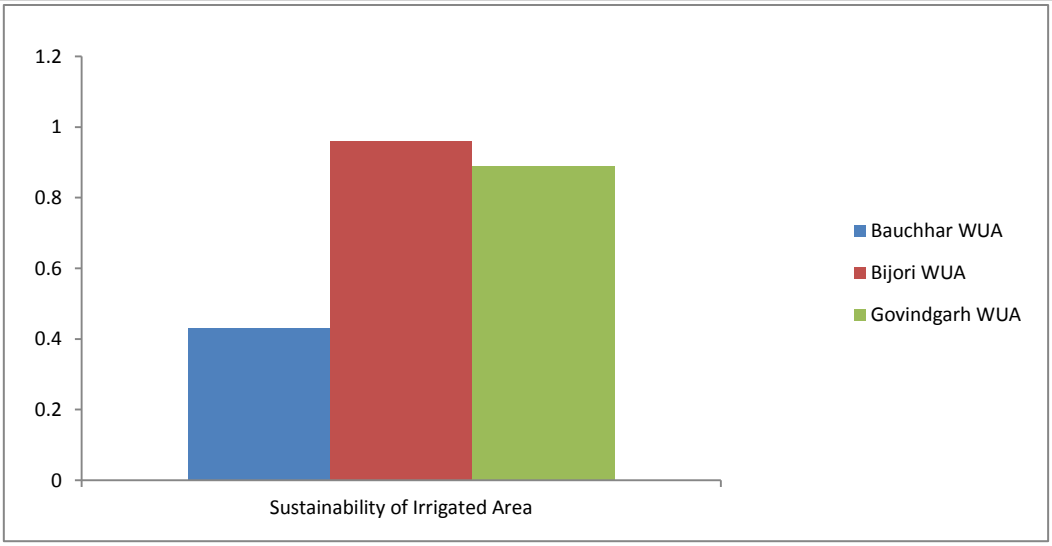

Fig Sustainability of irrigated area in different WUAs

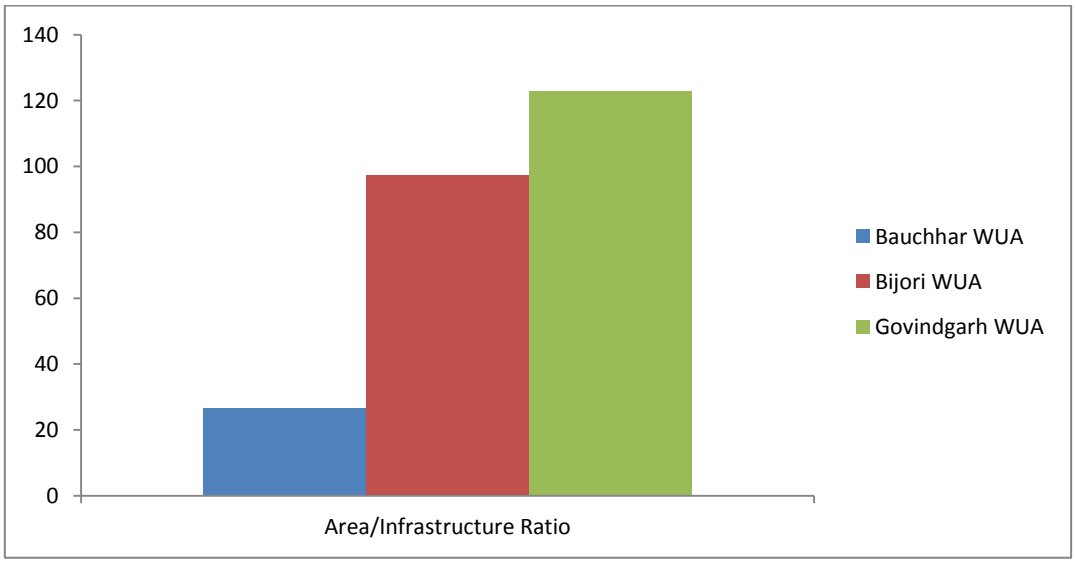

Fig. 4.13 Area/Infrastructure ratio in different WUAs

Water Productivity

Water Productivity at head reach

WUA Name	Farmer Category	Water Productivity (kg/m^3)		
		Wheat	Gram	Pea
Bijori WUA	Marginal	0.40	-	-
	Small	0.44	1.34	-
	Medium	0.64	2.05	0.47
	Large	0.60	2.07	0.32
Govindgarh WUA	Marginal	0.61	-	-
	Small	1.07	0.55	-
	Medium	1.35	2.25	-
	Large	0.93	1.19	-
Bauchhar WUA	Marginal	0.47	-	-
	Small	0.67	1.08	-
	Medium	0.62	1.06	-
	Large	0.67	1.03	0.15

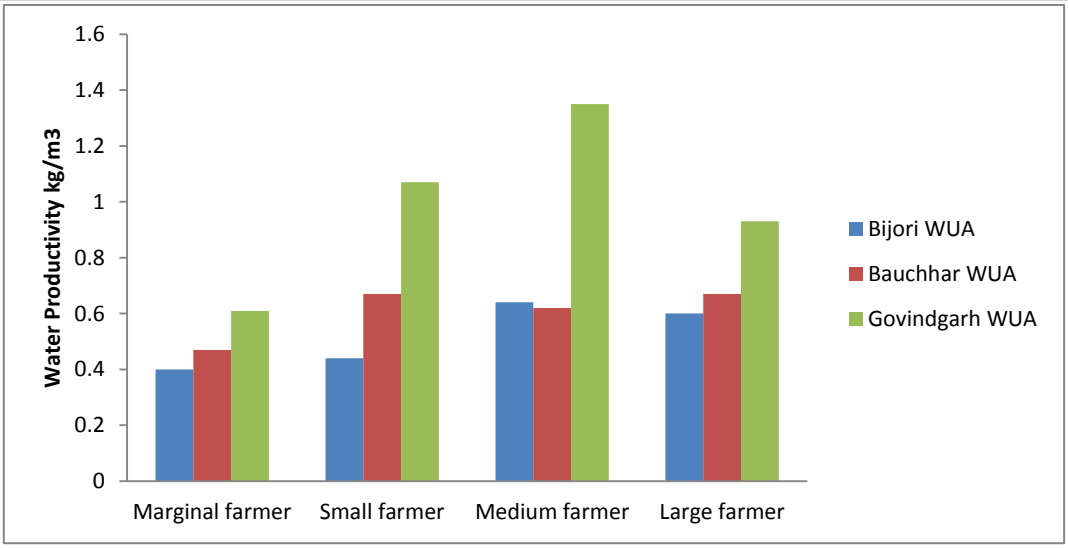

Fig. Water Productivity of Wheat at Head Reach in Different WUA's

Table Water Productivity at middle reaches in different WUA's

WUA Name	Farmer Category	Water Productivity (kg/m^3)		
		Wheat	Gram	Pea
Bijori WUA	Marginal	0.59	-	-
	Small	0.56	2.39	-
	Medium	0.85	1.53	0.19
	Large	0.59	1.97	0.32
Govindgarh WUA	Marginal	0.96	-	-
	Small	1.62	1.37	-
	Medium	1.25	1.10	-
	Large	1.53	1.36	-
Bauchhar WUA	Marginal	0.68	-	-
	Small	0.88	1.41	-
	Medium	1.55	1.41	-
	Large	1.13	1.35	0.15

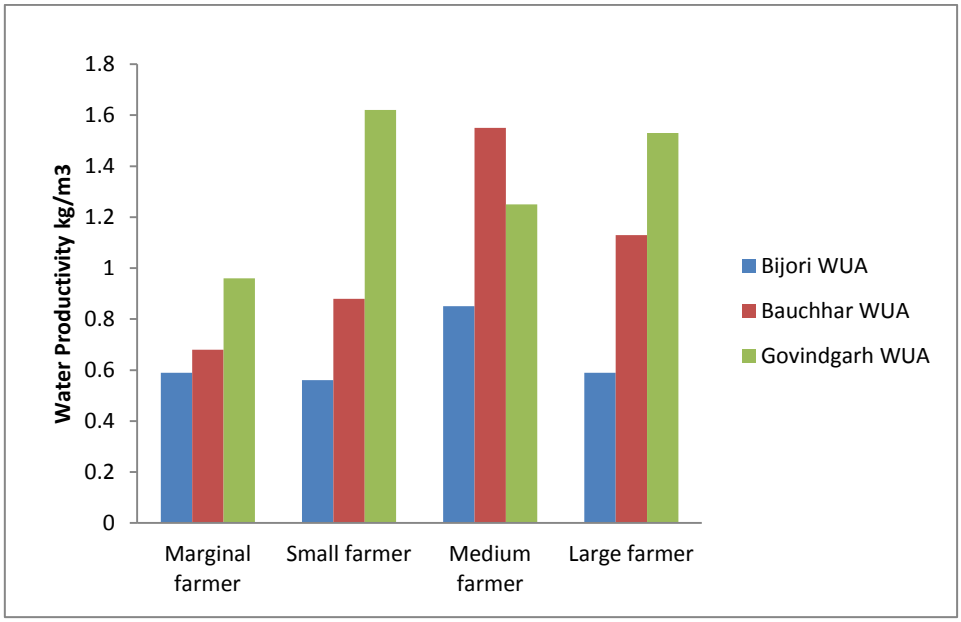

Fig. Water Productivity of Wheat at middle Reach in Different WUA's

Table Water Productivity at tail reaches in different WUAs

WUA Name	Farmer Category	Water Productivity (kg/m^3)		
		Wheat	Gram	Pea
Bijori WUA	Marginal	0.77	2.01	-
	Small	0.64	-	-
	Medium	0.60	-	0.58
	Large	0.48	4.01	0.43
Govindgarh WUA	Marginal	0.70	-	-
	Small	1.12	2.05	-
	Medium	2.09	2.25	-
	Large	2.06	2.56	-
Bauchhar WUA	Marginal	1.38	1.00	-
	Small	0.95	-	-
	Medium	1.45	-	0.15
	Large	1.41	1.39	0.17

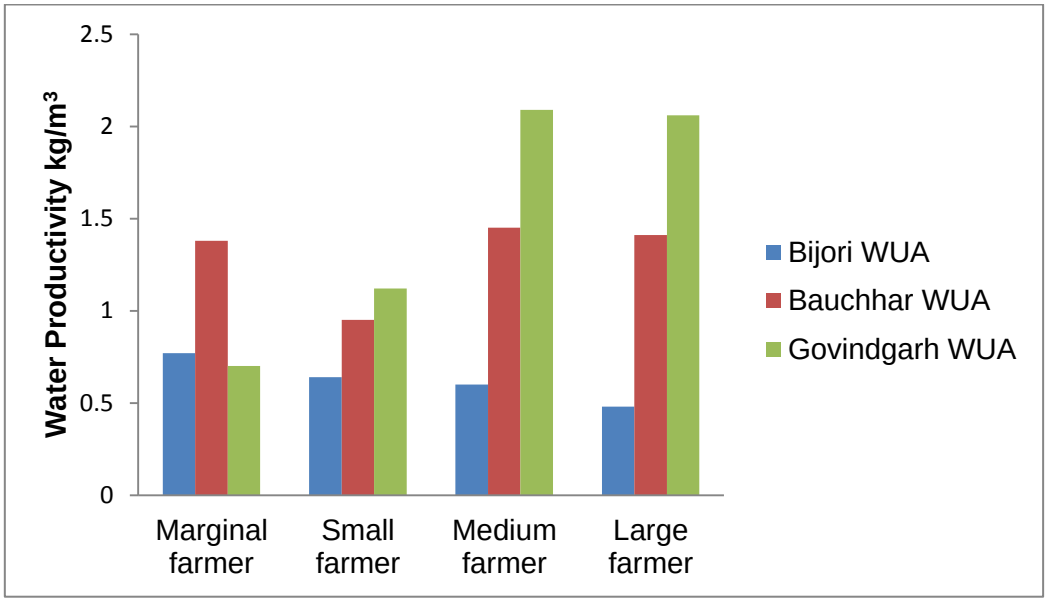

Fig. Water Productivity of Wheat at tail Reach in Different WUA's

CONCLUSION

Out of the total eleven physical indicators evaluated for characterizing WUA, nine are in acceptable range and it was observed that physical indicators are found superior than bio-economical indicator.

Physical indicators:

1. Tail-end supply ratio in Bijori WUA, Bauchhar WUA and Govindgarh WUA is 0.50, 0.47 and 0.61. This ratio was highest in Govindgarh WUA because sufficient canal water available for irrigation in tail reach.
2. Area uniformity ratio was 0.73, 0.73 and 0.45 in Bijori WUA, Bauchhar WUA and Govindgarh WUA respectively. This ratio is lowest in Govindgarh WUA because tail end farmers are wasting less canal water compared to other two WUAs.
3. Delivery timeliness ratio in Bijori WUA, Bauchhar WUA and Govindgarh WUA are 1, 0.75 and 1 respectively. It is lowest in Bauchhar WUA, because the canal water is not available in irrigation time.
4. Carrying capacity ratio in Bijori WUA is 0.86, in Bauchhar WUA is 0.86 and 0.98 in Govindgarh WUA. Carrying capacity ratio is highest in Govindgarh WUA because canal water discharge is near to design discharge.

5. Poor structure ratio is obtained at Bijori WUA 0.65, in Bauchhar WUA 0.85 and 0.46 in Govindgarh WUA respectively. In Bauchhar WUA poor structures is more as compared to other two WUAs so poor structure ratio is high in Bauchhar WUA.
6. Fee collection performance is 0.75, 0.66 and 0.84 in Bijori WUA, Bauchhar WUA and Govindgarh WUA respectively. Fee collection performance is highest in Govindgarh WUA as compared to other two WUAs. This was possible due to awareness among farmers.
7. Maintenance budget ratio of Bijori WUA is 0.60, 0.48 for Bauchhar WUA and 0.60 in Govindgarh WUA respectively. In Bijori WUA more expenditure in maintenance so this ratio is more in this WUA.
8. Personnel cost ratio is calculated for Bijori WUA, Bauchhar WUA and Govindgarh WUA is 0.54, 0.53 and 0.60 respectively. Govindgarh has personnel cost ratio as more because expenditure in personnel activity like training, wages etc. was more in this WUA.
9. Manpower number ratio in Bijori WUA, Bauchhar WUA and Govindgarh WUA is 0.0115, 0.04 and 0.01 respectively. In Bauchhar WUA number of staff is less and cultivable command area is more as compared to other WUAs.
10. Sustainability of irrigated area in Bijori WUA Bauchhar WUA and Govindgarh WUA is 0.96, 0.43 and 0.89 respectively. In Bijori WUA sustainability of irrigated area is higher as compared to other WUAs because irrigated area is more than other WUAs.
11. Area/infrastructure ratio is 97.38, 26.45 and 122.80 in Bijori WUA, Bauchhar WUA and Govindgarh WUA respectively. Govindgarh WUA has more Area/infrastructure ratio because in this WUA, number of structure and length of structure is less and irrigated area is more as compared to other two WUAs.

Bio-economical indicator

1. The water productivity range of wheat was found to be 0.32-0.77 kg/m^3, 0.51-1.52 kg/m^3 and 0.46-0.92 kg/m^3 in Bijori WUA, Govindgarh WUA and Bauchhar WUA in head reach, 0.37-0.90 kg/m^3, 0.67-1.68 kg/m^3 and 0.63-1.74 kg/m^3 in middle reach and 0.41-0.80 kg/m^3, 0.62--2.41 kg/m^3 and 0.81-1.88 kg/m^3 in tail reach.
2. The range of water productivity of gram in Bijori WUA, Govindgarh WUA and Bauchhar WUA was found to be 0.92-3.16 kg/m^3, 0.52-2.81 kg/m^3 and 0.82-1.30 kg/m^3 in head reach, 0.77-2.88 kg/m^3, 0.97-1.75 kg/m^3 and 1.24-1.47 kg/m^3 in middle reach and 2.86-5.68 kg/m^3, 1.67-3.05 kg/m^3 1.00-1.91 kg/m^3 in tail reach.
3. Govindgarh WUA command area has no pea crop. Water productivity of pea crop in Bijori WUA and Bauchhar WUA is 0.32-0.47 kg/m^3 and 0.15 kg/m^3 in head reach, 0.17-0.32 kg/m^3 and 0.12-0.18 kg/m^3 in middle reach and 0.32-0.58 kg/m^3 and 0.14-0.17 kg/m^3 in tail reach.

REFERENCES

1. Chouhan, D., Comparative Study on Canal Water Management through Water User Association (WUA). An unpublished M.tech thesis, JNKVV, Jabalpur. (2013).
2. Chouhan, S.S., Studies on irrigation performance in initial reach of Left Bank Canal network of Rani Avanti Bai Sagar Irrigation Project. An unpublished M.Tech thesis, JNKVV, Jabalpur. 2009.
3. Hooja, R., Below the Third Tier Water User Association in India. Forum of federation - www.forumfed.org (2005).
4. Kazbekov, J., Abdullaev, I., Manthrithilake, H., Qureshi, A., Jumaboev, K., Evaluating planning and delivery performance of Water User Association (WUAs) in Osh Province, Kyrgyzstan. *Agricultural Water Mamagement.* **(**2009).
5. Lohmar, Bryan, wang, jinxia, rozelle, scott, Huang, Jikun, Dawe, and David., China's agricultural water policy reforms: increasing investment, resolving conflicts, and revising incentives. Market and Trade Economics of Agriculture. *Agriculture*

Information Bulletin Number 782, Washington, DC. (2003).

6. Molden, D., Merry, H., Sakthivadivel, R. and Ian Makin., A Water Productivity Framework for Understanding and Action. *International Water Management Institute, Colombo, Shri Lanka*. (2003).
7. Nelson, D.E., Performance Indicators for Irrigation Canal System Managers of Water Users Association. Updated version of a presentation at the international congress on Irrigation and Drainage, Montrel Canada. (2002).
8. Shah, Tushar., Past, Present and the Future of Canal Irrigation in India. *International Water Management Institute, Colombo, Sri Lanka*. (2011).