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Performance evaluation of Bijori water user association in district Jabalpur M.P

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Abstract
A study was conducted on "Performance evaluation of Bijori Water User Association (WUA) in Jabalpur". The main aim of the study was 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 WUA and it was observed that physical indicators are found superior than bio-economical indicator. In terms of water productivity, highest water productivity of wheat achieved in middle reach medium farmer category, like this highest water productivity of gram and pea are found in tail reach large and medium farmer category respectively. This is also indicated by farmer satisfaction and in which Tail end supply ratio was in the acceptable limit and shows good availability of water in Bijori WUA. Manpower number ratio 0.0115 in Bijori WUA. Farmer's categories with different canal reach are also responsible for significant variation in the crop as analyzed. 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.

Keywords: 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. 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 (Shah, 2011) [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 (Lohmar *et al*., 2003) [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 (Hooja, 2005) [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) (Molden *et al*., 2003) [6].

Materials 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 Bijori WUA in Jabalpur district is a part of Left Bank Canal of Rani Awanti bai Sagar Irrigation Project. The command area of Bijori WUA lies between the 23º2'27" to 23º4'45" N latitude and 79º41'35" to 79º42'5" E longitude. 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 WUA was 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).

Performance Indicators

Performance indicators as proposed by Nelson (2002) 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. (Molden *et al*, 2003) [6].

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

Performance evaluation of command area 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 WUA, 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.

Performance of Bijori Water User Association

Parameters	Performance Indicator	Basic Input	Input Value	Value	Satisfactory range
Water Deliveries	Tail-end Supply Ratio	Ns	61	0.50	0.50-0.70
		Nt	120		
	Area uniformity Ratio	Dw	6356	0.73	0.50-0.90
		DAvg	8751		
	Delivery Timeliness Ratio	Nt	4	1	0.72-0.90
		Nt	4		
Maintenance	Carrying Capacity Ratio	Ca	265	0.86	0.60-1.0
		Cd	307		
	Poor Structure Ratio	Np	250	0.65	0.01-0.20
		Nt	382		
Financial	Fee Collection Performance	Fc	314333	0.75	0.62-1.0
		Fa	417478		
	Maintenance Budget Ratio	Em	54461	0.60	0.40- 0.70
		Em&om	90875		
	Personnel Cost Ratio	Ep	46393	0.54	0.50-0.60
		Et	86168		
	Manpower Numbers Ratio	Ns	23	0.0115	0.0004-0.001
		At	1992		
Sustainability	Sustainability of Irrigated Area	Ac	1992	0.96	0.50-1.0
		Ai	2080		
	Area/Infrastructure Ratio	At	1850	97.38	
		Lc	20.46		

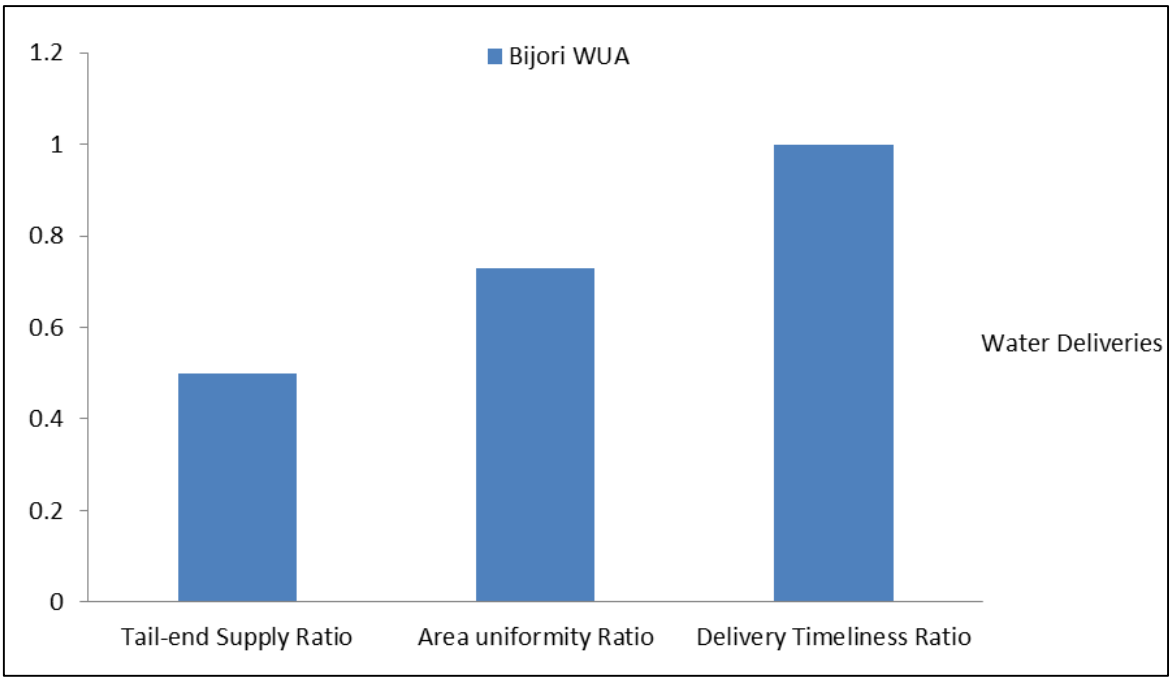

Fig 1: Water Deliveries performance indicator in WUA

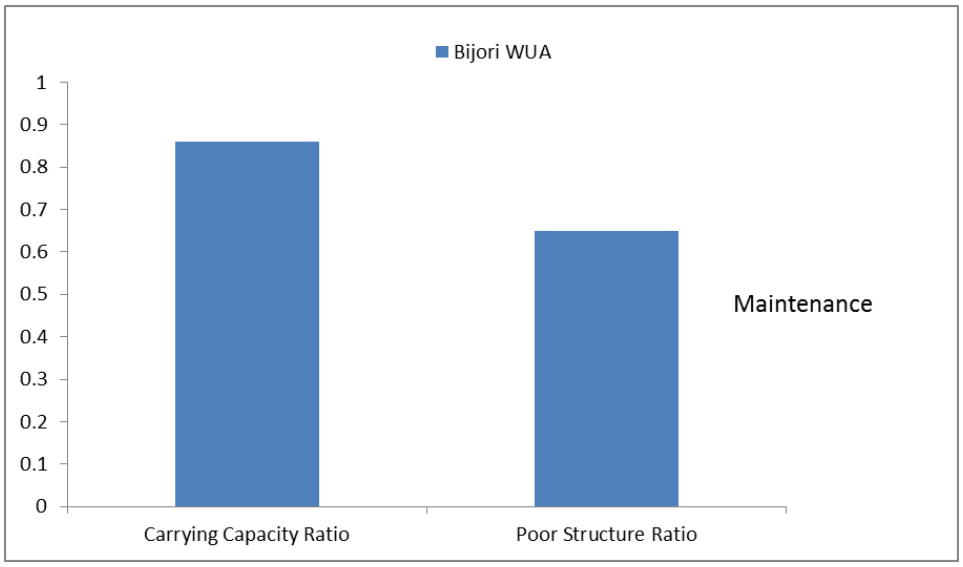

Fig 2: Maintenance performance indicator in WUA

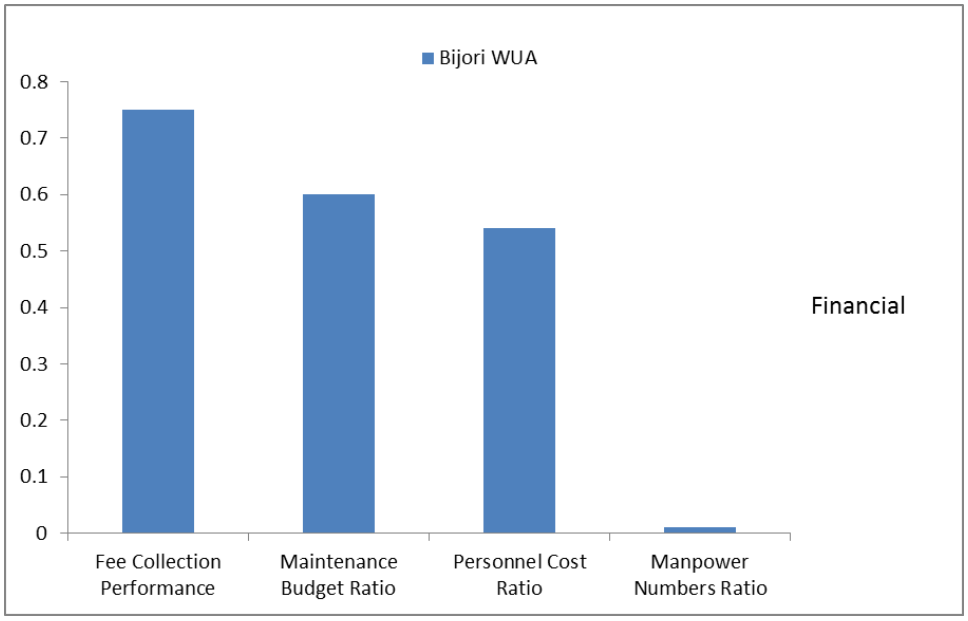

Fig 3: Financial performance indicator in WUA

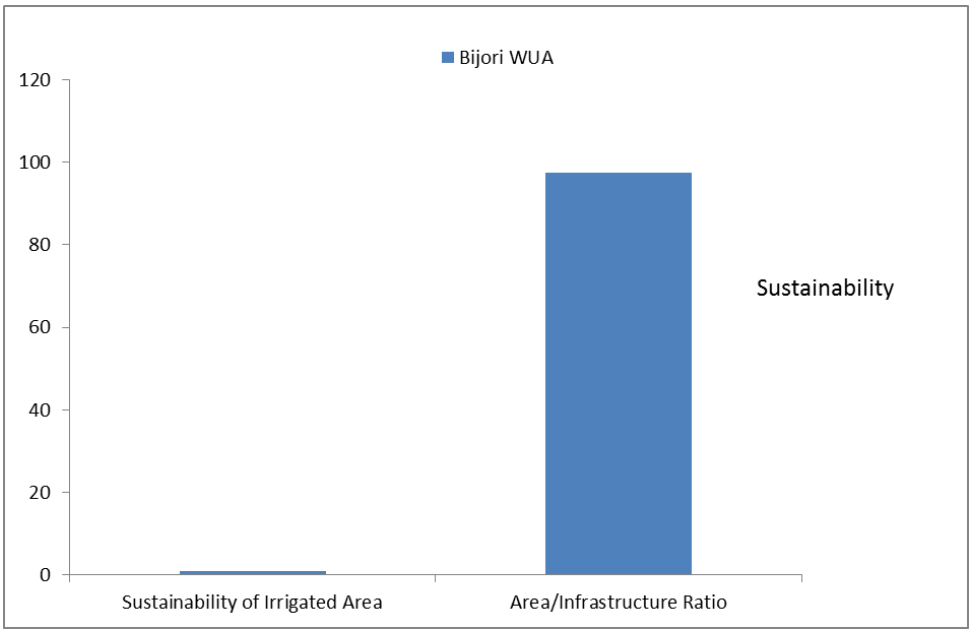

Fig 4: Sustainability performance indicator in WUA

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

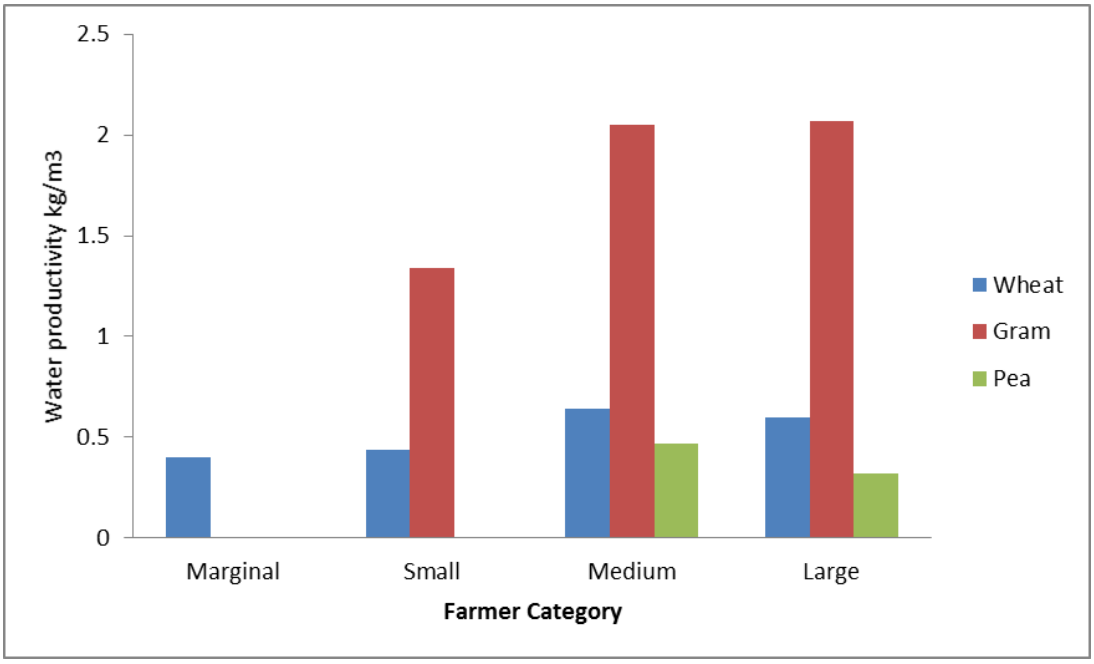

Fig 5: Water Productivity at head reach

Water Productivity at middle reach

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

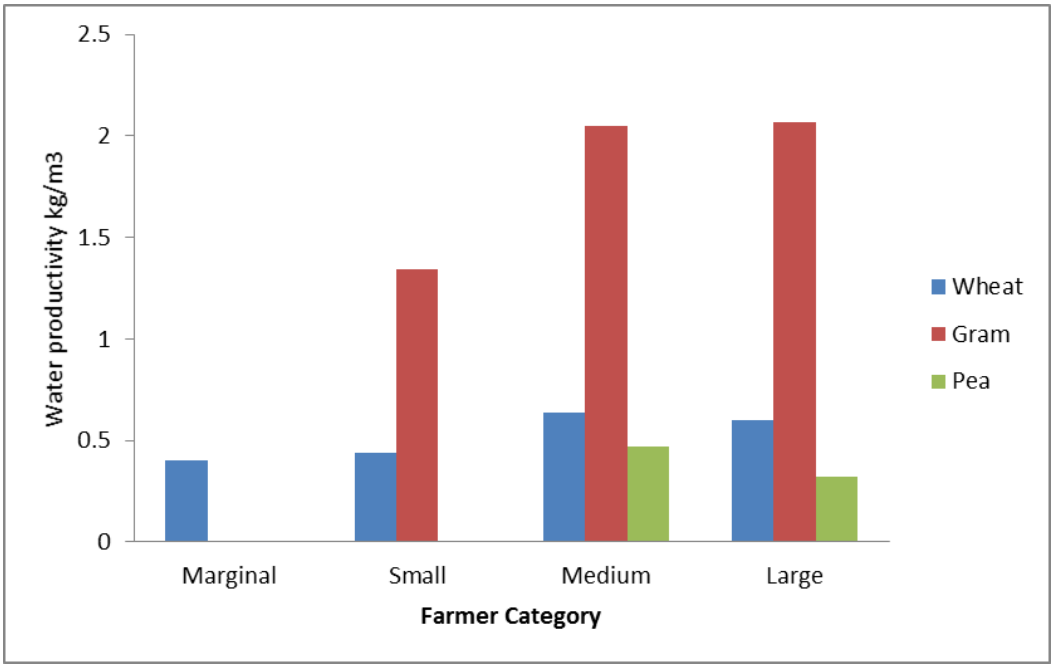

Fig 6: Water Productivity at middle reach

Water Productivity at tail reach

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

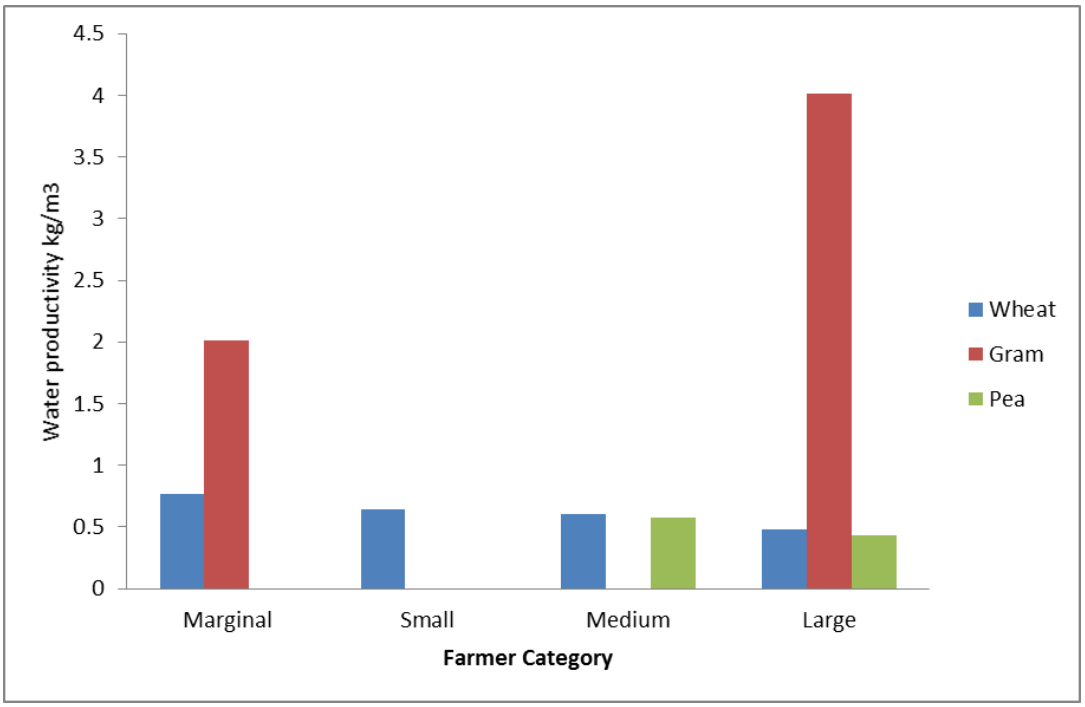

Fig 7: Water Productivity at Tail reach

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 is 0.50.
2. Area uniformity ratio was 0.73 in Bijori WUA.
3. Delivery timeliness ratio in Bijori WUA.
4. Carrying capacity ratio in Bijori WUA is 0.86.
5. Poor structure ratio is obtained at Bijori WUA 0.65.
6. Fee collection performance is 0.75 in Bijori WUA.
7. Maintenance budget ratio of Bijori WUA is 0.60.
8. Personnel cost ratio is calculated for Bijori WUA is 0.54.
9. Manpower number ratio in Bijori WUA is 0.0115.
10. Sustainability of irrigated area in Bijori WUA is 0.96.
11. Area/infrastructure ratio is 97.38 in Bijori WUA.

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 head, middle and tail reach in Bijori WUA.
2. The range of water productivity of gram in Bijori WUA was found to be 0.92-3.16 kg/m^3 in head reach, 0.77-2.88 kg/m^3 in middle reach and 2.86-5.68 kg/m^3 in tail reach.
3. Water productivity of pea crop in Bijori WUA is 0.32-0.47 kg/m^3 in head reach, 0.17-0.32 kg/m^3 in middle reach and 0.32-0.58 kg/m^3 in tail reach.

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