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Performance evaluation of west Banas irrigation project using technical indicators

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Abstract
Irrigation systems must have to be evaluated by acceptable indicators for expected outputs. Due to inappropriate, inadequate and wrong management of irrigation systems, farmers cannot obtain desirable outputs. In this study, five technical indicators which are developed by International Water Management Institute (IWMI) were applied on Right main canal of West Banas irrigation project, Sirohi region in Rajasthan (India) to evaluate system performance. Normal on-ranch application proficiency was discovered to be 80.42 percent. Harvest water use proficiency of Wheat and Gram accomplished greatest estimations of 49.51 Kg/ha-cm, 41.09 Kg/ha-cm in 2015-16. Grain achieved most extreme estimation of 73.27 kg/ha-cm in 2014-15. While Mustard accomplished greatest estimation of 37.00 Kg/ha-cm in 2015-16. Wheat performed reliably well from 2013-14 to 2017-18 and accomplished most noteworthy estimation of Field Water Use Efficiency (FWUE) of 42.87 Kg/ha-cm in year 2016-17. Grain got most elevated FWUE in 2015-16 with estimation of 51.54 Kg/ha-cm. Gram accomplished most elevated estimation of FWUE in year 2013-14 with esteem of 31.54 Kg/ha-cm. though Mustard got most elevated an incentive in year 2015-16 having FWUE of 25.94 Kg/ha-cm.

Keywords: Technical Indicators, FWUE, Water use efficiency, Grain

1. Introduction
Technical performance indicators make it possible to see how well-irrigated agriculture is performing at the system, basin or national scale. As a tool for measuring the relative performance of irrigation systems or tracking the performance of individual systems the IWMI comparative performance indicators help.
The aim of this study is to determine irrigation performance with technical indicators. No such investigation has been done in the region so far. Therefore, system managers can develop new strategies. Technical indicators will provide a chance to policymakers and planners to evaluate how productively land and water resources are being used for agriculture, and to make more informed strategic decisions regarding irrigation and food production. Researchers use these indicators to compare irrigation systems and identify factors that lead to better performance.

2. Description of study area
The Right Main Canal of West Banas Irrigation Project has been considered in this study, Sawrupganj a tehsil headquarter in the district Sirohi. The selected study site is accessible by a 2 km long road from Dhaneri village.

3. Methodology
In the present study, comparative indicators are used to evaluate the system performance of Right Main Canal which enables policymakers and planners to see how productive their use of water and land for agriculture is. They help answer important strategic questions, such as: What types of systems are getting the most from limited water and land resources? How much should we invest in irrigated agriculture, and how?

3.1 Technical Indicators
Specialized execution markers measure framework capacity for making productive stock and use of accessible water.

It assesses framework execution dependent on specialized perspectives. It incorporates Conveyance and Water Use Efficiency for surveying framework state of being.

3.1.1 Storage efficiency
The water stockpiling effectiveness alludes how totally the water required preceding water system has been put away in the root zone during water system. The capacity proficiency Er is characterized as

$$Er = \frac{W_s}{W_n} \times 100$$

Where
W = Water stored in the root zone during irrigation.
W = Water needed in the root zone before irrigation.

3.1.2 Conveyance efficiency
The vehicle adequacy will be assessed as extent of water passed on into the field from the source motivation behind the channel (Wf), to the water guided into the stream toward the early phase (Wr).

$$E_c = \frac{W_f}{W_r} \times 100$$

3.1.3 Area Uniformity (AU)
It is characterized as the proportion of water profundity (Dw) (volume/flooded zone) for the most exceedingly awful provided zone in the framework to the normal water profundity (Dave) provided to the entire framework during a similar time frame.

$AU = D_w/D_{ave}$

3.1.4 Farm Application Efficiency
The definition of application efficiency, E_a, has been fairly well standardized as:

$$E_a = \frac{\text{Depth of water added to the root zone}}{\text{Depth of water applied to the field}}$$

3.1.5 Water use efficiency: The water usage by the yield is by and large portrayed as far as Water Use Efficiency (Kg/ha-cm). It very well may be characterized in the accompanying manners (Michael, 1978) [7].

3.1.5.1 Crop water use efficiency: It is the extent of reap yield (Y) to the proportion of water depleted by the yield during the time spent Evapotranspiration (ET).
Water use efficiency = Y/ ET

3.1.5.2 *Field water use efficiency*: It is the extent of reap yield (Y) to the total amount of water used in the field (WR).

Field water use efficiency (kg /ha-cm) =Y/WR

4. Results and Discussion
This study compares the performance of Right Main Canal of West Banas Irrigation Project to the previous year's performance of the project by using five technical indicators.

4.1 Storage effectiveness
Capacity effectiveness was determined at rancher's field. Two fields of realized region were chosen to discover capacity effectiveness. The volume of water added to the root zone was determined by deciding profundity of water added to the root zone and it was duplicated by zone of the field. Potential soil dampness stockpiling volume was controlled by considering water holding limit of the dirt. The dirt dampness needed in the root zone was determined by accepting the water system applied when soil dampness is drained at 50% in the root zone. Capacity proficiency was found as 82.40 percent for field I while it was 86.65 percent for field II. Normal stockpiling productivity was discovered to be 84.52 percent showing great stockpiling limit of the dirt in the order region.

4.2 Conveyance proficiency
The Conveyance proficiency of Right Main Canal (RMC) was estimated at three areas chosen at head, centre and tail segments every one of which 200 m long. The inflow and surge was estimated for these ranges. A few times during whole water system season. For Right Main Canal, at head segment, transport proficiency got was 85.80 percent. At center and tail comes to, it was seen as 73.04 percent and 69.24 percent individually. A normal transport productivity of 76.02 percent was found for whole Right Main Canal, which is inside adequate reach for a conveyance framework. Table 4.1 shows transport productivity of Right Main Canal.
Further, it was seen during the hands-on work that water was spilling at places where the trench was penetrated, invaded with vegetation, and furthermore, water overtops the channel banks at certain spots. This is one of the significant explanations behind helpless water conveyance to tail comes to. Lesser the transport proficiency higher is the movement misfortune that makes issue for ranchers having fields at lower areas of waterway order zone.

Table 1: Conveyance Efficiency of Right Main Canal

Location	Length of Reach (m)	Inflow (CUMEC)	Outflow (CUMEC)	Conveyance losses/Km	Conveyance Efficiency (%)
Head	200	4.625	4.501	14.17	85.80
Middle	200	2.874	2.689	23.65	73.04
Tail	200	1.351	1.236	35.47	69.24
Average					76.02

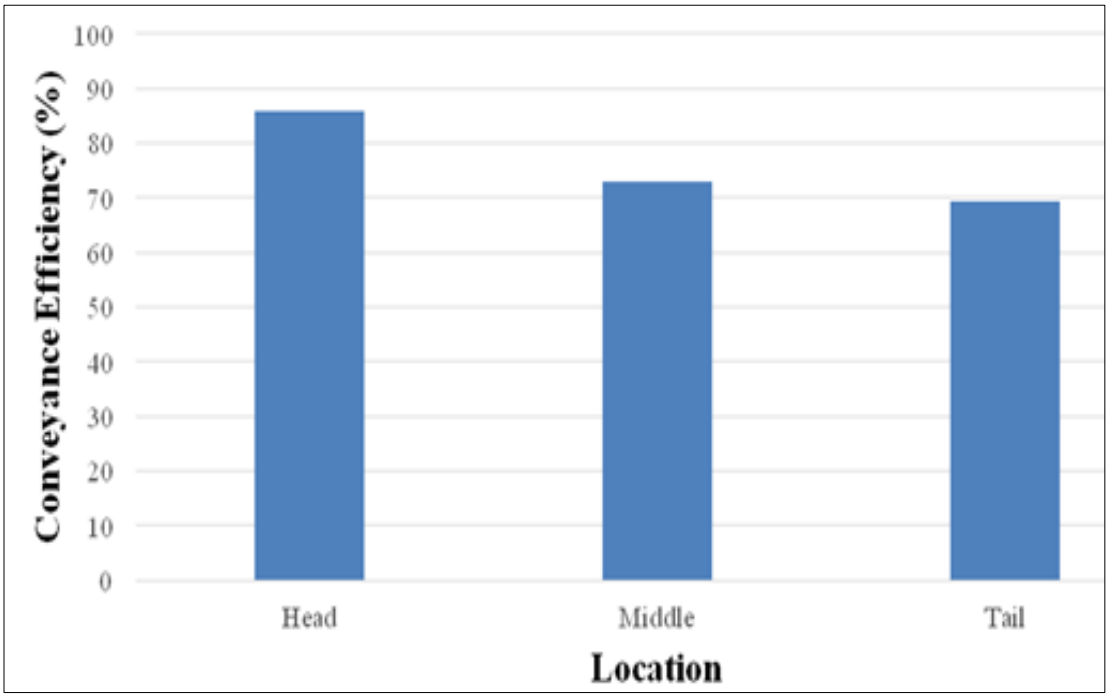

Fig 1: Conveyance Efficiency of RMC

4.3 Area uniformity (AU)

Zone consistency demonstrates how consistently water conveyed among the diverse minors. The territory consistency was determined for chosen minors for Rabi season. Most elevated territory consistency was found for Mungthala minor (0.73) which demonstrates that the water had circulated well among the various sources of Mungthala minor though least region consistency (0.14) was found for Kyaria minor showing that water had not very much conveyed and may bring about lesser yield. The region consistency for Fula bai khera, Sangwara and Achpura minor had was 0.45, 0.67 and 0.58 individually.

The normal region consistency of Right Main Canal minors was seen as 0.51. This shows that, there were reasonable for helpless conveyance of water. Subsequently, it is essentially to improve of water appropriation framework for better water application to field so as improve the harvest yield. The territory consistency noticed for minors is appeared in Table 4.2.

Table 2: Area uniformity (AU) for selected minors of RMC

Month Minors	Area Uniformity					
	Nov	Dec	Jan	Feb	Mar	Average
Fula bai khera	0.45	0.45	0.45	0.45	0.45	0.45
Sangwara	0.67	0.67	0.67	0.67	0.67	0.67
Achpura	0.58	0.58	0.58	0.58	0.58	0.58
Mungthala	0.73	0.73	0.73	0.73	0.73	0.73
Kyaria	0.14	0.14	0.14	0.14	0.14	0.14
Average						0.51

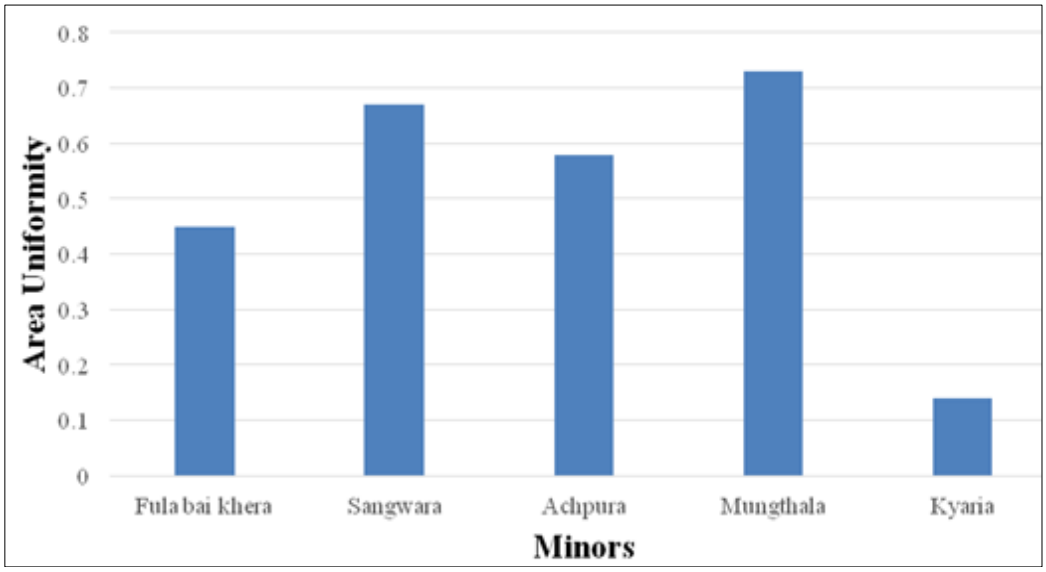

Fig 2: Area uniformity of selected minors of RMC

4.4 On farm application efficiency

On homestead application proficiency (OFAE) demonstrates how productive water is applied in the field. It was determined by estimating volume of water redirected to the field and by assessing volume of water added to the root zone. The volume of water redirected and volume of water added to the root zone were changed over into profundity units by separating it with region. The volume of redirected water to the field was determined by estimating release rate utilizing Parshall flume and recording complete time needed to flood the field. The volume of water added to the root zone was dictated by estimating soil dampness content at various profundity of soil when water system. It was discovered that, on homestead application effectiveness was 81.20 percent for field I and 79.64 percent for field II with a normal of 80.42 percent. This shows reasonable on homestead application proficiency. Graphical introduction of on homestead application productivity at fields I and II is appeared in index.

4.5 Water use effectiveness

The Crop Water Use Efficiency (CWUE) and Field Water Use Efficiency (FWUE) for period 2013-14 to 2017-18 was determined. The Crop yield information and Crop Water Requirement (CWR) and Gross Irrigation Requirement (GIR) were considered for assessing Water Use Efficiency. Harvest and Field Water Use Efficiency estimates capacity of yields that, how proficiently water has been used.

4.5.1 Crop water use proficiency

Water use effectiveness of Wheat, Mustard, Garlic and Coriander was determined for years 2013-14 to 2017-18.

4.5.1.1 Water use productivity of wheat

Wheat is one of the significant harvests filled in West Banas trench order region. The aftereffects of water use productivity of wheat from 2013-14 to 2017-18 are given in Table 4.3. Most extreme estimation of CWUE for wheat crop was determined as 49.51 Kg/ha-cm in 2016-17 while Minimum was gotten in 2017-18 with an esteem 40.54 Kg/ha-cm.

Table 3: Water use efficiency of wheat

Year	Crop Yield (Kg/ha)	ET (mm)	CWUE (Kg/ha-cm)
20013-14	1670	356.2	47.00
2014-15	1530	356.7	42.87
2015-16	1580	356.3	44.30
2016-17	1750	353.4	49.51
2017-18	1425	351.5	40.54

4.5.1.2 Water use efficiency of barley

The Crop Water Use Efficiency for grain was assessed most extreme in years 2013-2014 with 73.27 Kg/ha-cm. The base estimation of CWUE was seen in 2017-18 with esteem of 52.94 Kg/ha-cm. The CWUE Tabulated in Table 4.4.

Table 4: Water Use Efficiency of Barley

Year	Crop Yield (Kg/ha)	ET (mm)	CWUE (Kg/ha-cm)
2013-14	1820	313.5	58.05
2014-15	2300	313.9	73.27
2015-16	2270	313.2	72.47
2016-17	1800	310.8	57.91
2017-18	1630	307.9	52.94

4.5.1.3 Water use efficiency of gram

The Crop Water Use Efficiency for gram was greatest in year 2013-14 with its worth 45.65 Kg/ha-cm due because of adequate water for water system. The base CWUE was seen in 2014-15 with esteem 36.68 Kg/ha-cm. The yield water use proficiency acquired for most recent five years (2013-2018) are depicted in Table 4.5.

Table 5: Water use efficiency of gram

Year	Crop Yield (Kg/ha)	ET (mm)	CWUE (Kg/ha-cm)
20013-14	1020	223.4	45.65
2014-15	821	223.8	36.68
2015-16	875	223.1	39.22
2016-17	911	221.7	41.09
2017-18	880	219.9	40.02

4.5.1.4 Water use efficiency of mustard

The Crop Water Use Efficiency for mustard was greatest in year 2015-16 with its worth 37.00 Kg/ha-cm due by virtue of adequate water for water system. The base CWUE was seen in 2017-18 with esteem 30.15 Kg/ha-cm. The harvest water use effectiveness acquired for most recent five years (2003-2018) are portrayed in Table 4.6.

Table 6: Water use efficiency of mustard

Years	Crop Yield (Kg/ha)	ET (mm)	CWUE (Kg/ha-cm)
20013-14	1090	326.4	33.40
2014-15	1170	326.7	35.81
2015-16	1210	327.3	37.00
2016-17	1080	325.4	33.18
2017-18	980	325.1	30.15

4.5.1.5 Average values of water use efficiency for *Rabi* crops

Normal of five-year CWUE esteems for Rabi crops was processed and introduced in Table 4.7 Barley having most extreme estimations of CWUE among Rabi crops accomplishing esteem 62.93 Kg/ha-cm. Normal CWUE esteems for Wheat, Gram and Mustard were gotten as 44.85 Kg/ha-cm, 40.53 Kg/ha-cm and 33.90 Kg/ha-cm separately.

Table 7: Average Values of Water Use Efficiency for *Rabi* Crops

Crops	CWUE (Kg/ha-cm)
Wheat	44.85
Barley	62.93
Gram	40.53
Mustard	33.90

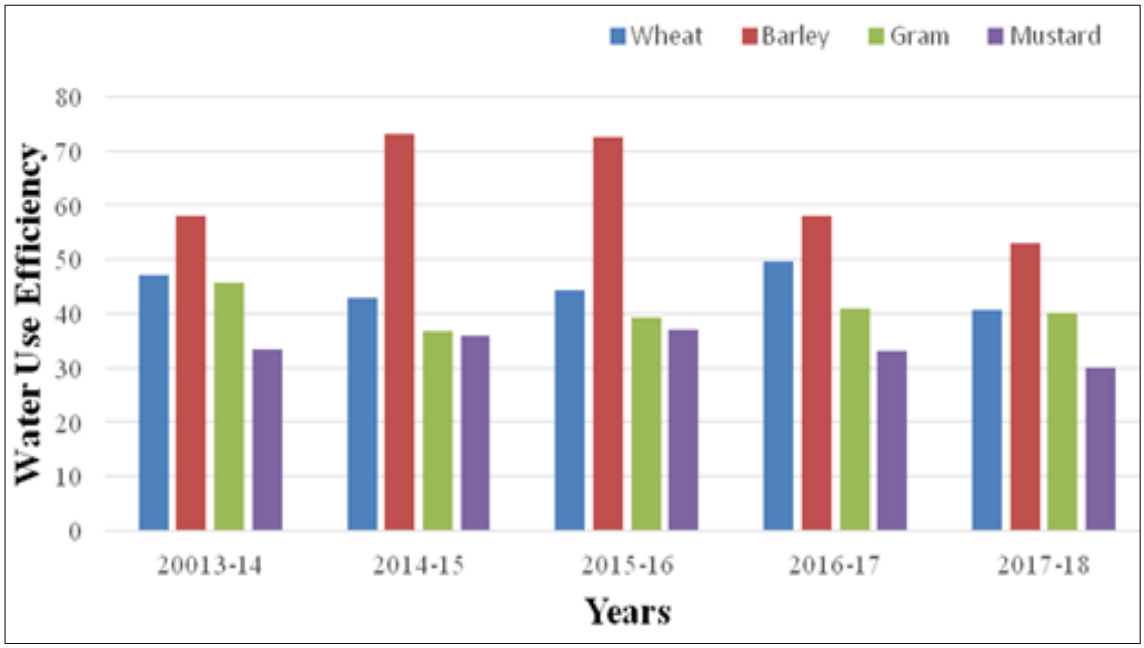

Fig 3: Crop water use efficiency of Rabi crops

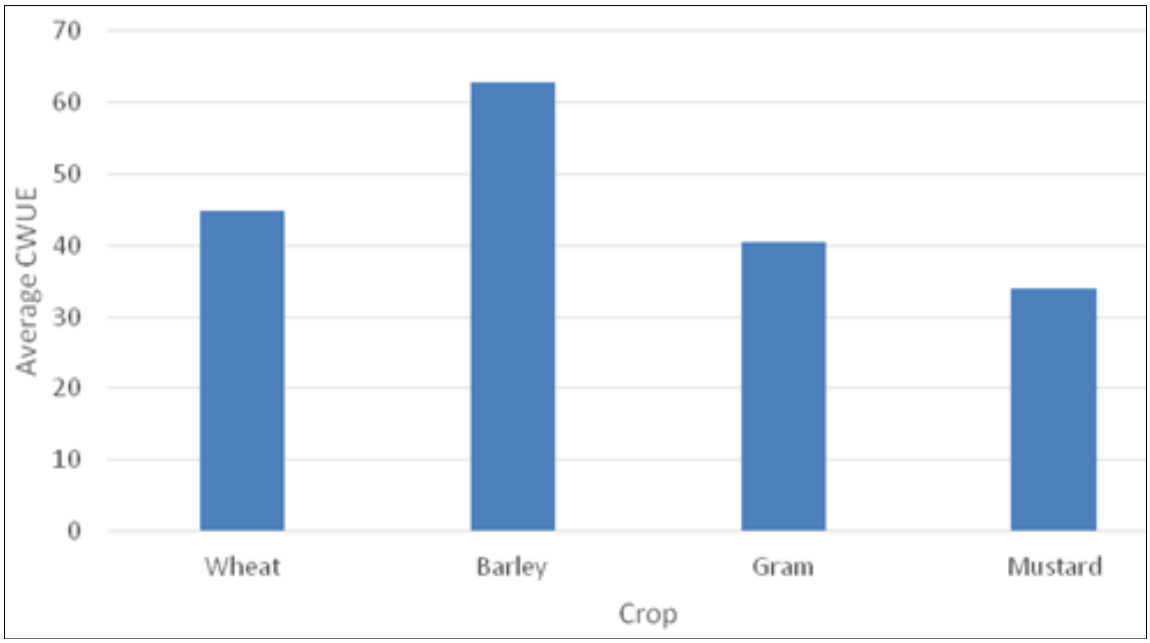

Fig 4: Average crop water use efficiency for Rabi crop

4.5.1.6 Field water use efficiency from year 2012-13 to 2017-18

Field Water Use Efficiency is the proportion of yield of harvest to the Gross Irrigation Requirement of Crop. FWUE was determined for Rabi crops from the year 2013-14 to 2017-18. In the year 2013-14, Barley achieved the most noteworthy FWUE estimation of 41.07 Kg/ha-cm followed by Wheat (40.81 Kg/ha-cm), Gram (31.54 Kg/ha-cm) and Mustard (23.32a Kg/ha-cm). Garlic has given the greatest estimation of FWUE (51.45 Kg/ha-cm) of all yields in the year 2014-15. In the year 2015-16, Barley used water adequately and gave most noteworthy FWUE while Mustard achieved least water utilization capacity. Wheat had accomplished most elevated FWUE of 42.87 (Kg/ha-cm) while mustard had achieved least FWUE of 23.07 (Kg/ha-cm) in year 2016-17. Grain achieved higher estimations of FWUE while Mustard had neglected to utilize water viably in year 2017-18. Table 4.8 shows Field Water Use Efficiency of Rabi Crops for term 2013-14 to 2017-18. Field Water Use Efficiency of Rabi crops is graphically introduced in Fig.4.5. Computation of Field Water Use Efficiency of Rabi Crops for period 2013-14 to 2017-18 is given in Appendix I1 to I5.

Table 8: Field Water Use Efficiency of *Rabi* Crops from Year 2013 to 2018

Crops	Field Water Use Efficiency (Kg/ha-cm)				
	2013-14	2014-15	2015-16	2016-17	2017-18
Wheat	40.81	37.17	38.37	42.87	34.84
Barley	41.07	51.45	51.54	40.47	36.54
Gram	31.54	25.62	27.25	28.09	27.31
Mustard	23.32	25.06	25.94	23.07	20.94

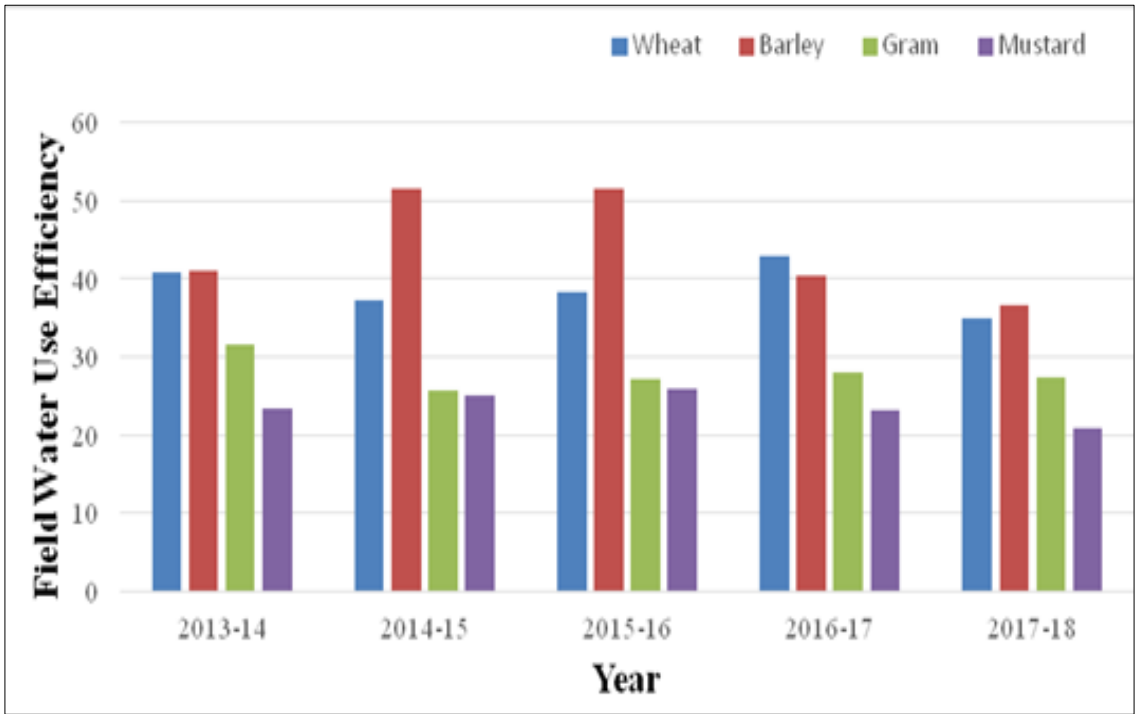

Fig 5: Field Water Use Efficiency of *Rabi* Crops from Year 2013 to 2018

4.5.1.7 Average field water use efficiency of *Rabi* Crops

Normal FWUE of Rabi Crops was discovered most elevated in 2015-16 while least estimation of FWUE was gotten in year 2017-18. Normal FWUE for period 2013-14 to 2017-18 is given in Table 4.9 and graphically introduced in Fig. 4.6.

Table 9: Average Field Water Use Efficiency of *Rabi* Crops

Year	Field Water Use Efficiency (Kg/ha-cm)
2013-14	34.19
2014-15	34.83
2015-16	35.78
2016-17	33.63
2017-18	29.91

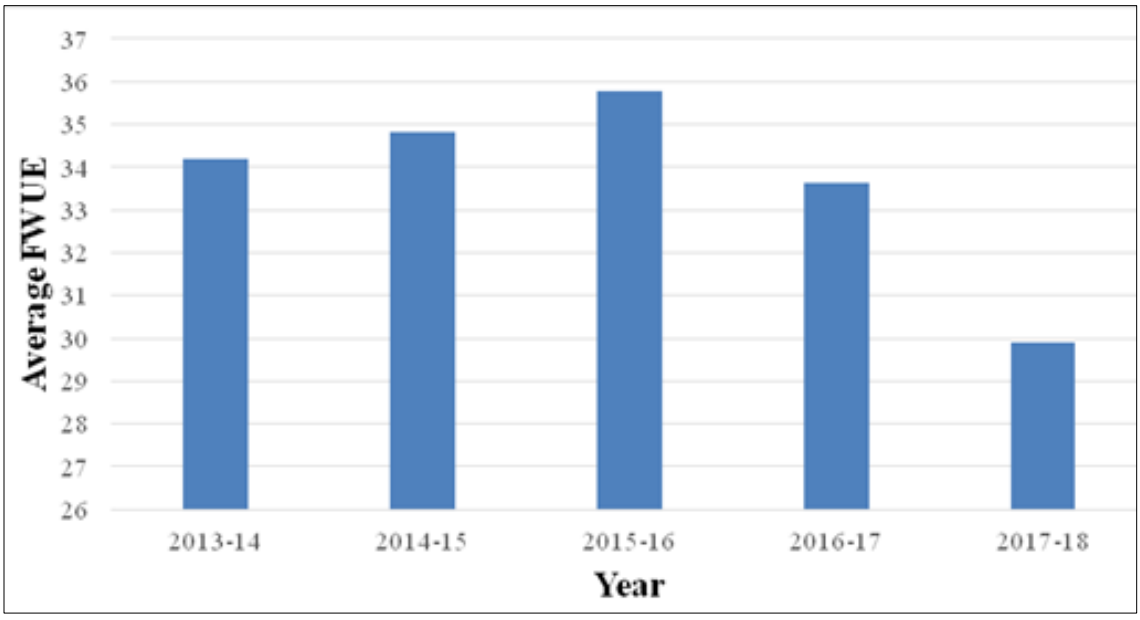

Fig 6: Average field water use efficiency of *Rabi* Crops

5. Conclusions

- The normal reliability for Right Main Canal was found as 0.12. Generally constancy for Right Main Canal shows reasonable ideal dispersion of water.
- The normal stockpiling effectiveness was discovered to be 84.52 percent showing great stockpiling limit of the dirts in the order zone. The normal estimation of transport productivity at head, centre and tail segments of Right Main Canals were gotten as 76.02 percent

- Area consistency was discovered reasonable for poor showing inconsistent circulation of water as for zone of every minor. Application proficiency was discovered acceptable (80.42) demonstrating water is applied viably and effectively to the land.
- The, generally speaking, normal Water Use Efficiency (WUE) of Rabi crops was discovered acceptable in year 2015-16 and poor in year 2017-18. Wheat was discovered most effective yield regarding water use.
- An in general normal change in water level was discovered 10% which has at last influenced in release of water in minors. Just 63 structures were found in presence out of complete 70 structures shows helpless upkeep and support of actual arrangement of West Banas waterway organization.
- Duration of water supply was not a lot of solid with constancy of term estimation of 0.88 during Ist water system demonstrating helpless working of activity administration and there is a need to create appropriate activity framework.

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