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Performance Evaluation of West Banas Irrigation Project using Comparative Indicators

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A B S T R A C T

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, four comparative 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. As a result of the study, based on the 2013-2018 years output per unit land cropped, output per unit command area, output per unit irrigation supply and output per unit water consumed were observed as 35302.78 Rs/ha, 9828.26 Rs/ha, 7.20 Rs/m^3, 12.53 Rs/m^3.Average value of Relative water supply and Relative irrigation Supply of the system for Five years (2013-2018) were calculated as 0.76 and 0.54 respectively. Physical performance of Right Main Canal was also evaluated for five years (2013-2018).

Introduction

Comparative 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 comparative indicators. No such investigation has been done in the region so far.

Therefore, system managers can develop new strategies. Comparative indicators will provide a chance to policy makers 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.

Description of Study Area

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

Jainapur (2007) evaluated performance of minor lift irrigation schemes in northern Karnataka. This study was taken up to evaluate the performance of minor lift irrigation schemes (MLIS). Objectives of the investigation were estimation of growth of MLIS in terms of numbers and area irrigated and financial feasibility analysis, performance evaluation and identification of constraints in working of Adihudi MLIS across Krishna River. Percentages, compound growth rate and financial feasibility tests were used for analysis. Major findings of the study are - Growth rate of Government MLI scheme increased during 1990-2005 at a compound rate of 1.40 per cent. In the erstwhile Bijapur district, about 61 per cent of MLIS were non-working.

Sener *et al.,* (2007) evaluated performance of Hayrabolu Irrigation Scheme of the Thrace district in Turkey by using some selected comparative indicators, classified into five groups, namely, agricultural, economic, water-use, physical and environmental performance by International Water Management Institute (IWMI). Agricultural performance, evaluated in different type of Gross Value of Production, was determined lower than that of the other respective national average. Analyses of water-use performance showed that relative water and relative irrigation supply were calculated 1.91 and 1.55 respectively, indicating that water distribution is not tightly related to crop water demand. Physical performance, evaluated in terms of irrigation ratio and sustainability of irrigated land, were poor.

Unver (2007) studied "Water Resources Sustainability" and also advocated an integrated development approach based on the sustainable development of water resources on a regional scale. This is the area where sustainable socioeconomic development and integrated water resources management intersect and yield to a holistic formulation involving multiple sectors and multiple stakeholders. The water based sustainable integrated regional development is covered in its theoretical and practical aspects and through a contemporary example, the Southeastern Anatolia Project (GAP) of Turkey.

Kuscu *et al.,* (2008) assessed the performance of irrigation water management a case study in the Karacabey irrigation scheme in Turkey. The study was carried out in two stages. According to the results, the physical performance indicators, which are average irrigation ratio and relative water supply, were found to be 61per cent and 0.77 respectively. In the second stage, the irrigation water management was tested and assessed by the Logit model taking farmers perceptions concerning satisfaction with taking irrigation service.

Materials and Methods

In the present study comparative indicators are used to evaluate the system performance of Right Main Canal which enables policy makers 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?

Comparative Indicators

The comparative indicators are suggested by IWMI are The Standardized Gross Value of Production (SGVP) makes it possible to compare the performance of systems, no matter where they are or what kind of crops are being grown. The SGVP captures both local preferences-for example, specialized crops that may have a low international price, but a high local value-and the value of non-traded crops.

$$SGVP = \left(\sum_{crops} A_i Y_i \frac{P_i}{P_b} \right) P_{district} \quad \ldots (1)$$

Where, A_i is the area cropped with crop *i* (ha),

Y_i is the yield of crop *i* (Kg/ha),

P_i is the local price *i* (Rs. /Kg),

P_b is the local price of the base crop (the predominant locally-grown, internationally-traded crop) (Rs. /Kg) and

$P_{district}$ is the value of the base crop traded at district prices.

Agricultural performance

The four indicators relate the monetary value of the system's final output, agricultural production, to the inputs of land and water.

By standardizing the gross value of agricultural production and relating it to inputs common to all systems (land and water), these indicators make it possible to compare the performance of radically different systems. These indicators were calculated as follows:

Output per land cropped (OPLC) = SGVP/ Irrigated cropped area ... (1)

Output per unit command area (OPCA) = SGVP/ Command area ... (2)

Output per unit irrigation supply (OPIS) = SGVP/ Diverted irrigation supply ... (3)

Output per unit water consumed (OPWC) = SGVP/ Volume of water consumed by ET ... (4)

Water use performance

Two type of indicators, relative water supply (RWS) and relative irrigation supply (RIS) were used for evaluation of water use performance *(Levine, 1982 and Perry, 1996):*

Relative water supply =Total water supply/Crop demand ... (5)

Relative irrigation supply = Irrigation supply Irrigation demand ... (6)

Where, total water supply (m^3) is diverted water for irrigation plus rainfall, crop water demand (m^3) is the potential crop evapotranspiration (ET_p), or the real evapotranspiration (ET_c) when full crop water requirement is satisfied. Net crop water requirement and irrigation requirement will be calculated by CropWat program.

Physical performance

Physical indicators are related with the changing or losing irrigated land in the command area by different reasons.

Irrigation ratio= land Irrigable / land Irrigated ... (7)

The intensity with which the irrigated area is cropped traditionally is a function of the

number of crops per year grown on an irrigated area.

Sustainability of irrigated land = land Irrigated / land irrigated Initial … (8)

Area infrastructure ratio=land irrigated / total length of canal and laterals …(9)

where, irrigated land (ha) refers to the portion of the actually irrigated land (ha) in given irrigation season. Irrigable land (ha) is the potential scheme command area.

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 three indicators. Agricultural performance, Water use performance, physical performance.

Agricultural Performance

The comparative indicators (OPLC, OPCA, OPIS, and OPWC) are the measures corresponding to per unit of land cropped, unit irrigation water and the values of them calculated based on the local price of crops grown in the area in particular year and observed value of indicators are given in the Table 1. Standard Gross Value of Production ranges between 66.20×10^6 Rs to 88.61×10^6 Rs. for the study period 2013-2018.

Indicators of output per unit of land cropped, output per unit of command area, output per unit irrigation supply and output per unit water consumed was calculated to evaluate the agricultural performance of Right Main Canal (Table 1). Year wise comparison of Agriculture performance indicators are shown in Figure 1 to 4.

Water Use Performances

Two indicators, Relative Water Supply (RWS) and Relative Irrigation Supply (RIS) were used in the evaluation of water use performance. RWS and RIS for head, middle and tail for year 2013-18 were calculated and represented in Table 2. This value implies that there is inadequate supply of irrigation water. For instance, RWS and RIS values alone in this study indicate that water demand of the crops in the command area of Right Main Canal of irrigation project is not satisfied.

Physical performances

Physical performance of Right Main Canal was determined by comparing it yearly giving results related with altering or losing of irrigated land in the command area due to different reasons. It was determined by calculating irrigation ratio (%), sustainability of irrigated lands (%) and Area infrastructure ratio (ha/Km).

Irrigation Ratio (IR)

It is the ratio of irrigated land (ha) and irrigable land (ha) determining percentage of land actually irrigated in past ten years within command area of Aspur branch canal.

Average Irrigation ratio for the period 2013-2018 was found to be 53.16%. A graph given in Figure 6 is drawn to compare irrigation ratio of different years (2013-2018).s

Sustainability of irrigated lands

In the present study irrigated area of Right Main Canal from 2013-2018 were divided by initial irrigated area. This ratio determines continuity of the system for increasing or maintaining the same initial irrigated area. The value equal to 100 per cent shows that system is sustainable.

Table.1 Values of comparative indicators from year 2013-20184u=4Year

Values of comparative indicators from year 2013-20184u=4Year	Output Per Unit of Land Cropped (Rs/ha)	Output Per Unit of Command Area (Rs/ha)	Output Per Unit of Irrigation Supply (Rs/m^3)	Output Per Unit of Water Consumed (Rs/m^3)	SGVP (10^6 RS)
2013-14	32529.21	9396.32	05.28	9.38	74.71
2014-15	32452.91	8325.44	07.48	12.20	66.20
2015-16	33683.60	10597.40	07.90	11.36	84.27
2016-17	38278.48	11143.69	06.80	11.24	88.61
2017-18	39569.73	9678.46	08.55	18.47	76.96
Average	**35302.78**	**9828.26**	**7.20**	**12.53**	**78.15**

Table.2 Average value of RWS and RIS form year 2013-2018

Location	Minor	Irrigation (10^3 m^3)	GIR (M m^3)	ET (M m^3)	RW	RIS	Avg RWS	Avg RIS
Head	Fula bai khera minor	8.04	15.50	11.70	0.69	0.51	**0.68**	**0.47**
	Sangwara minor	5.30	12.30	7.90	0.67	0.43		
Mid	Achpura minor	7.14	11.60	8.30	0.86	0.61	**0.86**	**0.61**
Tail	Mungthala minor	8.85	13.90	10.41	0.85	0.64	**0.75**	**0.54**
	Kyaria minor	4.14	9.25	6.31	0.65	0.45		
Average		**6.69**	**12.51**	**8.92**	**0.74**	**0.52**	**0.76**	**0.54**

Table.3 Values of Irrigation Diverted (m^3) from year 2013 to 2018

Sr. No.	Years	Irrigation Diverted (M m^3)
1.	2013-2014	8.04
2.	2014-2015	5.30
3.	2015-2016	7.14
4.	2016-2017	8.85
5.	2017-2018	4.14

Table.4 Values of GIR (m^3) from year 2013 to 2018

YEARS	GIR (m3)					Total ET(m^3)
	WHEAT	BARLEY	GRAM	MUSTARD	Total GIR (m^3)	
2013-14	5013680	423094	1214480	2028172	8679426	6075515
2014-15	8709074	726110	2885930	3942120	15463234	10823969
2015-16	11480643	968145	2780812	4649504	19879104	13915054
2016-17	19257131	449854	2337246	2721919	24766180	17335192
2017-18	21330315	506690	2609334	3192552	27638891	19352604

Table.5 Values of RWS and RIS from year 2005 to 2012

Years	RWS	RIS
2013-14	0.83	***0.58***
2014-15	0.56	***0.59***
2015-16	0.78	***0.54***
2016-17	0.79	***0.56***
2017-18	0.74	***0.52***
Average ***Max*** ***Min***	***0.74*** ***0.83*** ***0.56***	***0.52*** ***0.59*** ***0.52***

Table.6 Calculation of irrigation ratio (%)

Years	Irrigated Land (ha)	Irrigable Land (ha)	Irrigation Ratio (per cent)
2013-14	4927	7952	**61.95**
2014-15	3160	7952	**39.74**
2015-16	5180	7952	**65.14**
2016-17	4895	7952	**61.55**
2017-18	2975	7952	**37.42**
		Average = 53.16	

Table.7 Calculation of Sustainability of irrigated land

Years	Irrigated Area (ha)	Initial Irrigated Area (ha)	Sustainability of Irrigated Area (per cent)
2013-14	4927	5566	**88.50**
2014-15	3160	5566	**56.77**
2015-16	5180	5566	**93.06**
2016-17	4895	5566	**87.94**
2017-18	2975	5566	**53.44**
		Average = 75.95	

Table.8 Calculation of Area Infrastructure ratio

Years	Irrigated Land, Total Area (ha)	Total Length of Canal (km)	Area Infrastructure Ratio (Ha/Km)
2013-14	4927	34.74	**141.9**
2014-15	3160	34.74	**90.9**
2015-16	5180	34.74	**149.1**
2016-17	4895	34.74	**140.9**
2017-18	2975	34.74	**85.6**
		Average = 121.7	

Fig.1 Output per unit of land cropped in Rs/ha

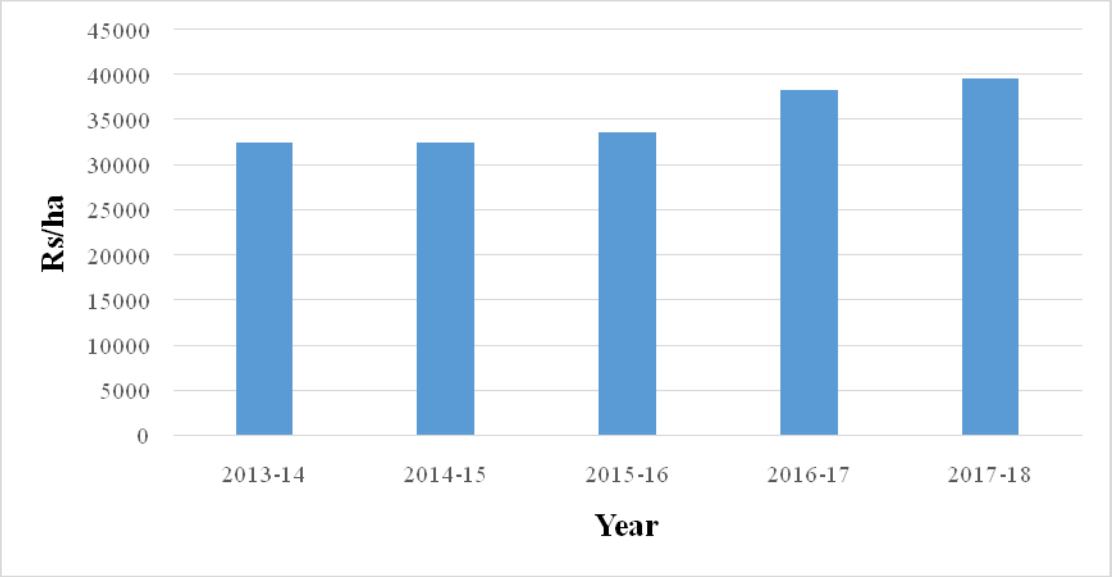


Fig.2 Output per unit of command area in Rs/ha

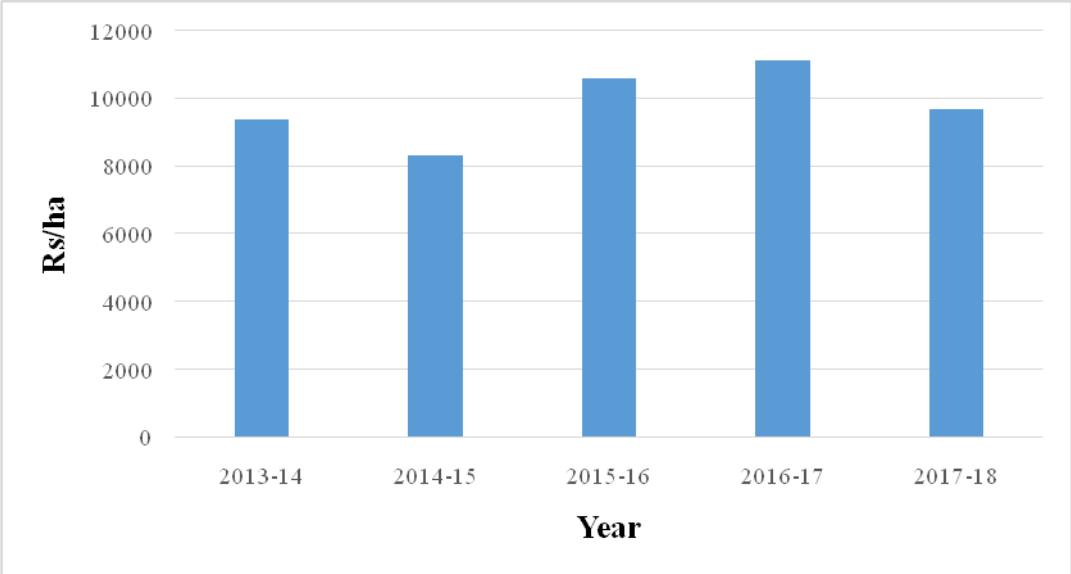


Fig.3 Output per unit of irrigation supply in Rs/ m^3

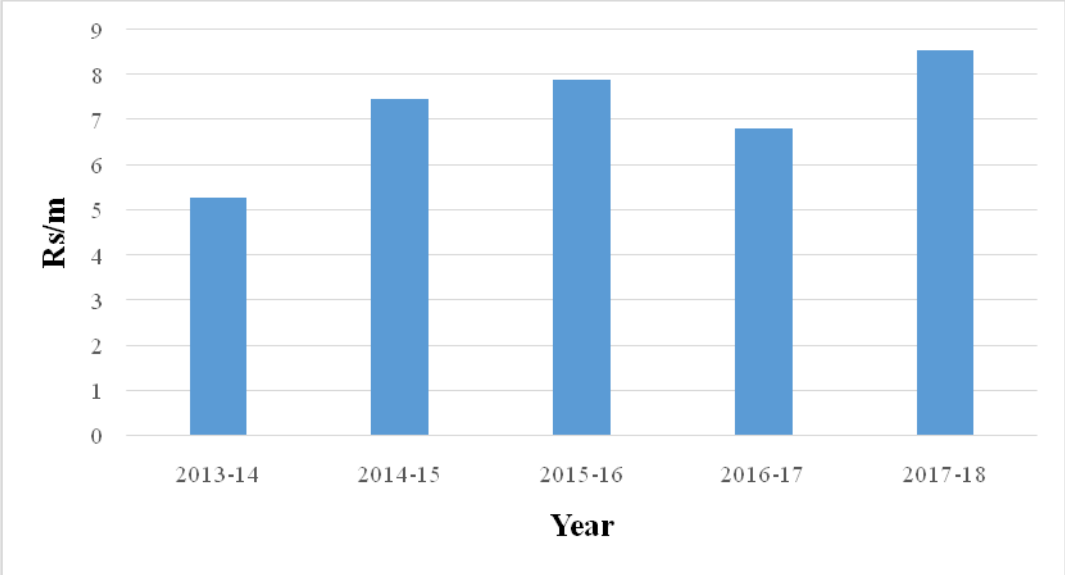


Fig.4 Output per unit of water consumed in Rs/ m^3

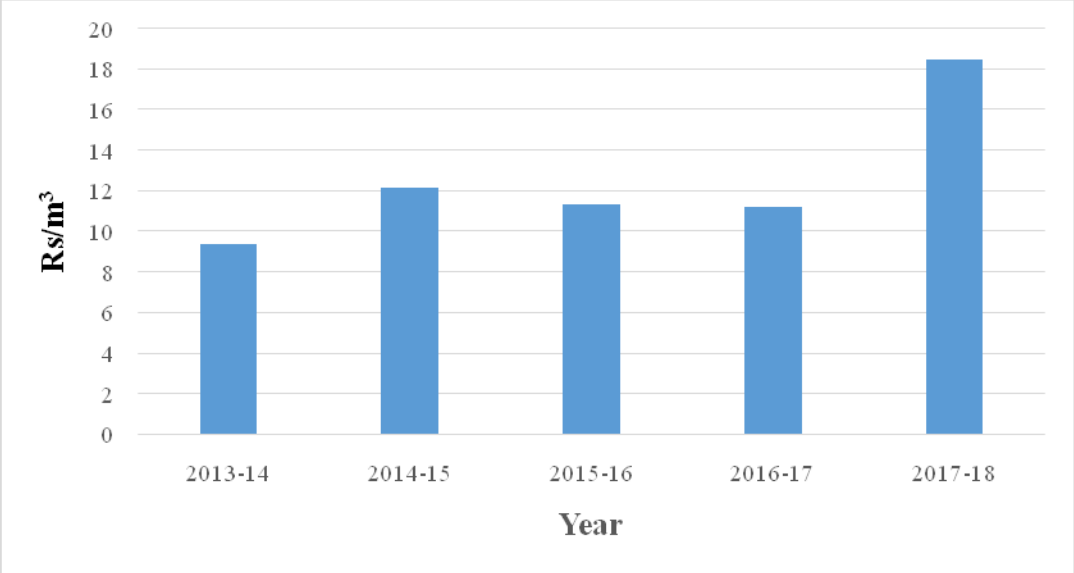


Fig.5 RWS and RIS at head, middle and tail reach of Right Main Canal

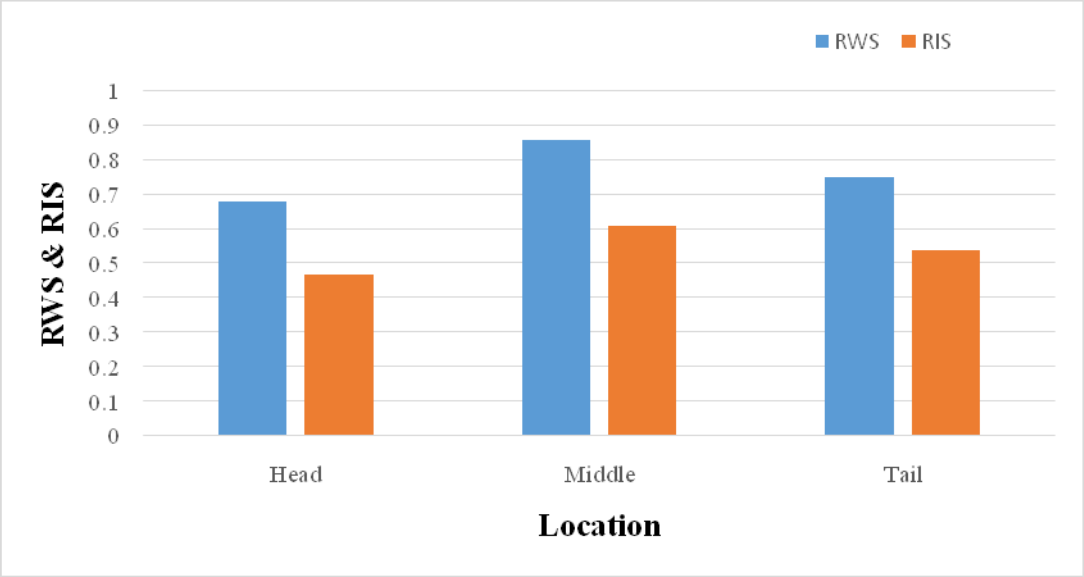


Fig.6 Irrigation ratio of west banas irrigation project

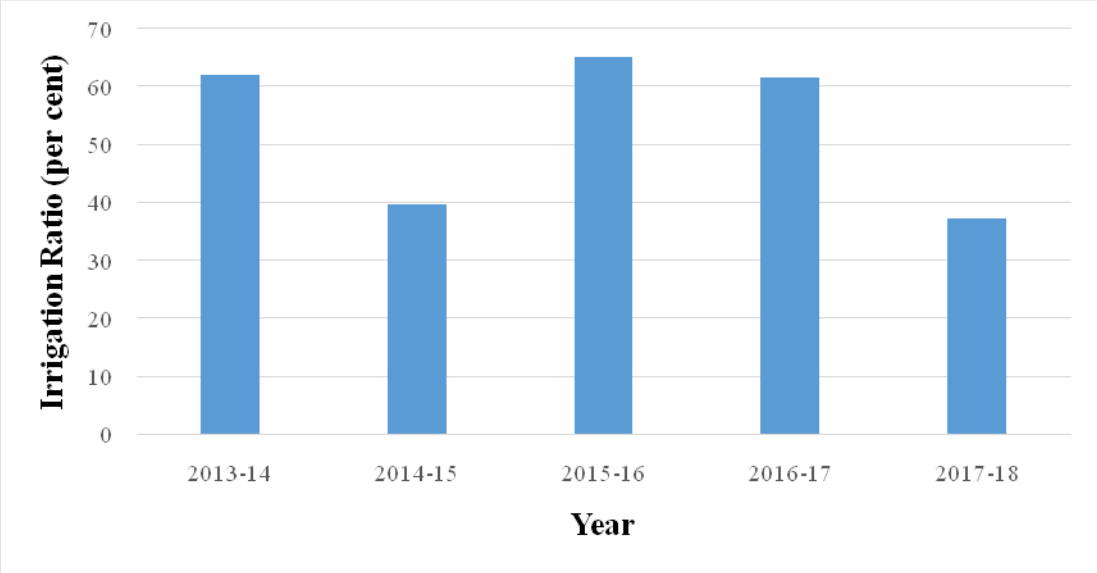


Fig.7 Sustainability of Right Main Canal

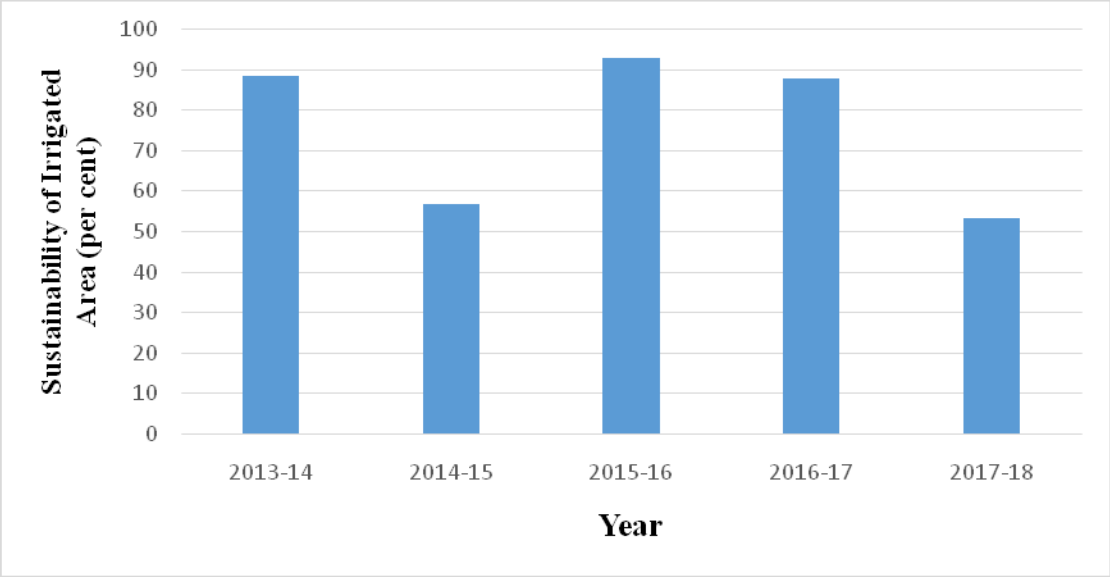
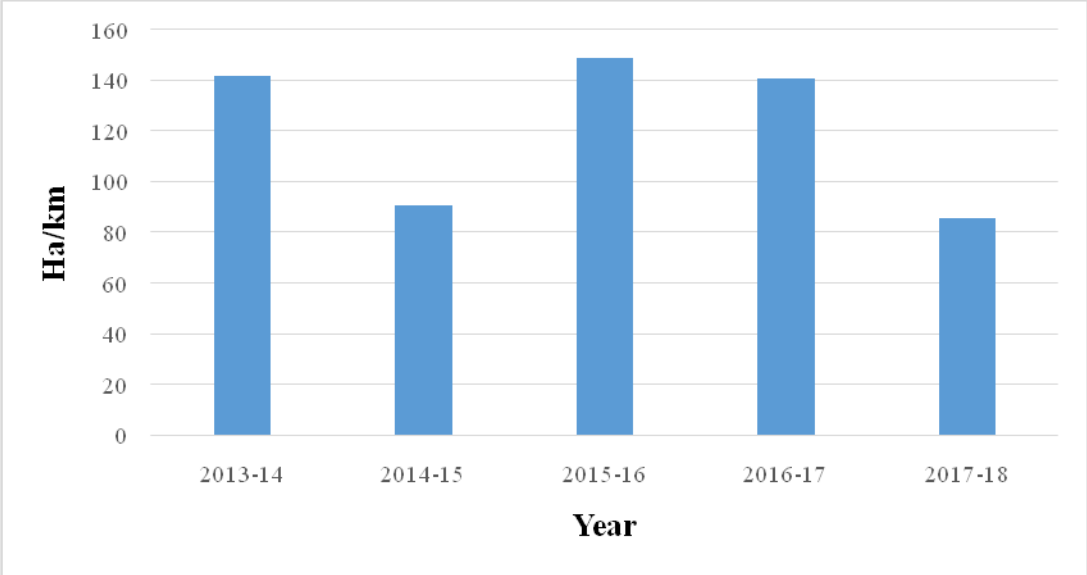


Fig.8 Area infrastructure ratio of Right Main Canal



Minimum area was irrigated in 2017-18 giving value of 53.44 per cent showing no sustainability during this year. An average SIA of 75.95 per cent was found for period in between 2013-2018. Figure 7 shows graph between years and sustainability.

Area Infrastructure Ratio

Highest AIR value for Right Main Canal is 141.9 ha/km observed in year 2013-14 and minimum value of AIR was found 85.6 ha/km. in 2017-18. That irrigated area which is having higher value of AIR shows that area will meet the infrastructure cost of the project. Year wise total irrigated area and total length of the canal is tabulated (Table 8) below. Graph (Figure 8) shows critical values of the Area Infrastructure Ratio from year 2013-2018.

The output per unit land cropped (OPLC) in 2014-15 was lower as compared to rest of years. The highest output per unit land cropped was in year 2017-18. There is variation in land cropped area from year to year. The output per unit command area was highest in year 2016-17 and lowest in year 2014-15. Output per unit irrigation supply (OPIS) was highest in year 2017-18 and minimum was in 2013-14, whereas Output per unit water consumed (OPWC) was highest in year 2017-18. And found minimum in year 2013-14.

Relative water supply values ranged from 0.68 to 0.86 for Right Main Canal, Relative irrigation supply values ranged from 0.47 to 0.61. These values were higher than one for head and middle section while less than one at tail section for Right Main Canal indicating crop water demand is always higher as compared to supply made available at tail section.

The irrigation ratio ranges from 37.42 to 65.14 per cent and was highest in year 2015-16. The canal network of West Banas irrigation system is found not sustainable from years 2013-14 to 2017-18. Maximum SIA in year 2015-16 having SIA value of 93.06 per cent. Maximum value of area infrastructure ratio (AIR) was in the year 2013-14 having AIR value of 141.9 Km/ha. This ratio was found comparable to its idle indicator in the years from 2013-14 to 2017-18 after completion of rehabilitation activities.

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