Assessment of Existing Water Productivity and Cropping Intensity of Right Bank Canal Command of Samrat Ashok Sagar Project of Vidisha District, Madhya Pradesh, India

ABSTRACT

The existing water productivity and cropping intensity of right bank canal (RBC), command area was found 0.60 kg m^{-3} and 163%, respectively. The right bank canal comprises of five water user association namely, Sarchampa, Ucher, Medaki, Sayar and Neemkheda whose existing cropping intensity was found to be 181, 149, 158, 177 and 172%, respectively. The cropping intensity of villages under study varies between 110~~%~~ to 200%. It was also found that only six village, out of 55 villages were having cropping intensity less than 140%. On the higher side, only five villages were having cropping intensity more than 190%. The lowest cropping intensity (115%,) was found in Sunari village of Medaki water user association (WUA). The village was having 245 ha net sown area in *rabi* season but very less net sown area (84 ha) in *kharif* season due to unavailability of water. Similarly, less cropping intensity (118%) was found in Anouriberkhedi village, was having 264 ha net sown area out of 455 ha in ~~R~~*rabi* season and 272 ha net sown area out of 455 ha in *kharif* season. The total water supplied in M m^3 excluding losses from RBC was collected from water resources department and the data on total production of wheat was collected from revenue record of Vidisha district to assess the existing water productivity. The existing water productivity of the command area was found to be 0.60 kg m^{-3} for ~~R~~*rabi* season.

Keywords: Cropping intensity;~~,~~ ~~W~~water productivity;~~,~~ ~~C~~canal command area;~~,~~ ~~W~~water management;~~,~~ ~~W~~water user association.

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1. INTRODUCTION

Crop yields everywhere in the developing world are consistently higher in irrigated areas than in rainfed areas (Rosegrant and Perez 1997; Ringler et al. 2000; Hussain and Hanjra, 2004; Lipton et al., 2005). About 17% of global agricultural land is irrigated contributing about 40% to the world's production of cereal crops (WCD, 2000). A comprehensive review of World Bank-assisted irrigation projects during 1994-2004 (IEG, 2006) and a review of irrigation projects in Asia that received assistance from the International Water Management Institute (ADB/IWMI, 2005) confirmed the significant role that irrigation plays in poverty reduction and economic growth. The impacts of irrigation on poverty reduction are both direct and indirect. Direct benefits of irrigation include higher farm productivity through crop yield increases and diversification of cropping patterns and crop technologies. These in turn result in higher household income, consumption and employment. To the extent that irrigation results in higher marketed surpluses and increased employment opportunities, it also indirectly benefits the landless through higher wages. Finally irrigation may lead to lower food prices which are especially beneficial to the poor since they spend a disproportionally large share of their income on food.

Access to irrigation water is widely credited to be one of the major underlying factors for the substantial productivity gains obtained during the green revolution in Asia in the 1960 and 1970s (Pingali et al., 1997; Bhattarai et al., 2002). In light of the recent rises in food prices and increasing demand for non-agricultural use of land, raising agricultural productivity is more important than ever. Will improvements in irrigation be able to contribute to further gains in crop productivity? If so, to what extent and how can we maximize the potential of irrigation? Some recent studies based on regional or state level data suggest that further investments in irrigation would make only a moderate contribution to agricultural production and agricultural gross domestic production (GDP) (Fan et al., 2000; Fan and Chan-Kang, 2004). At the same time, however, others claim that the economic gains from further improvements in irrigation are potentially large (Datt and Ravallion, 1997; Rosegrant et al., 1998; Barker et al., 2004; Hussain and Hanjra, 2004; Huang et al., 2005). There exist a large number of reports and research papers that analyze the economic impact of irrigation. However, the issues being analyzed as well as the data and methods being used suffer from various limitations including aggregation bias, small sample problems and inability to establish the true causal relationship between irrigation and impact of irrigation.

According to Bharadwaj (1974), irrigation can raise the productivity of land in three ways: by making multiple cropping, by increasing the yield per unit cost and by making the production of more lucrative crops. The objective of irrigation is to increase the productivity of crops. The irrigation water supply becomes a critical input in the agricultural production process. It enables and encourages farmers to invest in other inputs like HYV seeds, fertilizers etc., all of which increase productivity (Wickhami et al., 1988). India’s irrigation policy aimed at the single objective of maximizing the production of food and other corps to attain self-sufficiency. This objective could be attained by making massive investments in irrigation only on those areas where the possibilities of producing crops are maximum per unit of water (Irrigation Commission, 1972). A policy of extensive irrigation with surface water is potentially good for productivity, equity, stability and sustainability of Indian agriculture

(Dhawan, 1995). The extent of irrigation meets broad social objectives beyond those of increased production and incomes (Small, 1981). The importance of irrigation is recognized for many crops, because the yield of irrigated corps is better than dry land or rainfed crops, not only in experimental fields but also in farmer's field (Sinha et al., 1985). Food production and productivity depend greatly on an assured supply of water. Yields per hectare obtained from irrigated cereals are on an average more than twice and often four times as high when compared to those on non-irrigated land (Kandiah, 1999). Irrigation is a sure remedy for farm 104 development. Irrigation projects generally endure themselves to agriculturists because they tend to promote maximum yield per hectare a well understood and indeed, cherished goal. Irrigation thus provides farmers with a way to increase the productivity of their limited land significantly (Abbie, 1982). The level of cropping intensity is determined by several factors. The most important factor is the availability of water from natural rainfall and or man-made resources irrigation.

Keeping above facts in mind it wsa desired to study the existing water productivity and cropping intensity of Samrat Ashok Sagar project for right bank canal command area to focus on review for increasing the water productivity and cropping intensity in RBC command area.

2. MATERIAL AND METHODS

2.1 Description of the Study Area

The study was conducted for the command area of right bank canal of Samrat Ashok Sagar, a major irrigation project located in Vidisha district of Madhya Pradesh, India. Its command area falls in parts of Vidisha and Raisen districts. The dam is constructed on the Halali river, which is a tributary of Betwa river about 40 km from Bhopal. Command area of Samrat Ashok Sagar is located between on Longitude 77°33' E and Latitude 23°30' N, at an altitude of 426 m respectively, as shown in Fig. 1.

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~~catchment and gravity flow. The problems of farmer at tail end canal command area, because optimum water is not available. However individual farmers use diesel and/or electric pump sets to lift water out of the canals. This project was commenced in year 1977 to irrigate 25091 hectares in Rabi season (Irrigation department Vidisha 2016).~~

2.2 Characterization of the Irrigation Project

The project is based on catchment and gravity flow. The problems of farmer at tail end canal command area, because optimum water is not available. However, individual farmers use diesel and/or electric pump sets to lift water out of the canals. This project was commenced in year 1977 to irrigate 25~~,~~091 ha in ~~*R*~~*rabi* season. Irrigation in almost entire command is done by the surface method. Irrigation water is applied by flooding from a channel located at the upper reach of a field. Farmers of RBC command used free flooding surface irrigation method. No specific design criterion is followed in this method of water application.

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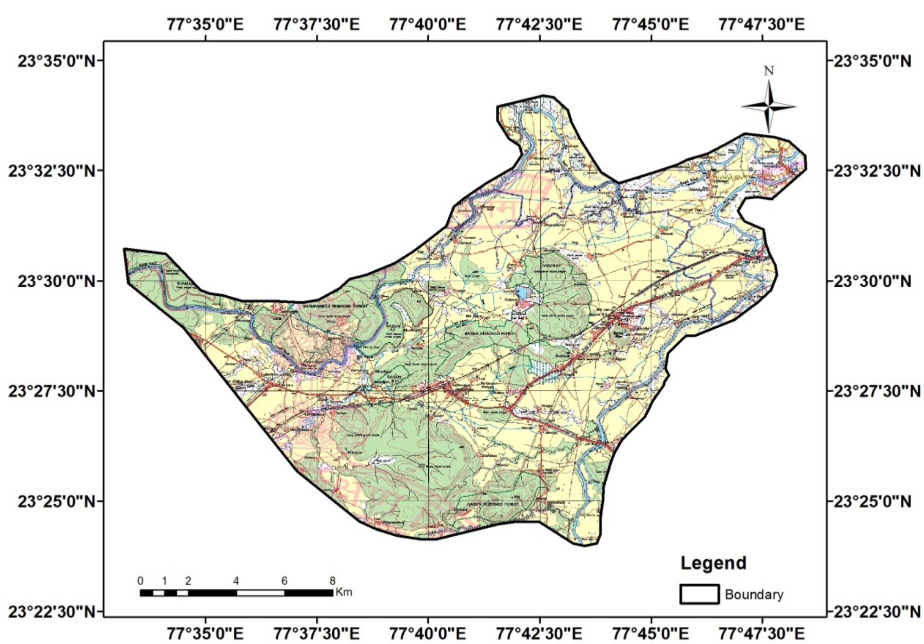

Fig. 1. Topographic ~~M~~map of the right bank canal ~~C~~command ~~A~~area

2.3 Data Acquisition and Calculations

With the help of the information collected from secondary sources, field visits were planned to conduct interviews with key informants and observations of the irrigation systems. The advices of an interdisciplinary team with backgrounds in soil science, agricultural engineering, agricultural economics, and agricultural extension were considered for further processes in the data collection and analysis. To characterize the command area information was collected from various sources regarding present irrigation system of command area, basic data related to crop, soil type, soil properties, irrigation water availability and rainfall. Assessment of water requirement of crops, discharge in head, middle and tail reach of canal and its distributaries irrigation methods and irrigation schedule followed. Farmer's survey was conducted to understand their opinion regarding the irrigation system at present.

Data of gross cultivated area and net sown area (*rabi* and *kharif* season) of 55 villages of RBC command were collected from Tehsil office (Revenue Department), Vidisha district. Cropping intensity is defined as the ratio of total cropped area in year to total cultivated area. This is also expressed in percentage.

Agricultural water productivity can be expressed either as a physical productivity in terms of yield per unit quantity of water consumed (tones per ha m of water or yield in kg per m^3 water consumed) in accordance with the scale of reference that includes or excludes the losses of water or an economic productivity replacing the yield term by the gross or net present value of the crop yield for the same water consumption.

Water productivity = Actual yield/actual water use

3. RESULTS AND DISCUSSION

To enhance the water productivity by adopting suitable surface irrigation methods and pressurized irrigation methods of right bank canal (RBC) command area it was necessary to study the existing waster relies from reservoir and water productivity in its command area. Similarly the increase in cropping intensity can be obtained by studying and analyzing present cropping intensity.

3.1 Water Availability of RBC

The canal was in operation for 24 hours for 112 days. It was observed that the water availability through main canal decreases in tail reaches. The deficit of irrigation water was supplemented by the tube well water at head, middle and tail end. The farmers were using tube well water mainly in the *rabi* season. Monthly water releases are presented in Table 1.

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Table 1. Monthly water releases to RBC

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S. No.	Month	Volume of water released (M m^3)
1	November	11051942.40
2	December	10912570.56
3	January	11726795.52
4	February	9282985.41
Total		**42.974294**

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3.2 Existing Water Productivity in Command Area

The total water supplied in M m^3 excluding losses from RBC was assess the existing water productivity. The existing water productivity of the command area was found to be 0.60 kg m^{-3} for *Rrabi* season as shown in tTable 2.

Table 2. Wheat Ccrop Yyield and Pproductivity in RBC Ccommand Aarea

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Name of WUAs	Cropped area (ha) in *Rrabi* season	Production (q ha^{-1})	Total Production (q)	Total water released from RBC (M m^3)	Water productivity (kg m^{-3})
Sarchampa	1087	27.66	29959	42.974294	0.60
Ucher	3210	28	89687		
Medaki	1611	28	44959		
Sayar	1895	27	52299		
Neemkheda	1700	26	44261		
Total	**9503**		**261165**		

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43.32 Existing Cropping Intensity

To determine the cropping intensity of canal command area covering all 55 villages', information of total area, area under different crops in *Rrabi* and *Kkharif* season was collected from revenue department and has been presented in the tTable 3, the cropping intensity of command area varies from 115% to 196%.

Table 3. Existing Ccropping Iintensity of Ccommand Aarea

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S.	Name of	CCA	*Rrabi*	*Kkhar*	Total	Cropping	Irrigated area

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No.	village		season area (ha)	*if* season area (ha)	cropped area (ha)	Intensity (%)	(ha) by different sources	
							Canal	Tube well
1	Sunari	285.56	245.52	84.39	329.91	115.53	25	220.52
2	Anauri berkhedi	455.12	264.00	272.71	536.71	117.93	200.99	63.00
3	Kanakheda kalan	312.31	300.70	102.19	402.89	129.00	243.50	57.20
4	Ratanpur girdhari	214.36	168.50	104.81	273.31	127.50	126.50	42.00
5	Manchi	171.15	150.73	71.43	222.16	129.81	110.73	40.00
6	Suganakhedi	292.10	178.43	179.02	357.45	122.37	170.00	8.43
7	Nagori	124.24	110.43	54.83	165.26	133.02	66.43	44.00
8	Narauda	102.26	68.47	71.37	139.84	136.74	0.00	68.47
9	Firojpur	338.58	250.00	210.92	460.92	136.14	119.87	130.13
10	Uneeda	79.83	51.62	62.60	114.22	143.09	22.00	29.62
11	Airan	264.07	203.00	169.95	372.95	141.23	140.00	63.00
12	Rataltai	352.97	297.61	224.73	522.33	147.98	20.00	277.61
13	Sanchi	186.36	144.98	129.03	274.01	147.03	37.57	107.41
14	Medaki	463.92	418.70	257.90	676.60	145.85	349.00	69.70
15	sookhansen	104.13	85.62	68.43	154.04	147.93	60.00	25.62
16	Kamapar	266.96	233.56	155.41	388.97	145.70	200.56	33.00
17	Dargava	123.19	118.58	61.39	179.97	146.08	80.39	38.19
18	Moralikhedi	336.26	270.10	265.95	536.05	159.41	0.00	270.10
19	Chiroli	247.24	183.41	191.60	375.00	151.68	175.00	8.41
20	Fatehpur	314.74	282.00	215.62	497.62	158.11	159.33	122.67
21	Ucher	276.80	219.69	196.30	415.99	150.29	214.00	5.69
22	Nonakhedi	127.77	99.96	104.41	204.37	159.96	80.00	19.96
23	Khamkheda	251.44	233.56	155.41	388.97	154.70	15.00	218.56
24	Bansakheda	491.19	475.94	354.88	830.82	169.14	310.94	165.00
25	Gulgaonv	312.53	224.03	291.60	515.63	164.99	24.00	200.03
26	Madvai	415.97	352.23	328.76	681.00	163.71	300.00	52.23
27	Kachhi	236.36	196.75	203.50	400.25	169.34	106.75	90.00

	kanakheda							
28	Piparia khurd	96.51	78.94	84.74	163.68	169.60	40.98	37.96
29	Madaiya khurd	87.09	82.18	60.70	142.88	164.06	25.23	56.95
30	Bamora	327.57	300.32	233.69	534.01	163.02	114.34	185.98
31	Neemkheda	775.21	689.06	631.52	1320.58	170.35	625.66	63.40
32	Sunpura	309.12	285.10	235.95	521.05	168.56	6.98	278.12
33	Karaiya haveli	200.35	191.70	147.51	339.21	169.31	123.00	68.69
34	Padariya maphi	89.14	85.92	65.00	150.92	169.32	19.00	66.92
35	Base	468.12	405.06	367.52	772.56	165.03	300.93	104.12
36	Udaygiry	151.77	139.30	120.23	259.53	171.00	59.99	79.30
37	Rangai	131.44	120.50	114.00	234.50	178.41	70.00	50.50
38	Dhaniyakhedi	172.59	164.40	141.80	306.20	177.41	4.00	160.40
39	Mada	173.83	129.42	168.11	297.53	171.16	100.00	29.42
40	Bagaud	359.85	325.32	312.10	637.41	177.13	311.20	14.11
41	Bala barkheda	583.23	546.99	500.50	1047.49	179.60	464.01	82.98
42	Berkhedi	242.20	229.54	216.17	445.71	184.03	116.54	113.00
43	Vighan	100.65	96.60	94.00	190.60	189.36	53.60	43.00
	Dakana							
44	chapana	277.67	252.71	255.25	507.96	182.94	100.00	152.71
45	vilori	203.81	181.69	196.24	377.93	185.43	40.00	141.69
46	Mudiakheda	228.07	200.40	219.10	419.50	183.94	0.00	200.40
47	Muktapur	80.98	74.89	75.55	150.44	185.77	0.00	74.89
48	Parasi khurd	141.23	134.93	131.03	265.97	188.32	50.28	84.65
49	Patharia	234.13	221.87	208.16	430.03	183.68	106.33	115.54
50	Karela	377.94	350.70	340.99	691.69	183.02	212.00	138.70
51	Silwaha	249.31	246.00	243.50	489.50	196.34	225.75	20.25
52	Sarchampa	369.98	395.59	324.36	719.95	194.60	302.11	93.48
53	Suakhedi	236.88	229.14	223.41	452.55	191.05	129.00	100.14
54	Aamkheda	183.58	178.80	182.33	361.13	196.72	100.00	78.80
55	Sayar	836.80	811.26	807.47	1618.73	193.44	620.00	191.26

34.43 Frequency Distribution of Cropping Intensity in Command Area

In order to obtained frequency distribution pattern the cropping intensity was divided in to ranges. It is also clear from Figure~~.~~ 2 that the cropping intensity of villages under study varies between110 to 200%. It is also depicted from the table that only six village, out of 55 villages were having cropping intensity less than 140%. On the higher side, only five villages were having cropping intensity more than 190%. The lowest cropping intensity (115%) was found in Sunari village of Medaki WUA. This village is having 245 ha net sown area in *~~R~~rabi* season but very less net sown area (84 ha) in *~~K~~kharif* season due to unavailability of water. Similarly less cropping intensity (118%) was found in Anouriberkhedi village. This village is having 264 ha net sown area out of 455 ha in *~~R~~rabi* season and 272 ha net sown area out of 455 ha in *~~K~~kharif* season.

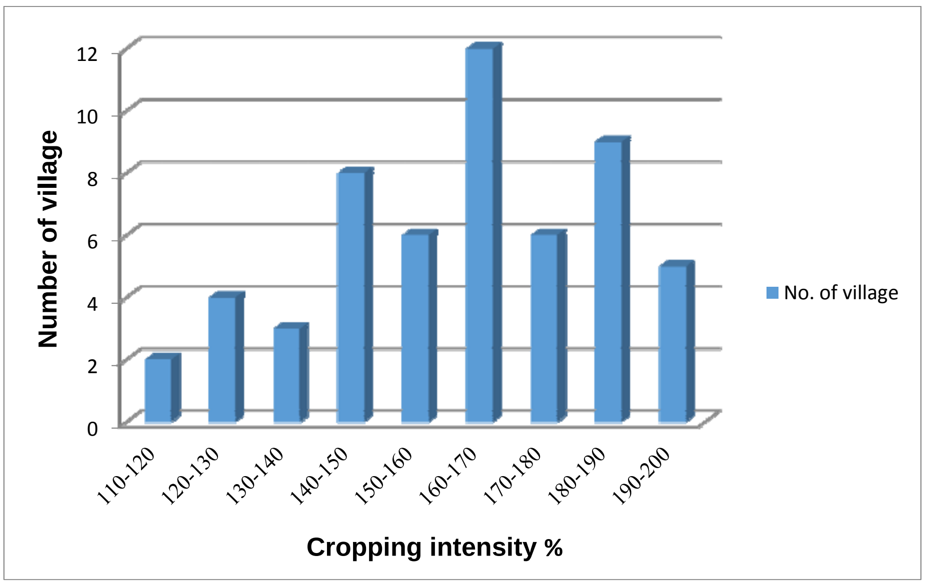

Fig 2. Frequency of cropping intensity RBC ~~C~~command ~~A~~area

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The cropping intensity of four villages namely Sugnakhedi, Ratanpurgirdhari, Kanakhedakalan and Manchi fall in range of 120-130% cropping intensity. All four villages have very less sown area in *~~K~~kharif* 61, 49, 33 and 42%, respectively, on the other side the net sown area in *~~R~~rabi* season is 78, 79, 96 and 88% for Sugnakhedi, Ratanpurgirdhari, Kanakhedakalan and Manchi villages, respectively. In village Kanakhedakalan 99% area is under irrigation which results in 300 ha net sown area out of 312 ha cultural command area in *Rrabi* season.

The cropping intensity of three villages namely, Sugnakhedi, Ratanpurgirdhari and Manchi was found very poor as shown in Figure. 2 due to rocky area, unavailability of canal water and tube wells are not successful. This all result in poor cropping intensity.

The cropping intensity of three villages namely, Nagori, Naroda and Firozpur falls in 130-140% cropping intensity range. Village Nagori is having only 54 ha net sown area in *Kkharif* season out of 124 ha and net sown area in *Rrabi* season is 110 ha (Table 3). Out of 110 ha net sown area 44 ha is irrigated from tube well. In village Naroda net sown area in *Rrabi* season 68 ha and 71 ha is the net sown area in *Kkharif* season against the total cultural command area 102 ha.

The cropping intensity of eight villages namely Uneeda, Airan, Rataltai, Sanchi, Medaki, Sookhansen, Kamapar and Dargava out of surveyed 55 villages were found in the range of 140-150%. The villages namely Uneeda, Airan, Rataltai, Sanchi, Medaki, Sookhansen, Kamapar and Dargava having canal irrigated area 22, 140, 20, 37.57, 349, 60, 200.55 and 80.39 ha, respectively and tube well irrigated area was found 29.619, 63, 277.60, 107.408, 69.7, 25.61, 33 and 38.19 ha, respectively. The *Kkharif* sown area in these villages was 50-78%. While the *Rrabi* sown area in these villages varies from 65-96%.

The cropping intensity of six villages namely Moralikhedi, Chiroli, Fatehpur, Ucher, Nonakhed and Khamkheda was found in the range of 150-160%. All these villages are having canal irrigated area of 175, 159.33, 214, 80 and 15 ha, respectively, except Moralikhedi village and tube well irrigated area was found 270.096, 8.40, 122.66, 5.69, 19.96 and 218.55 ha, respectively. The irrigated area in these villages varies from 64-100%.

The cropping intensity of twelve villages namely Bansakheda, Gulgaonv, Madvai, Kachhikanakheda, Pipariakhurd, Madaiyakhurd, Bamora, Neemkheda, Sunpura, Karaiyahaveli, Padariyamaphi and Baise was found varying between from 160-170%. All these villages are having canal irrigated area 310.93, 24, 300, 106.75, 40.98, 25.23, 114.34, 625.65, 6.98, 123, 19 and 300.93 ha, respectively, and tube well irrigated area was found 165, 200.03, 52.23, 90, 37.96, 56.95, 185.98, 63.40, 278.12, 68.69, 66.92 and 104.12 ha, respectively.

The cropping intensity of six villages namely Udaygiry, Rangai, Dhaniyakhedi, Mada, Bagaud and Balabarkheda was found range from 170-180%. All these villages are having canal irrigated area that is 59.99, 70, 4, 100, 311.20 and 464.01 ha, respectively, and tube well irrigated area was found 79.29, 50.5, 160.4, 29.42, 14.11and 82.98 ha, respectively. Irrigated area in these villages varies from 74-100%.

The cropping intensity of nine villages namely villages namely Berkhedi, Vighan, Dakana chapana, Vilori, Mudiakheda, Muktapur, Parasikhurd, Patharia and Karela, are having from 182-189%. All these villages are having canal irrigated 116.54, 53.6, 100, 40, 0, 0, 50.28, 106.33 and 212 ha, respectively, except Vilori, Mudiakheda villages and tube well irrigated area was found 113, 43, 152.71, 141.69, 200.4, 74.89, 84.65, 115.54 and 138.7 ha, respectively.

The cropping intensity of five villages namely Silwaha, Sarchampa, Suakhedi, Aamkheda and Sayar have exceptionally very high cropping intensity i.e. 191-196%. All these villages namely are having canal irrigated area 225.74, 302.11, 129, 100 and 620 ha, respectively villages and tube well irrigated area was found 20.253, 93.479, 100.13, 78.8 and~~,~~ 191.26 ha, respectively.

It is difficult to increase ~~*K*~~*kharif* sown area due to uncertainty of monsoon, excess of deficit rain fall, but it is easy to manage to take third crop as summer crop provided that there is assured irrigation. If considerable amount of water is saved, than summer cropping is easily feasible.

34.54 Existing Cropping Intensity in Command Area WUA Wise

The existing cropping intensity of ~~right bank canal~~RBC command area was found 163%. The ~~right bank canal~~RBC comprises of five water user association namely Sarchampa, Ucher, Medaki, Sayar and Neemkheda whose existing cropping intensity was found 181, 149, 158, 177 and 172%, respectively, as shown in Table 4.

Table 4. Existing ~~C~~cropping ~~I~~intensity in ~~C~~command ~~A~~area WUA ~~W~~wise

	Name of ~~W~~water ~~U~~user ~~A~~asssociation					
Area (ha)	**Sarcham**	**Uche**	**Meda**	**Saya**	**Neemkh**	**Total**
Cultivable command area (CCA) of WUA (ha)	1110	4320	3698	3240	2468	14836
Rabi crop season area (ha)	1087	3380	3249	2952	2243	12911
Kharif crop season area (ha)	923	3046	2591	2774	1992	11326
Total cropped area (ha)	2010	6426	5840	5726	4235	24237
Cropping intensity (%)	**181**	**149**	**158**	**177**	**172**	**163**

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A detailed survey was conducted in order to know the existing condition and performance of the system. In RBC command WUA, middle reach has highest area followed by head and tail reach. Highest total number of farmers present in marginal category was 1743 and lowest 496 were found in large category. Highest total area 3417 ha was covered by middle reach in medium category and lowest 2982 ha were covered in head reach in marginal category. The cropping intensity of the area was worked out and ranges from 115% to 196%. Similarly existing water productivity was found to be 0.60 kg m^{-3}.

54. CONCLUSION

This study was planned to assess existing water productivity and cropping intensity of the right bank canal command area of Samrat Ashok Sagar project. Enhancement in water productivity by adopting suitable irrigation system in right bank canal command area is the need of present scenario. In view of this existing water productivity and existing cropping intensity of RBC command area was studied analyzed and it was found that the existing water productivity determined as 0.60 kg m^{-3}.and 163% was the existing cropping intensity of right bank canal command.

ACKNOWLEDGMENTS

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