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Full Length Research Paper

Proportional operation review of irrigation schemes in Kastamonu area located in northern Turkey

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Performance analysis of six irrigation schemes in Kastamonu area located in northern Turkey were assessed using comparative performance indicators between the years 2008 and 2012. Performance indicators used for the analysis included relative water supply, financial performance as cost recovery ratio, maintenance expenditure to revenue ratio, operational cost per unit area, total cost per personnel employed on water delivery, revenue collection performance and service area per personnel. Additionally, production performance of the schemes were evaluated in terms of output per unit command area, output per unit irrigated area, output per unit irrigation supply and output per unit consumed-water. The results of the analysis indicated that all irrigation schemes except Asar had enough performance for the relative water supply ratios. Furthermore, cost recovery ratio and revenue collection performance was not satisfactory. On the other hand, maintenance expenditure to revenue, operational cost per unit area, total cost per person employed on water delivery and service area per personnel had performed well in most of schemes during the study years. Output per unit command area, output per unit irrigated area, output per unit irrigation supply and output per unit consumed-water were performed well for all schemes in the investigation year.

Key words: Comparative analysis, irrigation performance, performance indicators, irrigation schemes.

INTRODUCTION

Agriculture is a very important key for the socio-economic development of Turkey. Fresh water supply is the principle component of the agricultural practices in arid and semi-arid regions of Turkey. Thus the most important challenges for the management of agricultural lands is efficient use of fresh water resources in the region (Sayın et al., 2013).

Pressures on watersheds due to diverse demands with rapid increase in populations and the lack of homogeneity in the distribution of water sources put the situation worse in some part of the country (Çakmak and Aküzüm, 2006).

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Currently, less than 60% of potential 8.5 million ha of irrigable agricultural land are under irrigation condition in Turkey. And about 90% of these irrigated lands have gravity irrigation systems (Öztürk, 2004).

Performance of irrigation schemes needs to be analyzed to assess the efficiency of the system (Molden and Sakthivadivel, 1999). Studies in different regions of Turkey used multidisciplinary performance indicators such as water delivery, water use efficiency, sustainability of irrigation, environmental and socio-economic aspects and management are required in order to determine the

Table 1. Irrigation schemes in the study area.

Irrigation facility	Starting date for operation	Date of transfer	Type of irrigation organization
Asar	2009	3/2/2010	Asar Irrigation Association
Beyler	2006	31/10/2009	Beyler Irrigation Association
Germeçtepe-Kırcalar	2003	7/1/2004	Germeçtepe-Kırcalar Irrigation Association
Hasköy	2007	18/09/2008	Hasköy Irrigation Association
Karaçomak	2004	15/03/2004	Karaçomak Irrigation Association
Karaderer	2007	24/08/2010	Karadere Irrigation Association

Figure 1. Map showing the WUAs location in Kastamonu area in northern Turkey

performance of the irrigation schemes in all aspects (Akkuzu et al., 2007; Uçar et al., 2010).

Mengü and Akkuzu (2010) studied about the effects of the transfer of irrigation management on water and land productivity, and water supply in Gediz Basin in Aegean Sea Region of Turkey. In this study, researchers found out that there was a decline in water supply indicators with a steady increase in the productivity of water. They determined that the reason for this decrease in supply is the long-lasting and ongoing drought in the region.

Kukul et al. (2008) assessed the temporal variations of agricultural, water use, environmental and financial performance indicators for the pre transfer (1984 to 1994) and the post transfer (1995 to 2004) periods. They found a considerable increase in output per unit of land and per unit of water after turnover. According to results of this study, the transfer process created more sustainable management for irrigation. Study by Dorsan et al. (2004) in the same basin showed the similar results.

Değirmenci et al. (2003) evaluated irrigation system performance for irrigation schemes in Southeastern Anatolia Project (GAP) region in Turkey. Study showed that an information system for monitoring and evaluation which encompasses all stakeholders should be set up and irrigation scheduling should be designed for efficient and rational irrigation management.

The temporal variations of physical and economic performance were assessed in the irrigation schemes in Thrace region of Turkey by Şener (2012). In this study, it was concluded that the irrigation management transfer program increased the system performance and the schemes have become more self-sufficient under the management of Water User Associations (WUAs).

There is no study previously carried out on irrigation performance evaluation of irrigation schemes in Kastamonu region. Therefore, the aim of this study is to assess water delivery performance, financial performance and productive performance on irrigation schemes using the data acquired from the WUAs in Kastamonu region situated in northern Turkey for the years 2008 to 2012.

MATERIALS AND METHODS

In this study, WUAs namely Asar, Beyler, Germeçtepe-Kırcılar, Hasköy, Karaçomak and Karadere serving under the twenty-third State Hydraulic Works (SHW) Regional Directorate were assessed (Table 1). The twenty-third SHW Regional Directorate is geographically located in Kastamonu Area in Turkey (Figure 1). Its service area covers the watersheds of İncesu, Şadibey, Karadere, Karaçomak and Daday Stream. Asar Lake is also in this service area. Annual average precipitation during study years in the searched area is about 625 mm (Anonymous, 2013).

Data on irrigation area, irrigated land, water diverted to schemes, irrigation water requirement, cropping pattern, yield and unit prices of the crops grown for the years 2008 to 2012 were taken from evaluation and monitoring reports of the related WUAs (Table 2). The prices of products were converted from Turkish Lira to American Dollars using the Central Bank of Turkish Republic's foreign exchange rate.

In this study, the International Program for Technology and Research in Irrigation and Drainage (IPTRID) approach is used for performance evaluation in the irrigation and drainage sector. The comparative analysis of performance indicators used in performance assessment of irrigation schemes are given in Table 3 (Malano and Burton, 2001). Related data for performance evaluation were taken from the records of the SWH 23th Regional Directorate in Kastamonu.

RESULTS AND DISCUSSION

Irrigation ratios of schemes between 2008 and 2012

Table 2. Characteristics of evaluated irrigation schemes in Kastamonu area of Turkey.

Name of irrigation	Water resource	Irrigation area (ha)	Conveyance and distribution network	Cropping pattern	Irrigation management	Type of irrigation system
Asar	Asar Lake	1010	Closed System	Garden, Sugar Beet, Vegetables and Poplar	Pressurized	Pumping
Beyler	İncesu Stream	5178	Open Canal	Sugar Beet, Corn, Broom Grass, Potatoes and Forage Crops	Surface	Gravity
Germeçtepe-Kırcalar	Şadibey Stream	2196	Open Canal	Sugar Beet, Corn, Broom Grass, Fruit, Vegetable, Poplar and Forage Crops	Surface	Gravity
Hasköy	Karaçomak and Daday Stream	2580	Open Canal	Cereals, Garden, Sugar Beet, Corn, Broom Grass, Fruit, Vegetables, Forage Crops and Poplar	Surface	Gravity
Karaçomak	Karaçomak Stream	1670	Open Canal	Sugar Beets, Corn, Broom Grass, Fruit, Potato, Onion, Garlic, Forage Crops and Poplar	Surface	Gravity and Pumping
Karaderer	Karadere Stream	5810	Open Canal and Closed System	Cereals, Garden, Sugar Beet, Corn, Broom Grass, Fruit, Vegetables, Forage Crops and Poplar	Surface and Pressurized	Gravity and Pumping

Table 3. Comparative analysis of performance indicators used in the case study and data required.

Activity area	Performance indicator	Data required
Water delivery performance	Annual relative water supply	Total annual inflow volume to system/Volume of annual crop water requirement
Financial performance	Cost recovery ratio	Total revenue collected from water users/Total management, operation and maintenance (MOM) cost
	Maintenance expenditure to revenue ratio	Total maintenance expenditure/Total revenue collected from water users
	Operational cost per unit area ($ ha^{-1})	Total operation expenditure/Total command area serviced by the system
	Total cost per person employed on water delivery ($/person)	Total cost of MOM personnel/Total number of people employed
	Revenue collection performance	Total service revenue collected/Total service revenue due
	Service area per personnel (ha/person)	Total number of MOM staff/Total command area serviced by system
Productive performance	Output per unit command area ($ ha^{-1})	Gross value of agricultural production/Total cultivable command area
	Output per irrigated area ($ ha^{-1})	Gross value of agricultural production /Total irrigated crop area
	Output per unit irrigation supply ($ m^{-3})	Gross value of agricultural production/Total inflow volume of water
	Output per unit water consumed ($ m^{-3})	Gross value of agricultural production/Total volume of water consumed by crop

according to the records of the SWH in the study area are given in Table 4. Ratios are similar to study reported by Nalbantoğlu and Çakmak (2007) but are not similar to results of works by Yercan et al. (2004) due to regional conditions.

The ratio of maximum relative water supply was about 13 in Asar in 2012 while the minimum ratio of that was 1 in Germeçtepe-Kırcalar in 2009 (Table 5). Most of the results for water supply ratios in this area are higher than previous studies (Kukul et al., 2008). Water was diverted to system as needed when the relative water supply ratio equal to 1. Moreover, water was diverted to system with higher and lower amount for the relative water supply ratio value of higher than 1.0 and lower than 1.0, respectively (Beyribey, 1997). At this point, all values of relative water supply ratio of study equal and higher than 1. There is no problem for water diverted to system for all schemes in this study. The higher water was diverted to Asar scheme in all the schemes.

Cost recovery ratio was maximum in the Karadere irrigation scheme with 136% in 2011, and minimum in the Karaçomak irrigation scheme with 14% in 2008 (Table 6). Data indicated that the total revenue collected from water users were not sufficient to meet the maintenance

Table 4. Irrigation ratios of WUAs in the study area.

Irrigation schemes	Irrigation area (ha					Irrigated area (ha)					Irrigation ratios (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	1010	1010	1010	NA	NA	144	100	67.00	NA	NA	14.3	9.9	6.6
Beyler	NA	NA	5178	5178	5178	NA	NA	310	338	702.00	NA	NA	6.0	6.5	13.6
Germeçtepe-Kırcalar	2100	2100	2100	2196	2196	709	423	675	678	663.00	33.8	20.1	32.1	30.9	30.2
Hasköy	NA	2580	2580	2580	2580	NA	348	632	496	439.00	NA	13.5	24.5	19.2	17.0
Karaçomak	1670	1670	1670	1670	1670	407	376	440	475	501.00	24.4	22.5	26.3	28.4	30.0
Karaderer	NA	NA	NA	5810	5810	NA	NA	NA	744	1633.00	NA	NA	NA	12.8	28.1

NA: Not available.

Table 5. Relative water supply ratios of WUAs in the study area.

Irrigation schemes	Total water input to system (m^3)					Total irrigation water need (m^3)					Relative water supply ratios				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	4038000	2202000	2842000	NA	NA	490000	337000	222000	NA	NA	8.2	6.5	12.8
Beyler	4993000	2447000	2143000	4445000	5113000	965000	478000	966000	1024000	1857000	5.2	5.1	2.2	4.3	2.8
Germeçtepe-Kırcalar	2907000	1048000	3182000	4983000	6873000	1603000	1046000	2093000	1978000	1792000	1.8	1.0	1.5	2.5	3.8
Hasköy	NA	4256000	5345000	4811000	4575000	NA	867000	1756000	1401000	1186000	NA	4.9	3.0	3.4	3.9
Karaçomak	3457000	2842000	4937000	5573000	6716000	1154000	1950000	1297000	1375000	1379000	3.0	1.5	3.8	4.1	4.9
Karaderer	NA	NA	NA	7065000	10755000	NA	NA	NA	2235000	4419000	NA	NA	NA	3.2	2.4

NA: Not available.

Table 6. Cost recovery ratios of WUAs in the study area.

Irrigation schemes	Total revenue collected from water users (US$)					Total maintenance operational management cost (US$)					Cost recovery ratios (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	11966.7	6547.6	5500.6	NA	NA	13066.7	13947.6	12008.4	NA	NA	91.6	46.9	45.8
Beyler	NA	NA	26892.0	14636.9	43340.4	NA	NA	80192.0	78075.0	81128.1	NA	NA	33.5	18.7	53.4
Germeçtepe-Kırcalar	39578.9	26110.4	50760.0	64232.7	71844.9	186274.2	103451.3	168000.0	109324.4	114896.1	21.2	25.2	30.2	58.8	62.5
Hasköy	NA	44607.8	55713.3	17857.1	56751.1	NA	42835.1	73640.7	79488.7	75379.8	NA	104.1	75.7	22.5	75.3
Karaçomak	24375.0	23647.4	42562.0	28279.8	36713.5	178196.9	93056.5	112284.0	108560.1	99817.4	13.7	25.4	37.9	26.0	36.8
Karaderer	NA	NA	NA	91611.3	119551.1	NA	NA	NA	67252.4	167769.1	NA	NA	NA	136.2	71.3

NA: Not available.

Table 7. Maintenance expenditure to revenue ratio values of WUAs in the study area.

Irrigation schemes	Total maintenance cost (US$)					Total revenue collected from water users (US$)					Maintenance expenditure to revenue ratio (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	0.0	3218.5	3089.9	NA	NA	11966.7	6547.6	5500.6	NA	NA	0.0	49.2	56.2
Beyler	NA	NA	7236.7	10285.1	8036.0	NA	NA	26892.0	14636.9	43340.4	NA	NA	26.9	70.3	18.5
Germeçtepe-Kırcalar	16468.8	19513.0	16475.3	13095.2	13277.0	39578.9	26110.4	50760.0	64232.7	71844.9	41.6	74.7	32.5	20.4	18.5
Hasköy	NA	7175.3	10407.3	8285.7	9080.3	NA	44607.8	55713.3	17857.1	56751.1	NA	16.1	18.7	46.4	16.0
Karaçomak	12750	14961.0	21732.0	20895.8	16612.4	24375.0	23647.4	42562.0	28279.8	36713.5	52.3	63.3	51.1	73.9	45.2
Karaderer	NA	NA	NA	6742.3	34321.3	NA	NA	NA	91611.3	119551.1	NA	NA	NA	7.4	28.7

NA: Not available.

Table 8. Operational cost per unit area of the WUAs in the study area.

Irrigation schemes	Total maintenance operational management cost (US$)					Irrigation area (ha)					Operational cost per unit area (US$ ha^{-1})				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	13066.7	13947.6	12008.4	NA	NA	1010	1010	1010	NA	NA	12.9	13.8	11.9
Beyler	NA	NA	80192.0	78075.0	81128.1	NA	NA	5178	5178	5178	NA	NA	15.5	15.1	15.7
Germeçtepe-Kırcalar	186274.2	103451.3	168000.0	109324.4	114896.1	2100	2100	2100	2196	2196	88.7	49.3	80.0	49.8	52.3
Hasköy	NA	42835.1	73640.7	79488.7	75379.8	NA	2580	2580	2580	2580	NA	16.6	28.5	30.8	29.2
Karaçomak	178196.9	93056.5	112284.0	108560.1	99817.4	1670	1670	1670	1670	1670	106.7	55.7	67.2	65.0	59.8
Karaderer	NA	NA	NA	67252.4	167769.1	NA	NA	NA	5810	5810	NA	NA	NA	11.6	28.9

NA: Not available.

operation management costs. However, Beyribey (1997) determined that cost recovery ratios of state irrigation schemes and average of the country were between 21 to 91% and 65%, respectively.

The highest and lowest maintenance expenditure to revenue ratios were obtained in the Germeçtepe-Kırcılar irrigation scheme with 75% in 2009 and Karadere irrigation scheme with 7.4% in 2011, respectively (Table 7). Nalbantoğlu and Çakmak (2007) reported maintenance expenditure to revenue ratios between 2.5 and 11%. Their results are lower than those of the current study. However, revenue collected from water users were enough to maintenance costs in the most of schemes between 2008 and 2012 (Table 7).

Concerning the operational cost per unit irrigation area, the highest cost per unit area was obtained from the Karaçomak irrigation scheme with US$ 107 ha^{-1} in 2008 while the lowest cost was acquired in the Karadere irrigation scheme with US$ 12 ha^{-1} in 2011 (Table 8). In the study of Çakmak et al. (2010), operational cost per unit irrigation area was between US$ 6.5 ha^{-1} and US$ 71 ha^{-1}. Most of schemes in this study have higher values than that of a reported study by Çakmak et al. (2010). However values are similar to the study conducted by Nalbantoğlu and Çakmak (2007).

Operational cost per unit irrigation area was higher at the beginning of the study. But in the following years it started to decline, thanks to decreasing of total maintenance operational

Table 9. Cost per personnel employed in the WUAs.

Irrigation schemes	Total cost of maintenance-operating-management personal (US$)					Total number of people employed person					Cost per personnel (US$ person^{-1})				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	3466.7	3095.2	2106.7	NA	NA	2	3	2	NA	NA	1733.3	1031.7	1053.4
Beyler	NA	NA	35143.3	36183.9	41067.4	NA	NA	24	1	3	NA	NA	1464.3	36183.9	13689.1
Germeçtepe-Kırcalar	47415.6	44064.9	32900.0	47760.1	28089.9	9	9	10	10	11	5268.4	4896.1	3290.0	4776.0	2553.6
Hasköy	NA	18107.8	30161.3	29441.7	31011.2	NA	9	9	9	10	NA	2012.0	3351.3	3271.3	3101.1
Karaçomak	49710.9	39563.0	39071.3	47648.2	38679.8	7	7	7	8	7	7101.6	5651.9	5581.6	5956.0	5525.7
Karaderer	NA	NA	NA	37381.0	69053.4	NA	NA	NA	10	14	NA	NA	NA	3738.1	4932.4

NA: Not available.

Table 10. Revenue collection performance of the WUAs in the study area.

Irrigation schemes	Total collected water fee from the users (US$)					Total water fee to be collected (US$)					Revenue collection performance (%)				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	11966.7	6547.6	5500.6	NA	NA	23933.3	13392.9	11703.4	NA	NA	50.00	48.9	47.0
Beyler	NA	NA	26892.0	14636.9	43340.4	NA	NA	51666.7	50297.6	90850.0	NA	NA	52.05	29.1	47.7
Germeçtepe-Kırcalar	39578.9	26110.4	50760.0	64232.7	71844.9	110734.4	68711.7	104875.3	111066.7	146062.9	35.7	38.0	48.40	57.8	49.2
Hasköy	NA	44607.8	55713.3	17857.1	56751.1	NA	62559.7	100000.0	73797.6	86105.6	NA	71.3	55.71	24.2	65.9
Karaçomak	24375.0	23647.4	42562.0	28279.8	36713.5	79492.2	66964.3	85124.7	70699.4	100226.4	30.7	35.3	50.00	40.0	36.6
Karaderer	NA	NA	NA	91611.3	119551.1	NA	NA	NA	113166.7	222506.7	NA	NA	NA	81.0	53.7

NA: Not available.

management cost for all schemes.

The highest labor cost were determined for Beyler irrigation scheme with 36184 USD per person in 2011 and the lowest value with 1032 USD for Asar scheme in 2011 (Table 9). Labor cost steadily declined from year 2008 to 2012 for all irrigation schemes.

The highest revenue collection performance was estimated for Karadere scheme with the percentage value of 81 in 2011 (Table 10). The lowest figure for the same variable was calculated for Hasköy scheme with a value of 24% in 2011. Revenue collection performance values are mostly located around 50% in the irrigation schemes between 2008 and 2012 (Table 10). Similar results were reported by Şener et al. (2007) but these revenue collection performances are not sufficient when compared with the study of Yercan et al. (2009).

The highest and the lowest values of service area per personnel were found in Beyler scheme with 5178 ha person^{-1} in 2011 and Germeçtepe-Kırcalar irrigation scheme with 200 ha person^{-1} in 2012, respectively (Table 11). Yercan et al. (2009)

Table 11. Service area controlled per personnel in the selected WUAs.

Irrigation schemes	Total number of personnel employed in operation and maintenance					Irrigation area (ha)					Service area per personnel (ha person^{-1})				
	Years					Years					Years				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Asar	NA	NA	2	3	2	NA	NA	1010	1010	1010	NA	NA	505.0	336.7	505.0
Beyler	NA	NA	24	1	3	NA	NA	5178	5178	5178	NA	NA	215.8	5178.0	1726.0
Germeçtepe-Kırcalar	9	9	10	10	11	2100	2100	2100	2196	2196	233.3	233.3	210.0	219.6	199.6
Hasköy	NA	9	9	9	10	NA	2580	2580	2580	2580	NA	286.7	286.7	286.7	258.0
Karaçomak	7	7	7	8	7	1670	1670	1670	1670	1670	238.6	238.6	238.6	208.8	238.6
Karaderer	NA	NA	NA	10	14	NA	NA	NA	5810	5810	NA	NA	NA	581.0	415.0

NA: Not available.

Table 12. Output per unit command area for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Irrigation area (ha)	Output per unit command area (US$ ha^{-1})
Asar	697846.8	1010.0	690.9
Beyler	2308004.8	5178.0	445.7
Germeçtepe-Kırcalar	2434391.9	2196.0	1108.6
Hasköy	5788944.4	2580.0	2243.8
Karaçomak	3097159.6	1670.0	1854.6
Karaderer	22980052.2	5810.0	3955.3

stressed that the number of labor for an irrigation scheme should be less than 3 per 1000 ha of irrigated land for an effective management. Therefore, the analysis of the current data implies that more than enough people are employed for most of the schemes (Table 11). This situation can be partly attributed to the extensive open channel system to distribute available water supply to the farmers for all irrigation schemes.

The highest and the lowest output per unit of command area were obtained from the Karadere irrigation scheme with US$ 3955 ha^{-1} and for Beyler irrigation scheme with US$ 446 ha^{-1}, respectively (Table 12). In the study of Çakmak et al. (2004), output per unit of command area was between US$ 635 and US$ 2636 ha^{-1}. As similar to these results, the highest output per unit of irrigated area was obtained for Karadere irrigation scheme with US$ 14072 ha^{-1} while the lowest output of that is for Beyler scheme with US$ 3288 ha^{-1} (Table 13). Output per unit of irrigated area was calculated between US$ 87 ha^{-1} and US$ 4678 ha^{-1} in by Çakmak et al. (2002). Concerning the output per unit of water diverted to the network, Karadere irrigation scheme had the highest value with US$ 2.1 m^{-3} while Asar irrigation schemes had the lowest value with US$ 0.2 m^{-3} (Table 14). Merdun (2004) obtained these values between US$ 0.04 m^{-3} and US$ 0.56 m^{-3} for his study. The highest outputs per unit of consumed irrigation water was obtained for the Karadere irrigation scheme with US$ 5.2 m^{-3}, and the lowest for Beyler scheme with US$ 1.2 m^{-3} as similar to results of Tables 12 and 13. Values for Molden et al. (1998) study were between US$ 0.05 m^{-3} and US$ 0.62 m^{-3}. The differences in

Table 13. Output per unit irrigated area for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Irrigated area (ha)	Output per unit irrigated area (US$ ha^{-1})
Asar	697846.8	67.0	10415.6
Beyler	2308004.8	702.0	3287.8
Germeçtepe-Kırcalar	2434391.9	663.0	3671.8
Hasköy	5788944.4	439.0	13186.7
Karaçomak	3097159.6	501.0	6182.0
Karaderer	22980052.2	1633.0	14072.3

Table 14. Output per unit of irrigation supply for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Total amount of water diverted to network (m^3)	Output per unit of water diverted (US$ m^{-3})
Asar	697846.8	2842000.0	0.2
Beyler	2308004.8	5113000.0	0.5
Germeçtepe-Kırcalar	2434391.9	6873000.0	0.4
Hasköy	5788944.4	4575000.0	1.3
Karaçomak	3097159.6	6716000.0	0.5
Karaderer	22980052.2	10755000.0	2.1

Table 15. Output per unit water consumed for the year of 2012 in the study area.

Irrigation schemes	Annual total agricultural production (US$)	Crop water requirement (m^3)	Output per unit water consumed (US$ m^{-3})
Asar	697846.8	222000.0	3.1
Beyler	2308004.8	1857000.0	1.2
Germeçtepe-Kırcalar	2434391.9	1792000.0	1.4
Hasköy	5788944.4	1186000.0	4.9
Karaçomak	3097159.6	1379000.0	2.2
Karaderer	22980052.2	4419000.0	5.2

productivity performance compared with the previous studies were due to the higher total agricultural production in this study.

Conclusion

Results of this study showed that high amount of water was diverted to the most of the irrigation schemes. However, the highest amount of the water from the source was used by Asar scheme. On the other hand, productivity analysis showed the promising performance thanks to higher yield and the type of crop quality for all of the schemes. Regarding financial analysis, total revenue collected from water users were not sufficient to meet the maintenance operational management costs, however, it was generally sufficient to meet maintenance cost for all irrigation schemes. Moreover, operational costs per unit irrigation area and cost per personnel were found higher in the beginning of studied years, than they exhibited a decline up to 2012. Additionally, revenue collection performance results were almost 50% which is not sufficient. Regarding the service area per personnel, it can be explained that all irrigation services have excess employed personnel thanks to distribution network of all irrigation schemes. In conclusion, productivity analysis performed promising but water delivery and financial performance need further studies.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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