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Evaluation of Irrigation System Performance with Comparative Indicators in Irrigation Schemes, Kızılırmak Basin, Turkey

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Abstract: In this study, comparative indicators, which provide comparable analysis of irrigation performance among irrigation systems, were applied on Kızılırmak Basin Irrigation and system performance was evaluated. As a result of the study, based on the 1996-2000 years output per unit command area, output per cropped irrigated area, output per unit irrigation supply, output per unit water consumed, total water supply ratio, gross return on investment and irrigation ratio were determined as 45-22443 and 247-43928 \$ ha^{-1}, 0.03-2.21 and 0.05-9.75 \$/m^3 and 0.74-6.20, 53-8708 and 8-98% respectively.

Key words: Irrigation system performance, performance indicator, standardized gross value of production

Introduction

In the first quarter of 21th century, several countries are coming face to face with important water problems due to increasing population, financial and environmental problems. Although water is a renewable resource, it is also a limited resource. The highest demand for water among the different sector occurs in agricultural sector and it plays an important role in the occurrence of environmental problems.

The irrigated land area per person increases to 48 ha in 1978, however this area decreased by 6% in recent years. Annual average increase in irrigated lands between the years 1980 and 1989 was 2.6 million ha. The decrease in irrigated land areas per person was especially seen in developing countries (Ünver and Tüzün, 2001). Most of the irrigation systems were not effectively operated because of the maintenance and operational problems. Every year, a certain amount of land area is becoming unproductive for plant growth due to soil salinity comes ponding to unproper irrigation practices and excessive water use. That is why, effective use of soil and water resources and performance evaluation of irrigation systems are highly important issues in irrigated agriculture.

For an effective watershed management, watershed water budget should be evaluated and water should be optimally allocated among the various sectors. Total water potential of the country from the 26 watershed is 186 billion m^3 and only 95 billion m^3 as this potential is used for different purposes. However, based on technical and economical criteria, total available surface and subsurface water potential is 110 billion m^3. It is assumed that 95 m^3 this potential can be applied from rivers inside the country, 3 m^3 from the rivers among from out of country and 12 m^3 from subsurface water. Annual water potential per watershed exhibits large fluctuations. Of 42 m^3 water used in the year 2000, 75% was used for irrigation, 15% for drinking and utility and 10% for industry. Most of the water resources in the country is allocated to agricultural sector increasing water demand parallel to increasing population caused a decreases in the amount of water used in agricultural sector. This situation makes the water resources management an important issue and forces toward an effective use of water.

Governments aims the following issues by transferring the irrigation systems; sustainability of irrigation systems; improving the performances of irrigation systems; reducing operation, maintenance and management costs; effective use of resources. Like the other countries, irrigation schemes are transferred to user formed organizations. Transfer of irrigation schemes to time users are preferred by many countries in Asia, Africa, America and Fareast (Vermillion and Sagardoy 1999, Vermillion 2000). With support provided by World Bank in 19993, in Turkey, transfer of irrigation schemes to irrigation cooperations, municipalities and village authority was speed up (Çakmak *et al*., 1995). Significant improvements were achieved during the lost 8 years while 95.2% as irrigation schemes were operated by The State Hydraulic Works (DSI) in 1993, this rate was related to 9.6% in 2001. Çakmak *et al.* (1995) has applied the performance indicators developed International Water Management Institute (IWMI) for performance comparison between irrigation systems on Irrigation Association in Konya region and evaluated the system performance between the years 1995 and 1999. In this study, standardized gross production value per unit command was determined as

195-5391 \$ ha^{-1}, per unit cropped irrigated area as 359-6197 \$ ha^{-1}, corresponding to the per unit irrigation supply as 0 02-1.29 \$/m^3, per unit water consumed 0.07-2.25 \$/m^3, water supply rate as 0.30-7.83 and irrigation rate as 36-104%.

Murray-Rust and Svendsen (2001) performed a study to evaluate the performance of 6 irrigation association as of SarIgöl, Alaşehir, Adala, Turgutlu, Manisa and Menemen on Gediz Basin and determined the effectiveness of water as 20-40 \$ ha^{-1}. They also stated that after the transfer irrigation performance did not changed, cost were highly reduced and production of high market value crops played as supportive role.

Svendsen and Murray-Rust (2001) evaluated nationally the effectiveness of transfer programs in Turkey. They stated that water prices in irrigation association was 78\$ ha^{-1} and 13% higher in DSI irrigations; the rate of water fee collection was 79% in irrigation association and 43% in DSI irrigation. They also indicated that a regular monitoring program was needed for transferred irrigation of DSI.

In this study, performance of 16 irrigation schemes within 5, 12, 19 and 23th regional irrigation district of DSI as of Ağcaşar, Fehimli, Gemerek, Germeçtepe, Gökçeören, Kalecik, Karaçomak, Kızılırmak, Kovalı, Kumbaba, Sarımsaklı, Sarız, Suşehri, Taşhan, Uzunlu and Zamantı irrigation were determined and evaluated for the years 1996-2000.

Materials and Methods

With a connection to Black Sea, Kızılırmak basin is located on the east side of central Anatolia, Turkey, between 37°58'-41°44', north parallels and 32°48'-38°22' east longitudes. It has a surface area of 78180 km^2 (Fig. 1).

Kızılırmak basin has a uniform climate with arid summer. Average annual precipitation range between as 300-800 mm and falls during winter and spring months. Basin average precipitation is 446.1 mm and temperature is 13.7°C.

Main river of the basin is Kızılırmak. Cereal farming is the dominating culture in the basin. Beside cereals, vegetables, potato, sugarbeet, sunflower, onion, garlic, beans, vineyards, fruits, chickpeas, lentils, common vetch, alfalafa, tobacco and corn are also grown in the basin.

There are 26 irrigation schemes, some of which has already transferred to irrigation association, constructed by DSI in Kızılırmak basin. 16 of these irrigation schemes, which have provided reliable data, were taken as the material of this study. These schemes are as follows: Ağcaşar, Fehimli, Gemerek, Germeçtepe, Gökçeören, Kalecik, Karaçomak, Kızılırmak, Kovalı, Köprüköy, Kumbaba, SarmIsaklI, Sarız, Suşehri, Taşhan, Uzunlu and

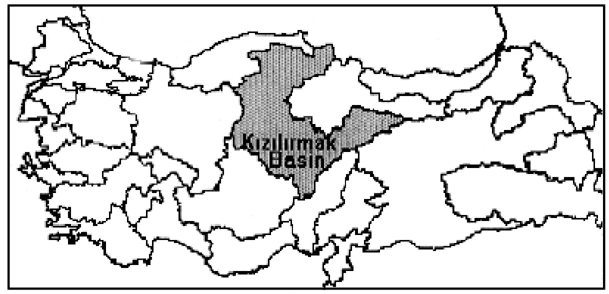
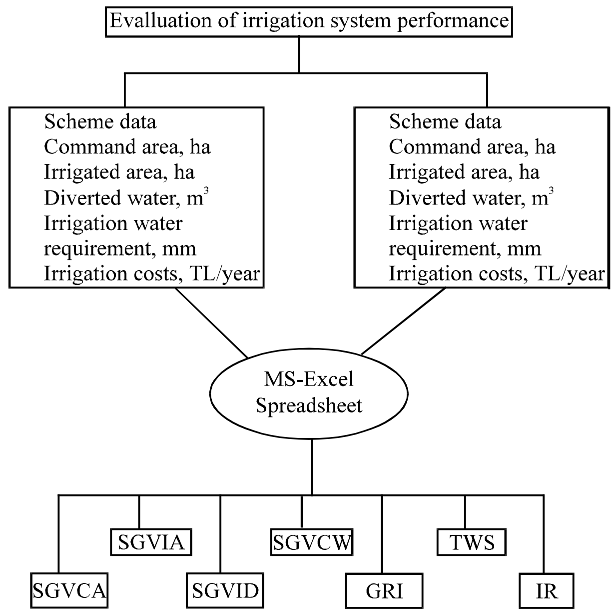


Fig. 1: The Kızılırmak basin



$$GVCA = \frac{\text{Production}}{\text{Command area}}, (\$/ha)$$

$$GVIA = \frac{\text{Production}}{\text{Irrigated cropped area}}, (\$/ha)$$

$$GVID = \frac{\text{Production}}{\text{Irrigation delivered}}, (\$/m^3)$$

$$GVCW = \frac{\text{Production}}{\text{Irrigation water requirement}}, (\$/m^3)$$

$$TWS = \frac{\text{Total water diverted}}{\text{Total irrigation water requirement}}$$

$$GRI = \frac{\text{Standardized gross value of production (TL/yil)}}{\text{Cost of irrigation infrastructure (TL/yil)}}$$

$$IR = \frac{\text{Irrigated cropped area}}{\text{Command area}}$$

TL: Turkish lira

Fig. 2: Stages followed in the study

Zamantı (Table 1). Irrigation area, irrigated land, diverted water, irrigation water requirement for the years 1996-2000 were taken from evaluation reports of irrigation facilities and cropping pattern, yield and unit prices were taken from reports of yield count results (Anonymous, 2001a,b).

Table 1: Irrigation schemes in the Kızılırmak basin (Anonymous 2002)

Name of scheme	DSI region number	The year of begining to irrigation	Irrigation area (ha)	Management type	Transferred year	Transferred organization
Ağcaşar	12	1970	12720	Devir	1994	Ağcaşar IA
Fehimli	12	1997	1210	Devir	1995	Fehimli IA
Kızılırmak	5	1995	4840	Devir	1994	Kızılırmak IA
Kovalı	12	1962	2860	Devir	1994	Kovalı IA
Sarımsaklı	12	1994	5500	Devir	1995	Sarımsaklı IA
Sarız	12	1968	1040	Devir	1993	Sarız Irrigation
IA Suşehri	19	1991	2750	Devir	1995	AkIncIlar IA
Uzunlu	12	1986	7222	Devir	1996	BoğazlIyan IA
Gemerek	19	1987	2150	DSI	-	-
Germeçtepe	23	1976	650	DSI	-	-
Gökçeören	5	1983	1850	DSI	-	-
Kalecik	5	1970	600	DSI	-	-
Karaçomak	23	1970	1400	DSI	-	-
Kumbaba	5	1980	550	DSI	-	-
Taşhan	12	1983	500	DSI	-	-
Zamantı	12	1963	3924	DSI	-	-

IA: Irrigation Association

Table 2: Data used on evaluation of irrigation system performance

Scheme name	Year	Command area (ha)	Irrigated cropped area (ha)	Irrigation supply (hm^3)	Irrigation water requirement (m^3/ha)
Ağcaşar	1996	12720	6543	50.732	3637
	1997	12720	7853	54.624	3294
	1998	12720	7153	51.899	3576
	1999	12720	7619	41.692	3460
	2000	12720	7165	47.545	3585
Fehimli	1996	1210	702	6.310	3701
	1997	1210	1102	8.840	3525
	1998	1210	523	5.123	3994
	1999	1210	980	4.827	3898
	2000	1210	150	2.930	4206
Kızılırmak	1996	1740	644	13.834	4520
	1997	1450	819	11.200	5152
	1998	1450	954	14.000	7280
	1999	4840	2367	58.060	5103
	2000	4840	1514	44.727	7445
Kovalı	1996	2860	2497	26.127	3431
	1997	2860	2547	26.077	3280
	1998	2860	2459	27.092	3599
	1999	2860	2442	18.753	3595
	2000	2860	2479	17.606	3710
Sarımsaklı	1996	8200	7950	63.687	2893
	1997	8200	8032	57.015	2892
	1998	8200	7688	48.847	2958
	1999	8200	7898	45.049	2912
	2000	8200	7730	58.035	3267
Sarız	1996	1040	1000	4.340	2344
	1997	1040	230	1.313	2759
	1998	1040	347	2.131	2550
	1999	1040	343	1.546	2433
	2000	1040	350	2.367	2519
Suşehri	1996	2500	1475	17.305	3678
	1997	2500	1945	13.680	3548
	1998	2750	1405	27.916	4503
	1999	2750	1605	27.827	4480
	2000	2750	1988	26.481	4152
Uzunlu	1996	6500	2495	21.765	4135
	1997	7222	2054	9.215	3708
	1998	7222	2960	33.183	4136
	1999	7222	2516	30.454	3532
	2000	7222	2523	31.932	4125

In this study, along with the other performance indicators, four comparative indicators developed by IWMI corresponding to unit area and water were used as performance indicators. These comparative indicators can be used to evaluate effect of interferences in irrigation schemes, to compare system performance based on time, and to compare performance of systems (Molden *et al.*, 1998). If the limiting factor is water, than income per unit of water may be more important, or if the limiting factor is land, then the income per unit of land may be more important. Gross value of output per unit command area (GVCA), gross value of output per unit cropped irrigated area (GVIA), gross value of output per unit irrigation delivered (GVID), gross value of output per unit consumed water (GVCW), total water supply ratio (TWS), gross return on investment (GRI), irrigation ratio (IR) were calculated the following equations and excel spreadsheets (Fig. 2).

While evaluating performance of irrigation schemes in a region since the prices will be similar, gross or net production value based on local prices can be used as indicators. However, incase of different regions and countries, the local prices differ from each other. For a better comparison between the systems, the crop with the largest production in the region or country is taken as base crop. Then the other crops are standardized based on the local and world market prices of this crop and the corresponding standardized gross production value is used as indicator (Molden *et al.,* 1998). Standardized gross production value is developed for performance comparisons among the irrigation systems different regions of the world in which local prices exhibit a change. In this study, standardized gross production value (SGVP) was used to compare on irrigation system performance with the other irrigation systems. Due to its wide range of production in irrigated areas as well as the utilization in world markets, wheat was taken as the base crop. SGVP was calculated by the following equation.

$$SGVP = \left(\sum_{cropi} A_i Y_i * P_i / P_b\right) * P_{world}$$

Where;

SGVP	=	Standardized gross value of production, ($ ha^{-1})
A_i	=	The area cropped with i, ha
Y_i	=	Yield of crop i, t ha^{-1}
P_i	=	Local price of crop i, ($/t)
P_b	=	Local price of base crop, ($/t)
$P_{dünya}$	=	The value of base crop traded at world prices, ($/t) dIr.

Irrigation areas, cropped irrigated area, amount of water diverted to scheme, irrigation water requirement for the irrigation schemes considering in this study were given in Table 2.

Results and Discussion

Among the irrigation performance indicators, four comparative indicators (GVCA, GVIA, GVID and GVCW) are the measures corresponding to unit land area and unit irrigation water and the values of them calculated based on the local prices were given in Table 3 and Table 4. SGVCA ranges between 45-22443 $ ha^{-1} with Suşehri irrigation having the highest as of 22443 while Gökçeören irrigation having the smallest as of 45 $ ha^{-1} (Table 5 and Table 6). Different annual values obtained from each irrigation schemes were due to the change in cropping pattern and change of price of base crop in world market. SGVCA was determined as 6233 $ ha^{-1} in Bergama-Kestel Irrigation, 5003 $ ha^{-1} in Manisa-Alaşehir Irrigation 5003 $ ha^{-1}, in Manisa-Turgutlu Irrigation 1469 $ ha^{-1}, in AşağI Seyhan Irrigation 2167 $ ha^{-1}, in Bursa Ulubat Irrigation 1070-1583 $ ha^{-1} and in Konya Irrigation Associations 195-5391 $ ha^{-1} (AvcI *et al.,* 1998, Molden *et al.*, 1998, Çakmak *et al.*, 1995). Performance of Salihli Irrigation Scheme between the years 1984-1995 using the IWMI performance indicators set. They determined that standardized gross production value per command area was 0.942-2238 $ ha^{-1}; per irrigated area 1317-2585 $ ha^{-1}, standardized gross production value corresponding to diverted water was 0.18-0.41$/m^3 and standardized gross production value corresponding to unit water consumed 0.17-0.35 $/m^3.

It carried out a performance evaluation study for Alto Rio Lerma Irrigation Association in Mexico and they determined that standardized gross production value per command area was 1840 $ ha^{-1}; per irrigated area 2780 $ ha^{-1}, standardized gross production value corresponding to diverted water was 0.16-0.00 $/m^3 and standardized gross production value corresponding to unit water consumed 0.35-0.00 $/m^3.

SGVIA ranges between 247-43928 $ ha^{-1}. SGVIA was determined as 2732 $ ha^{-1} in Manisa-Turgutlu Irrigation, 2526 $ ha^{-1} in AşağI Seyhan Irrigation 2526 $ ha^{-1}, in Bursa Ulubat Irrigation 2857-4415 $ ha^{-1} and in Konya Irrigation Associations 359-6197 $ ha^{-1} (Molden *et al.*, 1998, Çakmak *et al.*, 1995).

SGVID ranges between 0.03-2.21 $/m^3 and SGVCW ranges between 0.05-9.75 $/m^3 with the highest value in Suşehri Irrigation and the lowest value in Gökçeören Irrigation.

Table 3: Gross production values regarding local price in irrigation associations

Scheme name	Year	GVCA ($ ha^{-1})	GVIA ($ ha^{-1})	GVID ($ m^{-3})	GVCW ($ m^{-3})
Ağcaşar	1996	1147	2231	0.29	0.61
	1997	1593	2581	0.37	0.78
	1998	1114	1982	0.27	0.60
	1999	1090	1820	0.33	0.53
	2000	1047	1858	0.28	0.52
Fehimli	1996	2047	3529	0.39	0.95
	1997	3002	3296	0.41	0.94
	1998	1525	353	0.36	0.88
	1999	71	87	0.02	0.02
	2000	379	3054	0.16	0.73
Kızılırmak	1996	985	2662	0.13	0.59
	1997	1421	3020	0.22	0.59
	1998	3239	1776	0.22	0.44
	1999	2212	4523	0.18	0.89
	2000	639	2044	0.07	0.27
Kovalı	1996	2839	3251	0.31	0.90
	1997	1206	1354	0.13	0.41
	1998	2864	3331	0.30	0.92
	1999	3994	4678	0.61	1.30
	2000	2849	2774	0.46	0.75
Sarımsaklı	1996	1734	1789	0.22	0.61
	1997	18014	18391	2.59	6.36
	1998	2033	2169	0.34	0.73
	1999	2480	2575	0.45	0.88
	2000	2685	2415	0.38	0.74
Sarız	1996	1634	1699	0.39	0.72
	1997	1778	8041	1.41	2.91
	1998	899	2695	0.44	1.06
	1999	1471	4461	0.99	1.88
	2000	1122	3335	0.49	1.32
Suşehri	1996	1623	2751	0.23	0.75
	1997	1537	2858	0.28	0.80
	1998	1838	3598	0.18	0.80
	1999	1988	3406	0.20	0.76
	2000	1467	2029	0.15	0.49
Uzunlu	1996	1627	4342	0.49	1.05
	1997	874	3073	0.68	0.83
	1998	1594	3888	0.34	0.94
	1999	1406	4035	0.33	1.14
	2000	1213	3472	0.27	0.84

Table 4: Gross production values regarding local price in DSI schemes

Scheme name	Year	GVCA ($ ha^{-1})	GVIA ($ ha^{-1})	GVID ($ m^{-3})	GVCW ($ m^{-3})
Gemerek	1996	639	1796	0.25	0.58
	1997	1140	3101	0.51	0.94
	1998	426	1525	0.25	0.65
	1999	1486	3777	0.38	1.17
	2000	487	1509	0.22	0.49
Germeçtepe	1996	1136	4370	0.33	1.92
	1997	180	388	0.05	0.15
	1998	1327	3331	0.40	1.26
	1999	1160	4236	0.61	1.64
	2000	803	3089	0.68	1.21
Gökçeören	1996	496	2555	0.29	0.56
	1997	847	4304	0.44	0.85
	1998	505	2938	0.26	0.56
	1999	664	2314	0.27	0.64
	2000	477	2640	0.28	0.53
Kalecik	1996	1268	2237	0.26	0.50
	1997	986	3480	0.23	0.75
	1998	1341	4573	0.29	0.83
	1999	1731	4240	0.27	0.86
	2000	843	2090	0.20	0.41
Karaçomak	1996	1892	3515	0.43	1.25
	1997	248	541	0.04	0.18
	1998	2178	4586	0.36	1.59
	1999	1424	2784	0.32	0.35
	2000	2371	4974	1.13	1.70
Kızılırmak	1996	985	2662	0.13	0.59
	1997	1421	3020	0.22	0.59
	1998	3239	1776	0.22	0.44
	1999	2212	4523	0.18	0.89
	2000	639	2044	0.07	0.27
Kumbaba	1996	603	1529	0.60	0.44
	1997	751	2551	0.54	0.65
	1998	795	2651	0.50	0.70
	1999	352	2014	0.27	0.48
	2000	1864	14241	0.02	2.84
Taşhan	1996	489	2469	0.13	0.71
	1997	686	4285	0.18	1.12
	1998	229	287	0.40	0.90
	1999	395	2784	0.17	0.89
	2000	334	1392	0.11	0.44
Zamantı	1996	109	206	0.04	0.08
	1997	140	305	0.05	0.12
	1998	960	2589	0.44	0.84
	1999	933	2273	0.42	0.83
	2000	1106	2499	0.26	0.94

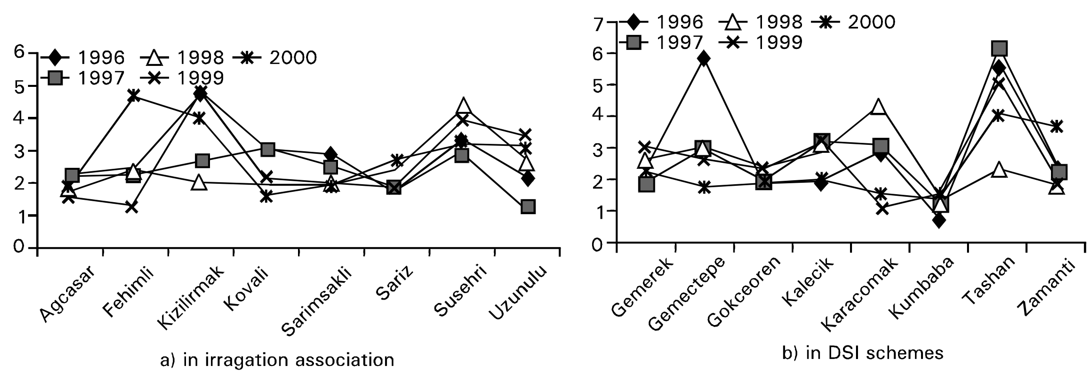


Fig. 3: Water supply ratio in irrigation associations and DSI schemes

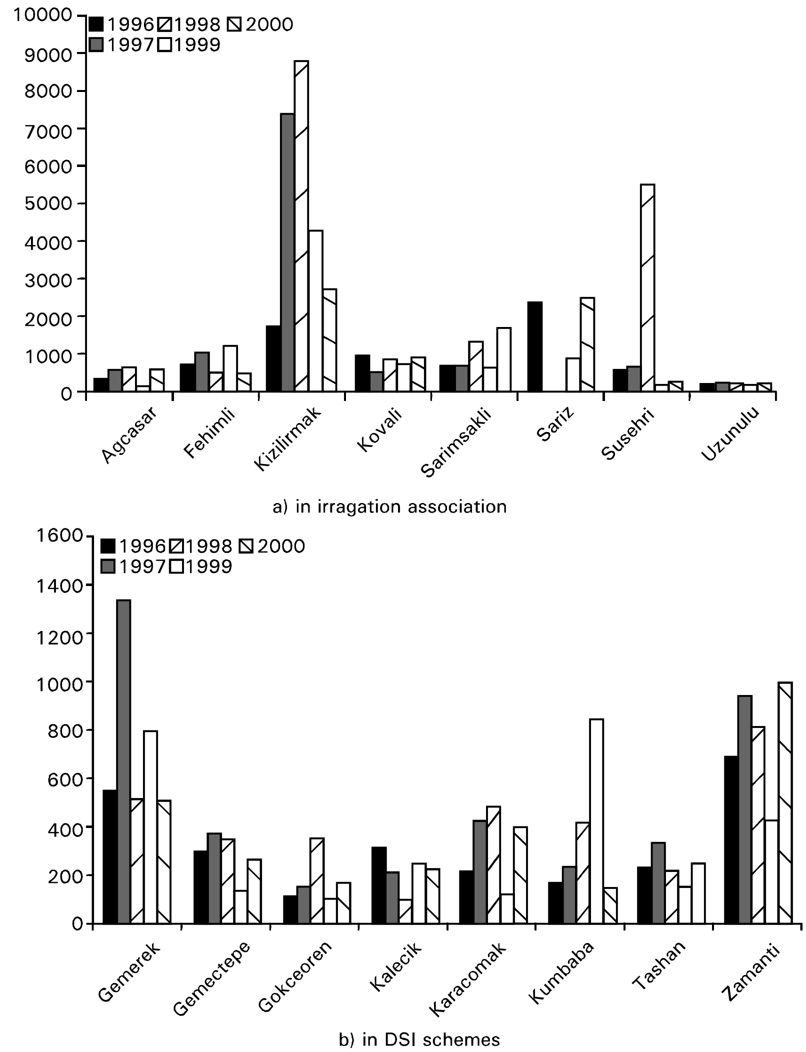


Fig. 4: Gross return on investment irrigation associations and DSI schemes

The difference between gross production value corresponding to unit irrigation land area and corresponding to diverted water and irrigation water requirement was due to change in diverted water to the scheme and change in crop pattern. SGVID in Bursa Ulubat Irrigation between the years 1992-1998 ranged between 0.31-.50 $/m^3, in Konya Irrigation Associations between the years 1995-1999 it was ranging between 0.02-1.29 $/m^3 (Çakmak *et al.*, 1995). Standardized gross production values obtained based on cropping pattern was exhibit a change. Based on studies carried out by IWMI on 18 irrigation system in 11 countries in the world since 1992, it was determined that the income obtained was found to be higher in irrigation schemes with higher rates of fruit, vegetable and industrial crops (Molden *et al.*, 1998).

Water supply rates calculated based on total irrigation water requirement in the study area, range between 0.74-6.20. Based on the total irrigation water requirement, a water supply ratio of 1 indicates that diverted water was enough for the need, a value less than 1 indicates that diverted water was less than need, and a value more than 1 indicates that diverted water was higher than need. As it can be seen from Fig. 3, water supply rates in irrigation schemes varies with the years and highest water supply rates were obtained in Taşhan Irrigation in 1997 with a value of 6.20 and the lowest rates were obtained in Kumbaba Irrigation in 1996 with a value of 0.74. All of the irrigation schemes in the basin had diverted water more than the need. Beyribey *et al.* (1997a) carried out a study on 119 irrigation schemes in 21 region determined the

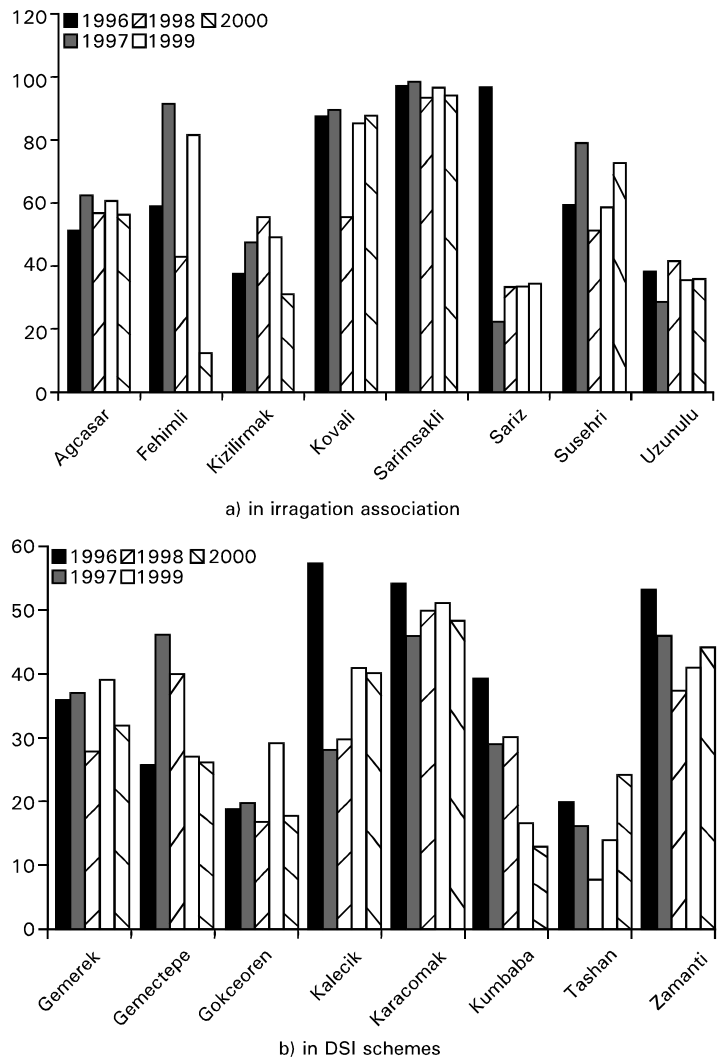


Fig. 5: Irrigation ratio in irrigation associations and DSI schemes

water supply rates based the total irrigation water requirement that for June it was 0.29-1.67, for July it was 0.44-1.49 and for August it was 0.40-1.71. They found that water diverted to 38% of irrigation schemes operated by DSI in June, to 43% of irrigation schemes in July and to 62% of irrigation schemes operated by DSI in August were higher than the need. Çakmak *et al.* (1995) determined the water supply rate in Konya Irrigation Associations between the years 1995-1999 as 0.70-7.83. Value as 0.91-7.15 for the irrigation schemes transferred to irrigation associations for the year 1998.

The gross return on investment used to analyze profitability of different irrigation systems ranges between 53 and 8708% (Fig. 4). The gross return rates calculated based on 1997 date by using the standardized gross production value and irrigation system cost values was found to be 130% in Bergama-Kestel Irrigation, and 88% in AşağI Seyhan and 125% in Bursa-Ulubat Irrigation (AvcI *et al.*, 1998, Molden *et al,* 1998). It can be said that the irrigation systems in the research area were highly profitable.

The highest rate of irrigation was obtained in Sarımsaklı Irrigation in 1997 with a value of 98% and the lowest rate of irrigation was obtained in Taşhan Irrigation in 1998 with a value of 8% (Fig. 4). Based on a study for 21 irrigation schemes in 21 irrigation region Beyribey *et al.* (1997b) determined the irrigation rates as 24-105% for the years 1984-1993. Beyribey (1997) determined irrigation rates for 199 irrigation schemes in 21 region for the years 1984-1993 and found that it was less than 30% in 74 schemes, between 30-60% in 72 schemes, and higher than 60% in 53

Table 5: Standardized gross production values in irrigation associations

Scheme name	Year	SGVCA ($ ha^{-1})	SGVIA ($ ha^{-1})	SGVID ($ m^{-3})	SGVCW ($ m^{-3})
Ağcaşar	1996	560	1088	0.14	0.30
	1997	954	1545	0.22	0.47
	1998	1034	1839	0.25	0.51
	1999	309	516	0.09	0.15
	2000	920	1634	0.25	0.51
Fehimli	1996	1276	2199	0.24	0.59
	1997	1780	1954	0.24	0.55
	1998	1401	3242	0.33	0.80
	1999	2362	2917	0.59	0.75
	2000	811	6540	0.33	1.55
Kızılırmak	1996	542	1463	0.07	0.32
	1997	2747	5836	0.43	1.13
	1998	667	1217	0.08	0.17
	1999	931	1903	0.08	0.37
	2000	499	1595	0.05	0.21
Kovalı	1996	2759	3160	0.30	0.92
	1997	1561	1753	0.20	0.53
	1998	2714	3157	0.28	0.90
	1999	2295	2688	0.35	0.75
	2000	2505	2439	0.41	0.66
Sarımsaklı	1996	1096	1130	0.14	0.39
	1997	1025	1047	0.15	0.36
	1998	2173	2318	0.36	0.78
	1999	1290	1339	0.23	0.46
	2000	2643	2373	0.37	0.73
Sarız	1996	1041	1082	0.25	0.46
	1997	1067	4826	0.85	1.75
	1998	1005	3012	0.49	1.18
	1999	503	1526	0.34	0.63
	2000	1103	3277	0.48	1.30
Suşehri	1996	965	1635	0.14	0.44
	1997	1115	2073	0.20	0.58
	1998	22443	43928	2.21	9.75
	1999	976	1672	0.10	0.37
	2000	1225	1695	0.13	0.41
Uzunlu	1996	987	2635	0.29	0.64
	1997	1107	3893	0.87	1.05
	1998	1087	2653	0.23	0.64
	1999	1026	2946	0.24	0.83
	2000	1067	3053	0.24	0.74

Table 6: Standardized gross production values in DSİ irrigation schemes

Scheme name	Year	SGVCA ($ ha^{-1})	SGVIA ($ ha^{-1})	SGVID ($ m^{-3})	SGVCW ($ m^{-3})
Gemerek	1996	410	1153	0.16	0.37
	1997	888	2416	0.40	0.74
	1998	443	1586	0.30	0.68
	1999	708	1799	0.18	0.56
	2000	399	1236	0.18	0.40
Germeçtepe	1996	1364	5245	0.40	2.30
	1997	953	2051	0.26	0.79
	1998	920	2308	0.27	8.70
	1999	467	1704	0.24	0.66
	2000	671	2580	0.57	1.01
Gökçeören	1996	314	1617	0.18	0.35
	1997	480	2438	0.25	0.48
	1998	91	531	0.05	0.10
	1999	350	1221	0.14	0.34
	2000	45	247	0.03	0.05
Kalecik	1996	960	1695	0.20	0.38
	1997	673	2377	0.16	0.51
	1998	280	856	0.06	0.17
	1999	881	2157	0.14	0.44
	2000	704	1746	0.17	0.34

Table 6: Continued

Scheme name	Year	SGVCA ($ ha^{-1})	SGVIA ($ ha^{-1})	SGVID ($ m^{-3})	SGVCW ($ m^{-3})
Karaçomak	1996	1204	2237	0.27	0.79
	1997	1536	3436	0.27	1.17
	1998	2526	5320	0.42	1.84
	1999	719	1405	0.16	0.18
	2000	1980	4154	0.94	1.42
Kumbaba	1996	347	880	0.34	0.25
	1997	476	1616	0.34	0.41
	1998	889	296	0.60	0.72
	1999	199	1138	0.15	0.27
	2000	283	2163	0.28	0.43
Taşhan	1996	334	1689	0.09	0.48
	1997	418	2615	0.11	0.68
	1998	278	3480	0.47	1.06
	1999	204	1440	0.09	0.46
	2000	328	1368	0.10	0.43
Zamantý	1996	686	1294	0.22	0.51
	1997	933	2039	0.34	0.77
	1998	853	2301	0.38	0.74
	1999	486	1183	0.22	0.43
	2000	1087	2456	0.25	0.93

schemes, provided that the lowest irrigation rate was considered. It determined the irrigation rates for irrigation associations for the year 1998 as ranging between 4-100%. It can be seen that although the water used was than the need, it wasn't used effectively, in irrigation schemes of Kızılırmak Basin and the production values corresponding to unit land and unit water were low. Utilization of comparison indicators in performance evaluation has provided on opportunity to compare different irrigation systems. GVCA, GVIA, GVID and GVCW values obtained for sixteen schemes in this study are in good agreement with the results obtained by Molden *et al.* (1998) in 18 irrigation systems in 11 countries.

In this study, the irrigation association was found to have higher gross return on investment rates. Higher rates indicate higher rates of profitability. This situation outlines the after transfer successful management practices in Kızılırmak Basin irrigation schemes.

Water supply rate for both transferred and DSI operated irrigation was found both higher than 1. The reasons to diverted water more than the need were unproper application of a planned water delivery, water losses in scheme, unconscious irrigation applications, and collection of water fees being based on the land area. For a more effective water utilization in the country, irrigation water pricing approach should be reconstructed at basin level. Since the infrastructure to measure utilized water in a field base, is not sufficient, water fees are calculated based on irrigated land area and the crop types and in a few irrigation association "duration of irrigation-hour" (TL/hour) was used for water fees. The pricing based in volumetric usage should be initiated and application has to be speed up. Effective water utilization policies should be developed and irrigation schemes should be evaluated in groups based on basin.

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