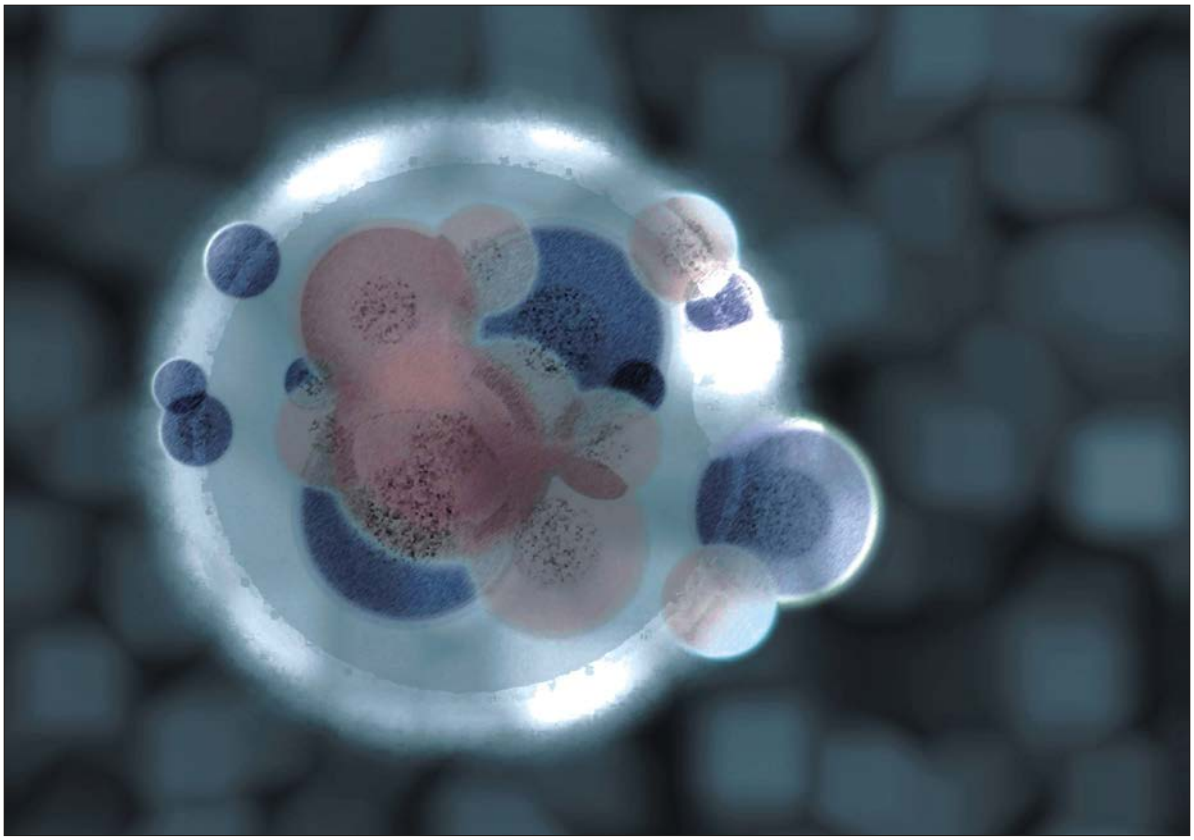

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Benchmarking and Assessment of Irrigation Management Transfer Effects on Irrigation Performance in Turkey

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Abstract: The objectives of this study are to identify irrigation management transfer effects on irrigation performance and to benchmark public irrigation schemes and transferred irrigation schemes. In this study, benchmarking performance indicators were applied both on state-managed and transferred irrigation schemes. Based on 1995-2002 data, following results were obtained for performance indicators of state-managed schemes: Water Delivery per Command Area (WDCA): 3547-6500 m^3 ha^{-1} Water Delivery per Irrigated Area (WDIA): 10054-13603 m^3 ha^{-1}; Relative Water Supply (RWS): 2.33-3.49; Gross Value of Output for Command Area (GVPCA): 710-1775 \$ ha^{-1}; Gross Value of Output for Irrigated Area (GVPIA); 1937-3550 \$ ha^{-1}; Gross Value of Output for Irrigation Supply (GVPIS); 0.19-0.31 \$ m^{-3}; Gross Value of Output for Water Consumed (GVPWC); 0.55-0.78 \$ m^{-3}. For the same period following results were derived in transferred schemes: water delivery per command area: 6431-7933 m^3 ha^{-1}; water delivery per irrigated area: 9127-11320 m^3 ha^{-1}; relative water supply: 2.05-2.45; gross value of output for command area: 1166-2265 \$ ha^{-1}; gross value of output for irrigated area; 1635-3121 \$ ha^{-1}; gross value of output for irrigation supply; 0.18-0.31 \$ m^{-3}; gross value of output for water consumed; 0.41-0.70 \$ m^{-3}. Amount of water used was more than required amounts and performances were low in both schemes. However, irrigation performance was higher in the transferred schemes than state-managed ones. Since water savings were increased by developing a sense of ownership concept during the post-transfer in transferred schemes and more efficient water use was provided.

Key words: Performance indicator, public irrigation schemes, transferred irrigation schemes, Turkey

INTRODUCTION

Increasing population and life standards put a heavy burden over water resources and competition among various sectors for water has increased during the recent years. Irrigation sector has drawn much more attention to provide food supply for constantly increasing populations. An efficient water use is required both to increase the production per unit area and to save water.

Irrigation and drainage sectors are faced with some problems like inefficient water use, poor operation and management of schemes, low returns etc. Poorly managed irrigation can have the opposite effect. Irrigation performance assessment is an important management tool. Performance assessment in irrigation and drainage is the systematic observation, documentation and interpretation of activities related to irrigated agriculture with the objective of continuous improvement (Molden *et al.*, 2007).

Performance of irrigation and drainage systems has to be increased to meet the food demand of increasing population, to produce more crops per drop, to raise the living standards of farmer families. The performance of irrigation and drainage systems has been the subject of many studies for over two decades. Several researchers have studied benchmarking and performance assessment in irrigation and drainage sector Molden and Gates (1990), Makin *et al.* (1990), Small and Svendsen (1992) Murray-Rust and Snellen (1993) and Rao (1993). Molden *et al.* (1998) carried out one of the first major studies on comparative performance evaluation with 9 indicators in 18 irrigation schemes. Also Murray-Rust

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and Snellen (1993) made a comparative assessment of 15 schemes in 8 countries. Significant researches on benchmarking were carried out at the International Water Management Institute (Perry, 1996; Molden *et al*., 1998; Kloezen and Garce´s-Restrepo, 1998; Sakthivadivel *et al*., 1999). Finally Malano and Burton (2001) developed the basis of framework in benchmarking and assessment in irrigation schemes.

Benchmarking is a performance improvement process. It should identify the gap between current and achievable performances and make changes to get higher performances. Benchmarking can be defined as (Malano and Burton 2001), a systematic process for securing continual improvement through comparison with relevant and achievable internal or external norms and standards. The overall objective of benchmarking is to improve the performance of an organization as measured against its mission and objectives (Malano *et al*., 2003). The overall aim of benchmarking is to improve the performance of an organization as measured against its mission and objectives. Benchmarking implies comparison-either against similar organizations, or organizations performing similar functions or processes (Malano *et al*., 2004).

The performance of the irrigation schemes has to be increased due to several reasons. The main reasons are as follows; increasing competition of agricultural sector with the other sectors, increasing food demand, the principle of necessity of more crops per drop, providing water use efficiency, rational water pricing approaches, efficient and economic use of resources in agriculture. It was determined that water user associations and participated management have led to an increase in performance of irrigation systems (Vermillion, 2000). Although it is known as a goal, participated irrigation management is generally a tool to increase irrigation performance. The practice of IMT in Turkey is considered as a successful model for the other countries (Yercan *et al*., 2004).

Currently, agriculture consumes 75% of the total water in Turkey. The growing demand for water by its rapidly increasing population is reducing the amount of water available for use in agriculture. This situation emphasizes the need for optimal water resource management and the economic use of water in agriculture. Due to high water losses, amount of water delivered is significantly higher than needed both in state-managed and transferred irrigation schemes. For that reason, the ratio delivered water to required water at system level was over one and also the delivered water is about 2 or 3 times of that needed. Water loss is the major problem in both schemes at field levels (Cakmak *et al*., 2003).

The management of irrigation systems, efficient use of water is now often a major goal, as well as production of the crop. Thus, it becomes necessary to quantify the performance of irrigation systems. In this study, performance of public irrigation schemes (state-managed) and transferred schemes were assessed by using the irrigation performance measures and effects of irrigation management transfer were discussed.

There are two government agencies responsible for water and soil resources development and management in Turkey and those are State Hydraulic Works (SHW) and General Directorate of Rural Services (GDRS).

SHW is the main investment agency responsible for planning, development and management of water and soil resources. It is therefore responsible for water supply and irrigation and construction and operation of large dams for flood control, irrigation, power generation, water supply and groundwater development. SHW defines the general principles and policies toward irrigation management by either directly taking the responsibility of services about irrigation management with its executive units or transferring the responsibility to the real or judicial personalities (Aküzüm *et al*., 1997).

GDRS deals with on-farm development and minor irrigation works such as land leveling, land consolidation, sub-surface drainage works and irrigation networks for minor irrigation projects. GDRS also works together with SHW on large irrigation projects and groundwater irrigation cooperatives in small size projects. According to 3202 numbered Law, responsibilities of GDRS related to the water sector are as follows: ensuring the protection, efficient utilization and development of land and water resources; identifying main principles and rules and carrying out work in relation to the construction, repair, maintenance and operation of roads as well as water, electricity and sanitation facilities of villages; providing drinking and domestic water to villages and military garrisons; supplying irrigation water to farms and constructing, improving, expanding and operating irrigation facilities for areas whose irrigation water need does not exceed 500 L sec^{-1}. If it exceeds 500 L sec^{-1}, the responsibility belongs to SHW (Cakmak *et al*., 2004a).

Transfer of irrigation systems to users started to be initiated at a slow pace in early 1950's. Only small and isolated schemes with an average annual area of about 2000 ha per year have been gradually transferred to users until 1993. This policy was guided primarily by the concern that it was difficult and uneconomical for SHW to manage such schemes. After 1993, with the persuasions of the World Bank staffs, SHW started to apply an Accelerated Transfer Program (ATP) without any delay (Table 1). The main objective of the ATP was to alleviate the unsustainable operation and maintenance irrigation schemes and financial burdens on both SHW and government resources (Svendsen and Murray-Rust,

Table 1: Results of the SHW's transfer program

Years	Transferred area (ha)
1953-1992	62620
1993	72042
1994	267362
1995	978576
1996	1190334
1997	1279039
1998	1483931
1999	1529454
2000	1618669
2001	1663730
2002	1694736

Source: www.dsi.gov.tr

Table 2: Distribution of transferred irrigation facilities by undertaking associations and agencies (01.11.2003)

Transferee	No.	Share (%)	Area (ha)	Share (%)
Village legal entity	224	29.2	34998	1.9
Municipality	135	18.0	57288	3.2
Irrigation association	321	42.9	1640402	91.2
Cooperative	64	8.6	65661	3.6
Other	4	0.5	1032	0.1
Total	748	100.0	1799381	100.0

Source: www.dsi.tr

2001). The ATP in Turkey has been founded on a downward-reaching link between the SHW and local administrations, rather than through the bottom-up organization of village-level associations of irrigators (Svendsen and Nott, 1999). The ATP is still being successfully implemented (Yıldırım and Cakmak, 2004).

The basic rule followed in transfer of irrigation schemes in Turkey is to transfer only the operation, maintenance and management responsibilities not the ownership of the facilities. Ownership still stays with the state. It can be called that IMT could provide monetary savings for state, enhance the cost effectiveness and increase the productivity of irrigated agriculture in Turkey.

Positive results generally from satisfactory operation and maintenance of transferred schemes were another important contributing factor against the concerns that the systems would rapidly deteriorate after transfer. By the beginning of November 2003, SHW had transferred about 1,799,381 ha irrigation area, which corresponds to over of 90% of the total area developed by SHW (Table 2).

MATERIALS AND METHODS

SHW-managed and transferred schemes were taken as material in this study and an evaluation was performed on data of the years 1995-2002. Main characteristics of the irrigation schemes were given in Table 3.

In this study, water delivery and economic performance indicators, proposed for benchmarking performance in irrigation and drainage sector by IPTRID (International Program Technology and Research in Irrigation and Drainage), were used (Malano and Burton, 2001). Environmental indicators and some of the recommended performance indicators were not considered due to the unavailability of reliable data.

Performance indicators for irrigation and drainage schemes are presented as follows. American dollars were taken as the currency unit to facilitate comparison internationally.

$$\text{Annual irrigation WDCA } (\text{m}^3\ \text{ha}^{-1}) = \frac{\text{Total annual volume of irrigation water inflow}}{\text{Total command area serviced by the system}}$$

$$\text{Annual irrigation WDIA } (\text{m}^3\ \text{ha}^{-1}) = \frac{\text{Total annual volume of irrigation water inflow}}{\text{The annual irrigated crop area}}$$

$$\text{Annual RWS} = \frac{\text{Total annual volume of water supply}}{\text{Total annual volume of crop water demand (Evapotranspiration-Effective rainfall)}}$$

$$\text{GVPCA } (\text{US\$ ha}^{-1}) = \frac{\text{Total annual value of agricultural production}}{\text{Total command area serviced by the system}}$$

$$\text{GVPIA } (\text{US\$ ha}^{-1}) = \frac{\text{Total annual value of agricultural production}}{\text{Total annual irrigated crop area}}$$

$$\text{GVPIS } (\text{US\$ m}^{-3}) = \frac{\text{Total annual value of agricultural production}}{\text{Total annual volume of irrigation water inflow}}$$

$$\text{GVPWC } (\text{US\$ m}^{-3}) = \frac{\text{Total annual value of agricultural production}}{\text{Total annual volume of water consumed by the crops}}$$

Table 3: Characteristics of the SHW-managed and transferred schemes

Characteristics	Management type	1995	1996	1997	1998	1999	2000	2001	2002
Command area (ha)	SHW	543650	413813	367991	248486	247699	214910	198718	200014
	Transferred	923512	1131337	1213559	1415288	1454262	1541464	1583543	1612251
Irrigated area (ha)	SHW	308824	215568	175832	97671	102785	85474	72829	76700
	Transferred	658808	825552	880542	1002517	1017684	1036524	1012886	1081934
Water supply unit									
Gravity (ha)	SHW	-	-	-	179002	174660	138112	127304	130613
Pumped (ha)		-	-	-	69484	73039	76798	71414	69401
Water supply unit									
Gravity (ha)	Transferred	-	-	-	1209845	1240432	1319658	1321739	1339129
Pumped (ha)		-	-	-	205443	213830	221806	261804	273122
No. of irrigation scheme (No.)	SHW	-	-	-	-	75	66	64	61
	Transferred	-	-	-	-	179	193	200	204
Inflow water (m^3 ha^{-1})	SHW	3315	2688	2392	1278	1242	976	705	711
	Transferred	6488	7535	8680	11018	11537	11734	10184	11424
Net irrigation water requirement	SHW	4736	4736	4535	3754	4071	3979	3507	3707
(m^3 ha^{-1})	Transferred	4540	4540	4469	4683	4561	4529	4705	4639
Gross irrigation water	SHW	-	-	-	6952	7538	7368	6495	6865
requirement (m^3 ha^{-1})	Transferred	-	-	-	8658	8433	8373	8700	8580
Delivered water per hectare	SHW	11022	11022	12852	13084	13182	11936	9281	9992
(m^3 ha^{-1})	Transferred	10206	10206	9921	10958	11154	10849	10849	10435
Irrigation efficiency (%)	SHW	43	43	35	29	31	33	38	37
	Transferred	44	44	45	43	41	42	48	44

-: Nonavailable

The total value of agricultural production received by producers is determined at local (domestic) market prices. For international comparison this value is converted into a common measure, the Gross Value of Production (GVP), in which:

$$GVP = \sum [A_i \; Y_i \; P_i] \; MU$$

Where:

GVP = Gross value of production (US$).
Yi = Yield of crop i.
Ai = Area planted to crop i.
Pi = Local prices of crop i.
MU = Currency exchange rate (US$/unit local currency).

RESULTS AND DISCUSSION

The annual irrigation water delivery values per unit command area (WDCA) in transferred schemes was higher than the ones in SHW-operated schemes (Table 4). The highest value was obtained in 1999 with 7933 m^3 ha^{-1}.

However, the annual irrigation water delivery per unit irrigated area (WDIA) was higher in SHW-managed schemes than transferred schemes and it was the highest in 1997 (Table 4). The differences between WDCA and WDIA have been increasing due to non-irrigated areas year by year.

During the period 1995-2002, total non-irrigated area increased from 48 to 62% in SHW-managed schemes and from 27 to 33% in transferred schemes (Table 5). Rain-fed agricultural lands constitute a great part in the non-irrigated areas. While the percentage of rainfed agriculture was 17% in SHW-managed irrigation schemes and 7% in transferred irrigation schemes in 1996, these ratios were reached to 23 and 9% in 2002, respectively. The major environmental problems encountered in non-irrigated areas were high water tables and salinity. The activities concerning the environmental impacts of irrigation in Turkey are well-below sufficient. The fallow areas have increased due to increasing post-transfer water fees, increasing agricultural input prices and low purchase prices for cash crops. As a result, farmers have preferred to grow cereals instead.

Relative Water Supply (RWS) rates, calculated based on total irrigation water requirement in the study area, ranged between 2.33-3.49 for SHW-managed schemes and 2.05-2.45 for transferred schemes (Table 4). The data show that there were adequate water supplies available. The relative water supply indicates how well irrigation supply is matched and demand. Based on the total irrigation water requirement, an RWS value 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. The optimum value of the relative water supply is one. RWS for both transferred and SHW-operated

Table 4: Water Delivery per Unit Command Area (WDCA), Water Delivery per Unit Irrigated Area (WDIA), Relative Water Supply (RWS) for WHS-managed and transferred schemes

	WDCA (m^3 ha^{-1})		WDIA (m^3 ha^{-1})		RWS	
Years	SHW	Transferred	SHW	Transferred	SHW	Transferred
1995	6097	7025	10734	9848	2.72	2.05
1996	6495	6660	12469	9127	2.33	2.25
1997	6500	7152	13603	9857	2.83	2.22
1998	5143	7784	13084	10990	3.49	2.34
1999	5014	7933	12083	11336	3.24	2.45
2000	4544	7612	11418	11320	3.00	2.40
2001	3547	6431	10054	9680	2.65	2.31
2002	3554	7085	10558	9269	2.70	2.25

Table 5: Non-irrigated areas (ha) and the causes in Turkey

		Year						
Causes	Management type	1996	1997	1998	1999	2000	2001	2002
Inadequacy of water resources	SHW	5297	5364	8945	9136	7557	9617	1987
	Transferred	22356	21692	26415	18519	21578	75267	32693
Inadequacy of irrigation facilities	SHW	6963	5002	23492	13522	9305	5054	5919
	Transferred	17155	22669	33610	38567	35436	31388	33690
High water table	SHW	6165	3031	5128	5088	2731	1662	2440
	Transferred	16111	7660	15984	15779	16840	11626	9275
Salinity and alkalinity	SHW	6702	11802	2331	2433	1520	700	750
	Transferred	10676	8995	8933	16609	17434	11600	17169
Inadequate maintenance and repair	SHW	2190	794	4480	2928	2519	1584	7556
	Transferred	4315	4102	5749	6206	6519	5472	7165
Irrelevant topography	SHW	9108	10382	7729	9010	7794	4797	4285
	Transferred	14932	15721	19848	20657	22094	18684	18545
Adequacy of rainfall	SHW	69421	49217	48000	42041	38134	45048	46364
	Transferred	83750	103530	132128	132358	149693	129523	144043
Fallow	SHW	19053	22563	18307	21046	20306	19676	20280
	Transferred	32952	35923	45482	42942	50682	68092	61604
Uncultured land due to social and economic factors	SHW	60587	66437	23094	34465	27533	26404	26196
	Transferred	53946	60296	69240	61976	89757	117345	115504
Other causes	SHW	11109	17567	9309	5245	12037	11347	7537
	Transferred	49592	52429	55382	82965	94907	101660	90629
Total non-irrigated area	SHW	197245	192159	150815	144914	129436	125889	123314
	Transferred	305785	333017	412771	436578	504940	570657	530317
Total irrigated area	SHW	413813	367991	248486	247699	214910	198718	200014
	Transferred	1131337	1213559	1415288	1454262	1541464	1583543	1612251
Share of non-irrigated area	SHW	39	37	27	25	20	18	19
	Transferred	61	63	73	75	80	82	81

irrigations was found to be higher than 1. Irrigation water withdrawal was normally above the consumption because of loses along the conveyance and distribution lines. Other reasons for excessive withdrawals were improper application of a planned water delivery, unconscious irrigation applications and land-based water pricing application (Cakmak *et al*., 2004a). Water fees are generally determined based on cultivated-area (with different rates for different crops) for the current year (Cakmak *et al*., 2003). The collection rates of water fees are generally high in transferred schemes. However, current fee levels may not be high enough to cover the full cost of operation and maintenance of irrigation schemes so a need was arisen to raise the water fees.

According to the results, RWS is lower in transferred schemes than SHW-managed schemes. In other words, the transferred schemes have shown a great success in water use. The transfer of the irrigation schemes caused less water use. Higher RWS values in state-managed schemes were mostly due to bad or improper management practices. While the irrigation efficiency was 37% in SHW-managed schemes, it was 44% in the transferred schemes in the year 2002. It was determined those 3.5 times more water than need was delivered in SHW-managed schemes. Since the area planted increased after transfer, much more Water was Delivered per unit Command Area (WDCA) after transfer than before (Table 4) and actual crop water needs were tried to be applied. IMT is an effective tool in efficient water use.

Degirmenci (2001), found relative water supplies as 0.91-7.15 for irrigation schemes transferred to Water User Association in 1998. Cakmak *et al.* (2004b), assessed benchmarking irrigation performance for the years between 1996 and 2000 in irrigation schemes of SHW 10th

Table 6: Gross value of output for command area, irrigated area, irrigation supply and water consumed

	GVPCA ($ ha^{-1})		GVPIA ($ ha^{-1})		GVPIS ($ m^{-3})		GVPWC ($ m^{-3})	
Years	SHW	Transferred	SHW	Transferred	SHW	Transferred	SHW	Transferred
1995	1616	1166	2845	1635	0.27	0.18	0.72	-
1996	1775	1789	3391	2452	0.31	0.24	0.71	0.54
1997	1697	2265	3550	3121	0.28	0.31	0.78	0.70
1998	1000	1899	2542	2682	0.19	0.24	0.68	0.57
1999	1158	1963	2791	2805	0.21	0.25	0.69	0.62
2000	994	1607	2499	2389	0.21	0.22	0.63	0.53
2001	710	1211	1937	1922	0.21	0.18	0.55	0.41
2002	875	1417	2282	2112	0.23	0.20	0.62	0.46

Region. The RWS values were determined as 1.65-2.57. It implies that excessive water use was the main problem of irrigation sector in Turkey.

GVPCA for SHW-managed schemes ranged between 710-1775 $ ha^{-1}. GVPCA values have decreased recently with a decrease in the command area of SHW-managed schemes. In transferred schemes, the highest was GVPCA 2265 $ ha^{-1} in 1997 and the lowest was 1166 $ ha^{-1} in 1995. The variability in the output per unit service area might be due to the variation in the cropping patterns (Table 6).

GVPIA ranged between 1635-3550 $ ha^{-1} and SHW-managed schemes had the highest value with 3550 $ ha^{-1} while transferred schemes had a value of 3121 $ ha^{-1} in 1997. Also the highest values of the GVPIS and GVPWC were obtained in 1997. The causes of different annual values for both SHW-managed schemes and transferred schemes were due to the change in cropping pattern and change of crop prices in local markets.

Degirmenci *et al.* (2003) assessed irrigation system performance of 12 irrigation schemes in Southeastern Anatolia Project (GAP) for 1997-2001 years. They determined the GVPCA, GVPIA, GVPIS and GVPWC values as 308-5771 and 1223-9436 $ ha^{-1}, 0.12-2.16 and 0.45-2.92 $ m^{-3}, respectively.

CONCLUSIONS AND RECOMMENDATIONS

In this study, performance assessment of public irrigation schemes (SHW-managed) and transferred schemes were made based on seven benchmarking performance indicators for the years 1995-2002 in order to determine how IMT affected the performance of the schemes and give some suggestions for better management of water resources.

IMT had significant positive impacts on water utilization, including increased responsibility, equitable and reliable water delivery and irrigation efficiency. It has been found that in general there was sufficient water available for all schemes so the RWS values are more than 1 in all.

The performance of the schemes were not at desired levels possibly because of inappropriate management, high water table, salinity and alkalinity, inadequate maintenance and repair activities, socio-economic and other factors. The main objective of irrigation is to apply water to the root zone at the required time, amount and quality. Although more water than the requirement is applied to all schemes, output per unit land and water is relatively low. This situation indicates that there is a great need to develop and implement effective water management policies.

In this study, the transferred schemes were found to be more successful than SHW-managed schemes on water use. This outlines the post-transfer successful management practices in Turkish irrigation schemes. Effective water management practices, proper water pricing, operation and maintenance practices increased the performance of transferred schemes.

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