EVALUATION OF IRRIGATION PERFORMANCE OF ASARTEPE IRRIGATION ASSOCIATION: A CASE STUDY FROM TURKEY

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Abstract

The objective of this study was to evaluate the irrigation system performances of the Water User Associations in Asartepe irrigation scheme in Turkey. Based on the field study, amount of water delivered to command area, water delivered to irrigated area and relative water supply were determined as 3.975-7.368 m^3/ha, 8.586-13.611 m^3/ha and 0,99-2,05, respectively. The financial performance indicators including cost recovery ratio, maintenance expenditure to revenue ratio, operating cost per unit area, total cost per person employed on water delivery, revenue collection performance, unit area per staff member were found out as 52-170 %, 24-38 %, 47-109 $/ha, 1.523-5.611 $/staff member, 54-100%, 83,1-105,0 ha/staff member respectively. As regard to productive performance, output per unit command area, output per unit irrigated area, output per unit irrigation supply and output per unit water consumed were determined as 1.979 - 2.262 $/ha, 3.534 – 4.930$/ha, 0,28-0,55 $/$m^3$, 2,79-3,37 $/$m^3$**,** respectively.

Keywords: Financial Performance, Production Performance, Water Delivery Performance, Water User Association

Asartepe Sulama Birliğinde Sulama Performansının Belirlenmesi: Türkiye'den Bir Çalışma

Özet

Bu çalışmanın amacı, Türkiye'de Asartepe Sulama Birliğinde sulama sistem performansını değerlendirmektir. Arazide elde edilen verilere göre sulama alanına saptırılan su, sulanan alana dağıtılan su ve su temin oranı sırasıyla 3.975-7.368 m^3/ha, 8.586-13.611 m^3/ha ve 0,99-2,05 olarak belirlenmiştir. Yatırımın geri dönüşüm oranı, bakım masraflarının gelire oranı, birim alan düşen işletme masrafı, su dağıtım personeli başına düşen masraf, su ücreti toplama performansı ve personel başına düşen birim alan olmak üzere mali performans göstergeleri sırasıyla 52-170 %, 24-38 %, 47-109 $/ha, 1.523-5.611 $/kişi, 54-100%, 83,1-105,0 ha/kişi olarak tespit edilmiştir. Üretim performansı kapsamında elde edilen sulama alanına, sulanan alana, saptırılan suya ve tüketilen suya göre brüt üretim değerleri ise sırasıyla 1.979 – 2.262 $/ha, 3.534 - 4.930 $/ha, 0,28-0,55 $/$m^3$, 2,79-3,37 $/$m^3$' dir.

Anahtar Kelimeler: Mali Performans, Su Dağıtım Performansı, Üretim Performansı, Sulama Birliği

1. Introduction

Scarcity and misuse of water pose a serious and growing threat to life and sustainable development. As water is the limiting factor in most of the world, increasing yields and sustaining food production depend mainly on irrigation. Therefore, protection and development of water resources are crucial for irrigation facilities. About 75% of the total area under irrigation in Turkey has been developed by the public sector. However, performance of many irrigation systems is significantly below their potential due to a number of shortcomings, including poor design, construction, operation and maintenance.

As a result, development in irrigation planning, operation and maintenance has not been achieved to the same extent as in developed countries.

Similar to the situation in other countries, the largest percentage of water resources is utilized in the agricultural sector in Turkey. Parallel to increasing population, increasing demands of non-agricultural sectors limit the water resources allocated to agriculture. That is why, the principle of

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'more gain for each drop of water' has been adopted in Turkey and structural and managerial measures taken for effective water resource utilization. The most dramatic change has been the transfer of irrigation schemes to irrigation associations.

Performance evaluation is the most practical tool to assess the success of any changes in irrigation management. That is why; performance evaluation studies have gained significance since the early 2000s. Compared to developed countries, performance evaluation studies are not sufficient in Turkey both in the aspects of their number and content. Especially, environmental performance indicators cannot be calculated due to a lack of reliable data. Only by performance evaluation reasons for low performances can be determined, related measured taken and overall system performance be improved.

The most significant purpose of performance evaluation is to provide effective project performance through continuous information flow to project management at each stage. Continuous performance evaluation helps project management assess whether or not performance is sufficient. If not, it allows management to determine the required measures to reach desired performance levels. Performance evaluation providing a periodical information flow about the key indicators of an irrigation project is an effective management tool in monitoring irrigation schemes (Bos, 1997). It also facilitates the determination of possible problems and thus improves the performance of irrigation schemes.

Irrigation management transfer to Water Users Associations (WUAs) has been implemented in several countries in Asia, Africa, America and Fareast (Vermillion and Sagardoy, 1999; Vermillion, 2000). In Turkey, with support provided by the World Bank, transfer of irrigation facilities operated by the State Hydraulic Works (DSI) to irrigation associations, irrigation cooperatives, municipalities and village judicial personalities was instituted by the Government. Starting in 1993, Turkey undertook an ambitious program of devolution to transfer management responsibility for large-scale irrigation systems to local control. The aim was to transfer virtually all of the government-managed irrigation to local control. The program achieved 60 percent of this goal in just 2 years, and it has been widely touted as an example of a successful IMT program. Under this program DSI transferred control of irrigation systems to locally controlled WUAs (Murray-Rust and Svendsen, 2001). Actually DSI has had a policy of transferring management-operation-maintenance (MOM) responsibility of smaller and more remote projects to local administrations since the 1950s. However, until 1993 the pace of this transfer activity was extremely slow, averaging only about 2.000 hectares per year. With the introduction of a so-called accelerated transfer program in 1993, transfer rates accelerated dramatically (Svendsen and Murray-Rust, 2001). The World Bank played an important catalytic role in this acceleration (Svendsen and Nott, 1999). By 2003, MOM responsibilities of 1 665 000 ha of irrigated area, (approximately 87 % of the public irrigation schemes) were turned over to the farmers' associations (Dorsan et al., 2004). In 1995, 95,2 % of irrigation areas developed by DSI were also under the operation of DSI. However, by 2005 the total area transferred by DSI reached 1 860 969 ha with a ratio of transferred area of 94%.

Performance evaluation in these transferred irrigation associations and determination of their current state of success is critically important in order to assess whether or not the transfer process has reached desired objectives. This paper reports on the evaluation of the performance of Ayaş Asartepe irrigation system. Irrigation system performance was divided into three components as of water delivery performance, financial performance and production performance.

2. Material and Method

Asartepe, with an irrigation area of 1500 ha, was selected as the location for this study. The irrigation system is located in Sakarya Basin. Asartepe Dam provides the

water resource for the irrigation scheme. Asartepe irrigation project was developed by DSI in 1984 and transferred to an irrigation association in 1996. There are unirrigable land areas due to canal capacity deficiencies. The main crops grown in study area were vegetable, fodder crops, sugar beet, cereals, melon and watermelon, vineyard and maize (Table 1).

In this study, the approach recommended by IPTRID for performance evaluation in irrigation and drainage sector was used (Malano and Burton, 2001). Environmental performance was not evaluated due to lack of reliable data. Related data for performance evaluation were taken from records of the irrigation association. Performance indicators used in this study are as follows:

- *Water delivery performance*; total annual water delivery per command area, total annual water delivery per irrigated area, relative water supply,

$$\text{Irrigation ratio} = \frac{\text{Irrigated area (ha)}}{\text{Command area (ha)}} \times 100$$

$$\text{Total annual water delivery per command area} = \frac{\text{Total annual volume of irrigation water inflow } (m^3)}{\text{Command area (ha)}}$$

$$\text{Total annual water delivery per irrigated area} = \frac{\text{Total annual volume of irrigation water inflow } (m^3)}{\text{Irrigated area (ha)}}$$

$$\text{Relative water supply} = \frac{\text{Total annual volume of irrigation water inflow } (m^3)}{\text{Total volume of water required by crop } (m^3)}$$

- *Financial Performance;* cost recovery ratio, maintenance expenditure to revenue ratio, operating cost per unit area, total cost per person employed on water delivery, revenue collection performance, unit area per staff member,

$$\text{Cost recovery ratio} = \frac{\text{Total revenue collected from water users}}{\text{Total (MOM) costs}} \times 100$$

$$\text{Maintenance expenditure to revenue ratio} = \frac{\text{Total maintenance expenditure}}{\text{Total revenue collected from water users}} \times 100$$

$$\text{Operating cost per unit area} = \frac{\text{Total operation expenditure (US\$)}}{\text{Total command area served by the system (ha)}}$$

$$\text{Total cost per person employed on water delivery} = \frac{\text{Total cost of MOM personnel (US\$)}}{\text{Total number of people employed (person)}}$$

$$\text{Revenue collection performance} = \frac{\text{Total service revenue collected}}{\text{Total service revenue due}} \times 100$$

$$\text{Unit area per staff member} = \frac{\text{Total command area served by the system (ha)}}{\text{Total number of MOM staff (persons)}}$$

- *Production performance;* output per unit command area, output per unit irrigated area, output per unit irrigation supply, output per unit water consumed,

$$\text{Output per unit command area} = \frac{\text{Total annual value of agricultural production (US\$)}}{\text{Total command area served by the system (ha)}}$$

$$\text{Output per unit irrigated area} = \frac{\text{Total annual value of agricultural production (US\$)}}{\text{Total annual irrigated crop area (ha)}}$$

$$\text{Output per unit irrigation supply} = \frac{\text{Total annual value of agricultural production (US\$)}}{\text{Total annual volume of irrigation water inflow } (m^3)}$$

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

3. Results and Discussion

3.1. Water delivery performance

Total annual water delivery per command area, total annual water delivery per irrigated area and annual relative water supply ratio were investigated to determine the water delivery performance.

Total annual water deliveries per command area and total annual water delivery per irrigated area are presented in Table 2. As shown in Table 2, total annual water delivery per command area was the lowest in 2001 with 3.975 m³/ha and the highest in 2003 with 7.368 m³/ha; total annual water delivery per irrigated area was the lowest in 2004 with 8.586 m³/ha and the highest in 2003 with 13.611 m³/ha.

Annual relative water supply ratios are detailed in Table 3. Annual water supply ratio was the lowest in 2001 with 0,99 and the highest in 2003 with 2,05. In contrast, Cakmak (2002b) determined the annual water supply ratio for Ceylanpınar Irrigation Association for 1995-2000 as 2,05-3,81. Değirmenci (2001) determined the same ratio in transferred schemes for 1998 as

Table 1 Crop Pattern in Irrigated Area

Years	Crops (%)							
	vegetables	cereals	fodder crops	sugarbeet	water melon	vineyard	others	Total
2001	69	0	25	4	0	2	0	100
2002	69	0	25	2	0	3	1	100
2003	67	2	17	3	0	0	11	100
2004	53	2	22	2	0	4	17	100

Table 2 Total Annual Water Delivery per Command Area and per Irrigated Area

Years	Total annual volume of irrigation water inflow (m^3)	Irrigated area (ha)	Command area (ha)	Irrigation ratio (%)	Total annual water delivery per irrigated area (m^3/ha)	Total annual water delivery per command area (m^3/ha)
2001	5 962 000	665	1500	44	8 965	3 975
2002	8 687 000	840	1500	55	10 342	5 791
2003	11 052 000	812	1500	51	13 611	7 368
2004	7 066 000	823	1500	54	8 586	4 711

Table 3 Relative Water Supply

Years	Total annual volume of irrigation water inflow (m^3)	Total volume of water required by crop (m^3)	Relative water supply
2001	5 962 000	5 970 000	0,99
2002	8 687 000	5 958 000	1,46
2003	11 052 000	5 383 000	2,05
2004	7 066 000	5 029 000	1,41

between 0,91-7,15. Rodriguez et al. (2004), has determined the annual water supply ratio for five different irrigation association located in Andalusia region of Spain as between 0,99-1,41. According to Beyribey (1997), a total water supply ratio of 1,0 indicates that sufficient water was diverted to the scheme, a value lower than 1,0 indicates that insufficient amount of water was supplied and a value higher than 1,0 indicates that excessive water was supplied to the scheme. Table 3indicated that excessive amount of water was diverted to the Asartepe Irrigation Association.

3.2.Financial Performance

Indicators of cost recovery ratio, maintenance expenditure to revenue ratio, operating cost per unit area, total cost per person employed on water delivery, revenue collection performance and unit area per staff member were used to evaluate the financial performance.

Cost recovery ratios in Asartepe irrigation association between the years 2001-2004 are presented in Table 4. The issue of whether the revenue collected is sufficient to cover the MOM for the year is related to financial sufficiency. Cost recovery ratios calculated based on revenue collected from the users and MOM costs were the lowest in 2003 with 52% and the highest in 2002 with 170%. In a previous study, Cakmak (2002b) determined the financial sufficiency rate of Ceylanpınar İkicırcıp Irrigation Association between 105-211%. Beyribey (1997) determined financial sufficiency rates of state operated irrigation schemes between 21-91% and the overall country average 65%. Molden et al. (1998), determined the financial sufficiency rates of 18 irrigation systems located in 11 different countries as between 28-139% they determined the rate as about 100% for farmer operated irrigations and 30-50% for state operated irrigations. In general, it can be seen from Table 4 that except for 2002, collected revenue is sufficient to cover MOM costs.

Maintenance expenditure to revenue ratios is given in Table 5. These ratios were calculated by dividing total maintenance cost by total collected revenue. As shown in Table 5, the ratio was the lowest in 2002 with 24% and the highest in 2001 with 38%. Based on this result, it can be concluded that total collected revenue was sufficient to compensate the maintenance costs. Rodriguez et al. (2004) determined the same ratio for five different irrigation schemes in Andalusia region of Spain between 2-13%.

Operating costs per unit area are

presented in Table 6. Costs were lowest in 2002 with 47,10 $/ha and the highest in 2004 with 108,61$/ha.

Total costs per person employed in water delivery are in Table 7. Costs were the lowest in 2002 with 1.523 $/person and the highest in 2004 with 5.611 $/person.

Table 4 Cost Recovery Ratio

Years	Total revenue collected from water users (US$)	Total (MOM) cost (US$)	Cost recovery ratio (%)
2001	30 926	50 804	61
2002	67 436	39 568	170
2003	41 402	79 719	52
2004	51 127	89 386	57

Table5 Maintenance Expenditure to Revenue Ratio

Years	Total maintenance expenditure (US$)	Total revenue collected from water users (US$)	Maintenance expenditure to revenue ratio (%)
2001	11 650	30 926	38
2002	16 426	67 436	24
2003	11 830	41 402	29
2004	14 248	51 127	29

Table 6 Operating Cost per Unit Area

Years	Total operation expenditure (US$)	Total irrigated area served by system (ha)	Operating cost per unit area (US$/ha)
2001	50 804	665	76,40
2002	39 568	840	47,10
2003	79 719	812	98,18
2004	89 386	823	108,61

Table 7 Total cost per person employed on water delivery

Years	Total cost of MOM personnel (US$)	Total number of people employed	Total cost per person employed on water delivery (US$/person)
2001	19 015	8	2 377
2002	12 183	8	1 523
2003	29 883	8	3 735
2004	44 885	8	5 611

Revenue collection performance for Asartepe irrigation association is presented in Figure 1. In the figure it can be seen that the best performance was in 2002 with 100% and the worst was in 2003 with 54%. Beyribey (1997) determined the overall collection rate for the State irrigation schemes as 36%. While the collection rates were between 36-50% under State operation, these rates have reached over 90% with the transfer of irrigation schemes to user organizations.

Unit area per staff member is detailed in Table 8. Based on this table, unit area per staff member was the lowest in 2001 with 83,1 ha/staff member and the highest in 2002 with 105,0 ha/staff member. Çakmak et al. (2004) determined the unit area per staff member in Batman-Silvan, Devegeçidi, Derik-Kumluca, Nusaybin-Çağdaş and Çınar-Göksu Irrigation Associations between 1996-2000 as between 113,6-588,2 ha/staff member.

Bekişoğlu (1994) reported that the ideal irrigation area that could be controlled by an irrigation staff is around 333 ha. Based on above results, unit area per staff members in the study area was found to be sufficient.

Table 8 Unit area per staff member

Years	Total number of MOM staff	Total irrigated area serviced by system (ha)	Unit area per staff member (ha/persons)
2001	8	665	83,1
2002	8	840	105,0
2003	8	812	101,5
2004	8	823	102,9

3.3. Production performance

Indicators of output per unit command area, output per unit irrigated area, output per unit irrigation supply and output per unit water consumed was used to evaluate the production performance.

Output per unit command area is listed in Table 9. It was the highest in 2004 with 2.262 $/ha and the lowest in 2002 with 1.979 $/ha. In another study, Cakmak (2002a), determined output per unit command area for 8 irrigation associations in Kızılırmak Basin for 1999-2000 as between 71-3 994 $ha. Similarly, Çakmak (2002b) also determined the output for Ceylanpınar Irrigation Association for 1995-2000 as between 771-1 711 $/ha. Rodriguez et al. (2004), determined the output per unit command area for five different irrigation schemes in Andalusia region of Spain between 1.970–2.985 €/ha.

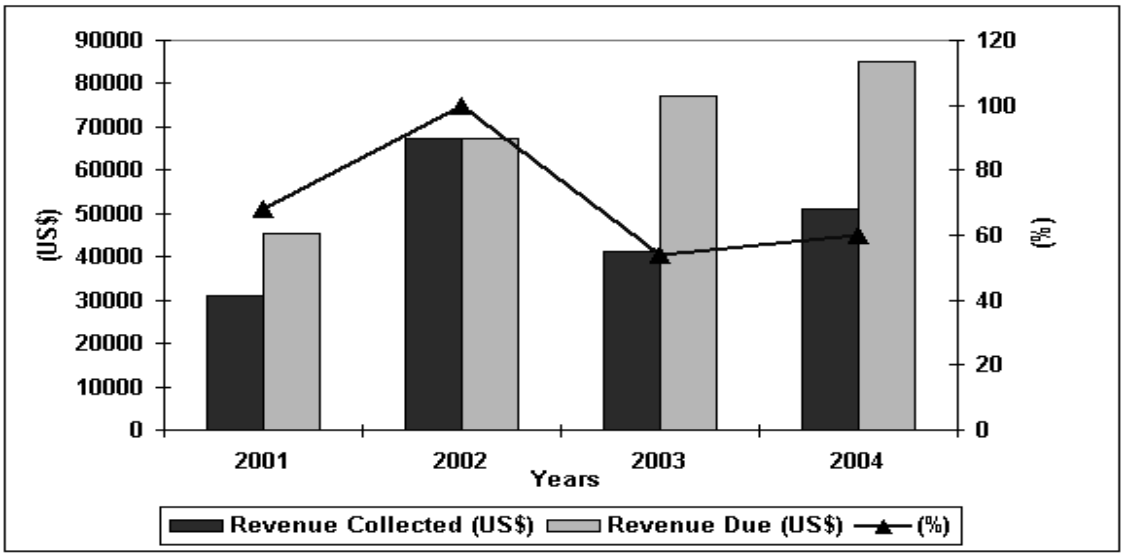

Figure 1 Revenue Collection Performance

Output per unit irrigated area in Asartepe irrigation is given in Table 10. It was the highest in 2001 with 4.930 $/ha and the lowest in 2002 with 3.534 $/ha. Çakmak (2002a), determined output per unit irrigation area for 8 irrigation associations in Kızılırmak Basin for 1999-2000 as between 87 - 4 678 $/ha. Çakmak (2002b) also determined output per irrigated are for Ceylanpınar Irrigation Association for 1995-2000 as between 4 057–1 854 $/ha.

Rodriguez et al. (2004), determined the output per unit irrigation area for five different irrigation schemes in Andalusia region of Spain between 1 970–3 148 €/ha.

Output per unit irrigation supply is presented in Table 11. Based on this table, the output per unit irrigation supply was the highest in 2001 with 0,550 $/m^3 and the lowest in 2003 with 0,280 $/m^3. Çakmak (2002a), determined output per unit irrigation supply for 8 irrigation associations in Kızılırmak Basin for 1999-2000 between 0,02-0,99 $/m^3. Çakmak (2002b) also determined the output per unit supply for Ceylanpınar Irrigation Association for 1995-2000 between 0,23-0,13 $/m^3. Rodriguez et al. (2004), determined the output per unit irrigation supply for five different irrigation schemes in Andalusia region of Spain between 0,57-1,31 €/m^3.

Output per unit water consumed is detailed in Table 12. It was the highest in 2004 with 3,37 $/m^3 and the lowest in 2002 with 2,79 $/m^3. Çakmak (2002a), determined the output per unit water consumed for 8 irrigation associations in Kızılırmak Basin for 1999-2000 between 0,02-1,88 $/m^3. Çakmak (2002b) also determined the output per unit water consumed for Ceylanpınar Irrigation Association for 1995-2000 as between 0,70-0,33 $/m^3. Rodriguez et al. (2004), determined the output per unit water consumed for five different irrigation schemes in Andalusia region of Spain between 0,30-0,76 €/m^3.

4. Conclusion

In this study, water delivery performance, financial performance and production performance were determined for Asartepe Irrigation Scheme for the years 2001-2004.

Irrigation ratios ranged from 44% to 55%. Whole irrigation area cannot be irrigated due to fallow area, deficiency of irrigation facilities, topographic structure and socio-economic factors in the irrigation scheme. If it can be irrigated completely, production performance indicators will be arisen to the current level. Irrigation facilities should be improved to irrigate command area. All, RWS values for the scheme was found higher than 1, except the

year of 2001. The reason for that can be cited as more water diverted than required, water losses and unconscious irrigation applications in the scheme. Precautions should be taken to increase efficiency of water use. Irrigation water pricing based on volumetric rate should be initiated; rehabilitation of the scheme should be realized.

Table 9 Output per Unit Command Area

Crop	Total annual value of agricultural production ($)				Total command area serviced by the system (ha)				Output per unit command area ($/ha)			
Years	2001	2002	2003	2004	2001	2002	2003	2004	2001	2002	2003	2004
Legume	-	-	-	40 366	1500	1500	1500	1500	-	-	-	27
Water melon	-	10 249	16 716	2 675					-	7	11	2
Sugar beet	54 840	51 472	86 460	43 597					37	34	58	29
Fruit	69 902	-	-	-					47	-	-	-
Vegetable	2875339	2465693	2860266	2979417					1917	1644	1907	1986
Fodder crops	272 285	342 455	44 485	178 052					182	228	30	119
Maize	-	-	81 290	108 793					-	-	54	73
Cereal	612	-	7 618	12 947					0	-	5	9
Onion-Garlic	-	-	-	2 431					-	-	-	2
Vineyard	5 295	98 793	-	25 207					4	66	-	17
Total	3278273	2968662	3096835	3393486	-	-	-	-	2 187	1 979	2 065	2 264

Table 10 Output per Unit Irrigated Area

Crop	Total annual value of agricultural production ($)				Total annual irrigated crop area (ha)				Output per unit irrigated area ($/ha)			
Years	2001	2002	2003	2004	2001	2002	2003	2004	2001	2002	2003	2004
Legume	-	-	-	40 366	665	840	812	823	-	-	-	49
Water melon	-	10 249	16 716	2 675					-	12	21	3
Sugar beet	54 840	51 472	86 460	43 597					83	61	107	53
Fruit	69 902	-	-	-					105	-	-	-
Vegetable	2875339	2465693	2860266	2979417					4324	2935	3523	3620
Fodder crops	272 285	342 455	44 485	178 052					410	408	55	216
Maize	-	-	81 290	108 793					-	-	100	132
Cereal	612	-	7 618	12 947					1	-	9	16
Onion-Garlic	-	-	-	2 431					-	-	-	3
Vineyard	5 295	98 793	-	25 207					8	118	-	31
Total	3278273	2968662	3096835	3393486	-	-	-	-	4 931	3 534	3 815	4 123

Table 11. Output per Unit Irrigation Supply

Crop	Total annual value of agricultural production ($)				Total annual volume of irrigation water inflow ($x10^3$ m^3)				Output per unit irrigation supply ($/$m^3$)			
Years	2001	2002	2003	2004	2001	2002	2003	2004	2001	2002	2003	2004
Legume	-	-	-	40 366	5962	8687	11052	7066	-	-	-	0,006
Water melon	-	10 249	16 716	2 675					-	0,001	0,002	0,000
Sugar beet	54 840	51 472	86 460	43 597					0,009	0,006	0,008	0,006
Fruit	69 902	-	-	-					0,012	-	-	-
Vegetable	2875339	2465693	2860266	2979417					0,482	0,284	0,259	0,422
Fodder crops	272 285	342 455	44 485	178 052					0,046	0,039	0,004	0,025
Maize	-	-	81 290	108 793					-	-	0,007	0,015
Cereal	612	-	7 618	12 947					-	-	0,001	0,002
Onion-Garlic	-	-	-	2 431					-	-	-	0,000
Vineyard	5 295	98 793	-	25 207					0,001	0,011	-	0,004
Total	3278273	2968662	3096835	3393486	-	-	-	-	0,550	0,342	0,280	0,480

Table 12. Output per Unit Water Consumed

Crop	Total annual value of agricultural production ($)				Total annual volume of water consumed by the crops ($x10^3$ m^3)	Output per unit water consumed ($/$m^3$)			
Years	2001	2002	2003	2004		2001	2002	2003	2004
Legume	-	-	-	40 366	750	-	-	-	0,05
Water melon	-	10 249	16 716	2 675	500	-	0,02	0,03	0,01
Sugar beet	54 840	51 472	86 460	43 597	750	0,07	0,07	0,12	0,06
Fruit	69 902	-	-	-	540	0,13	-	-	-
Vegetable	2 875 339	2 465 693	2 860 266	2 979 417	1040	2,76	2,37	2,75	2,86
Fodder crops	272 285	342 455	44 485	178 052	1040	0,26	0,33	0,04	0,17
Maize	-	-	81 290	108 793	520	-	-	0,16	0,21
Cereal	612	-	7 618	12 947	-	-	-	-	-
Onion-Garlic	-	-	-	2 431	200	0,00	-	-	0,01
Vineyard	5 295	98 793	-	25 207	-	-	-	-	-
Total	3 278 273	2 968 662	3 096 835	3 393 486	-	3,23	2,79	3,10	3,37

Irrigation ratios, cost recovery ratio and maintenance costs are the most commonly used performance indicators for the assessment of operational success of the schemes. The results of the study showed a significant improvement especially in irrigation ratios, revenue collection and financial costs of facility operation as the state have transferred the irrigation schemes to the user organizations. It can be concluded that Asartepe irrigation Association is successful in decision making on system development.

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