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**Anahtar sözcükler:** Sulama kooperatifi, sulama yönetimi, performans göstergesi, sistem performansı

## Evaluation of water use management performances for irrigation cooperatives in Aydın province\*

Aydın ilinde bulunan sulama kooperatiflerinin su yönetim performanslarının değerlendirilmesi

\* This article is summarized from the first author's M.Sc. Thesis.

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### ABSTRACT

**Objective:** The objective of this study was to assess the performance indicators for 2006-2017 years. Hence for a better Management-Operation-Maintenance organization, irrigation management efficiencies of 23 groundwater irrigation cooperatives located in Aydın was used. .

**Materials and Methods:** The indicators chosen from comparative performance evaluation set by FAO and IPTRID were used in this study for the evaluation of the efficiency of irrigation cooperatives.

**Results:** Main findings of this study indicated that the values of the indicators varied as follows; irrigation ratio 7-94%, cost recovery ratio 53-146%, irrigation water fee collection efficiency 70-91%, maintenance costs to total revenue ratio 4-104%, total MOM costs per unit area 102.2-1103.7/ha, number of staff employed per irrigation area 26.5-316.9 ha/person, total costs per staff employed in irrigation area varied between 2013-11996 \$/ person.

**Conclusion:** In order to bring solutions to the main problems of irrigation cooperatives which creates benefits to the irrigated agriculture in the region; operation management and maintenance organizations should be better fulfilled, participatory management should be encouraged, support and credit systems should be re-arranged. Also, supporting irrigation services by irrigation credits with lower interest rates or providing costless would be a solution.

### ÖZ

**Amaç:** Aydın ilinde bulunan 23 adet yeraltı sulama kooperatifinin sulama yönetim etkinlikleri 2006-2017 yılları için çeşitli performans göstergeleriyle incelenerek, İşletme-Bakım-Yönetim organizasyonunun geliştirilmesine yönelik bazı önerilerde bulunulması hedeflenmiştir.

**Materyal ve Yöntem:** Sulama kooperatiflerinin performanslarının değerlendirilmesinde; FAO ve IPTRID tarafından geliştirilmiş olan karşılaştırmalı değerlendirme rehberindeki göstergeler kullanılmıştır.

**Araştırma Bulguları:** Bu araştırma sonucunda; sırasıyla sulama oranı %7-94, yatırımın geri dönüşüm oranı %53-146, su ücreti toplama etkinliği %70-91, bakım masrafının gelire oranı %4-104, birim alana düşen toplam işletme-bakım-yönetim masrafı 102.2-1 103.7 \$/ ha, birim alanda çalıştırılan personel sayısı 26.5-316.9 ha/personel, su dağıtımında çalıştırılan her bir kişi başına toplam masraf ise 2 013-11 996 \$/kişi değerleri arasında değiştiği saptanmıştır.

**Sonuç:** Bölgede sulu tarım açısından büyük öneme sahip olan sulama kooperatiflerinde tespit edilen problemlerin çözümüne yönelik olarak işletme-bakım-yönetim ve denetim mekanizmalarında özen gösterilmesi, katılımcı sulama yönetimi anlayışının benimsenmesi, kredi ve destek sistemlerinin revize edilmesi, bazı hizmetlerin hibe yoluyla verilmesi, düşük faizli sulama kredileriyle temel sulama hizmetlerinin desteklenmesi ve mevcut uygulamaya konan desteklerin de sürdürülmesi gerekmektedir.

## INTRODUCTION

The importance of water, one of the most vital inputs of the agricultural sector, is increasingly understood. The main reason for this situation is that the already scarce water resources become even more valuable with the effect of global climate change. Akyüz & Atış (2023) emphasized the importance of creating applicable policies in the agricultural sector by giving more importance to environmental problems such as climate change. With the increasing demand for water, which is a natural resource that is decreasing in quantity and increasing in value, a competition between agricultural, industrial and drinking-use water users has emerged and water, which is of great importance in meeting the basic needs of people, has become a valuable commercial good. The world population is estimated to exceed 9.5 billion by 2050. Therefore, it is clear that the pressure that the increasing population will create in the future will affect the quality and quantity of water resources. Therefore, when planning water use in the agricultural sector, it is of great importance to manage it in an integrated manner along with other water-using sectors (Bouwer, 2003; DSI, 2016).

The concept of "Participatory Irrigation Management" was first introduced by the World Bank. In accordance with the practices in the world, the process of restructuring in the irrigation sector started in Türkiye in the 1990's. This understanding is based on the pricing of irrigation services through the loading of the services and investments carried out by the state in the irrigation sector to the water user. With the transfer of irrigation facilities, water users who benefit from this facility and infrastructure pay the water fee to organizations that provide irrigation services in return for management-operation-maintenance (MOM) costs (Akıllı, 2011; Kasalak et al., 2012).

State Hydraulic Works (DSI) completes the construction and transfers the responsibility of the irrigation systems, it undertakes to the irrigation union, irrigation cooperative, municipality and village legal entities. The fact that producers can receive irrigation services more regularly with the transfer process has accelerated the process of transferring the responsibility for irrigation management from the public institution to irrigation organizations (DSI, 2018).

Irrigation Cooperatives were established in Türkiye in 1966 in accordance with the Cooperative Law No. 1163. Irrigation cooperatives are non-governmental organizations with variable capital and variable partnerships established by public legal entities, municipalities, villages, associations and private administrations. The purpose is to provide financial benefits to their partners and to protect the interests of the partners by providing mutual assistance, solidarity and surety. In this context, irrigation cooperatives are responsible for the construction, operation, maintenance and repair of irrigation facilities required for the proper distribution of irrigation water to be used from the irrigation infrastructure that has been completed with public resources and, in the case if it is necessary, to carry out land consolidation activities (Çiftçi et al., 2012).

Raising awareness of farmers about irrigated agriculture, requesting the construction of an irrigation system in the region, and adopting the concept of participatory irrigation is an important stage in the implementation of irrigated agriculture projects. Groundwater Irrigation (YAS) Cooperatives can be shown as one of the best examples of this (Anonymous, 2018). Irrigation projects using groundwater are divided into two as State Funded Projects and Public Irrigation. State-backed irrigation projects are designed in three different ways: Public Groundwater Irrigation, DSI Groundwater Irrigation, and Groundwater Irrigation Cooperative (DSI, 2018).

After the implementation of YAS projects in Türkiye, the most significant developments were achieved by irrigation cooperatives and the share of cooperative irrigation reached 75% in total groundwater irrigation. Among all the areas opened by DSI for irrigation, YAS cooperatives have a share of approximately 16%. A total of 1 456 irrigation cooperatives in operation are mostly located within the borders of İzmir, Konya, Samsun, Edirne Isparta, Kayseri and Eskişehir provinces. In this process, the

transfer of YAS projects completed to irrigation cooperatives is carried out within the scope of Law No. 6200 (DSI, 2018).

Performance assessment studies were carried out in irrigation systems in order to determine to what extent the planned targets were achieved in irrigation projects (Beyribey et al., 1997). Therefore, irrigation targets should be set at the beginning, and then the efficiency of the system should be evaluated (Nalbantoğlu & Çakmak, 2007). With some improvements in irrigation networks, performance will be improved; however, by saving water, efficiency will increase and some negative environmental effects that may occur with irrigation activities can be minimized (Lencha, 2008). In order to determine the irrigation management performance of irrigation cooperatives, some studies conducted by Süheri & Topak (2005), Yercan et al. (2009), Sayın (2011), Özkan et al. (2012), Demir & Topak (2015), Cin & Çakmak (2017), Fişekçioğlu (2018), Cengiz & Uçar (2018), Taşpınar (2018).

In this study, the efficiency status of 23 YAS cooperatives operating in Aydın province was evaluated with various performance indicators for the years 2006-2017. Some suggestions have been made to improve irrigation system performance in cooperatives and to provide a better Operation-Maintenance-Management organization.

## MATERIALS and METHOD

### Material

In this study, the irrigation activities of 23 groundwater irrigation cooperatives located in Aydın province in the Büyük Menderes Basin for the years 2006-2017 were assessed. The locations of the irrigation cooperatives evaluated in the study are depicted in Figure 1.



Figure 1. Location of irrigation cooperatives in Aydın.

Şekil 1. Aydın ilinde faaliyet gösteren sulama kooperatiflerinin konumu.

Aydın province is located in the Büyük Menderes Basin, which is formed by the Büyük Menderes stream and side streams that give the basin its name. The basin, which has fertile plains in the central and western parts, is surrounded by mountains from the north and south. The basin has a typical Mediterranean climate. Agriculture is carried out in an area of 363 215 ha (45.3%) of Aydın province.

Aydın province, which have a high potential in every branch of agriculture, is very suitable for agricultural production with its topographic structure, climate and ecological features. The plant pattern of the province dominantly consists of cotton, corn, olives and figs (Anonymous, 2013; Anonymous 2018). The average temperature is 17.8°C, the annual total precipitation average is 621.3 mm, the average relative humidity value is 61.2%, and the average total evaporation value is 1493.5 mm (DMI, 2019).

Some basic information about the cooperatives evaluated in the study is tabulated in Table 1.

**Table 1.** Information about the irrigation cooperatives located in Aydın

**Çizelge 1.** Aydın ilinde faaliyet gösteren sulama kooperatiflerine ilişkin bazı bilgiler

Irrigation Cooperative	District	Established Date	Number of partners	Number of wells	Irrigation area (ha)
Dalama	Efeler	12.02.1991	334	3	110
Mesutlu	Efeler	27.07.1971	131	-	350
Kızılcaköy	Efeler	07.09.1995	241	4	200
Olukbaşı	Bozdoğan	27.11.2002	75	-	125
Buharkent	Buharkent	10.11.1997	76	-	80
Savcılı	Buharkent	20.11.1997	64	-	50
Feslek-Gelenbe	Buharkent	06.05.2013	92	5	400
Balat	Didim	13.10.2011	26	-	120
Ataeymir	Karacasu	14.07.1978	454	9	900
Palamutçuk	Karacasu	16.07.1990	232	2	180
Geyre	Karacasu	02.10.1996	98	5	180
Kirazlı	Kuşadası	14.07.1995	179	2	130
Yöre	Kuyucak	12.05.1975	63	3	150
Çobanisa	Kuyucak	27.02.1992	142	-	315
Bucak	Kuyucak	06.10.1992	119	-	120
Beşeylül	Kuyucak	27.09.1995	168	4	210
Horsunlu	Kuyucak	30.11.1995	146	4	240
Gencelli	Kuyucak	12.09.2007	28	5	530
Kestel	Nazilli	15.01.1968	360	4	350
İsabeyli	Nazilli	11.07.1990	43	2	75
Bozyurt	Nazilli	27.01.1998	74	3	100
Demirciler	Nazilli	19.03.2008	173	2	150
Yuvaca	Söke	16.07.1974	61	4	180
Sultanhisar	Sultanhisar	13.01.1975	652	18	735
Atça	Sultanhisar	08.08.1975	865	19	470

## Method

In this study, the temporal change of irrigation performance of 23 irrigation cooperatives in Aydın province between 2006-2017 was examined. In the evaluation of the efficiency of the irrigation cooperatives examined, the Irrigation Ratio indicator revealed by (Rao, 1993) was used. Six of the performance indicators proposed in the comparative evaluation indicator set, which was put forward jointly by IPTRID (International Programme for Technology and Research in Irrigation and Drainage) and FAO (World Food and Agriculture Organization), were used (Malano & Burton, 2001). The equations used to calculate the are given below.

Irrigation ratio (%)

$$IR = \frac{\text{Irrigated area (ha)}}{\text{Irrigation area (ha)}} \times 100 \quad (1)$$

Irrigation water fee collection performance (%)

$$WFPCP = \frac{\text{Total revenue collected from water users (TL)}}{\text{Total service revenue due (TL)}} \times 100 \quad (2)$$

Cost recovery ratio (%)

$$CRR = \frac{\text{Total revenue collected from water users (TL)}}{\text{Total management operation maintenance cost (TL)}} \times 100 \quad (3)$$

Maintenance cost to revenue ratio (%)

$$MCRR = \frac{\text{Total maintenance expenditure (TL)}}{\text{Total revenue collected from water users (TL)}} \times 100 \quad (4)$$

Total MOM Cost per unit area (\$/ha)

$$TCPA = \frac{\text{Total MOM expenditure (\$)}}{\text{Irrigation area (ha)}} \quad (5)$$

Irrigation area per staff (ha/staff)

$$SN = \frac{\text{Irrigation area (ha)}}{\text{Total staff number (staff)}} \quad (6)$$

Total cost per person employed on water delivery (\$/ person)

$$TCEWD = \frac{\text{Total cost of MOM personnel (\$)}}{\text{Total number of MOM personnel employed(person)}} \quad (7)$$

The data required for the calculation of the indicators were obtained from the records of the relevant irrigation cooperatives.

## RESULTS AND DISCUSSION

### Irrigation ratio

The results of the irrigation ratio values of the cooperatives evaluated in the study are given in Table 2. In this study, assessment was made for a 12-year period covering the years 2006-2017. The irrigation ratio values of the cooperatives varied between 7-94% for the 12-year period. The lowest irrigation ratio was found to be 7% in Mesutlu Irrigation Cooperative and the highest irrigation ratio was 94% in Atça Irrigation Cooperative.

The irrigation ratios of the irrigation cooperatives evaluated fluctuate from one year to another except Kızılcaköy Irrigation Cooperative since the value of 100% has been reached. In Atça Irrigation Cooperative, it was determined that the highest irrigation rate reached 94% in terms of average values. In other cooperatives examined, irrigation rates were observed to be well below the targeted value. This situation is thought to be caused by administrative problems of the cooperatives related to irrigation management. In addition, it has been determined that the irrigation ratios are low in some cooperatives, which are known to have poor cooperative-partner relations. Among the cooperatives evaluated, the Mesutlu Irrigation Cooperative can be shown as an example of this situation. The low rate of irrigation in the Mesutlu Irrigation Cooperative can be explained by the fact that the partners do not have a demand for water from the cooperative. The main reason for the high irrigation rate in Atça and Sultanhisar Irrigation Cooperatives can be explained by the fact that strawberry production is quite common in these regions by using pressurized irrigation systems and that strawberries can be marketed at a high price as an important export product.

**Table 2.** Irrigation ratios of the irrigation cooperatives (%)**Çizelge 2.** Sulama kooperatiflerine ait sulama oranı değerleri (%)

Irrigation Cooperative	Years												Avg.
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Dalama	79	59	74	68	60	59	62	64	66	74	83	87	70
Mesutlu	6.5	5	7	6	4	5	4	10	12	15	*	*	7
Kızılcaköy	*	36	48	48	54	68	100	100	96	97	81	84	74
Olukbaşı	52	44	53	72	60	54	70	72	68	75	80	83	65
Buharkent	87	55	86	95	89	88	91	90	89	93	82	75	85
Savcılı	87	77	85	83	80	86	90	91	87	83	43	78	81
Ataeymir	61	54	97	86	57	89	89	89	92	90	95	84	82
Palamutçuk	56	44	97	82	56	69	69	73	74	85	88	90	74
Geyre	*	*	63	42	17	42	44	53	49	53	64	80	51
Kirazlı	48	58	69	73	75	85	88	91	84	68	65	82	74
Yöre	60	47	86	65	60	63	90	88	92	95	97	91	78
Çobanisa	54	28	63	56	51	60	73	77	83	48	87	92	64
Bucak	96	88	92	75	13	*	*	*	*	*	*	*	73
Beşeylül	*	17	88	82	59	51	89	81	77	65	63	64	67
Horsunlu	8	34	73	75	67	71	76	82	89	62	95	93	69
Gencelli	*	*	96	92	47	64	68	52	84	75	77	73	73
Kestel	57	80	66	56	61	89	83	80	82	89	92	94	77
İsabeyli	29	17	29	40	17	33	33	42	38	54	62	64	38
Bozyurt	23	78	73	32	27	41	21	15	43	17	18	*	35
Demirciler	*	*	93	43	9	10	53	65	54	72	95	*	55
Yuvaca	83	61	72	83	83	83	83	83	83	85	71	72	79
Sultanhisar	82	72	88	82	76	68	60	68	74	87	92	86	78
Atça	95	81	99	96	95	94	96	98	98	97	92	82	94

\* No irrigation

**Irrigation water fee collection performance**

The findings on the level of water fee collection efficiency in Aydın irrigation cooperatives from 2006 to 2017 are shown in Table 3. In irrigation cooperatives, it is very important for water users to pay water fees in order to ensure the healthy functioning of the Management-Operation-Maintenance activities and the financial self-sufficiency of the cooperatives.

**Table 3.** Water fee collection ratios of the irrigation cooperatives (%)**Çizelge 3.** Sulama kooperatiflerine ait su ücreti toplama performansları değerleri (%)

Irrigation Cooperative	Years												Avg.
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Dalama	94	90	95	80	89	87	99	82	75	82	70	82	85
Mesutlu	81	73	67	74	65	75	76	72	62	58	*	*	70
Kızılcaköy	*	66	89	73	80	84	78	80	79	83	71	78	78
Olukbaşı	85	79	89	86	80	83	84	72	68	58	63	68	76
Buharkent	89	85	90	92	94	87	81	83	72	43	78	67	80
Savcılı	81	85	86	86	92	87	89	82	75	84	72	93	84
Ataeymir	96	93	92	96	94	97	98	87	85	91	83	75	91
Palamutçuk	95	85	93	91	83	69	79	83	87	79	71	82	83
Geyre	*	*	75	100	100	100	100	78	83	74	73	63	85
Kirazlı	93	83	90	80	93	94	95	75	80	83	74	78	85
Yöre	95	84	98	99	99	94	94	92	81	53	87	70	87
Çobanisa	82	77	99	81	82	95	88	75	72	82	73	79	82
Bucak	91	90	99	94	72	*	*	*	*	*	*	*	89
Beşeylül	*	78	99	95	95	94	97	86	78	73	75	76	86
Horsunlu	71	75	95	96	96	89	99	82	93	71	97	93	88
Gencelli	*	*	98	99	76	74	79	73	81	80	82	87	83
Kestel	91	96	97	95	93	94	97	78	88	85	82	72	89
İsabeyli	67	55	63	80	73	85	86	68	62	78	72	64	71
Bozyurt	81	91	90	83	63	78	70	72	61	82	74	*	77
Demirciler	*	*	94	61	55	63	82	87	92	78	96	*	79
Yuvaca	81	92	91	95	86	88	94	87	83	75	78	74	85
Sultanhisar	75	77	75	85	82	83	73	80	73	68	77	81	77
Atça	94	90	95	80	89	87	99	82	75	82	70	82	80

\* No irrigation

Water fee collection performance in irrigation cooperatives in Aydın province varied between 43-100%. When examined at the level of averages, it is seen that water fee collection efficiency in the range of 71-91% is reached. Beyribey et al. (1997), determined the water fee collection performance in Büyük Menderes Basin irrigation associations as 54% for the pre-transfer period, and Özlü (2004) determined this value as 90% in irrigation cooperatives operating in Türkiye.

According to Vermillion (2000), water fee collection efficiency can be described as "poor" if it is lower than 40%, "acceptable" if it is in the range of 40-60%, "satisfactory" if it is between 60-75%, and "good" if it is higher than 75%. Dorsan et al. (2004), reported that this indicator was 100% after the transfer in the Lower Gediz Basin irrigation networks. Sönmezıldız & Çakmak (2013), found this value at the level of 100% in Eskişehir Beyazaltın village. Although the water fee collection performance was at a good level in the irrigation cooperatives examined in the study, it was observed that the average value of the country remained slightly below. The increase in water fee collection efficiency can be considered as an indicator of management success in cooperatives.

### Cost recovery ratio

The cost recovery ratio indicator of the cooperatives discussed in the study is given in Table 4. With this important financial indicator, it is determined whether the irrigation fees collected in irrigation organizations and the total expenses incurred in that year are covered or not. It was determined that the average cost recovery ratio varied between 53-146% in cooperatives (Table 4).

**Table 4.** Cost recovery ratios of the irrigation cooperatives (%)

**Çizelge 4.** Sulama kooperatiflerine ait yatırımın geri dönüşüm oranları (%)

Irrigation Cooperative	Years												Avg.
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Dalama	137	90	146	217	218	157	210	110	85	120	89	73	138
Mesutlu	60	75	48	53	34	60	72	51	43	37	*	*	53
Kızılcaaköy	*	141	68	56	72	106	100	61	57	53	103	130	86
Olukbaşı	106	112	152	128	148	101	105	72	65	63	112	130	108
Buharkent	88	37	89	176	91	104	99	82	73	87	63	54	87
Savcılı	77	81	85	87	93	84	101	75	80	71	34	62	78
Ataeymir	102	57	120	98	127	135	99	87	85	92	68	65	95
Palamutçuk	79	74	81	63	74	74	83	113	108	108	109	113	90
Geyre	*	*	87	67	110	55	79	54	101	68	76	50	75
Kirazlı	55	42	45	70	105	121	78	94	97	81	92	79	80
Yöre	125	61	112	106	76	88	74	108	127	92	119	119	101
Çobanisa	92	80	99	99	98	134	101	99	110	92	106	101	101
Bucak	115	250	146	119	101	*	*	*	*	*	*	*	146
Beşeylül	*	72	191	95	107	91	71	78	81	55	68	59	88
Horsunlu	102	101	100	73	115	105	143	124	126	107	142	118	113
Gencelli	*	*	100	92	73	98	97	101	92	106	124	98	98
Kestel	83	98	112	90	116	101	99	99	100	105	115	80	100
İsabeyli	97	93	97	99	99	130	157	118	149	85	108	110	112
Bozyurt	57	120	71	51	53	93	29	47	66	49	55	*	63
Demirciler	*	*	126	57	28	106	89	42	40	119	134	*	82
Yuvaca	165	115	127	125	155	147	158	79	103	89	95	77	120
Sultanhisar	73	73	85	69	73	71	61	77	89	90	92	88	78
Atça	88	42	91	76	70	67	59	74	95	101	109	87	80

\* No irrigation

This rate, which was determined by using the total operating, maintenance and management costs of the cooperative and the total water fee collected from water users, was calculated as the lowest (29%) in Bozyurt Irrigation Cooperative and the highest (250%) in Bucak Irrigation Cooperative on a yearly basis. This cooperative has the highest average (146%) among all cooperatives evaluated and this is an indication of self-sufficiency of the cooperative. The cost recovery ratio is "acceptable" between 40-60%, "satisfactory" between 60-75%, and "good" between 75-100% (Vermillion, 2000). In this case, values less

than 40% can be considered as an unsuccessful management indicator. It is thought that the main reasons for this rate to be "satisfactory" and "good" in the majority of the cooperatives discussed in the study are the volumetric pricing of the groundwater used in the research area and the timely collection of water fees and the timely provision of irrigation services in the cooperative.

The fact that the cost recovery ratio indicator is at a good level in the irrigation cooperatives of Aydın province, shows that the irrigation water fees collected from the producer and the total Management-Operation-Maintenance (MOM) expenses are managed appropriately.

### Maintenance cost to revenue ratio

The ratio of maintenance cost to revenue is defined as the ratio of the total maintenance cost required in irrigation systems to the total water fee collected from water users. Or; it can be expressed as; to what extent of the collected water fees covers the maintenance costs. Maintenance cost to revenue ratio between 2006-2017 in irrigation cooperatives in Aydın province are given in Table 5.

**Table 5.** Maintenance cost to revenue ratio of the irrigation cooperatives (%)

**Çizelge 5.** Sulama kooperatiflerine ilişkin bakım masrafının gelire oranı değerleri (%)

Irrigation Cooperative	Years												Avg.
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Dalama	10	21	7	1	6	17	16	30	45	38	51	13	21
Mesutlu	13	6	14	11	16	5	6	28	37	32	*	*	17
Kızılcaköy	*	3	*	12	20	1	0,6	0,1	0,02	0,1	0,2	0,02	4
Olukbaşı	20	28	12	15	16	17	11	32	17	41	21	24	21
Buharkent	45	112	39	18	40	35	40	5,1	5,5	12,7	24,9	13,8	33
Savcılı	48	40	37	35	31	43	34	6,2	4,5	2	56	2,4	28
Ataeymir	5	15	10	10	10	5	6	23	38	42	26	47	20
Palamutçuk	26	49	12	21	12	12	14	2,9	4,9	5,5	5,5	4,2	14
Geyre	*	*	17	54	578	81	44	6,3	45	38	60	113	104
Kirazlı	8	173	66	4	5	3	25	4,7	17	1,6	*	2,6	28
Yöre	3	119	26	22	42	20	21	3,9	3,6	5,4	3,4	3,2	23
Çobanisa	31	20	9	3	5	19	23	19	21	12	19	24	17
Bucak	21	7	8	40	87	*	*	*	*	*	*	*	33
Beşeylül	*	12	10	14	7	10	5	12	3,7	2	4,4	19	9
Horsunlu	15	8	34	63	17	14	2	1	6	16	6	14	16
Gencelli	*	*	1	8	10	1	13	93	11	7	3	19	17
Kestel	21	22	10	11	14	8	5	7	3	5	13	26	12
İsabeyli	35	8	26	33	46	23	18	64	49	17	7	9	28
Bozyurt	49	17	40	62	79	10	59	55	50	186	81	*	63
Demirciler	*	*	12	88	83	12	9	2,9	8	5,7	11	*	26
Yuvaca	19	22	19	7	3	5	5	9,5	9	15,5	5,6	18	11
Sultanhisar	8	18	17	21	17	23	25	9	10,6	9,5	10	11,7	15
Atça	5	10	5	3	12	5	19	7,6	14	12	8	11	9

\* No irrigation

Considering the average values in the research area, it was determined that the ratio of maintenance cost to revenue varied between 4-104%. In some of the cooperatives examined, it was determined that the collected water fees covered the maintenance costs, while in others it was partially sufficient and there were problems in this sense in the cooperatives. The average value of 104% determined in the Geyre irrigation cooperative shows that the share allocated to maintenance and repair services is higher than necessary. In a study conducted in five different irrigation systems in Spain, it was determined that the rate of maintenance cost to income was in the range of 2-13% (Rodriguez et al., 2004). Tekiner & Çakmak (2011), stated that this indicator is between 17-156% in three different networks in Çanakkale, and Cin and Çakmak (2017), determined the rate of maintenance cost to income as 14% in their study conducted at Beypazarı Başören Irrigation Cooperative. The high ratio of maintenance cost to revenue indicator indicates that more than the share of maintenance and repair services is allocated in cooperatives and shows that cooperative management should make a more accurate planning in terms of the sustainability of the irrigation services provided.



### Total Management-Operation-Maintenance (MOM) cost per unit area

The total cost of MOM per unit area is the ratio of the cost of MOM made in that year in irrigation networks to the irrigation area. Table 6 shows the findings obtained for this indicator in Aydın province irrigation cooperatives between 2006-2017.

**Table 6.** Total management-operation-maintenance cost of the command area of the irrigation cooperatives (\$/ha)

**Çizelge 6.** Sulama kooperatiflerinde birim alana düşen toplam işletme-bakım-yönetim masrafı değerleri (\$/ha)

Irrigation Cooperative	Years												Avg.
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Dalama	519	800	609	267	253	299	245	402	493	336	318	466	417
Mesutlu	1 366	1 692	1 608	1 333	1 917	1 125	859	430	405	303	*	*	1104
Kızılcaköy	*	107	304	252	219	142	129	289	359	243	171	146	215
Oluksbaşı	523	569	416	506	405	442	461	205	508	314	343	272	414
Buharkent	343	937	276	243	348	291	309	557	613	261	777	711	472
Savcılı	488	511	714	567	594	604	535	845	812	660	910	1105	695
Ataeymir	149	290	156	166	114	116	151	154	131	116	171	217	161
Palamutçuk	292	401	418	319	257	263	333	255	241	221	248	208	288
Geyre	*	*	62	90	209	106	90	140	187	162	127	172	134
Kirazlı	173	377	392	249	195	184	248	222	220	159	145	258	235
Yöre	158	376	404	210	302	221	281	165	174	123	168	156	228
Çobanisa	154	184	190	131	138	106	121	102	99	70	98	92	124
Bucak	178	125	287	204	94	*	*	*	*	*	*	*	178
Beşeylül	*	250	119	194	176	183	226	216	215	233	162	158	194
Horsunlu	146	171	330	253	166	153	155	110	205	160	192	188	186
Gencelli	*	*	252	213	26	31	32	29	178	92	102	115	107
Kestel	189	203	194	139	117	188	145	136	177	131	128	161	159
İsabeyli	117	127	108	111	145	84	68	77	77	93	122	98	102
Bozyurt	120	148	235	168	106	64	185	166	50	45	53	*	122
Demirciler	*	*	265	283	618	192	196	544	697	198	473	*	385
Yuvaca	68	128	162	105	98	106	127	116	104	95	82	87	106
Sultanhisar	191	378	358	279	315	308	337	312	266	192	196	165	275
Atça	459	669	585	406	424	429	551	508	409	342	389	407	465

\* No irrigation

Accordingly, it can be seen that the MOM expense (1104 \$/ha) for the unit irrigation area in Mesutlu irrigation cooperative is quite high on the basis of averages. Relatively low irrigation ratio is the main reason for this situation. In Isabeyli Irrigation Cooperative, the average value of 102.2 \$/ha shows that the cost of MOM per unit area is quite low.

The total MOM cost indicator per unit area was determined to be between 22.53-108.61\$/ha in Akıncı Irrigation Association (Nalbantoğlu & Çakmak, 2007), 51.98 TL/ha in Eskişehir Beyazaltın village (Sönmezıldız & Çakmak, 2013), 700 TL/ha in Beypazarı Başören Irrigation Cooperative (Cin & Çakmak, 2017), and 81.52-141.96 \$/ha in Kırıkhan irrigation unit (Gençoğlu & Değirmenci, 2019).

It has been determined that the cooperatives with higher values of this indicator are generally the ones with very old irrigation infrastructure and facing management problems.

### Irrigation area per staff

The average values given in Table 7, shows the change in the number of personnel per unit area in irrigation cooperatives in Aydın province between years 2006-2017. When the values are examined, it is seen that number of staff number per unit area varied between 26.5-316.9 ha/staff. Lower values indicate that less staff is employed in irrigation services, while higher values show the over-employment and this could be attributed to poor administration of the cooperatives.

According to Yercan et al., (2009), in order to qualify this indicator as appropriate, less than 3 staff should be employed in an area of 1000 ha. Bekişoğlu (1994) stated that it is sufficient for an irrigation

staff to provide service on an area of 333 ha. Koç et al. (2009), conducted a study to determine the optimum number of staff to serve in Büyük Menderes Basin irrigation units and they determined that this value should be between 137.61-287.83 ha/staff. When the values obtained in the cooperatives in the research area were examined, it was found that excessive staff were employed in the Gencelli irrigation cooperative, but the number of staff in other cooperatives was consistent with the number as proposed by Koç et al., (2009) for Büyük Menderes Basin irrigation schemes.

**Table 7.** Irrigation staff per unit irrigation area in the irrigation cooperatives (ha/staff)

**Çizelge 7.** Sulama kooperatiflerinde birim alana düşen personel sayısı (ha/personel)

Irrigation Cooperative	Years												Avg.
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Dalama	87	65	81	75	66	65	68	35	36	40.5	45.5	48	59.3
Mesutlu	23	18	26	21	15	18	15	35	42	52.5	*	*	26.5
Kızılcaköy	*	72	96	96	108	136	200	200	192	194	162	168	147.6
Olukbaşı	65	55	66	90	75	68	87	90	85	93	100	104	81.5
Buharkent	69.9	43.7	68.5	75.6	71	70	72.5	72	71.2	74.4	32.8	60	65.1
Savcılı	43.6	38.5	42.6	41.5	40	43	45	45.5	43.5	41.5	21.5	39	40.4
Ataeymir	107.5	126.6	113.3	120	100	200	200	160	165.6	135	171	189	149
Palamutçuk	100	80	175	148.2	100	125	125	131.4	133.2	153	158.4	162	132.6
Geyre	*	*	113.9	75	30	75	80	95.4	88.2	95.4	115.2	72	84
Kirazlı	62	75	90	95	97	110	115	118.3	109.2	88.4	84.5	106.6	95.9
Yöre	90	70.8	129	98	90	95	135	132	138	142.5	145.5	136.5	116.8
Çobanisa	170	88	200	175	160	190	230	242.5	261.5	151.2	274	144.9	190.5
Bucak	115	105	110	90	15	*	*	*	*	*	*	*	87
Beşeylül	*	35	185	173	124	108	186	170.1	161.7	136.5	132.3	134.4	140.5
Horsunlu	20	82	175	180	160	171	182.5	196.8	213.6	148.8	114	111.6	146.2
Gencelli	*	*	255	245	250	340	360	275.6	445.2	397.5	408.1	193.4	316.9
Kestel	100	93.3	76.6	97.5	107.5	103.3	96.6	140	143.5	103.8	80.5	65.8	100.7
İsabeyli	21.5	13	22	30	12.5	25	25	31.5	28.5	40.5	46.5	48	28.6
Bozyurt	23	78	73	32	27	41	21	15	43	17	18	*	35.2
Demirciler	*	*	70	65	14	15	80	97.5	81	108	142.5	*	74.7
Yuvaca	150	110	130	150	150	150	150	149.4	149.4	153	127.8	129.6	141.6
Sultanhisar	86.4	66.2	81.2	100	92.5	83.3	88.6	83.3	90.6	91.3	96.6	90.3	87.5
Atça	89	95	116.2	112.5	111.2	88	90	76.7	76.7	75.9	61.7	55.2	87.3

\* No irrigation

### Total cost per person employed on water delivery

The results of this indicator is obtained by evaluating the number of staff employed in MOM and the total cost of the staff working in MOM in the irrigation cooperative (Table 8). When the average values in the table are examined, it is seen that the cost per person employed in MOM varies between 2 013-11 996 \$/person in 23 irrigation cooperatives included in the study.

When the average values of the total cost indicator per capita employed in water distribution are examined from the table, it was found that this value was the lowest with 2 013 \$/person in İsabeyli Irrigation Cooperative and the highest with 11 996 \$/person in Atça Irrigation Cooperative.

Tekiner & Çakmak (2011) determined that the cost per person in three irrigation networks varies between 1 367-11 700 TL. In Akıncı Irrigation, the total cost per person working in water distribution was determined between 1 091-8 659 \$/person (Nalbantoğlu & Çakmak, 2007). Eliçabuk (2016) calculated this value as 20 976-42 296 TL/person in Gevrekli irrigation scheme. Gençoğlu & Değirmenci (2019), determined that the total cost per person varied between 10 055-20 183 \$/person in their study conducted in Kırıkhan Irrigation Association.

When irrigation cooperatives in Aydın province were compared to the other irrigation schemes in Türkiye in terms of cost per staff employed in water distribution, mostly compatible values were found. However, for the increase in the indicator value in different years, it is thought that cooperatives should take the necessary measures to reduce staff expenses.

**Table 8.** Total cost per person employed on water delivery of the irrigation cooperatives (\$/person)**Çizelge 8.** Sulama kooperatiflerine ilişkin su dağıtımında istihdam edilen kişi başına düşen toplam masraf (\$/kişi)

Irrigation Cooperative	Years											Avg.	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		2017
Dalama	5 463	6 208	6 435	5 179	6 779	6 470	6 789	8 554	8 600	8 445	10 070	5 733	7 060
Mesutlu	2 321	3 922	3 224	4 233	3 649	3 466	3 245	3 347	2 804	2 192	*	*	3 240
Kızılcaköy	*	1 721	1 963	5 265	3 689	3 195	4 846	7 733	7 643	6 466	9 875	5 262	5 241
Olukbaşı	5 786	4 473	5 310	5 485	4 925	4 080	4 292	9 334	8 756	8 453	11 405	12 432	7 060
Buharkent	2 085	2 408	2 155	1 543	2 585	2 293	3 165	6 928	8 602	10 588	6 976	8 097	4 785
Savcılı	2 015	1 988	3 155	2 572	2 983	2 859	2 776	9 148	5 844	4 770	8 999	3 870	4 248
Ataeymir	3 605	4 485	4 363	3 151	3 480	3 882	4 554	4 002	3 512	2 817	2 437	2 732	3 585
Palamutçuk	4 993	7 072	9 909	5 273	6 740	8 388	10 662	11 113	9 785	6 340	6 095	7 804	7 847
Geyre	*	*	6 041	4 334	2 201	4 428	4 720	6 197	8 915	8 202	12 406	8 417	6 586
Kirazlı	3 127	4 587	8 081	7 717	7 955	8 148	7 774	7 461	9 384	4 582	3 302	2 356	6 206
Yöre	2 278	3 271	4 387	2 694	3 061	2 506	2 790	3 826	4 415	4 358	5 069	2 665	3 443
Çobanisa	2 929	1 720	5 772	3 537	3 977	2 795	3 132	6 061	8 441	2 292	8 086	4 186	4 410
Bucak	3 371	2 790	4 540	5 251	1 750	*	*	*	*	*	*	*	3 540
Beşeylül	*	2 278	5 156	4 289	4 209	3 529	3 776	11 868	7 386	6 722	6 034	6 947	5 654
Horsunlu	1 593	2 125	3 291	2 141	3 049	5 200	3 654	4 135	9 276	8 735	5 695	5 755	4 554
Gencelli	*	*	5 349	6 527	5 237	5 212	5 942	7 872	10 139	8 376	2 747	5 201	6 260
Kestel	11 260	11 622	10 441	9 775	10 182	8 587	9 018	7 344	6 751	6 602	5 705	4 897	8 515
İsabeyli	1 657	1 529	1 774	2 234	987	1 471	1 218	2 623	3 421	2 762	2 357	2 129	2 013
Bozyurt	1 946	5 581	6 003	3 215	1 657	2 382	2 332	3 002	2 554	2 311	611	*	2 872
Demirciler	*	*	7 150	6 592	5 527	2 501	5 553	10 072	5 656	5 869	13 555	*	6 941
Yuvaca	1 737	2 293	2 462	1 697	1 988	1 786	2 165	3 357	3 307	3 504	1 473	2 486	2 332
Sultanhisar	4 839	5 484	6 938	8 246	8 599	7 869	9 720	10 243	10 435	7 394	7 733	6 571	7 839
Atça	12 261	12 769	15 075	12 926	13 681	12 063	12 289	10 667	12 894	10 479	10 097	8 761	11 996

\* No irrigation

## RESULTS and DISCUSSION

In Türkiye, some of the irrigation networks which constructed and operated by DSI have been transferred to irrigation cooperatives. By taking the authority and MOM responsibility of the irrigation systems from the public institution and transferring them to different irrigation organizations, it is aimed to operate, maintain and repair the irrigation networks in a more effective way and to manage them correctly. In order to measure the level of success of management in an irrigation organization, irrigation activities should be monitored and evaluated. For this, it is necessary to measure their effectiveness with accepted performance evaluation indicators. In this way, the causes of low performance in irrigation systems can be determined and the system performance can be increased by taking the necessary measures to eliminate the problems.

According to the results obtained in this study, it was found that the average values of irrigation ratios of irrigation cooperatives in Aydın vary between 7-94%. It has been determined that Mesutlu Irrigation Cooperative has the lowest irrigation rate with 7%, and Atça Irrigation Cooperative has the highest irrigation rate with 94%. The lowest water fee collection efficiency was observed in Mesutlu Irrigation Cooperative, and the highest one was Ataeymir Irrigation Cooperative. In the irrigation cooperatives in the research area, the cost recovery ratios vary between 53-146%. Except for Mesutlu Irrigation Cooperative, it has been determined that the cost recovery ratios in irrigation cooperatives are generally at a good level. Considering the averages it has been determined that the ratio of maintenance cost to revenue varies between 4-104%. In the cooperatives, Mesutlu cooperative exhibited the lowest values where the water fee collection efficiency is the lowest. Indicator values of "Total Operation Maintenance and Management Cost Per Unit Area" calculated in the study were 102.2 \$/ha in Isabeyli Irrigation Cooperative and 1 103,7 \$/ha in Mesutlu Irrigation Cooperative on the basis of averages. When the cooperatives are examined in terms of the staff numbers, the lowest value was determined in Mesutlu Irrigation Cooperative with 26.5 ha/staff., and the highest value was determined in Gencelli Irrigation

Cooperative with 316.9 ha/staff. In terms of the cost per person employed in MOM indicator, the lowest values were observed in Isabeyli Irrigation Cooperative, while the highest values were observed in Atça Irrigation Cooperative. The cost per person employed in MOM activities over the years within the scope of the study varied between 2 013-11 996 \$/person.

This study was conducted on 23 irrigation cooperatives located in Aydın covering 2006-2017 period. All the cooperatives evaluated in this study are still actively functioning. In 2023, Çamarası irrigation cooperative was established. In further studies, the efficiency of the cooperatives can be assessed for longer evaluation periods in order to create better MOM services to the area.

Various technical, managerial and economic problems are observed in irrigation cooperatives. Although these problems vary from cooperative to cooperative, their general characteristics are the same. The lack of coordination between institutions and the complexity of authority prevent the functioning of irrigation cooperatives from time to time. Therefore, a special care should be taken to ensure that investment programs are carried out in a coordinated manner between institutions.

The success of agricultural activities depends on the education level and socio-cultural structures of the farmers. For this reason, training and extension activities should be organized for producers in the service area of the cooperative. In addition to irrigation infrastructure. Water delivery and distribution systems in the project area should be projected according to the pipe system, water users should be encouraged to use pressurized irrigation systems and volume-based water pricing should be started.

As a result; in order to solve the problems identified in irrigation cooperatives that provide great benefits to the irrigated agriculture of the country and the region, attention should be paid to MOM activities and transparent management as well as supervision. By adopting a participatory irrigation management approach, the participation of all cooperative partners should be ensured at every stage. Support and credit systems should be revised, some services should be provided free of charge through grants, etc., basic irrigation services should be supported by low-interest irrigation loans, and the supports put into practice should be continued.

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