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Performance evaluation of irrigation associations; the case of Ankara province

Merve AYYILDIZ Zehra Meliha TENGİZ*

Yozgat Bozok University, Faculty of Agriculture, Department of Agricultural Economics, Yozgat, Türkiye

***Corresponding author e-mail:** z.meliha.tengiz@yobu.edu.tr

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Abstract: Due to the agricultural sector having the greatest need for clean water usage, water management in this area is becoming a priority. While the development of irrigation infrastructure in Turkey is carried out by the General Directorate of State Hydraulic Works, the management of irrigation services is conducted through local public institutions, irrigation associations, and irrigation cooperatives. Within this structure, irrigation associations hold a significant position as they serve as mechanisms that enable farmers' participation in water management and operate approximately 23% of the total irrigated area in Turkey. This study aims to present a comparative analysis of the performance of irrigation associations in Ankara province. This study utilizes secondary data acquired from the Akıncı Plain Irrigation Association, the Ayaş Asartepe Irrigation Association, and the Şereflikoçhisar Plain Irrigation Association, all located in Ankara Province. The unions were evaluated using globally recognized metrics for water allocation and fiscal performance. Based on the data obtained, it was determined that there were no significant differences among the three irrigation associations in the water distribution and financial performance dimensions, and that their performance was not at the desired level. For irrigation associations to achieve an effective and sustainable operational structure, it is observed that various improvements and developments are required, particularly in strengthening existing irrigation systems through digital infrastructures, restructuring collection mechanisms, and enhancing water and energy efficiency. Additionally, it can be stated that financial and personnel support from State Hydraulic Works and related organizations may be important for the unions to provide more effective services. The execution of these steps is expected to improve the efficiency of water resource use and foster the sustainability of agricultural production.

Keywords: Irrigation association, Performance indicators, Türkiye, Water resources.

Sulama birliklerinin performans değerlendirmesi; Ankara ili örneği

Öz: Tarımsal sektörün temiz su kullanımına en fazla ihtiyaç duyan alan olması nedeniyle, bu alanda su yönetimi giderek daha önemli bir öncelik hâline gelmektedir. Türkiye'de sulama altyapısının geliştirilmesi Devlet Su İşleri Genel Müdürlüğü tarafından gerçekleştirilirken, sulama hizmetlerinin yönetimi yerel kamu kurumları, sulama birlikleri ve sulama kooperatifleri aracılığıyla yürütülmektedir. Bu yapı içerisinde sulama birlikleri, üreticilerin su yönetimine katılımını sağlayan mekanizmalar olmaları ve Türkiye'deki toplam sulama alanının yaklaşık %23'ünü işletmeleri bakımından önemli bir konuma sahiptir. Bu çalışmanın amacı, Ankara ilinde faaliyet gösteren sulama birliklerinin karşılaştırmalı performanslarını ortaya koymaktır. Çalışmanın ana materyalini, Ankara ilinde faaliyet gösteren Akıncı Ovası Sulama Birliği, Ayaş Asartepe Sulama Birliği ve Şereflikoçhisar Ovası Sulama Birliği'nden elde edilen ikincil veriler oluşturmaktadır. Birlikler, uluslararası geçerliliğe sahip su dağıtımı ve mali performans göstergeleri kullanılarak değerlendirilmiştir. Elde edilen veriler ışığında, üç sulama birliği arasında su dağıtımı ve mali performans boyutları açısından anlamlı bir farklılık bulunmadığı ve incelenen performansların istenen düzeyde olmadığı belirlenmiştir. Sulama birliklerinin etkili ve sürdürülebilir bir işletme yapısına kavuşabilmesi için mevcut sulama sistemlerinin dijital altyapılarla güçlendirilmesi, tahsilat sistemlerinin yeniden yapılandırılması ve su–enerji verimliliğinin artırılmasına yönelik çeşitli iyileştirme ve geliştirme çalışmalarına ihtiyaç olduğu görülmektedir. Ayrıca, birliklerin daha etkin hizmet sunabilmesi açısından Devlet Su İşleri ve ilgili kuruluşlardan sağlanacak mali ve personel desteğinin önemli olabileceği ifade edilebilir. Bu düzenlemeler, su kaynaklarının daha verimli kullanılmasına ve tarımsal üretimin sürdürülebilirliğine katkı sağlayacaktır.

Anahtar kelimeler: Sulama birliği, Performans göstergeleri, Türkiye, Su kaynakları.

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1. Introduction

Water is a vital resource for many sectors, including agriculture, energy generation, and domestic consumption. Population growth, changing consumption patterns, and climate change are increasing the pressure on water resources. Therefore, water resources must be managed efficiently, productively, and sustainably. Approximately 70% of global water use is allocated to agricultural irrigation (Anonymous, 2012). As water resources decline, the risk of drought increases, agricultural production patterns change, and water-dependent farming practices become increasingly costly. The reduction in water resources affects not only agriculture but also the economy and society. To ensure the sustainability of agriculture, water must be used strategically, efficiently, and deliberately.

Türkiye is among the countries experiencing water scarcity. The country has a total land area of approximately 78 million hectares, of which nearly 24 million hectares are suitable for agricultural activities. Of this agricultural land, about 8.5 million hectares have irrigation potential. Approximately 81.9% of these 8.5 million hectares have been developed for irrigation (Anonymous, 2024). Water infrastructure and water user organizations, such as irrigation associations and cooperatives, help farmers in Türkiye irrigate their crops more efficiently and sustainably (Vermillion, 2000). These institutions play a critical role in optimizing the use of water resources and increasing agricultural productivity. The State Hydraulic Works has developed irrigation infrastructure in 54.9% of these areas, and the operation of these systems has been transferred to various legal entities, including irrigation associations, cooperatives, and municipalities (Aydoğdu et al., 2015; Dorak et al., 2019; Turan & Bayrakdar, 2020). The State Hydraulic Works constructs irrigation facilities, while irrigation associations are largely responsible for their operation. Irrigation associations ensure the proper functioning of irrigation infrastructure, carry out maintenance activities, and promote the efficient use of water resources. These organizations aim to ensure that farmers, as the primary beneficiaries of irrigation systems, take ownership of and protect these systems. In addition, they seek to maintain service continuity and improve productivity by involving farmers in the operation, maintenance, and repair of irrigation facilities. Irrigation associations manage approximately 23% of irrigated areas and 84.7% of transferred irrigation infrastructure (Kurucu & Başer, 2023).

The evaluation of irrigation associations is an essential process undertaken to ensure the optimal and efficient use of water resources, improve agricultural productivity, and establish sustainable irrigation management (Çakmak, 2001; Ersöz & Çamoğlu, 2020). This evaluation aims to identify opportunities for improvement by analyzing the organization's technical, economic, social, and environmental performance. Numerous studies have been conducted to evaluate irrigation performance. Gençoğlu and Değirmenci (2019) evaluated the Kırıkhan Irrigation Association; Kırnak et al. (2021) investigated the Sarımsaklı Pumping Irrigation Association through a five-year comparative study; Ayyıldız and Baran (2024) analyzed five irrigation associations in Yozgat province; Karacalar and İrik (2024) assessed the Paşaköy Irrigation Association from 2017 to 2021; Torun and Çakmak (2024) examined ten irrigation associations in the Konya Basin; Harman and Çakmak (2025) conducted a comparative evaluation of the Eskişehir Irrigation Association from 2016 to 2022; and Kirmikil (2025) evaluated the Karacabey Irrigation Association concerning irrigation performance.

The primary objective of this study is to use performance indicators to demonstrate how effectively irrigation associations in Ankara province distribute water, manage finances, and improve productivity. Standardized performance criteria were utilized to evaluate the efficacy of irrigation associations. The study aims to improve the policies that relevant agencies and organizations would develop and revise regarding agricultural irrigation.

2. Materials and Methods

This study aims to evaluate the effectiveness of irrigation associations in water distribution and financial performance using performance indicators, focusing on associations in Ankara province during the 2024 production season. Agricultural activities in Ankara province are carried out under the influence of a continental climate. The province’s geographical characteristics and climatic conditions provide a suitable environment for the cultivation of certain crops. Agricultural production in Ankara involves both traditional and modern farming practices. However, due to limited water resources in the region, irrigation practices must be managed carefully and efficiently.

The Akıncı Plain Irrigation Association (APA), Ayaş Asartepe Irrigation Association (AAA), and Şereflikoçhisar Plain Irrigation Association (SPA) were examined in this study to determine whether water user associations are responsible for operating irrigation facilities established by the State Hydraulic Works. The Akıncı Plain Irrigation Association began operations in 1998 following the transfer of the Kazan–Mürted Plain Irrigation System, commissioned in 1973. The association is responsible for the operation and maintenance of irrigation activities in the Mürted Plain. The Ayaş Asartepe Irrigation Association operates the Asartepe Gravity Irrigation Facility, the Ayaş Başayaş and Çanıllı ponds, and the Kızılcahamam Doğanözü irrigation facilities. The Şereflikoçhisar Plain Irrigation Association is responsible for the management of the Kesikköprü Dam Irrigation Facility and the Peçenek Dam Irrigation Facility. The irrigation areas served by the irrigation associations examined in this study are 3692, 2740, and 8010 hectares, respectively. Irrigation systems primarily consist of open canal structures, and irrigation practices are crucial to the sustainability of agricultural production in the region.

The study utilizes secondary data obtained from three irrigation associations: Akıncı Plain Irrigation Association, Ayaş Asartepe Irrigation Association, and Şereflikoçhisar Plain Irrigation Association. The International Program for Technology and Research in Irrigation and Drainage (IPTRID) proposed performance evaluation criteria to assess how well the associations performed.

Performance evaluation is essential for assessing the operational efficiency and effectiveness of irrigation associations. Cross-tables were used to present the performance evaluation, which contrasted the unions based on Vermillion's (2000) lower and upper boundaries of performance criteria (Table 2) and examined them in relation to similar regions. Table 1 shows the criteria for evaluating performance, and Table 2 shows the lower and upper bounds associated with them.

Table 1. Performance criteria used (Malano & Burton, 2001)

Indicators	Performance Criteria	Formula
Water distribution performance	Annual water supply rate	= Total amount of water entering the irrigation system (m^3) / Total irrigation water requirement (m^3)
	Irrigation rate	= Irrigated area (ha) / Irrigation area (ha)
Financial Performance	Return on investment rate	= Total water fee collected from users ($) / Total operation maintenance management costs ($)
	Total operation, maintenance management cost per unit area	= Total operation maintenance management costs ($) / Irrigation area (ha)
	Total cost per person employed in water distribution	= Total cost of operation maintenance personnel ($) / Number of staff in operation maintenance (person)
	Water fee collection performance	= Total water fee collected from users ($) / Total water fee to be collected ($)
	Number of employed personnel per unit area	= Number of operation maintenance personnel (person) / Irrigation area (ha)
Production performance	Income obtained per unit of irrigation area	= Total production value ($) / Irrigation area (ha)
	Income obtained per unit of irrigation water taken into the network	= Total production value ($) / Total amount of water taken into the network (m^3)

The irrigation rate indicates the extent to which farmers in the designated irrigation area carry out irrigation practices using only the network. It is the ratio of actual irrigation to total potential. An elevated irrigation rate indicates effective water delivery and system functionality. The performance of water fee collection is measured by the ratio of collected water fees to the total accruing fees. A high value signifies effective financial management. The expense coverage ratio indicates the extent to which collected fees offset operational and maintenance expenses. It is a vital metric for sustainability. The personnel target should be set at three individuals per 1000 hectares. Surplus manpower signifies diminished efficiency or resource wastage (Table 2). The assessment of irrigation associations is accepted as crucial for evaluating their efficacy and managing associated issues

3. Results and Discussion

The performance of irrigation associations in 2024 is shown in Table 3. The Şereflikoçhisar Ovası Irrigation Association has the largest irrigation area (8010 ha) and the largest irrigated area (4348 ha), although the irrigation and irrigated areas of other associations are also related. The total volume of irrigation water ranged from 15160 to 47372 thousand m^3, with the minimum value recorded in the Akıncı Ovası Irrigation Association. The irrigation water distribution ranged from 2728 to 5284 m^3 ha^{-1} for the unit area and from 5065 to 11939 m^3 ha^{-1} for the irrigated area. Ayyıldız and Baran (2024) conducted a study assessing the performance metrics of irrigation associations in Yozgat province, revealing that the irrigation water allocated per area varied from 676 to 3091 m^3 ha^{-1}, while the irrigation water allocated per irrigated area ranged from 2650 to 8673 m^3 ha^{-1}. Torun and Çakmak (2024) discovered that the volume of irrigation water allocated within the irrigation associations of the Konya Closed Basin ranged from 529 to 8688 m^3 ha^{-1} per area and from 787 to 33909 m^3 ha^{-1} per irrigated area.

Table 2. Indicators used in classifying performance criteria (Vermillion, 2000)

Indicators	Poor	Acceptable	Satisfactory	Good
Irrigation rate	<30	30-40	40-50	>50
Performance of water fee collection	<40	40-60	60-75	>75
Expense coverage ratio	<40	40-60	60-75	>75
Number of personnel per unit area (person/1000ha)	>3	-	<3	-

The irrigation ratio stands as one of the fundamental performance indicators. The irrigation ratio is determined by dividing the irrigated area by the total area under irrigation. The irrigation ratios of irrigation associations diminish when areas are unable to be watered due to factors such as inadequate funding for irrigation infrastructure, elevated input costs, diminished product prices, and excessive groundwater levels. The maximum irrigation ratio, determined at 54%, was attained by the Ayaş Asartepe Irrigation Association and the Şereflikoçhisar Ovası Irrigation Association. The percentage in the Akıncı Ovası Irrigation Association was 44%. Abdisamad (2021) found that the irrigation performance of the Karataş Irrigation Association fluctuated between 20% and 72% from 2015 to 2019. Karacalar and Irık (2023) indicated that the irrigation percentage of the Paşaköy Irrigation Association fluctuated between 34% and 61% from 2017 to 2021.

Table 3. Irrigation performances of irrigation associations (2024)

	APA	AAA	SPA
Irrigation area (ha)	3692	2740	8010
Irrigated area (ha)	1634	1476	4348
Total irrigation water requirement (thousand m^3)	15160	17768	47372
Total amount of water taken into the network (thousand m^3)	19509	7476	41227
Irrigation rate (%)	0.44	0.54	0.54
Total irrigation water requirement per unit (m^3 ha^{-1})	5284.13	2728.47	5146.94
Amount of irrigation water distributed per unit irrigated area (m^3 ha^{-1})	11939.41	5065.04	9481.83
Annual water supply rate	1.29	4.20	0.87

APA: Akıncı Plain Irrigation Association Ayaş, AAA: Asartepe Irrigation Association, SPA: Şereflikoçhisar Plain Irrigation Association.

The provision of requisite water by the associations serves as a metric for efficient water distribution. The primary metric for water-use efficiency in agriculture is the water supply ratio. The water supply ratio (Table 3), which approaches 1, indicates that sufficient water is available to meet the requirements of the irrigation systems. On the other hand, the water supply ratio in Ayaş is 4.20, indicating that more water than required

is supplied to the irrigation system and pointing to low water-use efficiency. This value, which considerably exceeds the optimal level, may indicate multiple structural and operational issues in irrigation management. Excessive losses in open canal irrigation systems, inadequate irrigation planning, uncontrolled water consumption by farmers, or underestimating irrigation water requirements may all lead to a significantly elevated value. Similar studies indicate that the water supply ratio ranges between 0.5 and 1.5 (Eliçabuk et al., 2016; Kırmıkıl, 2025; Tanışıklı & Çakmak, 2023).

Table 4. Financial information on irrigation associations (2024)

	APA	AAA	SPA
Total income ($)	5416639.03	6258851.73	16768466.87
Total water fee collected from users ($)	75918.60	134678.81	148089.54
Total water fee to be collected ($)	120825.96	137178.66	368102.22
Total operation maintenance management costs ($)	75250.91	110932.89	166222.98
Total cost of operation maintenance personnel ($)	28190.52	77854.74	88301.00
Number of staff in operation maintenance (units)	5	6	5
Facility maintenance and repair costs ($)	24829.60	5979.33	27481.67

APA: Akıncı Plain Irrigation Association Ayaş, AAA: Asartepe Irrigation Association, SPA: Şereflikoçhisar Plain Irrigation Association.

The data in Table 4 were employed to assess the financial performance of the irrigation associations. The viability of irrigation associations depends on the economic benefits of their services. The scope of the study, only the Ayaş Asartepe Irrigation Association recovered the economic cost of its services, achieving a rate of 98%. In the remaining associations, the water charge collection ratio persisted below the generally regarded optimum of 75% (Table 5). The inadequate collection of water fees is attributable to diminished farmers' incomes and substandard payment practices among farmers. Tekiner et al. (2021) claimed that over an 8-year period, the Truva Irrigation Association increased the water charge collection ratio, which correlated with growth in farmer income, resulting in an average collection rate of 87%. Ayyıldız and Baran (2024) conducted a study on irrigation associations in Yozgat, reporting minimum and maximum values of 49% and 92%, respectively, for the Yenimahalle and Musabeyli Irrigation Associations. As the water fee collection ratio increases, network maintenance and repair can be carried out promptly. The cost recovery ratio is calculated by dividing irrigation revenue by the costs of operation, maintenance, and repair. The proportion of operation and maintenance management expenditures paid was 4.44% for the Ayaş Asartepe Irrigation Association, 18.56% for Şereflikoçhisar, and 32.70% for Akıncı. İmalı (2024) indicated that this number fluctuated between 17% and 29% within the Kılavuzlu Irrigation Association. The operational, maintenance, and repair costs per unit area ranged from $ 20.38 to $ 40.49 ha^{-1} across the examined irrigation associations. Harman and Çakmak (2023) calculated the operational, maintenance, and management costs per unit area for the Sakaryabaşı Irrigation Association from 2018 to 2022 to range between 51.35 and 73.07 $ ha^{-1}.

The cost per employee is determined by dividing total personnel expenditures, including administrative staff, by the total number of employees. The evaluated irrigation associations employ five or six permanent staff members. Within the irrigation associations, Şereflikoçhisar (SPA) had the highest cost per staff member at $ 17,660, whereas Akıncı (APA) had the lowest at $ 5,638. Moreover, the personnel density per unit area (1000 ha) is an essential metric for assessing success. None of the irrigation associations meets the optimal staffing standard of around 3 personnel. The personnel level of the Ayaş Asartepe Irrigation Association is closest to this value yet falls short of expectations. This suggests that the workers inside the associations are not underused; however, their deployment is suboptimal. Harman and Çakmak (2023) reported that the cost per individual working in water distribution within the Sakaryabaşı Irrigation Association ranges from $ 9,632 to $ 13,589. Ayyıldız and Baran (2024) estimated the cost per employee in water distribution to be between $ 6,946 and $ 9,970, with worker density per unit area ranging from 0.19 to 0.96.

The income per area (ha) of irrigation water supplied to the network peaked at $0.018, with the lowest values recorded in Şereflikoçhisar and Akıncı at $0.004. The research by Harman and Çakmak (2023) indicated that the revenue per unit of irrigation water provided to the network ranged from $0.277 to $0.405. The revenue per unit of irrigated land ranged from $34.06 to $91.25. A cost recovery ratio of 75% is typically seen as advantageous. In this study, these values are evaluated as acceptable (Table 5). Tekiner et al. (2021) reported a ratio of 74% for the Truva Irrigation Association in the year 2017.

Table 5. Financial performances irrigation associations (2024)

	APA	AAA	SPA
Water fee collection performance	0.63	0.98	0.40
The ratio of operation, maintenance, and management expenses to income (%)	32.70	4.44	18.56
Total operation maintenance management cost per unit area ($ ha^{-1})	20.38	40.49	20.75
Total cost per person employed in water distribution ($ $person^{-1}$)	5638.10	12975.79	17660.20
Number of personnel per unit area (person 1000 ha^{-1})	1.35	2.19	0.62
Average income per unit of irrigation water taken into the network ($ m^{3-1})	0.004	0.018	0.004
Income obtained per unit of irrigation area ($ ha^{-1})	46.46	91.25	34.06
Expense coverage ratio	0.59	0.69	0.53

APA: Akıncı Plain Irrigation Association Ayaş, AAA: Asartepe Irrigation Association, SPA: Şereflikoçhisar Plain Irrigation Association.

4. Conclusion

The results of this study highlight the need for institutional and operational improvements to enhance the sustainability and effectiveness of irrigation activities in irrigation associations in Ankara province. This finding indicates that water fee collection rates are consistently low, particularly in certain irrigation associations. This situation may be explained by several economic and institutional factors, such as limited farmer incomes, rising agricultural production costs, and ineffective fee collection mechanisms. Low collection rates may result in insufficient financial resources for the operation and maintenance of irrigation systems, adversely affecting the sustainability of irrigation infrastructure.

To increase the sustainability and effectiveness of irrigation activities carried out within the boundaries of Şereflikoçhisar Irrigation Association, the collection system needs to be restructured first. Enhancing the current digital water management infrastructure and upgrading or modernizing irrigation systems are crucial in this context. Strategies must be formulated to minimize operational expenses to sustain the significant agricultural output capacity in the Ayaş Asartepe irrigation zone. The high water supply ratio, particularly in the Ayaş Irrigation Association, highlights the need for improved irrigation planning and more efficient water distribution. The high values suggest that the irrigation system supplies water in excess of crop requirements, resulting in low water use efficiency. Transmission and distribution losses in open canal irrigation systems, inadequate irrigation planning, and uncontrolled water consumption by farmers are the main factors contributing to this situation. Furthermore, the inability to accurately estimate irrigation water requirements may result in higher water supply costs. Consequently, priority should be given to optimization efforts to improve water-use efficiency and reduce energy consumption. In the Akıncı Irrigation Association, the efficiency of water supply procedures must be enhanced to elevate the current middle performance. The efficient administration of current resources and systematic maintenance techniques are essential in this process.

Enhancing irrigation management at the institutional level necessitates a more cohesive governance framework. To enhance efficiency in irrigation management, irrigation associations, cooperatives, and public systems should be consolidated under a unified legislative framework. Establishing a comprehensive legal framework to facilitate this merger will avert sector fragmentation and promote more efficient resource utilization. Moreover, institutional frameworks must be created for the oversight and assessment of the formation and operational

operations of irrigation associations; standardized tariffs that establish threshold values for water usage service fees, accounting for regional disparities, should be instituted.

Efficient operation and regular maintenance of irrigation facilities are essential for the sustainability of the infrastructure. Operational programs must be developed to ensure that completed single or multi-purpose dams and irrigation projects deliver uninterrupted services over their economic lifespan. Regular maintenance and repairs of the facilities must be conducted; irreparably damaged infrastructure should be replaced. The operational and management responsibilities for these facilities should be delegated to irrigation associations, irrigation cooperatives, municipalities, and other village legal bodies in compliance with applicable laws. Implementing monitoring and evaluation methods in post-transfer activities is crucial for guaranteeing sustainability.

The digital change in water management must be expedited. The promotion of irrigation associations' transition to digital monitoring and automation systems should be advocated, and the incorporation of current water data into the National Water Information System must be guaranteed. Furthermore, enhancing digital water management infrastructures at the regional level will facilitate decision-making processes by improving water traceability.

Enhancing the institutional capacities of irrigation associations is essential for enduring success and sustainability. In this context, in-service training programs aimed at strengthening people's technical competence should be undertaken, and continuing education activities should be established for farmers. Furthermore, formulating investment and rehabilitation strategies at the district level will enhance the efficiency of resource utilization.

To boost water-use efficiency in agriculture, the scope of government support and incentive mechanisms for modern irrigation technologies, notably drip irrigation systems, should be expanded. Creating these supports tailored to local requirements will enhance the likelihood of successful adoption.

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Authorship contribution statement

In this study, the authors contributed equally to the development of the research idea, data analysis, writing, and proofreading.

Conflict of interest

The authors declare no conflicts of interest.

Ethical Statement

There is no need to obtain ethics committee approval for this study.

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