Türk Tarım ve Doğa Bilimleri Dergisi 11(3): 704–712, 2024

https://doi.org/10.30910/turkjans.1468531

TÜRK
TARIM ve DOĞA BİLİMLERİ
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JOURNAL of AGRICULTURAL
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Araştırma Makalesi

Performance Analysis For Yamula Downstream Gravity And Pump Irrigation Association

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Geliş Tarihi: 16.04.2024 Düzeltme Geliş Tarihi: 24.05.2024 Kabul Tarihi: 03.06.2024

ABSTRACT

This study was conducted for performance assessment of the Yamula Downstream Gravity and Pump Irrigation Association, operating in the province of Kayseri, covering 2018-2022. The association's performance was evaluated using some performance indicators recommended by the International Program for Technology and Research in Irrigation and Drainage (IPTRID). Performance evaluation included indicators such as the amount of irrigation water distributed per unit irrigated area, irrigation ratio, sustainable irrigation area ratio, irrigation network density, water supply ratio, irrigation fee collection ratio, and irrigation network personnel density. The amount of irrigation water distributed per unit irrigated area ranged from 3957.7 m^3/ha to 5746.6 m^3/ha, irrigation ratios ranged from 58.5% to 95.6%, sustainable irrigation area ratios ranged from 1.05 to 1.71, irrigation network densities ranged from 20.0 to 32.6 ha/km, water supply ratios ranged from 0.64 to 1.02, and irrigation fee collection ratios ranged from 80% to 84%. The irrigation network personnel density was determined to be 10.3 km/personnel, as there was no change in the number of employees. With the increasing demand for water due to recent droughts, efficient use of every drop of water is inevitable, particularly in the agricultural sector, which is the largest water user. Therefore, performance analysis in irrigation associations, which are the planners and distributors of water, plays a key role in sustainability.

Anahtar kelimeler: Irrigation assosiation, water supply ratio, irrigation ratio, performance analysis.

Yamula Mansap Cazibe ve Pompaj Sulama Birliği Sulama Birliği Performans Analizi

ÖZ

Bu çalışma Kayseri ilinde faaliyetlerini yürüten Yamula Mansap Cazibe ve Pompaj Sulama Birliği'nde 2018-2022 yıllarını kapsayan dönemde yürütülmüştür. Uluslararası Sulama ve Drenaj Teknoloji ve Araştırma Programı (IPTRID) tarafından önerilen bazı performans göstergeleri kullanılarak birlik performansı değerlendirilmiştir. Performans değerlendirmesinde birim sulanan alana dağıtılan sulama suyu miktarı, sulama oranı, sürdürülebilir sulama alanı oranı, sulama şebeke yoğunluğu, su temin oranı, sulama ücreti toplama oranı ve sulama şebekesi personel yoğunluğu göstergeleri kullanılmıştır. Performans değerlendirmesi sonuçlarına göre birim sulanan alana dağıtılan sulama suyu miktarı 3957.7 m^3/ha ile 5746.6 m^3/ha arasında, sulama oranları %58.5 ile %95.6 arasında, sürdürülebilir sulama alanı oranının 1.05-1.71 arasında, sulama şebeke yoğunluğu 20.0-32.6 ha/km, su temin oranı 0.64-1.02 arasında, sulama ücreti toplama oranı %80 ile %84 arasında değişim gösterdiği bulunmuştur. Sulama şebekesi personel yoğunluğu ise çalışan sayısında bir değişim olmadığı için 10.3 km/personel olarak tespit edilmiştir. Son yıllarda yaşanan kuraklık ile birlikte suya olan talebin fazlaca arttığı günümüzde suyun en çok kullanıcısı olan tarım sektöründe her bir damla suyun etkili bir şekilde kullanımı kaçınılmaz bir zorunluluktur. Bu açıdan suyun planlayıcısı ve dağıtıcısı olan sulama birliklerinde performans analizinin yapılması sürdürülebilirlik için önemli rol oynamaktadır.

Key words: Sulama birliği, su temin oranı, sulama oranı, performans analizi.

INTRODUCTION

Water, as a natural resource, has played critical roles not only in human life and the development of societies. In today's world, water availability, in desired quantities and at desired times concerns every part of society. When history was examined, it become evident that civilizations flourished in areas where water was abundant (Kara, 2005).

With the global increase in population, the need for food is also growing day by day. Besides, both domestic and agricultural water demands are increasing. The water demand is also rising in ever-growing industrial sector. This leads to competition among the water-user sectors. Effective and environment-friendly utilization of the limited water resources is crucial across all sectors. Globally, among these sectors, agriculture stands out as the largest consumer of water (Çakmak et al., 2008).

In irrigated crop production in arid and semi-arid regions, the increase in desired income levels is related to the efficient use of irrigation water. Effectively managed irrigation water leads to both increased productivity and income. Additionally, by controlling environmental factors, the necessary conditions for sustainable agriculture are provided. Well-managed irrigation water also contributes significantly to the socio-cultural development of producers (Karaca, 2017). Due to these reasons, the importance of irrigation is increasing day by day, both in Turkiye and globally. The rapid expansion of irrigated areas in Turkiye and worldwide further explains this trend (Yıldız, 2010).

Regarding food production in Turkiye, two-thirds of it is made from irrigated agricultural areas. Therefore, it is essential to use the available water efficiently. For sustainable agriculture and rural development, it becomes crucial to take conservation measures in the conveyance, distribution, and operation for delivering water from its source to agricultural lands (Muslu, 2015).

Irrigation is defined as the controlled provision of water to the land to meet the plant's water needs that cannot be met by natural rainfall, storing it evenly in the plant's root zone (Kara, 2005). In arid and semi-arid climate regions, irrigation is one of the most crucial parameters for crop production. In areas where the average annual rainfall is sufficient, irregular rainfall during the growing season poses significant risks in rainfed agriculture areas (Çakmak, 1999).

Water management can be defined as the planned development, distribution, and utilization of water resources. The primary goal of management in irrigation networks is to ensure the efficient distribution and utilization of water resources, maximizing benefits and increasing farmers' income levels (Aküzüm and Çakmak, 2008).

In irrigation investments, operational issues play a significant role in the failure to achieve the desired/planned efficiency rather than the construction of irrigation networks. Therefore, developed countries allocate significant funds to establish new irrigation areas or enhance existing irrigation networks' performance (Kıymaz, 2006).

The performance of irrigation systems can be defined as the ratio of the achieved value of selected performance parameters to the targeted values in planning. Setting goals in irrigation networks is essential for both the efficient use of water resources and the effective utilization of financial resources. Determining the current usage level of existing water and soil resources is necessary for their efficient utilization, for identifying and solving problems. Therefore, monitoring and evaluations in irrigation networks are important (Bulut and Çakmak, 2001).

Benchmarking assessments of irrigation networks can determine the current level of success in different countries worldwide. These results can highlight opportunities for improving performance in irrigation networks. The identification of success criteria in these performance studies is directly proportional to the selection of common comparable methods and indicators (Beyribey, 1997).

In this study, a performance evaluation covering the years 2018-2022 was conducted at the Yamula Downstream Gravity and Pump Irrigation Association operating in the Kayseri province of Turkey. Assessments were conducted using some performance criteria recommended by the International Program for Technology and Research in Irrigation and Drainage (IPTRID).

MATERIAL and METHODS

In this study, the material used was the Yamula Downstream Gravity and Pump Irrigation Association operating in the Kayseri province.

Kayseri province is located in the central part of the Central Anatolia Region, in the Middle Kızılırmak section where the southern part of the region and the Taurus Mountains approach each other. Kayseri province, with an altitude of 1094 m, extends between 34°05' to 36°59' east longitudes and 37°45' to 38°18'

north latitudes. Yozgat surrounds the province in the north, Adana and Kahramanmaraş in the south, Sivas in the east and northeast, Nevşehir in the west, and Niğde in the southwest.

Kayseri province has a terrestrial climate with cold and snowy winters and hot and dry summers. According to long-term data from 1927 to 2022, the annual average temperature is 10.7 °C, the annual average maximum temperature is 18.1 °C, the annual average minimum temperature is 3 °C, the annual average sunshine duration is 7 hours, the annual average number of rainy days is 107.4 days, and the annual total precipitation is 391.1 mm.

The Yamula Downstream Gravity and Pump Irrigation Association operates in the Mahzemin neighborhood of the Kocasinan district in Kayseri province. The authority of this association includes 10 settlements: Mahzemin, Ebiç, Yemliha, Kalkancık, Karakimse, Dadağı, Beydeğirmeni, Boğazköprü, Molu, and Süksün neighborhoods. The water resource for the association is the Yamula Dam (Figure 1).

Figure 1. Yamula Dam

Yamula Downstream Gravity and Pump Irrigation Association has a total irrigation area of 7748 hectares, consisting of 4103 hectares under pump irrigation and 3645 hectares under gravity irrigation. With the addition of main, secondary, and tertiary canal lengths, and pipe length, the total length reaches 227 kilometers. As of October 16, 2024, the association's operation, maintance, and activities have been transferred to the Yamula Downstream Gravity and Pump Irrigation Association by the State Hydraulic Works (DSİ) with the approval of the relevant Ministry.

The cropping pattern for 2018-2022 within the Yamula Downstream Gravity and Pump Irrigation Association area is provided in Table 1.

Table 1. Cropping pattern in Irrigated Areas (%)

Years	Sunflower	Sugar Beet	Grain	Others
2018	42	28	14	16
2019	32.2	22.8	19.8	25.2
2020	45.2	17.6	16.9	20.3
2021	37.5	16.3	21.2	25
2022	28.5	14.7	28.5	28.3

It is observed that the most commonly cultivated crop in the operational area of the Association is the sunflower. Following sunflower, the most cultivated crops are wheat and sugar beet.

Performance assessments were conducted for the 2018-2022 period using some performance indicators approved by the International Program for Technology and Research in Irrigation and Drainage (IPTRID) (Malano and Burton, 2001). Performance indicators such as annual irrigation water distributed per unit irrigated area, irrigation ratio, sustainable irrigation area ratio, irrigation network density, water supply ratio, irrigation fee collection ratio, and irrigation network personnel density parameters have been considered.

All the information to be used in the Irrigation Association performance assessments were obtained from the Association.

Indicators Used for Irrigation System Performance Assessments

Details regarding the parameters used as performance indicators in the study are provided below.

Annual Irrigation Water Distributed per Unit Irrigated Area (m³/ha)

$$\text{AIWDUIA} = \frac{\text{Total Water Intake into the Network}}{\text{Irrigated Area}}$$

Irrigation Ratio

The ratio of the area actually irrigated within the irrigated area to the area available for irrigation is expressed by Equation 2 (Beyribey, 1997).

$$IR = \left(\frac{ASA}{AIA}\right) \times 100 \quad (2)$$

where, IR: Irrigation Ratio (%); ASA: Area Actually Irrigated (ha); AIA: Area Available for Irrigation (ha).

Sustainable Irrigation Area Ratio

Drainage, salinity issues, and land loss due to non-agricultural use indicate dimensional changes in the irrigation area (Koç, 1997). The ratio of the current irrigation area to the initial irrigation area is defined as Equation 3.

$$SIAR = \left(\frac{ISA}{IAA}\right) \quad (3)$$

where, SASO: Sustainable irrigation area ratio; ISA: Initial irrigation area (ha); IAA: Current irrigation area (ha).

Irrigation Network Density

The ratio of the total length of transmission and distribution channels existing in the irrigation network to the total area of the irrigation area is defined as Equation 4 (Koç, 1997).

$$IND = \left(\frac{IA}{TCTL}\right) \quad (4)$$

Where, IND: Irrigation network density, (ha/km); IA: Irrigation area, (ha); TCTL: Total length of transmission and distribution channels, (km).

Water Supply Ratio

The water supply ratio (WSR) is calculated with Equation 5, as specified below (Beyribey, 1997).

$$WSR = \frac{DWI}{TTWI} \quad (5)$$

Where, DWI: Water diverted to the network, (m³/ha/year); TTWI: Total irrigation water requirement, (m³/ha/year).

WSR = 1: No development or decrease
WSR < 1: No increase in the irrigated area
WSR > 1: Increase in the irrigated area

Irrigation Fee Collection Ratio

The irrigation fee collection ratio, expressed in Equation 6, represents the percentage of irrigation fees accrued in irrigation networks that are collected (Beyribey, 1997).

$$IFCR = \frac{CCFI}{ACFI} \times 100 \quad (6)$$

where, IFCR: Irrigation Fee Collection Ratio, (%); CCFI: Collected Irrigation Fee, (TL); ACFI: Accrued Irrigation Fee, (TL).

Irrigation Network Personnel Density

The ratio of the total length of transmission and distribution channels existing in the irrigation network to the total number of personnel working in operation, maintenance, and management (OMM) services is provided in Equation 7 (Koç, 1997).

$$IND = \frac{TCTL}{TPW} \quad (7)$$

where, IND: Irrigation network personnel density (km/personnel); TCTL: Total length of transmission and distribution channels, (km); TPW: Total personnel working in operation, maintenance, and management.

RESULTS and DISCUSSION

The performance indicators for the Yamula Downstream Gravity and Pump Irrigation Association for 2018-2022 are presented in Table 2.

Table 2. Performance Indicators for the Yamula Downstream Gravity and Pump Irrigation Association

Performance Indicators	2018	2019	2020	2021	2022
Annual Irrigation Water Distributed per Unit Irrigated Area (m³/ha)	5746.6	3957.7	4553.7	4635.7	4741.3
Irrigation Ratio (%)	58.5	88.5	95.6	88.4	90.0
Sustainable Irrigated Area Ratio	1.71	1.13	1.05	1.13	1.11
Irrigation Network Density (ha/km)	20.0	30.2	32.6	30.2	30.7
Water Supply Ratio	0.93	0.64	1.02	0.94	0.98
Irrigation Fee Collection Ratio (%)	84	82	80	80	83
Irrigation Network Personnel Density (km/personnel)	10.3	10.3	10.3	10.3	10.3

Annual Irrigation Water Distributed per Unit Irrigated Area (m³/ha)

In the research area, in 2018, 26,061,000 m³ of water was taken into the network for an irrigated area of 4,235 ha, and the annual irrigation water distributed per unit irrigated area was calculated as 5,746.6 m³/ha. In 2019, for an irrigated area of 6,857 ha, 27,138,000 m³ of water was taken into the network, and the annual irrigation water distributed per unit irrigated area was 3,957.7 m³/ha. In 2020, for an irrigated area of 7,405 ha, 33,720,000 m³ of water was taken into the network, and the annual irrigation water distributed per unit irrigated area was 4,553.7 m³/ha. In 2021, for an irrigated area of 6,848 ha, 31,745,000 m³ of water was taken into the network, and the annual irrigation water distributed per unit irrigated area was 4,635.7 m³/ha. In 2022, for an irrigated area of 6,974 ha, 33,066,000 m³ of water was taken into the network, and the annual irrigation water distributed per unit irrigated area was calculated as 4,741.3 m³/ha. The average amount of water taken into the network over 2018-2022 was calculated as 30,346,000 m³, while the average annual irrigation water distributed per unit irrigated area was calculated as 4,727 m³/ha. In 2018, the area not irrigated was 3,213 ha, while in other years, it ranged from 343 to 900 ha. It can be said that planning has improved, especially after 2018. Baş (2019) reported in his study conducted at the Ayrancı Irrigation Association operating in Karaman that the annual irrigation water distributed per unit irrigated area ranged from 3,153.56 m³/ha to 5,266.41 m³/ha. In the study conducted at the Develi Irrigation Association, it was determined that the amount of irrigation water given per unit irrigated area was the lowest in 2015 with 6,444 m³/ha and the highest in 2017 with 9,666 m³/ha (Turhan, 2019). Kayadelen (2021) reported in his study that the annual irrigation water distributed per unit irrigated area ranged from 10,012 m³/ha to 70,613 m³/ha.

Irrigation Ratio

Irrigation ratios of the Yamula Downstream Gravity and Pump Irrigation Association varied between 58.5% and 95.6% (Table 2). The lowest irrigation ratio was 58.5% in 2018, while the highest was 95.6% in 2020. In 2019, the irrigation ratio was 88.5%, in 2021 it was 88.4%, and in 2022 it was 90%. The average irrigation ratio for the years 2018-2022 was calculated as 84.2%. It was observed that the irrigation ratio increased after 2018 in this association. Yavuz (2019) reported in his study conducted in Kayseri that irrigation ratios ranged from 35% to 99% between 2016 and 2018. The reasons for the low irrigation ratio were stated as inadequacies in water resources, lack of maintenance and repairs in channels, and socio-economic reasons. In another study conducted at the Karataş Irrigation Association, which operates in Burdur province, an evaluation of irrigation performance was conducted for the period covering 2015 to 2019, and it was reported that the irrigation ratios ranged from 20% to 72% (Abdisamad, 2021). Kayadelen (2021) reported in his study covering the years 2012-2018 in the Mut Irrigation Association that irrigation ratios ranged from 24% to 51%.

While it is desired to irrigate all areas where irrigation is practiced, achieving a 60% irrigation ratio is considered a success in management (Akçay, 2016). According to the 2022 report of the State Hydraulic Works (DSİ), Turkiye's avarage irrigation ratio was 67%. From this perspective, it is seen that the irrigation ratios for the Yamula Downstream Gravity and Pumping Irrigation Association were higher than the Turkish average.

Significant increases in irrigation ratios have been observed in the Yamula Downstream Gravity and Pumping Irrigation Association after 2018. The appointment of an association president by the State Hydraulic Works (DSİ) at the end of May 2018 significantly impacted this increase. With the appointment in late May 2018, significant increases were recorded with implementing more planned water distribution and operation.

Sustainable Irrigated Area Ratio

Koç (1997) pointed out that the sustainable irrigated area ratio is a significant parameter representing dimensional changes in irrigated areas, particularly expressing the loss of irrigated area due to drainage, salinity, and non-agricultural use. Following the examination, the sustainable irrigated area ratio in the Yamula Downstream Gravity and Pump Irrigation Association was calculated as 1.74 in 2018, 1.13 in 2019, 1.05 in 2020, 1.13 in 2021, and 1.11 in 2022. The five-year sustainable irrigated area ratio for the years 2018-2022 was found to be 1.23 (Table 2). In a study conducted in 13 irrigation associations in Kayseri province between 2010-2015, it was reported that the sustainable irrigated area ratio was the lowest at 0.16 in the Develi Plain Irrigation Association and the highest at 1.05 in the Sarımsaklı Pumping Irrigation Association. The average sustainable irrigated area ratio for the 13 irrigation associations was 0.55 (Karaca, 2017). Koç (2012) reported a sustainable irrigated area ratio of 1.68 in the Daphan Irrigation Association. Karacalar (2023) reported in their study that the sustainable irrigated area ratio ranged from 1.64 to 2.94.

Irrigation Network Density

In the Yamula Downstream Gravity and Pump Irrigation Association, the irrigation network density was calculated as 20.0 ha/km in 2018, 30.2 ha/km in 2019, 32.6 ha/km in 2020, 30.2 ha/km in 2021, and 30.7 ha/km in 2022 (Table 2). The Yamula Downstream Gravity and Pumping Irrigation Association serves a 4,103-ha area with pumping irrigation and a 3,645-ha area with gravity irrigation. Karacalar (2023) reported in their study that irrigation network density ranged from 17.74 ha/km to 31.85 ha/km. In this association, the length of the channels was reported as 78 km, and all of them were reported to be open channels. A performance analysis study covering 2010 to 2015 was conducted in the Sarımsaklı Pumping Irrigation Association, which operates in Kayseri. According to the study, the irrigation network density was the lowest at 37.93 ha/km in 2012 and the highest at 40.69 ha/km in 2014. It was reported that in the examined Sarımsaklı Pumping Irrigation Association, wells were constructed to irrigate their irrigation areas along with open channels. In this association, it was reported that there were 87 km of concrete-lined open channels and 89 irrigation wells (Kırnak et al., 2021).

Water Supply Ratio

Year-based water supply ratios are provided in Table 2. The water supply ratios for the Yamula Downstream Gravity and Pump Irrigation Association were calculated as 0.93 in 2018, 0.64 in 2019, 1.02 in 2020, 0.94 in 2021, and 0.98 in 2022. When looking at the five-year average, the water supply ratio for the Yamula Downstream Gravity and Pump Irrigation Association was calculated as 0.90. The water supply ratio holds significant importance in performance analyses conducted in irrigation associations. It indicates the extent to which the water diverted to the network can meet the required amount of water for irrigation in the irrigation area. When the water supply ratio is equal to 1, it signifies that the required irrigation water amount is fully met by the water diverted to the network. If it is less than 1, it indicates that the diverted water cannot meet the required irrigation water amount, and if it is greater than 1, it indicates that more irrigation water is diverted to the network than needed (Beyribey, 1997).

When examining the water supply ratios for the Yamula Downstream Gravity and Pump Irrigation Association, it is generally observed that they are below 1. Although it is said to be below 1, the average of 0.90 is remarkably close to 1. This indicates that excessive irrigation is not being practiced in this examined association. In a period where the importance of every drop of water is increasing, the significance of these values is greatly amplified.

In a performance analysis study covering the years 2011-2014 in 6 irrigation associations operating in Yozgat province, it was reported that the four-year average water supply ratios were the lowest at 1.49 in the Yahyasaray Irrigation Association and the highest at 4.80 in the Sekili Irrigation Association. The study concluded that generally, more water was diverted to the network than needed in the examined associations (Aslan, 2019). Kalender (2017) reported in their study conducted at the Ilgın Plain Pumping Irrigation Association in Konya province that the water supply ratio was below 1 in 2008, 2010, and 2015, while it was above 1 in 2011, 2012, and 2013. Ersöz and Çamoğlu (2020) reported in their study on 11 irrigation associations in Bursa that the water supply ratios ranged from 0.73 to 2.33.

Irrigation Fee Collection Ratio

The timely collection of irrigation fees is of immense importance for providing the desired level of services in an irrigation association and ensuring its sustainability. The variation in the irrigation fee collection ratio, indicating the extent to which the irrigation fees accrued during the growing season are collected, covering the years 2018-2022, is provided in Table 2. In the Yamula Downstream Gravity and Pump Irrigation Association, the irrigation fee collection ratios were 84% in 2018, 82% in 2019, 80% in 2020, 80% in 2021, and 83% in 2022. The five-year average irrigation fee collection ratio was calculated as 81.8%. In this association covered by the study, irrigation fees are collected based on the pricing of water used per cubic meter. The classification of irrigation fee collection ratios for irrigation associations is shown in Table 3. (Sönmezyıldız and Çakmak, 2013).

Table 3. Classification of Irrigation Fee Collection Ratio

Indicators	Poor	Acceptable	Satisfactory	Good
Irrigation Fee Collection Ratio (%)	<40	40-60	60-75	>75

According to the obtained data, the lowest irrigation fee collection ratio occurred in 2020 and 2021, while the highest was observed in 2018. Both on average and annually, it is evident that the irrigation fee

collection ratio in the Yamula Downstream Gravity and Pump Irrigation Association is quite good. A decrease was mainly observed in 2020 due to the global pandemic (COVID-19) and delays in payments by the sugar beet cooperative.

A study conducted in irrigation association in Nazilli found that the irrigation fee collection ratio increased from an average of 47% before the transfer to 94.8% after the transfer (Şeker, 2015). Polat and Değirmenci (2023) reported in their performance evaluation covering the years 2018-2022 on the Bozozva Yaylak Plain Pump Irrigation Project in Şanlıurfa that the irrigation fee collection ratios ranged from 51% to 74%, with an average irrigation fee collection ratio of 63%. Yürekli (2018) stated in their study conducted in the Ereğli district of Konya province that the irrigation fee collection ratio ranged from 51.69% to 99.99%, with an average of 72.80% for the period between 2012 and 2016, indicating that the association's performance in collecting irrigation fees is in good condition.

Irrigation Network Personnel Density

In the mentioned association, the number of employees remained constant, so there was no change in the irrigation network personnel density over the years. In the Yamula Downstream Gravity and Pump Irrigation Association, the irrigation network personnel density was 10.3 km per personnel. Kıymaz (2006) reported in a study examining irrigation associations in the Gediz Basin that the irrigation network personnel density ranged from a minimum of 8.0 km per personnel in the Sarıkız Irrigation Association to a maximum of 42.6 km per personnel in the Salihli Right Bank Irrigation Association, with a general average of 23.4 km per personnel for the associations surveyed. Ersöz and Çamoğlu (2020) reported in their study conducted in Bursa that the highest irrigation network density was 21.2 km per personnel in the Mustafakemalpaşa Association, while the lowest was 4.4 km per personnel in the İznik Lake Keramet Association. Karaca (2017) reported that the irrigation network personnel density in the Sarıoğlan Irrigation Association was 31.33 km per personnel from 2010 to 2014 and 26.86 km per personnel in 2015.

CONCLUSION

In this study, the performance of the Yamula Downstream Gravity and Pump Irrigation Association operating in Kayseri was evaluated based on parameters such as annual irrigation water distribution per unit area, irrigation ratio, sustainable irrigation area ratio, irrigation network density, water supply ratio, irrigation fee collection ratio, and irrigation network personnel density for the years 2018-2022.

The annual irrigation water distribution per unit area varied between 3957.7 m3/ha and 5746.6 m3/ha, with a 5-year average of 4727 m3/ha. The area not irrigated ranged from 3213 ha in 2018 to 343-900 ha in other years.

The irrigation ratio ranged from 58.5% to 95.6%, with an average of 84.2% over the 5 years. Significant improvements in irrigation ratios were observed after the appointment of the association president by the State Hydraulic Works (DSİ) in May 2018.

The sustainable irrigation area ratios varied between 1.03 and 1.71 during 2018-2022. A ratio greater than 1 indicates an increase in the irrigated area over the years, potentially influenced by DSİ's appointment of engineers as association presidents.

The water supply ratios ranged from 0.64 to 1.02, with a 5-year average of 0.90. Although excess water was supplied to the network in 2020, in other years, less water than needed was supplied. Despite being below the requirement, the most of the water demand was met on average.

The irrigation network density ranged from 20.0 ha/km to 32.6 ha/km, with a 5-year average of 28 ha/km. On average, there was approximately 1 km of irrigation canal for every 28 ha of land.

The irrigation fee collection ratio in the Yamula Downstream Gravity and Pump Irrigation Association ranged from 80% to 84%. The association's fee collection ratio was found to be quite satisfactory.

Çıkar Çatışması Beyanı: Makale yazarları aralarında herhangi bir çıkar çatışması olmadığını beyan ederler.

Araştırmacıların Katkı Oranı Beyan Özeti: Yazarlar makaleye eşit oranda katkı sağlamış olduklarını beyan ederler.

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