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Water Distribution Performance Assessment for Seydişehir Irrigation Association

Fulya FİŞEKÇİOĞLU ÜSTÜN[1*]
State Hydraulic Works 4.Regional Directore, KOS Branch Directorate, Konya
***Corresponding author's email:** fulyafisekcioglu@gmail.com

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Abstract: This study was conducted to evaluate water distribution performance of the Seydişehir Irrigation Association, for the years 2019–2023. Within scope of the performance assessment, various performance indicators, including the amount of water taken into the network, irrigation rate, amount of irrigation water delivered per unit area and amount of irrigation water delivered per unit of irrigated area, were used. The highest amount of water was supplied to the irrigation network in 2019, while the lowest amount was used in 2021. The highest irrigation rate occurred in 2021 as 52.85%, while the lowest rate was in 2019 as 34%. The highest amount of water delivered per hectare was in 2022, while the lowest was in 2019. The amount of irrigation water delivered per unit of irrigated area reached its peak in 2019 as 17,016.83 m³/ha, while the lowest level was recorded in 2021 as 2,637.79 m³/ha. In today's world, where every drop of water has increasing value and plays a critical role, promoting water conservation across all areas of life starting from agriculture, the sector with the highest water use-is vital for the environment, ecosystem and human life. Therefore, evaluating the performance of irrigation associations, which bear this significant responsibility of proper water resource planning in agricultural production, is of utmost importance.

Keywords: Irrigation association, Irrigation performance, Irrigation rate, Irrigation schemes

Seydişehir Sulama Birliğinde Su Dağıtım Performansının Değerlendirilmesi

Öz: Bu çalışma Konya İli, Seydişehir İlçesinde bulunan Seydişehir Sulama Birliği alanındaki sulama şebekesinin 2019-2023 yıllarına ilişkin performansını belirlemek amacıyla yürütülmüştür. Bu kapsamda performans incelemesinde şebekeye alınan su miktarı, sulama oranı, birim alana dağıtılan yıllık sulama suyu miktarı, birim sulanan alana dağıtılan yıllık sulama suyu miktarı incelenmiştir. Sulama şebekesine en fazla su 2019 yılında alınmış olup en az su ise 2021 yılında kullanılmıştır. Yıllar içerisinde en yüksek sulama oranı %52,85 ile 2021 yılında gerçekleşirken bu oranın en düşük olduğu yıl %34 ile 2019 yılına aittir. Hektar başına sağlanan suyun en fazla olduğu yıl 2022 yılı iken en az yıl 2019 yılıdır. Birim sulanan alana dağıtılan yıllık sulama suyu miktarı en yüksek 17016,83 m³/ha ile 2019 yılı iken en düşük 2637,79 m³/ha ile 2021 yılında gerçekleşmiştir. Her bir su damlasının değeri ve kritik rolünün arttığı günümüzde su tasarrufunu suyu en yoğun kullanan tarım sektöründen başlayarak hayatımızın her alanına yaymak çevre, ekosistem ve insan yaşamı açısından son derece önemlidir. Bu yüzden tarımsal üretimde su kaynak kullanımının doğru planlanması bu önemli sorumluluğu üzerine alan sulama birliklerinde performansların değerlendirilmesi büyük önem arz etmektedir.

Anahtar Kelimeler: Sulama birliği, Sulama oranı, Sulama performansı, Sulama şebekeleri,

1. Introduction

Besides economic, social and environmental impacts of ever-increasing population worldwide, climate change-induced droughts and extreme weather events increase the need for natural resources. The unbalanced distribution and scarcity of water in the world adversely affects food production. Access to food and water has become difficult simultaneously with the increasing population. Agricultural production constitutes the building block of nutrition that ensures sustainable life on earth. The first priority of policies aiming sustainable agricultural production is to increase yield per unit area. However, limited arable areas and climate change-induced droughts have revealed the need to improve potential outcomes of irrigation networks.

The surface volume of the world's water resources is 1.36 billion km³. However, only 2.55% (35 million km³) of this amount is available as fresh water. Most of the water on the earth's surface is salt water. Limited nature of these resources and increasing demands exert intense pressures on water management authorities. The primary reason for these pressures is the agricultural sector with the largest share in the inter-sectoral water distribution.

The amount of water available in underground and above-ground resources in Turkiye is 112 billion m^3 and 44 billion m^3 of this amount is used for agricultural, industrial and domestic purposes. Of the amount of water spent annually, 73% is utilized in agricultural sector and this amount is quite high. Annual amount of

water per capita is around 1400 m^3 in Turkiye. With this amount, Turkiye is classified among the countries experiencing water scarcity. Therefore, it is necessary to implement realistic reforms and innovations for sustainable use of land and water resources. Application of modern irrigation technologies in the field is the leading innovation in this issue. It is possible to reduce the amount of water used in the agricultural sector from 73% to 60-65% (Candan & Çiftçi, 2018).

Modern irrigation methods should be used to increase irrigation performance levels for sustainable agricultural production. Despite all the struggles to increase the level of irrigated agriculture development, the desired levels have not been reached. Improvement efforts in irrigation are faced with the organizational problems related to operation, maintenance and management together with the high cost of facility and operation expenditures, limitation of water use for agricultural purposes due to industrial use and domestic uses. Such a case then causes a decrease in the success of irrigation systems. To achieve success, water and water management should be the primary concerns of irrigation facilities.

Sustainable water management aims to protect the existing water availability of any project site in the long term, to store it in a planned manner for future years, to distribute it according to the needs, to use it efficiently and to develop the resources, while at the same time taking an approach in harmony with the whole ecosystem. In this sense, the focus should be on the development of different water resources as well as the consumption of existing resources and long-term strategies should be developed for potential problems.

Although Türkiye is in a position that can be considered relatively sufficient among the world countries in terms of land and water resources, deficient and wrong practices are observed especially in the use of water in agriculture. The most important of these problems is that irrigation rates and irrigation yields remain far below the desired levels or are low. Current data revealed that irrigation rate in agricultural lands in Turkiye was 62% and irrigation efficiency was 42%. Such low values indicate that 58% of the water consumed in agriculture was lost and irrigation management was not effective and sustainable (Kalkınma Bakanlığı, 2013).

International organizations similar to the World Bank, playing active roles in the formation of global water policies, with their strategies supporting privatization policies in water distribution management, have had a visible impact on the spread of irrigation associations. Since the 1980s, the World Bank stated that Turkish governments should take measures to reduce the cost items for investment, facility operation and maintenance in irrigation projects. 'Irrigation Associations', defined as an "innovative" institutional structure in irrigation, and the "Accelerated Irrigation Management Transfer Program", which was put into effect under the leadership of State Hydraulic Works (DSI) in the early 1990s, became the most actual example of the measures taken with this recommendation

The irrigation facilities constructed and opened for irrigation by DSİ within the intensive efforts and high costs spent have been transferred to irrigation associations. However, serious problems have been experienced in the irrigated areas, especially due to the insufficient training level of water users and lack of utilization of modern irrigation techniques. Irrigation practices without considering crop water consumption resulted in soil erosion, salinity and alkalinity. Inability to collect water fees is also resulted in not meeting the operation and maintenance costs of the facilities. Such cases all hampered infrastructure, maintenance and repair works (Değirmenci, 2008).

Analyzing the performance levels of irrigation associations to determine whether the transfer works have achieved their objectives is of great importance in terms of irrigation management. Determination of the problems experienced in irrigation networks contributes to the improvement of irrigation system performance.

The primary objective of this study is to analyze the efficient use of water and soil resources in Konya Plain, which has an important agricultural production capacity. Water and land use efficiency parameters to assess the performance of irrigation association in the plain.

2. Material and Method

2.1. Material

In this study, Seydişehir Irrigations of Seydişehir Irrigation Association (SSB) was used as material. The study area is located in the Konya Closed Basin, on the northern foothills of the Taurus Mountains and in Seydişehir District, which has fertile lands along the Çarşamba Stream. The district, which has large and fertile lands between Lake Beyşehir in the northwest and Lake Suğla in the southeast, is approximately 1120 m above sea level.

The responsibility area of the irrigation association starts from Bektemur neighborhood of Beyşehir District and continues along the Beyşehir-Suğla-Apa (BSA) canal. The irrigations within the irrigation association

consist of Gevrekli Irrigation (4438 ha), Seydişehir Gravity Irrigation (7202 ha) and Suğla Gravity Irrigation (9530 ha).

In Seydişehir district, summers are hot and dry and winters are cold and rainy. Although it has the general climate characteristics of the Central Anatolia Region, it shows a transition between the Mediterranean climate and the terrestrial climate. The hottest months of the year are July and August, while the coldest months are January and February. The average annual temperature is 11.8 ºC. Long-term (1960-2012) average rainfall is 750.3 mm (Sarı & İnan, 2011).

The soils of the study area contain all textures from heavy to very light. Heavy textured soils cover half of the cultivated areas and medium textured soils are found in 10% of the area (Anonymous, 1984).

The main irrigation water source of SSB is Beyşehir Lake. Beyşehir-Suğla-Apa (BSA) Canal starts from Beyşehir Regulator and continues until Apa Dam. Beyşehir, Seydişehir, Yalıhüyük, Ahırlı and Akören districts are irrigated by this canal. This canal, which comes to Apa Dam, which is within the borders of Çumra District, is one of the first canals of Turkiye in terms of length and flow rate (Arıaslan, 2022).

With the Bektumur Regulator on the BSA Canal, water is taken by gravity to 4438 ha area of Gevrekli Irrigation. Seydişehir Regulator and Seydişehir Gravity Irrigations (7202 ha) receive water and Saray Regulator and Suğla Gravity Irrigations (9530 ha) feed the main and tertiary canals.

The values regarding the amount of irrigated area, cropping pattern and the amount of irrigation water taken into the network in the period covering the years 2019-2023 in the field of Seydişehir Irrigation Association were obtained from DSİ IV Region KOS Brach Directorate.

In the irrigation network between 2019-2023, sugar beet is the most cultivated plant type with 33%, followed by corn (16%), vegetables (16%) and cereals (14%) (Table 1 and 2).

Table 1. Cropping pattern of irrigated areas
Çizelge 1. *Sulanan Alanlarda Gerçekleşen Bitki Deseni*

	Gevrekli Irrigation					Seydişehir Gravity Irrigation				
Crops	**2019 Irrigated Area (da)**	**2020 Irrigated Area (da)**	**2021 Irrigated Area (da)**	**2022 Irrigated Area (da)**	**2023 Irrigated Area (da)**	**2019 Irrigated Area (da)**	**2020 Irrigated Area (da)**	**2021 Irrigated Area (da)**	**2022 Irrigated Area (da)**	**2023 Irrigated Area (da)**
Cereal	4	107	3716	2865	32	14	1452	7810	9308	95
Legumes	30	337	178	112	284,5	3006	6956	6621	2960	3355,4
Melon	7	37	80	21	14,5	416	146	322	161	86,4
Sugarbeet	8234	6814	8269	4781,23	8503,6	10434	10781	9584	9486,7	10005,7
Sunflower	1		354	17	309,5			284	1128	1687,5
Corn	739	796	726	839	581,1	2254	853	1121	1858	1513,3
Feed crops	703	725	863	757	978,9	1399	1233	1150	831	615,8
Fruits	116	96	93	55	121,5	92	92	153	162	125,3
Vegetables	3196	3664	7101	4042,9	6961,6	5576	5522	6394	4134,4	3641
Total	13030	12576	21380	13490,13	17787,2	23191	27035	33439	30029,1	21125,4

Table 2. Cropping pattern of irrigated areas
Çizelge 2. *Sulanan Alanlarda Gerçekleşen Bitki Deseni*

Suğla Gravity Irrigation						Seydişehir Irrigation Association				
BitkiDeseni	**2019 Irrigated Area (d A)**	**2020 Irrigated Area (d A)**	**2021 Irrigated Area (d A)**	**2022 Irrigated Area (d A)**	**2023 Irrigated Area (d A)**	**2019 Irrigated Area (d A)**	**2020 Irrigated Area (d A)**	**2021 Irrigated Area (d A)**	**2022 Irrigated Area (d A)**	**2023 Irrigated Area (d A)**
Cereal	388	4500	15535	14565	1441	406	6059	27061	26738	1568
Legumes	884	2534	3841	945	1847,7	3920	9827	10640	4017	5487,6
Melon	5187	4966	3984	3962	4284,3	5610	5149	4386	4144	4385,2
Sugarbeet	15412	14723	11299	10156,8	10588,9	34080	32318	29152	24424,73	29098,2
Sunflower	6	100	452	2251	3454,2	7	100	1090	3396	5451,2
Corn	7970	11799	11639	15561	12149,2	10963	13448	13486	18258	14243,6
Feed crops	2234	3239	3617	2505	2885,6	4336	5197	5630	4093	4480,3
Fruits	313	541	271	243	460,8	521	729	517	460	707,6
Vegetables	3865	7154	6449	1850,4	2405,5	12637	16340	19944	10027,7	13008,1
Total	36259	49556	57087	52039,2	39517,2	72480	89167	111906	95558,43	78429,8

2.2. Method

In this study, the water use efficiency of irrigation activities for the years 2018-2023 was analyzed. Performance indicators used in this study are provided in Table 3. The indicators used in the examination of water use efficiency are; irrigation rate, amount of irrigation water delivered per unit area and the amount of irrigation water delivered per unit of irrigated area.

Table 3. Performance indicators used in this study (Burton et al., 2000, Çakmak et al., 2004)
Çizelge 3. *Çalışmada Kullanılan Performans Göstergeleri (Burton ve ark.,2000, Çakmak ve ark.,2004)*

Performance Indicator	Required Data
Water Use Efficiency	
$\text{IR} = \frac{\text{Irrigated Area (ha)} x100}{\text{Irrigation Area (ha)}}$	Irrigated Area Irrigation Area
$\text{WDUA} = \frac{\text{Total amount of water delivered}}{\text{Irrigation Area}}$	Daily amount of water delivered Irrigation area
$\text{WDIA} = \frac{\text{Amount of water delivered}}{\text{Irrigated Area}}$	Daily amount of water delivered Irrigated area

Note: IR: Irrigation rate; WDUA: Amount of water delivered per unit area (m³/ha); WDIA: Amount of water delivered per unit of irrigated area (m³/ha)

3. Results and Discussion

3.1. Water Use Efficiency Indicators

The irrigation works carried out by Seydişehir Irrigation Association in its area of responsibility in 2018-2023 were evaluated and water use efficiency performance criteria were calculated and given in Tables 4, 5 and 6.

3.2. Amount of Irrigation Water Taken into the Network

The amount of irrigation water taken into the irrigation area of Seydişehir Irrigation Association is 123.321.000 m³ for 7247 ha area in 2019; 109.569.999 m³ for 8915 ha area in 2020; 29.514.240 m³ for 11189 ha area in 2021; 62.366.976 m³ for 9554 ha in 2022 and 55.630.000 m³ for 7841 ha in 2023. In the last 5 years, 44746 ha area has been irrigated and the water taken to the total irrigation area is 281.789.215 m³. At the same time, while the most water was used in 2019, the least water was used in 2021.

3.3. Irrigation Rate

It is the parameter determined by the ratio of irrigated area to irrigation area. The irrigation rates of the irrigations belonging to Seydişehir Irrigation Union are given in Table 4.

Table 4. Performance indicators for water use efficiency (Irrigation-based) (DSİ)
Çizelge 4. *Su Kullanım Etkinliği Performans Göstergeleri (Sulama bazlı) (DSİ)*

Gevrekli Irrigation Irrigation Rate				Seydişehir Gravity Irrigation Irrigation Rate			
Years	**Irrigated Area (ha)**	**Irrigation Area (ha)**	**Irrigation Rate**	**Years**	**Irrigated Area (ha)**	**Irrigation Area (ha)**	**Irrigation Rate**
2019	1303	4438	29,36	2019	2319	7202	32,19
2020	1257	4438	28,32	2020	2703	7202	37,53
2021	2138	4438	48,17	2021	3343	7202	46,61
2022	1349	4438	30,39	2022	3002	7202	41,68
2023	1778	4438	40,06	2023	2112	7202	29,32
Suğla Gravity Irrigation Irrigation Rate				**Seydişehir Irrigation Association Irrigation Rate**			
Years	**Irrigated Area (ha)**	**Irrigation Area (ha)**	**Irrigation Rate**	**Years**	**Irrigated Area (ha)**	**Irrigation Area (ha)**	**Irrigation Rate**
2019	3625	9530	38,03	2019	7247	21170	34,23
2020	4955	9530	51,99	2020	8915	21170	42,11
2021	5708	9530	59,89	2021	11189	21170	52,85
2022	5203	9530	54,59	2022	9554	21170	45,13
2023	3951	9530	41,45	2023	7841	21170	37,04

For 2019, Gevrekli Irrigation had an irrigation rate of 29.36%, Seydişehir Gravity Irrigation had 32.19% and Suğla Gravity Irrigation had 38.03%. Seydişehir Irrigation Association (SSB) had an IR of 34.23% in 2019. In 2020, Gevrekli Irrigation had an irrigation rate of 28.32%, Seydişehir Gravity Irrigation had 37.53%, Suğla Gravity Irrigation had 51.99%. Seydişehir Irrigation Association (SSB) had an IR of 42.11% in 2020. In 2021; Gevrekli Irrigation had an irrigation rate of 48.17%, Seydişehir Gravity Irrigation had 46.61% and Suğla Gravity Irrigation had 59.89%. Seydişehir Irrigation Association had an IR of 52.85% in 2021. In 2022, Gevrekli Irrigation had an irrigation rate of 30.39%, Seydişehir Gravity Irrigation had 41.68%,

Suğla Gravity Irrigation had 54.59% and SSB had 45.13%. In 2023, the Gevrekli Irrigation had an IR of 40.06%, Seydişehir Gravity Irrigation had and 29.32%, Suğla Gravity Irrigation had 41.45% and SSB had 37.04%. While 2021 has the highest irrigation rate, 2019 has the lowest rate. The reason for the low irrigation rates is recorded as the fact that the local people do not irrigate because they find the rainfall sufficient according to the data obtained from the DSİ Monitoring and Evaluation Reports. Eliçabuk and Topak (2016) reported that the irrigation rates between 2008 and 2013 varied between 22 - 31.5% and were quite low.

Gençoğlu and Değirmenci (2019), in their research conducted in the irrigation facility constructed and put into operation by DSİ and transferred to Kırıkhan Irrigation Association, determined that the lowest irrigation rate was 33% in 2009 and the highest rate was 89% in 2013.

In the evaluation of the irrigation rate in Çorum Irrigation Association between 2019 and 2022; it was found that the minimum irrigation rate was 27.4% in 2019 and the highest rate was 65.3% in 2021. It was emphasized that 2021 was high due to the fact that water was supplied to the off-grid area (Tanışıklı & Çakmak 2023).

3.4. Amount of irrigation water delivered per unit area (WDUA)

The amount of irrigation water delivered per unit area (WDUA) is calculated as the ratio of total amount of water taken into the network to total irrigation area (Table 5).

Table 5. Amount of water delivered per unit area (m³/ha)
Çizelge 5. *Birim Alana Dağıtılan Yıllık Sulama Suyu Miktarı (m³/ha)*

Years	Water taken into network (m³)	Total Area (ha)	WDUA (m³/ha)
2019	123.321.000	21170	582,53
2020	109.569.999	21170	517,57
2021	29.514.240	21170	1394,15
2022	62.366.976	21170	2946,01
2023	55.630.000	21170	2627,78

SSB has an irrigation area of 21170 ha. In 2019, total amount of water taken into the network was 123.321.000 m³ and WDUA was calculated as 5825,27 m³/ha. In 2020, total amount of water taken into the network was 109.569.999 m³ and WDUA was calculated as 5175,72 m³/ha. The values were 29.514.240 m³ and 1394,15 m³/ha in 2021, 62.366.976 m³ and 2946,01 m³/ha in 2022 and 55.630.000 m³ and 2627,78 m³/ha in 2023. As can be inferred from Table 5, the year with the highest amount of water provided per hectare is 2022 with 2946,01 m³/ha and the year with the lowest amount is 2020 with 517,57 m³/ha. When the total of 5 years in the Irrigation Association was analyzed, the total area was 105,850 ha. The water delivered per hectare in the irrigation area was 3593,78 m³/ha. In the study conducted in Asartepe Irrigation Association, as a result of the 4-year evaluation, the lowest amount of annual irrigation water delivered per unit area was reported as 1375 m³/ha in 2007 and the highest was reported as 6312 m³/ha in 2005 (Kapan, 2010).

3.6. Amount of irrigation water delivered per unit of irrigated area (WDIA)

The amount of irrigation water delivered per unit of irrigated area (WDIA) is calculated as the ratio of total amount of water taken into the network to irrigated area (Table 5).

Table 6. Amount of water delivered per unit of irrigated area (m³/ha)
Çizelge 6. *Birim Sulanan Alana Dağıtılan Yıllık Sulama Suyu Miktarı (m³/ha)*

Years	Water taken into network (m³)	Irrigated Area (ha)	WDIA (m³/ha)
2019	123.321.000	7247	17016,83
2020	109.569.999	8915	12290,52
2021	29.514.240	11189	2637,79
2022	62.366.976	9554	6527,84
2023	55.630.000	7841	7094,76

In 2019, total amount of water taken into the network was 123.321.000 m³ and WDIA was calculated as 17.016,83 m³/ha on 7247 ha. In 2020, WDIA was calculated as 12.290,52 m³/ha on 8915 ha. In 2021, WDIA was calculated as 2.637,79 m³/ha on 11189 ha. In 2022, WDIA was calculated as 6.527,84 m³/ha on 9554 ha. In 2023, WDIA was calculated as 7.094,76 m³/ha on 7841 ha. When the results are analyzed, it was determined that the highest amount of water distributed per hectare was in 2019, while the least amount of water distributed was in 2021. In 2019 and 2020, it was determined that more water was taken into the network than it needed. The total irrigated area in the Irrigation Association for 5 years was 44746 ha. The water distributed per hectare of the irrigated area was 8501.37 m³/ha. In the study covering the years 2007-2018 in Acıpayam Irrigation Association, it was reported that the amount of water distributed per unit of irrigated area

varied between 4747 - 9793 m³/ha (average: 7020 m³/ha) (Cengiz & Uçar, 2021).

4. Conclusion and Recommendations

Urgent measures should be taken to realize food safety and sufficiency, which is one of the main independence criteria of the countries. The impact of climate change is felt not only in Turkiye but also all over the world. The danger of drought predicted for the coming years and the decrease in water resources are likely to cause serious problems. Effective water management policies, innovative agricultural techniques and rational sustainable water use between the sectors will be effective in reducing the danger of drought.

Lake Beyşehir, which is the water source of SSB, has not been able to store water at the desired levels due to decreasing precipitation in recent years because of drought and evaporation of water in the lake with high temperatures. Such a case has been very difficult for water users who irrigate from the lake. In the years of drought, it should be aimed to obtain maximum high yield despite minimum yield loss and deficit irrigation with a good irrigation schedule in the agricultural areas of the basin. When planning deficit irrigation, crop development periods should be taken into account and the irrigation schedules should be adjusted very well without causing yield loss in the plant.

The irrigation of Gevrekli Irrigation, Seydişehir Gravity and Suğla Gravity irrigations, for which SSB is responsible, with open canal irrigation system instead of closed irrigation systems causes serious water losses in the conveyance and distribution of water. The concrete in the open canals loses its properties over time, the lack of adequate maintenance and repair works in the canals, siltation accumulation and illegal irrigation by farmers cause intense water losses. Therefore, switching to closed irrigation systems will be effective in reducing water losses and maintenance and repair costs. Another important issue is to provide incentives for modern irrigation methods and irrigation at night or in the early hours of the morning will be effective in saving water. At the same time, it is necessary to make water users aware of irrigation when the plant needs it. Another problem caused by taking more water than needed into the network is the groundwater problem. It is thought that the development of state policies and the implementation of sanctions will be beneficial for the acquisition of this awareness.

In the light of the data obtained in this research, it was determined that the highest irrigation rate of Seydişehir Irrigation Association was in 2021 with 52.85% and the lowest rate was in 2019 with 34.23%. At the same time, the year in which the most water was taken into the network between 2019-2023 is 2019 with 123,321,000 m^3 and 7247 ha irrigated. Especially the fact that the canals of Gevrekli Irrigation are quite old and canalized irrigation is still applied in some lines causes high amounts of in-field water losses.

When the plant cultivation areas were analyzed, a decrease was observed in the last 2 years. It is thought to be the effect of the drought experienced. In the cropping pattern that has been changed due to economic concerns, it would be beneficial to turn to and support the cultivation of cereals with low plant water consumption needs instead of sugar beet and corn, which are the most cultivated plant varieties.

Irrigation planning studies are of serious importance in dry years. In irrigation areas, irrigation water allocation plans should be made according to the highest yield that can be achieved with deficit irrigation.

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