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Farmers' Knowledge on Agricultural Irrigation Programs: The Case of Altınekin District of Konya Province

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ABSTRACT

Climate change-induced droughts have various negative impacts on different sectors, especially on agricultural sector. Altınekin District, where the research was conducted, has the lowest precipitation in Konya Province, therefore is expected to be most affected by drought. For sustainable use of water resources, each stage of agricultural production should be carried out within the framework of a specific program. With this study, knowledge level of farmers engaged in irrigated agriculture in Altınekin district regarding irrigation and irrigation programs they applied were determined through a face-to-face survey. Present findings revealed that 38.7% of the participant farmers are aged 50 years and over and a large proportion of them (54.7%) are primary school graduates. Participant farmers were all (100%) using groundwater resources in agricultural production and 88% of them stated that they did not receive any training on irrigation. While 32% of the farmers participating in the survey stated that they had knowledge about the concept of irrigation program, 68% reported that they did not have any knowledge. Incorrect and improper practices regarding efficient use of irrigation water in the region, especially regarding the irrigation program, were identified and solutions were proposed for these problems.

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Introduction

Climate change seriously threatens the agricultural sector and poses great risks for both developed and developing countries (Çakmak & Gökalp, 2011; Arbuckle et al., 2013). Climate change causes serious problems in various economic sectors, especially water management. Therefore, it is extremely important to conduct research to detect and better comprehend on-going climate change trends (Atılgan et al., 2023). Climate change has significant effects on hydrological cycle, thus local-regional-global management and distribution of water resources have become even more important. There are spatial and temporal changes in water resources in different parts of the world. The quantity and quality of water resources are deteriorating day by day. Climate change-induced increase in temperatures and decrease in water resources significantly increase water demands of different sectors. Such a case, together with population growth and industrial development, will result in significant water stress in the upcoming years (Kanber et al., 2010).

Sustainable agriculture and water resources management are highly significant issues in regions with deficit water resources (Ashraf et al., 2007). More than 70% of available water resources are used in the agricultural sector (Fischer et al., 2007; Galán-Martín et al., 2017). Because of rapid socio-economic development and continuous population growth, future irrigated agriculture will face difficulties in meeting the increasing demand for food and water available for agriculture will decrease (Wang et al., 2017). Therefore, efficient use and optimal allocation of available water resources are critical issues for agricultural water management (Li et al., 2018; Koech & Langat, 2018).

Together with climate change, decreasing agricultural areas and continuously increasing populations make agricultural production difficult and increase the importance of natural resources, especially in irrigated agriculture and the search for measures to save water (Ward & Pulido-Velazquez, 2008). Therefore, good agricultural practices will become a necessity, especially for reliable food supply in the future. Thus, for sustainable use of soil and water resources, each stage of agricultural production should be carried out within the framework of a specific program. Domestic and industrial water uses are increasing. To meet increasing food demands, more areas should be opened to irrigation and available water resources should be used more efficiently. In Türkiye, 70-75% of water resources are used for agricultural irrigations (Çakmak & Gökalp, 2013). Climate change-induced recent

especially meteorological and hydrological droughts in different regions of Türkiye negatively affect ground and surface water resources. Constantly increasing energy and labor costs in agricultural irrigation also require more efficient use of water resources. Therefore, use of new modern technologies that ensure efficient water use in agricultural production should be increased.

Improper irrigation method selection and project design, lack of a correct irrigation program and annual maintenance of irrigation systems result in serious losses in yield and quality. In particular, insufficient or excessive irrigation water also reduces yield levels. Irrigation programs should so be implemented as to maximize yield per unit water in regions where irrigation water is insufficient and expensive and to ensure maximum yield per unit area in regions where agricultural production areas are insufficient. Therefore, irrigation time, amount, interval and duration must be determined by taking into account soil-plant-water-climate relations and this information must be conveyed to engineers and producers through agricultural extension practices. However, due to the lack of a sufficient and very effective farmer training service in Türkiye, soil, water and plant relations are not well-comprehended and negative effects of improper practices on environment are not sufficiently emphasized. At the end, producers tend to use more water than necessary because they are not trained enough (Tekinel et al., 2000)

Several researchers have conducted studies to examine the demographic, socio-economic and organizational factors affecting farmers' participation into irrigation management and to identify the problems and obstacles encountered in implementation of irrigation management programs (Khalkheili & Zamani, 2009; Atılgan et al., 2010; Knox et al., 2012; Tekiner & Beyribey, 2017; Taşpınar & Ertek, 2018; Yohannes et al., 2017; Uçar & Cengiz, 2018; Cui et al., 2022; Xiulingve et al., 2023). In this study, within the framework of irrigation water management, irrigation water source, irrigation methods and agricultural irrigation programs of farmers engaged in irrigated agriculture in Altınekin District, which has a high agricultural potential in Konya Closed Basin, which has arid and semi-arid climate characteristics, were investigated, current problems were identified and potential solutions were proposed.

Material and Method

This study was conducted in Altınekin District of Konya province, located in the central part of Turkiye. Altınekin district is located between 38°08' and 38°34' Northern latitudes and 32°32' and 32°58' Eastern longitudes. The altitude of the district is 950 meters (Anonymous, 2022). Altınekin district has a dominant terrestrial climate with an average annual precipitation of 343 mm (Tuncer & Tuncer, 2023). The district generally has a flat slope and brown fertile soils. The district's surface area is 1,106 km². The amount of arable land in the district is around 78.000 hectares. Irrigated agriculture is practiced on 53.550 hectares of this area and dry farming is practiced on 24.450 hectares. In other words, 69% of the arable land in the district is irrigated and rain-fed agriculture is practiced on 31%. Maize, wheat, barley, sunflower and sugar beet are among the most common crops of the district (Anonymous, 2021).

In this research, the knowledge level of farmers in Altınekin district of Konya province about the agricultural irrigation programs and current irrigation practices were determined through a survey. This study was carried out in accordance with E-29529695-050.99-678262 numbered and 15.01.2024 dated written Ethics Committee Decision of Selçuk University Rectorate, Faculty of Agriculture. Questionnaire forms were applied through face-to-face interviews with farmers both in the field and in social facilities during the 2022 irrigation season (April-October).

Stratified random sampling method was used in the research. With the use of the following equation, number of farmers to be surveyed was calculated as 71 (within 5% margin of error and 99% confidence limits) (Yamane, 1973). During the implementation phase, number of farmers to be surveyed was increased by four, thus the survey was conducted with 75 farmers. All farmers participating in the survey are men.

$$n = \frac{(\Sigma\, Nh.Sh)^2}{N^2.D^2 + \Sigma\,(Nh.Sh^2)} \quad D^2 = d^2/z^2 \qquad (1)$$

where;
n : Number of samples,
N : Number of facilities in the population,
Nh : Number of facilities in the h^{th} layer,
Sh : Variance of the h^{th} layer,
d : Margin of error from population mean,
z : Error-dependent z value in standard normal distribution table.

Number of samples to be surveyed was distributed into strata with the use of the following equation (Yamane, 1973):

$$n = \frac{N_h\, S_h \times n}{\Sigma\, N_h\, S_h} \qquad (2)$$

Results and Discussion

Socio-economic Characteristics of the Farmers

In recent years, the use of technology in agriculture has been increasing. With the increase in inputs in agricultural production, the use of modern agricultural technologies is gaining importance to obtain higher quality products from a unit area. The age and education level of farmers are very important in the adoption of agricultural innovations (Yolal & Değirmenci, 2020). In this sense, the socio-economic and education characteristics of participant farmers are provided in Table 1.

As can be seen in Table 1, 38.7% of the farmers are aged 50 years and over and a large proportion of them (96%) are married. The fact that most of the farmers are 50 years old and above shows that the farmers engaged in agriculture in the region are in the middle-aged and elderly group. It was seen that young people were moving away from agricultural production in Konya as well as in Türkiye. In terms of number of households, 88% of the farmers have a number of households of 3-6 people. A large proportion of farmers (54.7%) had primary school education and only 8% had university education. Oğuz & Diyanah (2021) indicated in a study conducted in Altınekin

district that the average age of farmers was 47.3 years. The average household size in the study area was determined to be 5 people. Yolal & Değirmenci (2020) reported that as the education level of farmers increases, pressurized irrigation systems that allow effective and efficient use of water will become more widespread. Therefore, to ensure the effective use of existing water resources in the research area and the continuity of agricultural production, farmers should be provided with theoretical and practical trainings on the irrigation program.

Farmer's knowledge on Irrigation

Traditional practices and resultant high input use are among the most important problems of agricultural production. Irrigation constitutes the most important and largest input in agricultural production (Düğmeci & Çelik, 2020; Gönülal & Soylu, 2020). Insufficient precipitations and water resources of the region exert serious pressure on existing ground water resources. Therefore, groundwater levels are decreasing every year. Irrigation water should be managed well in the region. Farmer's knowledge on irrigation is provided in Table 2.

As can be inferred from Table 2, 88% of the farmers reported that they did not receive any training on irrigation. Again, it was seen that 69.3% of the farmers participating in the survey did not receive any consultancy support during the agricultural production phase and even 82.7% of the producers did not receive sufficient training services from the irrigation cooperatives of which they are members.

Ciftci et al. (1994) emphasized that successful and continuous irrigated agriculture was possible only with effective farmer training. Tekinel et al. (2000) stated that when the producers were not adequately trained, they tend to use more water than necessary. Sahin et al. (2012) reported that technical consultancy was very important in agricultural production and that producers who receive consultancy services had the benefits of the training in the following production seasons.

Response of farmers who received irrigation training to the questions about where and from whom they received the training are given in Table 3.

As can be seen in Table 3, 73.3% emphasized that they received training from private institutions, 40% from Provincial and District Directorate of Agriculture and Forestry, 28% from their friends, 16% from television and 14.7% from the internet. In a similar study conducted in Konya province, Jalal (2018) emphasized that one of the problems encountered in agricultural irrigation water management was the lack of practical training. Sahin et al. (2003) conducted a study with regional farmers and asked them whether farmers in the region were informed about irrigation. About 79.2% of the farmers answered "no" and 20.8% answered "yes", therefore it was stated that farmers were not provided sufficient information about irrigation.

Farmer's Opinions about Agricultural Water Resources

Agricultural irrigation water in Altınekin district is supplied from groundwater. The amount of precipitation has decreased in recent years, thus the change in the precipitation regime in the region and the decrease in snowfall cause the underground water resources to gradually decrease and their levels to decrease. According to climate change projections made for the period 2015-2100, a continuous increase in average temperatures is expected. According to the observation data of 1971-2000, the average annual precipitation amount of the basin in the reference period was determined as 397.6 mm. According to the projection results, it is seen that total precipitation tends to decrease compared to the reference period (1971-2000), and it is predicted that the basin will receive 16% less precipitation in the 2071-2100 period compared to the reference period (Anonymous, 2020). In addition, the fact that farmers in the region prefer irrigated agricultural products with high added value increases the pressure on water resources. Farmer's opinions about water resources are provided in Table 4.

Table 1. Socio-economic characteristics of participant farmers

	n	(%)
Age		
20-29	8	10.7
30-39	13	17.3
40-49	25	33.3
50 and over	29	38.7
Marital Status		
Married	72	96
Single	3	4
Number of households		
1-2	2	2.7
3-4	31	41.3
5-6	35	46.7
7 and over	7	9.3
Education		
Primary	41	54.7
Secondary	15	20
Highschool	13	17.3
University	6	8

Table 2. Farmer's knowledge on irrigation

	n	(%)
Have you ever got training on irrigation?		
Yes	9	12
No	66	88
Have you ever got consultancy for agricultural production?		
Yes	23	30.7
No	52	69.3
Have you got sufficient training from your cooperative?		
Yes	9	12
Little	4	5.3
No	62	82.7

Table 3. Sources of training on irrigation

Which options you mostly prefer for training on irrigation?	n	(%)
Province District Directorate of Agriculture and Forestry	30	40
Private organizations	55	73.3
Friends	21	28
Books and Magazines	0	0
Television	12	16
Internet	11	14.7

Table 4. Farmer's opinions about water resources

	n	(%)
Water resources		
Ground	75	100
Drainage	0	0
Surface	0	0
Do you know about well capacity?		
Yes	42	56
No	33	44
Is there a decrease in water level in the last 5 years		
Yes	71	94.7
No	4	5.3
Do you own the water resource?		
Yes	75	100
No	0	0
Are you a member of the cooperative?		
Yes	46	61.3
No	29	38.7
Is there a water deficit in your district?		
Yes	33	44
No	39	52
No idea	3	4

Table 5. Farmer's opinions about irrigation methods

	n	(%)
Which irrigation methods do you use in agricultural production?		
Sprinkler	73	97.3
Surface	0	0
Drip	69	92
Center Pivot	0	0
Lineer Pivot	0	0
Sub-surface drip	0	0
Which factors do you consider while selecting an irrigation method?		
Soil properties	16	21.3
Plant characteristics	63	84
Irrigation water characteristics	26	34.7
Irrigation water availability	36	48
Costs	53	70.7
Labor	50	66.7
Easy water and fertilizer application	13	17.3
Common practices	4	5.3
Preferred methods	1	1.3
Scientific recommendations	0	0
Automation	1	1.3
Other	1	1.3

As can be seen in Table 4, 100% of farmers reported that they use groundwater resources in agricultural production, since there is no surface water source in the region. While 100% of the farmers stated that the water resources belonged to them, 61.3% stated that they were members of the irrigation cooperative. These answers contain contradictions, because farmers use both cooperative wells and their own wells, many of which are unlicensed, in agricultural production. While 94.7% of the farmers reported that the water levels in the wells had decreased in the last five years, 5.3% stated that there was no water shortage in the region. There is a contradiction in these answers, because the only water resource in the region where the research was conducted is groundwater. Ground water resources of the region are decreasing day by day due to intensive irrigated agriculture and decreasing rainfall as a result of climate change (Durduran et al. 2021). Sahin et al. (2013) emphasized in a study on sustainability of water resources in Konya plain that the groundwater level in the basin decreased by an average of 3 m every year due to excessive water use.

Farmer's Opinions about Irrigation Methods

For an effective irrigation in the region, amount of water needed by the plant must be calculated and given to the effective root zone of the plant at an appropriate time and amount with a correct irrigation method. Effective irrigation can be achieved with an irrigation method determined by taking into account Soil-Plant-Water-Climate relationships, a good project design and a correct irrigation program. Table 5 shows the knowledge levels and opinions of the surveyed farmers about irrigation methods.

As can be seen in Table 5, 97.3% of farmers reported that they use sprinkler irrigation and 92% reported that they use drip irrigation. Since farmers have land in more than one place, they prefer drip irrigation in some of their fields and sprinkler irrigation in others, especially depending on the product type. In choosing the irrigation method, 84% of farmers stated that they took into account the plant type, 70.7% the irrigation cost, 66.7% labor, 48% the availability of irrigation water, 34.7% the irrigation water characteristics and 17.3% the efficiency of fertilizer use along with water. Since only groundwater is available in the region, pressurized irrigation systems were prominent. Patlar (2018) reported that pressurized irrigation methods that save a large amount of water in agricultural irrigation should be encouraged and greater financial support should be provided.

Farmer's Knowledge on Irrigation Programs

Unconscious irrigation practices without any irrigation programs exert serious threats on groundwater resources of the region. Plants will get into stress when the less water than the plant requirement is supplied to the effective rootzone. On the other hand, diseases incidence will increase, yields will decrease, drainage and salinity problems will be encountered when the given water to the effective rootzone is greater than the field capacity. Farmer's knowledge on irrigation programs is provided in Table 6.

As can be seen in Table 6, 32% of the participants stated that they had knowledge about the concept of irrigation program, while 68% reported that they had no knowledge. Around 69.3% of the farmers emphasized that they did not have any knowledge about the term "available water capacity". However, the rate of those who answered that we do our irrigation at the right time is 100%. Farmers think that they irrigate at the right time because of their misconceptions. In dry years, 92% of farmers irrigate based on their own experience and 6.7% consult experts. The majority of farmers do not have sufficient knowledge about irrigation programming. Sahin et al. (2003) conducted a similar study in Konya province and emphasized that the majority of producers do not have sufficient information about how to determine the amount irrigation water to be applied and irrigation intervals. Ainechee et al. (2009) stated that an effective irrigation program should be implemented to achieve high efficiency. Yildirim et al. (2016) conducted a study to evaluate irrigation efficiency

under Central Anatolian conditions and emphasized that the expected yield and quality increases in irrigated agriculture can only be achieved with appropriate irrigation programs that combine parameters such as irrigation water quality and quantity, climate conditions, plant requirements and soil properties.

Farmer's opinions about plant water consumption, irrigation timing and night irrigations are provided in Table 7.

100% of the farmers stated that they irrigate at night, because it is impossible for them to irrigate their entire land during daylight hours. About 52% of the participants reported that they did not have information about plant water consumption and 48% reported that they had information. For irrigation timing, 81.3% of the farmers determine it by looking at the plant, 53.3% according to their own experience and 5.3% by checking the soil. Tekiner & Beyribey (2009) conducted a study to determine how the producers determine irrigation timing in Salihli District and indicated that 73.6% of the producers irrigate at night and 78.2% can irrigate on time, 79% of the producers stated that they decided irrigation timing based on the plant, 4.5% based on the soil and 4.5% based on their own experience.

Financing and Labor use of Farmers

Lack of labor and finance constitute important obstacles to agricultural production today. In recent years, there has been a major labor shortage in rural areas, especially due to migration from rural areas to cities. This labor shortage is being tried to be eliminated through foreign nationals. However, these people are not trained on irrigation and such a case causes problems in irrigation water management. Therefore, producers should use automation-supported modern irrigation systems in agricultural irrigation. However, these systems are expensive, thus requires farmers to be supported with financing. Table 8 shows farmers' opinions about irrigation financing and labor.

As can be seen in Table 8, 98.7% of farmers reported that irrigation energy costs are expensive. Since irrigation water is supplied from groundwater wells by pumping, energy costs are generally high. When the farmers were asked about how irrigation fees should be calculated, 42.7% stated that it should be determined based on irrigation hours, 42.7% stated that it should be determined based on irrigation water quantity, 9.3% stated that it should be determined based on irrigated area and 5.3% stated that they had no opinion on this issue. About 57.3% of the farmers reported that they employed daily workers and 42.7% reported that they did not need labor. The rate here varies depending on the irrigation method used and the household size. To reduce irrigation water losses and costs, water must be measured and given within a certain program. Charging for irrigation water in places or periods where water resources are limited is also important for effective water use.

A large majority of farmers (88%) stated that they provided the irrigation system they used with their own resources. The large number of unlicensed wells in this region and the fact that the state does not provide grant support to unlicensed well owners are the biggest reasons why farmers purchase new pressurized irrigation systems with their own capital.

Table 6. Farmer's knowledge on irrigation programs

	n	(%)
Do you have an idea about the concept of irrigation program?		
Yes	24	32
Nor	51	68
Do you have an idea about available water capacity of the soil?		
Yes	10	13.3
Little	13	17.3
No	52	69.3
Do you practice irrigations at proper time?		
Yes	75	100
No	0	0
How do plan irrigation program in dry years?		
Deficit irrigation with expert opinions	5	6.7
Deficit irrigation with my own knowledge	69	92
Alternative irrigation method	1	1.3
Other	0	0

Table 7. Farmer's opinion about plant water consumption and irrigation timing

	n	(%)
Do you irrigate at night?		
Yes	75	100
No	0	0
How do you identify irrigation timing?		
By checking soil	4	5.3
By checking plants	61	81.3
With my own experience	40	53.3
With the use of soil moisture meters	0	0
Do you have an idea about plant water consumption?		
Yes	36	48
No	39	52

Table 8. Farmer's opinions about irrigation financing and labor.

	n	(%)
Do you think electricity costs are high?		
Yes	74	98.7
No	1	1.3
How the irrigation pricing should be done?		
Based on irrigation hours	32	42.7
Based on water quantity	32	42.7
Based on irrigated land size	7	9.3
Based on number of sprinklers	0	0
No idea	4	5.3
Do you employ daily workers for irrigation?		
Yes	43	57.3
No	32	42.7
Do you have difficulties in finding foreign workers?		
Yes	37	49.3
No	38	50.7
How did you purchase irrigation system?		
Bank credit	7	9.3
Grants	2	2.7
Own finance	66	88
Do you know about irrigation supports of the State?		
Yes, I use	11	14.7
Yes, but I don't use	57	76
No, I don't know	7	9.3

This result is also evident from the fact that 76% of farmers reported that although they were aware of government supports, they did not benefit from these supports. Şahin (2016) conducted a study on agricultural irrigation management in the KOP Region and emphasized that unlicensed well owners in the region did not benefit from grant supports and that unlicensed wells should be taken under control urgently. When this happens, unconsciously used irrigation water from unregistered wells will be taken under control and farmers will be able to purchase modern pressurized systems with grant supports and therefore use water more effectively. Yolal & Değirmenci (2020) state that agricultural supports in Turkey will cause pressurized irrigation systems to become widespread, therefore, grants will increase productivity and offer sustainable use of soil and water resources.

Farmer's Knowledge about Irrigation System Design

Most of the farmers do not have technical knowledge about the irrigation system they use in agricultural irrigation. However, for effective irrigation water management, properly designed irrigation systems must be used. Farmers procure irrigation systems from the private sector and commercial exchange is based on trust. If the company is reliable, it projects a suitable system according to soil-water-plant characteristics and gives an appropriate irrigation program within the framework of this system. However, some companies may mislead farmers by thinking purely commercially. In this sense, it is important for farmers to receive training on irrigation and therefore to carry out irrigation system supply and project design within the framework of this information.

Farmer's knowledge about the irrigation system they use in agricultural production and system design is provided in Table 9.

Table 9. Farmer's knowledge about irrigation system design

	n	(%)
Do you have any idea on irrigation system design?		
Yes	19	25.3
No	56	74.7
Who made the application of irrigation system?		
Own	72	96
Someone I know	2	2.7
Agricultural engineer	1	1.3
Plumer	0	0
Other	0	0
How did you decide about irrigation system project?		
Based on soil analysis	0	0
Based on company advises	50	66.7
Randomly	16	21.3
Other	9	12

As can be seen in Table 9, 74.7% of the participants stated that they had no knowledge about the project design of the irrigation method and 25.3% stated that they had knowledge about it. 66.7% of the farmers reported that they implemented the system project based on company's recommendations and 21.3% reported that they implemented it randomly. As can be seen from here, most of the farmers do not have knowledge about the irrigation systems they use. Therefore, the rate of incorrect project design that causes irrigation water losses in irrigation water management is very high. About 96% of farmers reported that they made the application of irrigation systems by themselves.

Conclusion and Recommendations

With climate change and rapidly increasing populations, the need for food makes agricultural production even more important. Lack of surface water resources in Altınekin district directs farmers to groundwater resources for agricultural irrigation. However, unconsciously applied cropping patterns and excessive water use have caused rapid decreases in groundwater levels and groundwater pollution in recent years. Re-planning agricultural production within the framework of climate-soil-water-plant relations in the region and planned consumption of groundwater resources are very important for the sustainability of water resources in the region.

In agricultural production, producers need to be made aware of the agricultural irrigation program to obtain higher quality and yields per unit area within the framework of sustainability of soil and water resources. Although pressurized irrigation methods are used in almost the entire region, there are deficiencies in the management and programming of irrigation water. Since irrigation is not done according to the plant's water needs in the region, even if irrigation is done with the most modern pressurized irrigation methods, water is wasted because there is no irrigation program. Therefore, necessary measures should be taken regarding the efficient use of water by taking the opinions of universities, relevant public institutions and organizations and water users in the region. Theoretical and practical training should be provided to farmers regarding this issue.

Considering the answers given by the farmers, it was concluded that the existing pressurized irrigation systems in the district were not fully designed according to the relevant design criteria. When farmers switch to pressurized irrigation systems, wrong projects and unscheduled irrigation practices cause waste of water. Therefore, prepared irrigation projects should be checked by an expert or responsibility should be given to the companies that carry out the project.

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Declaration of conflict of interests

Authors declare no competing interest.

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