Pak. J. Agri. Sci., Vol. 59(3),319-327 ;2022
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI:10.21162/PAKJAS/22.349
http://www.pakjas.com.pk

A survey of Amik plain maize (*Zea mays*) farmers' views on drip irrigation

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Efficient use of water resources is important all over the world. Excessive water consumption threatens agricultural sustainability. Besides, drip irrigation draws attention in terms of higher efficiency. It has been studied in cereals as maize has a wide cultivation area. In this study, a total of 100 maize farmers— half of whom practice drip irrigation— were selected at random and interviewed face to face to ascertain the views of Amik Plain farmers regarding drip irrigation systems. By the SPSS software; descriptive statistics were calculated first, and since some data showed normal distribution the Independent Samples T test was applied, while the non-normal distribution data was subjected to the Mann-Whitney U test and analysed. The results of the study reveal that there is significant correlation between the farmers' preferred method of irrigation and variables such as education level, family size, level of training regarding irrigation systems, bookkeeping habits, annual income, newspaper preferences, produce yield, planting area, field ownership, credit usage, weed extermination methods, drip irrigation awareness, source of blockages, and intention to grow maize and employ drip irrigation in the following year. Suggestions were made to increase the Amik Plain farmers' awareness regarding water shortages, to survey their opinions on the matter, and to enlighten them as to the consequences of drip irrigation usage. New agricultural support policies in the region have led to a decrease in maize fields, however, some drip irrigation farmers state that they intend to continue growing maize as they can obtain a higher yield with this method.
Keywords: Maize, drip irrigation, efficiency, conservation, innovation, agricultural extension.

INTRODUCTION

Water is necessary not only for human consumption but for the preservation of ecosystems, economic growth, national security, and energy production. Today, the need for water is greater than ever before due to population growth linked to economic development and improved living standards. However, climate change and water scarcity mean that one of the most important problems of the 21st century is water shortages, particularly when we consider that 4/3s of water resources are used in agricultural irrigation (Üzen and Çetin, 2012).

Today, insufficiency of water resources is one of the biggest and most important problems for people. Rapid population growth brings along the water problem. Increasing population, industrialization, transition to irrigation in agricultural production and, unconscious use of water resources are among the causes of water problems (Gültekin Burçak, 2006; Iqbal *et al*., 2020). According to the annual rainfall and seasonal distribution varies depending on the climatic conditions in Turkey. It prevents productivity and increases in crop from being at the desired level. In this respect, irrigation, which also increases the efficiency of production inputs, is the most important factor of agricultural development (Kanıt, 1991). Considering that Turkey is located on water scarcity zone in the world, the right management of water use is very important (Dorak *et al.* 2018). The increase in production per unit area in agriculture depends on production factors. These are qualified seeds adequate fertilizer use of appropriate equipment irrigation agricultural struggle, and others (Talmaç, 2006). Water and irrigation are important in agricultural activities (Tognetti *et al.* 2003). The increase in the non-agricultural use of water necessitates water saving in agricultural production. It also requires water use efficiency (Özçelik *et al.* 1999). Effective and sustainable use of natural resources is important in achieving the determined goals and objectives (Akgül, 2009). Farmers need to be careful with effective irrigation. Irrigation is required depending on the plant water consumption soil and climatic conditions (Şener, 2004). The water problem is one of the biggest obstacles to agricultural progress and rural development. For this reason, optimal use is important in agricultural production in droughty regions (Piraiesh, 2015). Development and management of water resources is essential

Kaya A. and D.B. Budak. 2022. A survey of Amik plain maize (*Zea mays*) farmers' views on drip irrigation. Pakistan Journal of Agricultural Science. 59:319-327.
[Received 15 Mar 2021; Accepted 26 May 2022; Published 27 Jun 2022]

in agricultural areas for sustainability (Ashraf *et al.* 2007). Considering the fact that most of the water resources used in our country are used in agricultural irrigation and irrigation methods are still the most inefficient surface irrigation methods, the need for water management in this area comes to the forefront (Karaaslan, 2020).

The inefficient and unproductive use of water sources in Turkey causes significant problems in the area of irrigated farming. Excessive water consumption, particularly due to the employment of incorrect irrigation techniques and farmers' insufficient knowledge regarding water use and irrigation methods threaten to destroy the arability of certain areas of land soon. Irrigation is vitally important for vegetable production as meeting the plants' water needs during the production stage ensures steady and continuous growth. It also increases the efficacy of agricultural supplements such as fertiliser and pesticides. Using the appropriate irrigation method is necessary to reap these benefits (Bıçaklı, 2005). Efficient use of water is provided by pressurized irrigation systems. Product quality improves with increased production and yield. It supports the safety and economic development process with the reduction of agricultural diseases (Deng *et al.* 2006). Therefore, adopting modern irrigation methods increases water efficiency. It also prevents excessive use of input (Amankwah and Egyir, 2013). It supports the enhancement of farmer welfare. It increases irrigation efficiency and reduces irrigation costs. (Rigby *et al.* 2010). A suitable surface or pressurized irrigation type should be developed to increase agricultural production and irrigation efficiency (Valipour, 2013; Karami, 2006).

Water scarcity and climate change are two of the most important issues facing us today. The daily increasing need for industrial and domestic water supplies means that the use of water in agriculture must be efficient. In water networks with water scarcity, there is an increased use of sprinkling and drip irrigation methods, both of which are water saving methods. The Union of Irrigators also encourages farmers to opt for pressurised irrigation methods (Değirmenci *et al.* 2016).

Maize is a warm climate grain (C4 plant) used as a food both for animals and for humans; it also has the highest yield per unit of area in Turkey and the world (Konuşkan *et al.* 2015). Maize is also rich in nutrients and by-products that create added value such as oil, glucose, starch, and flour.

When we look at the current production levels of grain and maize in Turkey, and the share of maize in the total amount of grain produced, we can see that the country's grain fields have shrunk exponentially between 1995-2015. Conversely, the amount of land taken up by maize fields, which is a leader in the grain category both in terms of productivity and versatility, has increased. The total area of maize fields in Turkey was 520.00 hectares in 1995; this number rose to approximately 700.000 hectares by 2015. Consequently, the share of maize fields in the total amount of grain cultivation areas has also increased. Within the same specified timeframe, maize production has risen from approximately 2.000.000 metric tonnes to 6.500.000 metric tonnes, an increase of more than double. This dramatic increase in the amount of maize produced, despite the lack of a similar increase in the amount of land used for the cultivation of maize, is ascribed to an improvement in the amount of yield that can be derived from any given field. The yield of corn between 1995-2015 has increased nearly threefold (Anonymous, 2015).

Hatay contributes to the Turkish economy in almost every sector, but its agricultural contribution is particularly important. Farmers in the province cultivate grain more than any other produce. The geographical features and the climate of the region allow more than one type of product to be grown simultaneously. Maize is an important crop in the region. Due to water shortages in recent years, maize farmers have begun to opt for drip irrigation. Drip irrigation increases yield and consequently the farmers' income. However, there's a steep cost associated with the initial implementation of the system which some growers find prohibitive.

This study explores maize farmers' views on drip irrigation on the fertile Amik Plain, which is located in the province of Hatay and encompasses the towns of Antakya, Kırıkhan, Kumlu, and Reyhanlı.

MATERIALS AND METHODS

Hatay boasts a large selection of locally grown produce. The total area of arable land in the province is 275.578 hectares, and intensive farming is practiced. Wheat, industrial crops (cotton, maize etc.), vegetables, olives, oily seeds, citrus, fruit, vegetables, animal feed, and aftercrop are grown; intercropping is also practiced. The Amik Plain makes up around 119.350 hectares of the province's arable land. Approximately 26.750 hectares of this land are located in Antakya, the province's centre; 53.000 hectares are located in Kırıkhan, and 39.600 hectares are located in Reyhanlı and Kumlu. The other plains of the province measure 44.960 hectares. The total area of Hatay plains is 164.310 hectares, 73% of which comprises the Amik Plain. 61.024 hectares of arable land in Hatay are irrigated by state subsidy, whilst 115.491 are irrigated by the public. Out of the total 275.578 hectares of agricultural land in Hatay, 206.553 hectares are suited to irrigation, however, only 176.515 hectares of this land are irrigated (Anonymous, 2014).

The questionnaires were subjected to pre-testing, after which the necessary adjustments were made and the required data collected through on-site surveys. On-site observations and group interviews were also used to strengthen and further develop the data set.

The data evaluation method was chosen in line with the study's aims, and the analysis was conducted by using the SPSS software. The representative metrics of all variables

were calculated; categorical variables were presented as frequency and percentage, whilst quantitative variables were presented as average and standard deviation. Quantitative variables were analysed via the Kolmogorov-Smirnov test to see whether they fit the normal distribution; differences between independent groups were analysed using the Student t-test and single direction variance analysis in parametric cases, and the Mann-Whitney U test in non-parametric cases. A sample of individuals were selected since interviewing every Amik Plain maize farmer would have been impractical due to financial and time constrains. A total of 100 maize farmers in the area use drip irrigation; 50% of this group was selected for the study. The 50 growers were selected at random while keeping in mind equal representation for each area. For the control group, 50 farmers who don't practice drip irrigation were selected, all of whom were from the same region and shared the same attributes as the drip irrigation group. Questionnaires were submitted to all 100 farmers from the towns of Antakya, Kırıkhan, Kumlu, and Reyhanlı that comprise the Amik Plain.

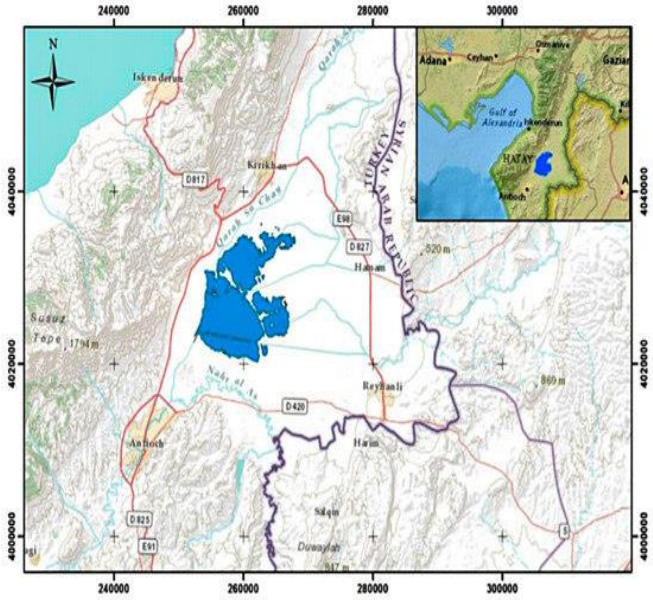


Figure 1. Location of the study

The data resulting from the survey was entered into a database using the aforementioned packaged software and prepared for analysis. Various statistical analyses were conducted in line with the aims of the study. Defining statistics of the sample and averages were represented using frequency and percentage.

The data set was tested for normal distribution compliance and variance homogeneity to apply various parametric tests. Data collected were input into the database to be analysed by the SPSS software; descriptive statistics were calculated first, and since some data showed normal distribution the Independent Samples T test was applied, while the non-normal distribution data was subjected to the Mann-Whitney U test and analysed. Two independent representative t-tests can be used to compare the averages of two different sample groups (Kalaycı, 2016).

RESULTS AND DISCUSSION

***General attributes of farmers*:** The general attributes of farmers are presented in Table 1. Despite growers in both groups sharing similar attributes, it can be seen that farmers who use drip irrigation have a higher income, and the area of their land is larger. They also use more credit, and their yield is higher than farmers using irrigation ditches. The results by Karami (2006) found that there are differences between farmer groups that farmers have determined to adopt irrigation methods (border, basin and sprinkler). Cuenca (1989); Skaggs (2001); Zibaie (2003); Alcon *et al.* (2011); Ebrahimi *et al.* (2014); Qolamrezai *et al.* (2014); Piraiesh *et al.* (2015) stated that low interest credit, cultivation area, yield, land slope and extension activities are effective on the use of pressurized irrigation methods. Schuck *et al.* (2005) argued that in adopting modern irrigation methods, farmers who continue their agricultural activities by renting avoid long-term investment. Also Noroozi and Chizari (2006); Yuan (2010); Rogers (2003); Dinar, (1990); Foltz, (2003) argued that the experience, age, education and income level of farmers are also important for water saving. Green and Sunding (1997) new technology promoting efficient water use; Caswell and Zilberman (1986); Lichtenberg (1989), the idea of evaluating areas with low land quality is effective on the adoption tendency of farmers.

All surveyed farmers grow products such as maize, cotton, wheat, cantaloupe, onion, carrot, olive, and pepper. Farmers who employ drip irrigation also grow apricot, spinach, tomato, vicia sativa, potato, nectarine, and parsley. Non-drip irrigators grow clover, silo maize, and cucumber. It is evident that those who practice drip irrigation are able to grow a wider variety of produce. Green *et al.* (1996); Pannell *et al.* (2006) stated that there are aquaculture differences between crops and irrigation methods may also vary, and this has an impact on the adoption of new methods. Aydın *et al.* (2020) the farmers in each group stated that drip irrigation method provided water save, decreased the labor, increased the yield and protected the soil, initially.

***Irrigation source*:** Growers who use drip irrigation irrigate their fields between 5-13 times if maize is their primary product, with an average of 7.30 irrigations. They irrigate their secondary products between 4-6 times, with an average of 5. Farmers who don't use drip irrigation irrigate their land between 4-10 times if their primary product is maize, with an average of 6.34. For secondary products, this number is between 5-10 with an average of 6.73. When we look at the source of the water, it can be seen that drip irrigation farmers

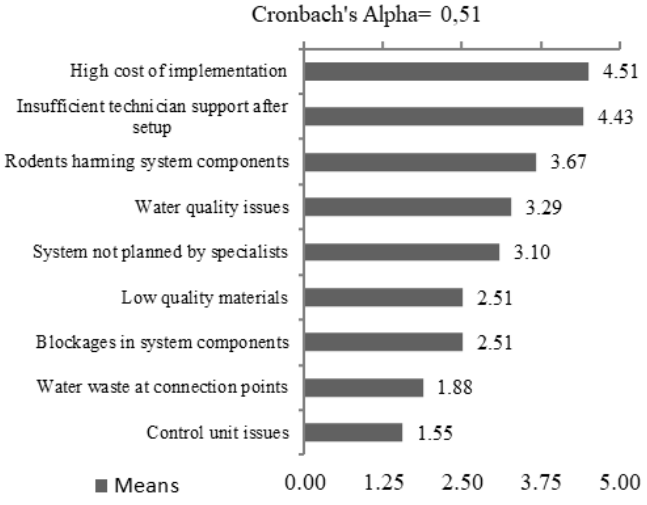
Table 1. General attributes of farmers

Variables	Defination	Drip irrigation			Non drip irrigation		
		Frequency	%	Mean	Frequency	%	Mean
Age	24-45	19	38	49.66	20	40	49.30
	46-65	26	52		27	54	
	65<	5	10		3	6	
Family size (person)	1-3	15	30	4.66	12	24	4.56
	4-7	30	60		31	62	
	8≤	5	10		7	14	
Experience	1-20	13	26	28.54	14	28	27.30
(year)	21-50	34	34		33	66	
	50<	3	6		3	3	
Income (₺)	50.000>	5	10	125.69	20	40	69.70
	50.000-300.000	36	72		21	42	
	300.000<	4	8		-	-	
Land size	100>	9	18	251	35	70	118
(maize-da)	101-300	32	64		11	22	
	300<	9	18		4	8	
Maize yield (kg/da)	1000>	-	-	1.394	4	8	1.270
	1000-1500	34	68		44	88	
	1500<	16	32		2	4	
Maize price (₺/kg)				0.705			0.717
Maize cost (₺/da)				435.7			416.7
Education	Graduate	11	22		6	12	
	High school	22	44		18	36	
	Primary school	17	34		26	52	
Farm record	Yes	41	82		28	56	
	No	9	18		22	44	
Computer ownership	Yes	38	76		30	60	
	No	12	24		20	40	
Use of computer	Yes	36	72		29	58	
	No	14	28		21	42	
Internet access	Yes	40	80		32	64	
	No	10	20		18	36	
Credit	Yes	28	56		10	20	
	No	21	42		37	74	
Irrigation seminar	Yes	20	40		6	12	
	No	30	60		44	88	
Soil analysis	Yes	18	36		19	38	
	No	32	64		31	62	

tend to use a greater amount of well water. 74% of the drip irrigation farmers surveyed for the study state that they decide on irrigation frequency based on their plants' appearance, while 8% decide on irrigation frequency based on soil dryness. 18% base their decision both on plant appearance and on soil dryness and water availability. Non-drip irrigation farmers decide on irrigation frequency based on plants' appearance at a rate of 72%, while 8% make their decision based on soil dryness and 20% use both plant appearance and soil dryness and water availability as their criteria. A similar result was obtained in a 2006 study by Direk *et al.* They ascertained that modern irrigation methods such as drip irrigation were difficult to embrace and implement for farmers, and most farmers decided on when to irrigate their produce based on the appearance of their crop, as they lacked the necessary training and equipment to do otherwise. Skaggs (2001) provides effective irrigation in sloping lands that need tillage by reducing evaporation on the soil surface, reducing flow and deep infiltration. The results by Aydın *et al.* (2020) the most important criteria of the farmers in the groups on preferring the drip irrigation method were determined as water application convenience, economic conditions and water source and the characteristics of the irrigation water.

***Awareness of drip irrigation systems*:** Farmers access information regarding innovation at different times and from different sources. When questioned as to where they first heard about drip irrigation, both sets of growers cited the same informational sources. As can be seen in the study, most were informed by their neighbouring farmers. The second most common source of information was irrigation systems companies, and the third, agricultural engineers. Pannell *et al.* (2006); Ohlmer *et al.* (1998), the fact that the application has been tested before affects the perspective of the farmers to the modern technology. Smith and Munoz (2002) stated that consultancy services are also effective in the adoption of modern irrigation methods.

***Problems encountered in drip irrigation*:** Figure 2 shows the farmers' views on problems encountered in the drip irrigation of maize. They state that the biggest problem is the high cost of the initial setup. They also state that technicians who set up the systems don't follow up further issues, and rodents cause great harm to the water hoses. It can be clearly seen that farmers who use drip irrigation can encounter problems related to the system. However, the majority think that the system's benefits outweigh the issues, and intend to continue using it.



Scale: 1=Never, 2=Occasionally, 3=Sometimes, 4=More Often, 5=Very Often

Figure 2. Problems encountered in drip irrigation

***Thoughts on drip irrigation*:** Crop farmers states that drip irrigation cuts down on water consumption, saves labour costs, and allows fertilizer to be applied directly at the root of the plant; however, implementation of the system is costly and the state subsidy is insufficient (Table 2). Deng *et al.* (2006); Alcon *et al.* (2011); Piraiesh (2015) prefers modern irrigation methods because it reduces irrigation costs and increases yield; In this context, he argued that the support, technical infrastructure, economic level of the farmers and their usage rates are effective. Skaggs (2001); Rogers, (2003) stated that drip irrigation increases yield and quality as well as efficient resource use. Chen and Huang (2004); Ebrahimi and Kalantari (2010); Alcon *et al.* (2011); Ebrahimi *et al.* (2014); Qolamrezai *et al.* (2014); Piraiesh *et al.* (2015) stated that social, economic and natural factors affect the adoption process by farmers in adopting modern irrigation methods. Skaggs (2001) provides efficiency in fertiliser and other chemical applications with drip irrigation.

***Relations between variables*:** To decide which statistical tests would be used in the study, the single-sample Kolmogorov Smirnov test was applied, and the age (K-S(z)=0,200; p>0,05), maize yield (K-S(z)=0,065; p>0,05), and maize price (K-S(z)=0,148; p>0,05) variables were found to have a normal distribution. The other variables were found to not have a normal distribution. For this reason, in cases where variables show normal distribution, the parametric Independent Samples T-test was applied, while in non-parametric cases, the Mann Whitney U test was applied.

According to the findings (F=0,004;p<0,05), the analysis of the age variable revealed that there is no meaningful difference between drip irrigation users and non-users on a level of significance of 0.05. This shows that there is no difference in terms of median age between farmers who use drip irrigation and who don't, and that irrigation methods do not change based on age. The Mann-Whitney U test revealed that there is statistical importance on a level of significance of 0.05 when it comes to the drip irrigation and non drip irrigation farmers' education level, family size, bookkeeping habits, total annual income, and training regarding irrigation systems. There is no difference related to irrigation method in variables associated with crop growing duration, ownership and ability to use the computer, and internet access. Noroozi and Chizari (2006); Alcon *et al.* (2011); Piraiesh *et al.* (2015) emphasized the importance of communication channels as well as age, literacy, farming experience and land size.

In evaluating the analysis results of the agricultural farms' general information, looking at the normalcy test results of farmers regarding the usage of maize fields and production revealed that the criteria maize yield (K-S(z)=0,065; p>0,05) and maize price (K-S(z)=0,148; p>0,05) had normal distribution; for this reason the Independent Samples T test was used. According to the LEVENE test results, the group variables regarding the businesses' maize yield and maize price were evenly distributed. The test (F=1,211;p>0,05) shows that analysis of groups relating to the growers' maize yield displays a significant difference (t=-3,517;p>0,05) on a scale of importance of 0.05 between farmers that use drip irrigation and farmers who don't. Farmers who use the drip irrigation method had a higher average (Xf= 1393,20 da) than those who did not (Xa=1270,20 da). There is a significant difference in irrigation method based on the maize farmers' average yield.

The Mann-Whitney U Test was applied to the criteria of maize plantation area, land ownership, soil structure, and

Table 2. Farmers' views regarding drip irrigation

Views on drip irrigation	Mean	
	Drip irrigation	Non drip irrigation
Less water is used	2.88	2.69
Labour costs are lowered	2.86	2.82
Fertiliser can be applied directly to the root of the plant	2.80	2.86
Initial set-up is highly expensive	2.61	2.90
Not suited for every crop due to high cost	2.57	2.71
Implementation requires skill	2.47	2.55
Technicians' motivation influences the outcome	2.45	2.51
State subsidy is inefficient	2.41	2.90
Cuts down on water costs	2.37	2.69
Increases arable land	2.29	2.55
Increases crop variety	2.14	2.61
Insufficient information available	2.02	2.49
Decreases weeds	1.88	2.49
Decreases fertiliser use	1.73	2.59
Not enough water sources to use the system	1.65	2.02
Crops are not provided with enough water	1.35	1.80
Access to system components is difficult	1.29	1.76
Decreases yield	1.12	1.49
Cronbach's Alpha	0.72	0.87

Scale: 1= Not agree 2=Partly agree 3= Agree

irrigation water source, which revealed that there was a difference based on irrigation method for the maize plantation area and land ownership criteria, but there was no significant difference based on irrigation method for the soil structure, soil elevation, and irrigation water source criteria.

According to the analysis results of other information, variables such as the farmers' credit use, credit providers, the duration of installments, and interest rate were discovered to not have a normal distribution. The Mann-Whitney U test was applied, the result of which revealed that for farmers who use drip irrigation and who don't, the credit use and credit provider criteria differed based on irrigation technique, while there was no meaningful difference for the installment duration and interest rate criteria. Maize production costs and farmer income were also compared based on irrigation method; it was seen that variables relating to income and the cost of seeds, pesticide, fertiliser, petrol, water, harvest, labour, and transport per 0.1 hectares did not display normal distribution. The Mann-Whitney U test was conducted, which revealed that variables related to income per 0.1 hectares and the cost of fertiliser, water, and labour per 0.1 hectares were significant, while there was no difference for the pesticide, petrol, harvest, and transport variables. It was seen that farmers' reservations related to embracing innovation and their worry that their business would cease to be profitable effected this negatively.

Conclusıons and recommendatıons: It was discovered that farmers who use drip irrigation had a higher level of education, and farmers with a higher level of education were more ready to embrace innovation. Growers who don't use drip irrigation were found to have larger families, which is significant when it comes to the supply of a labour force, as farmers who don't use drip irrigation and instead use irrigation ditches to water their crops require more labourers on their fields. Amongst farmers who don't use drip irrigation, a large percentage had received training on irrigation systems; it was seen that any training received on the subject did not influence the farmers' decision to use drip irrigation. Drip irrigation farmers were found to have higher annual incomes than those who did not practice drip irrigation, and farmers with higher incomes found it easier to embrace the technique, as well as other innovations. Drip irrigation farmers also obtained a higher yield from their crops.

Farmers who use drip irrigation were found to have a larger area of maize fields, and that larger fields influenced the adaptation of drip irrigation methods positively, regardless of whether they were owned or rented. This shows that those practicing farming on larger areas of land are more innovative and more ready to take risks. Drip irrigation farmers were found to use less credit than those who did not practice drip irrigation. It was discovered that farmers who do not currently use drip irrigation intended to continue maize farming in the following year, and that they also wanted to use the drip irrigation method.

Suggestions were made to further raise awareness regarding water scarcity on maize farmers on the Amik Plain in Hatay, and how to relay the outcome of the use of drip irrigation to them. These suggestions, based on the results obtained from this study, are listed below.

As well as alerting farmers to new technologies; they must also be informed on any issues they might encounter while using these technologies, and it must be verified that they are implementing new methods correctly.

Efforts must be made to increase farmers' computer skills and access to the Internet (IT in agriculture).

Regular courses must be offered to increase the use of new technologies and production methods in the region. These courses must be offered on-site and must have a practical component.

The Ministry of Agriculture and Forestry and the relevant departments at universities must work in tandem to correctly direct farmers and to evaluate and check the outcome of newly implemented technologies.

The study reveals that some farmers who use the drip irrigation method are aware of the need for decreased fertiliser use, but they don't have a clear idea of how much fertilizer they should be using. Briefings regarding fertiliser use must be held.

New agricultural support policies in the region have led to a decrease in maize fields, however, some drip irrigation farmers state that they intend to continue growing maize as they can obtain a higher yield with this method. Face-to-face interviews with growers revealed that those who use drip irrigation get approximately 20% more yield than those who don't. Continued subsidies for drip irrigation systems will have a significant influence on swaying farmers' opinion.

Pigs cause great harm to maize fields, and a ban on pig hunting lands farmers in a difficult situation. This issue must be resolved swiftly.

Cooperation between farmers must be increased; this will lead to the collection of more data and fewer product marketing problems. Farmer unionisation is highly important.

Farmers stated that if the Turkish Grain Board does not purchase any maize, they have to sell their produce to merchants for a lower price. This must be kept in mind when formulating new agricultural policies.

An increased use of drip irrigation in the region will lead to an increase in the variety and amount of produce; this will support the country's economic development as well as the farmers' and the region's own economies. Farmers who use drip irrigation must be prioritised to prevent them from abandoning the practice.

Further studies must be conducted not just on drip irrigation but on any other agricultural issue growers are currently facing, and the results must be shared with them.

Conflict of Interest: The Authors declare that there is no conflict of interest.

Authors' Contribution Statements: The contribution of the authors is equal.

Acknowledgment: This study was carried out by Institute of Natural and Applied Sciences of Çukurova University.

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