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DOI

<https://doi.org/10.5281/zenodo.73025>

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**Alınış (Received):** 20/05/2022

**Kabul Tarihi (Accepted):** 26/06/2022

### Keywords

Climate change, agriculture, qualitative analysis, Mardin

## The Effects of Climate Change on the Agriculture Sector of Mardin Province: A Qualitative Research

### Abstract

This study aims to examine the effects of climate change on Mardin where both the arable land and livestock are high and the agriculture-based industry is developed and to realize perspectives of these stakeholders on implemented climate change policies in Mardin. In the study qualitative analysis methods is used and the results are aimed to guide the policies to be applied. In the study, a semi-structured questionnaire is prepared and directed to participants. The data obtained from the research is interpreted by making descriptive and content analyzes. The snowball method is used to create the sample size. Most of the participants directly associated climate change with precipitation and stated that they felt the effect of drought as result of precipitation regime change in the region. In this respect, the effect of climate change in Mardin province is perceived with the degeneration of agricultural activities and drought. However, it is seen that the producers do not take effective precautions against climate change. Agriculture sector has been affected by these extreme wheather events and natural disasters; it has also negative contribution to carbon emission. Therefore, it is important to examine the interaction between climate change and the agricultural sector on a regional basis, to measure the perception levels of relevant stakeholders about the policies implemented, and to determine the individual measures they take against climate change. The study has a unique value in terms of showing the problems of the region with the attitudes of local stakeholders against climate change.

## INTRODUCTION

Environmental problems do not only effect the geography in which they arise, but also have consequences that go beyond the borders of the country. Because of this effect, "protection of the environment" is accepted as a global public good. Combating climate change comes first in environmental problems that require global cooperation networks. As a matter of fact, climate change causes deterioration in the composition of the atmosphere as a result of human activities, resulting in consequences such as extreme weather events and natural disasters. Studies on climate change date back to 1895. However, it is clearly observed that "climate change" is the main agenda item of research, discussion, workshop and other activities on the environment today. The common result of these activities and research conducted by different disciplines is that climate change will affect many systems and processes that affect human well-being (Adams, 1989). As a matter of fact, various emissions such as carbon dioxide (CO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), nitrous oxide (NO<sub>x</sub>) arising from greenhouse gases cause global warming and climate change, while affecting sectors socially and economically. Both developed and developing countries are affected by this situation created by climate change. In recent years, climate change and its impact on the agricultural sector of developing economies have become a global concern. The change caused by climate change in the hydrological cycle can prevent reaching the ideal criteria for soil moisture balance and access to water, and the occurrence of extreme weather events can have a negative impact on production (Akalin, 2014; Karaer et al., 2021). In this respect, world food production and population projections reveal that the agricultural sector has the potential to meet food demand only if there is a moderate greenhouse gas emission condition (Adams, 1989; Kaya and Dagistan, 2016). It is accepted that the global discussion of the effects of climate change on agricultural production and food

security started with the United Nations World Food Conference (1974) convened in Rome under the supervision of the Food and Agriculture Organization (FAO). This conference was followed by the International Rice Research Institute (IRRI) and the American Association for the Advancement of Science (AAAS) symposium in 1987 and the World Food Summit (1996). World Food Summit on agricultural production, food security, extreme weather events etc. drew attention to the precautions to be taken in these matters (Akalin, 2014). For this reason, many forums and conferences have been held to discuss how to solve the climate change problem on the global platform. In this context, it is possible to talk about three basic international agreements. The first of these, the United Nations Convention on Climate Change, is the first international convention to address the problem of climate change globally. However, the Kyoto Protocol, signed by 183 countries, entered into force in 2005. Finally, the Paris Agreement was prepared in December 2015 and entered into force in November 2016. All of these agreements aim at low-carbon development, which aims to limit the use of fossil fuels and protect the climate, and contributes to the fight against sustainable development (Ma et al., 2021). The agricultural sector, which meets the compulsory food needs of individuals, has an important place in the economic structure with its contribution to foreign trade, employment and agricultural industry (Bayraç and Doğan, 2016). The agriculture sector is affected by climate change, similar to many other sectors such as tourism, health and construction. On the other hand, wrong practices in the agricultural sector also affect climate change negatively. Among these applications, water scarcity caused by irrigation methods of agricultural lands, damage to soil by chemicals used to increase harvest and productivity, energy consumption, fertilization, change in use of agricultural lands can be counted (Aydoğdu, 2020; Kaya, 2021). As a result

of these and similar applications, when the agriculture sector is evaluated on a global scale, it is the second sector that causes greenhouse gas emissions after electricity and heat production (Polat and Dellal, 2016). Especially after the second world war, the acceleration of the demand for food products with the increase in population brought conventional agriculture, which is an application for intensive input use in agriculture, to the agenda. With this application, the use of more inputs in agricultural production has brought about an increase in environmental costs. The concept of sustainable agriculture has emerged in order to reduce the destruction of environmental problems caused by agriculture. In this context, the use of products that do not harm the environment has been important in the choice of agricultural production techniques (Aydın Eryılmaz and Kılıç, 2018). On the other hand, agriculture also has a mitigating effect on climate change. While the first contribution of green plants is the capture of carbon in the atmosphere by photosynthesis, the second contribution is the reduction of greenhouse gases with the use of biofuels (Bayraç and Doğan, 2016). According to Aydoğdu (2020), who stated that climate change has negative effects on the agriculture sector, the drought due to climate change brought up the inability of agricultural lands to be irrigated enough and thus a decrease in plant varieties. Climate change also triggers natural disasters. In this context, natural disasters such as excessive precipitation, earthquakes and high temperatures cause the reduction of agricultural lands. The melting of the glaciers and the rise of sea water will similarly reduce agricultural lands and decrease the productivity of agricultural lands. In addition, increasing temperatures cause damage to natural defense mechanisms such as resin developed by trees against harmful insects, and this change becomes the main factor in the deterioration of the natural balance (Doğan and Tuzer, 2011). In the light of the

explanations above, climate change has economic effects as well as social and environmental effects in the world. Tax practices aimed at meeting natural disasters caused by climate change and reducing greenhouse gas emissions show a few examples of these (Bayraç and Doğan, 2016). Sectors such as tourism, energy and agriculture are also economically affected by climate change. Climate change may affect employment and economic growth by affecting these sectors (Başoğlu, 2014; Kaya, 2021). In addition, the fact that drought and excessive precipitation cause losses in agricultural production also affect costs. The impact of climate change on agricultural production also causes economic balances and international trade to be affected (Gurel and Şenel, 2010). In addition to the economic effects of drought, it has effects on the agriculture sector through animal and plant production, forestry and fisheries (Engindeniz and Öztürk, 2010). The contribution of the agricultural sector to the Turkish economy emerges in the form of employment, supply of compulsory food products, increasing exports and national income, and providing intermediate goods to the manufacturing sector (Uslu, 2021). Turkey gets its share from the effects of climate change on the agricultural sector globally. As a matter of fact, according to the Crop Production 1st Forecast (2021) report prepared by TURKSTAT, it is estimated that cereals, other plant products and vegetables will decrease in 2021 compared to 2020. In 2021, production amounts are expected to decrease by 4.7% at most in cereals and other herbal products, while an increase by 7.1% is expected in fruits, beverage and spice plants. Undoubtedly, in these developments, it is possible to encounter traces of the COVID-19 pandemic, which has affected all countries in recent years, as well as climate change. According to the TUSİAD (2020) Agriculture and Food Report, which reveals the possible effects of climate change in Turkey in the future, it is stated that the temperature increase should

be 2-3 °C in the determination of agricultural policies in 10-20 year projections in our country. In the related report, it is predicted that temperature increases of 1.1-1.3 °C between 2030 and 2040 may cause a decrease of 1% in production, 6-7% in productivity, and a decrease of 1.4% in production and 8-9% in productivity in the years 2040-2049 (Ministry of Agriculture and Forestry, 2020). It is expected that Turkey will be more affected by climate change due to the

differing climate structure. In addition, since the climate structure differs at the regional level in Turkey, climate change may affect the regions at different levels. The Southeastern Anatolia region, which is an arid region, is faced with temperature increase and desertification due to climate change (Öztürk, 2002). Agriculture in the province of Mardin, which is one of the provinces of the South East Anatolian region, also takes its share from the developments.

**Table 1.** Climate data of Mardin Province for the years 2020-2021 and Long-Year Averages Source: Mardin Meteorology Provincial Directorate, 2021

		January	February	March	April	May	June	July	August	September	October	November	December
Number of rainy days	2020	15	16	17	12	8	4	3	0	0	0	11	9
	2021	9	5	12	3	3	0	0	0				
	LTA(1941-2020)	12	11.1	12.3	11.5	7.8	1.8	0.5	0.4	1	6.1	8.3	11.2
Monthly Average Rainfall (mm)	2020	75.9	102.8	157.3	51.6	30.5	31.5	4	0	0	0	35.7	40.8
	2021	105.3	19.4	62.6	7.1	2.1	0	0	0				
	LTA(1941-2020)	116.7	105	97.5	83.8	47.2	6.6	3.2	2.3	4	34.8	72.3	111.2
Average monthly temperature ©	2020	3.5	3.8	10.7	14.1	19.9	26.3	31.5	30	29.3	22.9	12.1	7.5
	2021	6.4	7.8	8.8	17.6	23.7	26.8	31.3	31				
	LTA(1941-2020)	3	4.1	7.9	13.4	19.4	25.5	29.8	29.6	25.3	18.6	11.1	5.4

Source: Mardin Meteorology Provincial Directorate, 2021

In Table 1, the long-year average (UYO) of the province of Mardin covering the years 1941-2020, the number of rainy days, monthly average precipitation and monthly ambient temperature data for the years 2020 and 2021 are included. Accordingly, when the first 8 months of 2021 data are examined, it is seen that there is a 3.2 °C increase in temperatures compared to the average of many years, and a decrease of 235.2% in the monthly average precipitation compared to the long-term average and a decrease of 230.8% compared to the previous year. Again, when the first 8 months' data are examined, the number of rainy days decreased by 25 days compared to the average of many years and 43 days compared to the previous year. These indicators are of great importance for the province of Mardin, where the share of the agricultural sector in total income is quite high. Because, according to TUIK 2020 data, the share of the plant production value of Mardin province in the Level 2 region has been approximately 49%. In the same year, the total cultivated agricultural area

was 269,119 hectares and its share in the Level 2 region was approximately 53%. Therefore, when these data are taken into account, it is obvious that Mardin, which has an important share among the provinces of the Level 2 region in terms of the agricultural sector, will contribute to the development of the province by raising awareness about the developments in the agricultural sector due to climate change. In this study, conducting the interviews with leading farmers, representatives of agricultural professional organizations, relevant academicians, agro-industry operators and representatives of relevant public institutions in Mardin province, where both the arable land and livestock are high and the agriculture-based industry is developed, it is aimed to reveal the economic effects of climate change on Mardin's agriculture and perspectives on the policies implemented of the said people. In the study, the interview method, one of the qualitative analysis methods, was used and it was aimed that the results obtained would guide the policies to be implemented and

the strategic studies of the relevant institutions on the subject.

## MATERIAL and METHODS

In the study, the interview method, one of the qualitative analysis methods, was used. The determination of some of the research questions by transforming the problems related to the events or phenomena examined in the individual interviews into some predetermined

questions helps to prevent the confusion of questions that may occur during the interview, both by forming the theoretical framework and by creating a clear field of view in the interviews. For this reason, a semi-structured questionnaire was prepared and directed to the participants in order to obtain in-depth information from the interviewees. The data obtained as a result of the research were interpreted by making descriptive and content analyzes.

**Table 2.** Characteristics of the interviewed persons

Participant	Position/age/Education	Activity Period/Land if Available	District/Village	Type of Activity
U1	Producer/48 yaş/ Bachelor degree	30 yıl/1200 decaire	Kızıltepe/	Wheat, Cotton, Corn
U2	Producer/42 yr.old/High school	25 year/700 decaire	Kızıltepe/Kılduman	Wheat, Lentil, Corn
U3	Producer/68 yr. old/Primary school	50 year/100 decaire	Artuklu/Yalım	Orcharding, Small cattle
U4	Producer/65 yr. old/ High school	50 year/600 decaire	Kızıltepe/KöprUbaşı	Wheat, Corn, Greenhouse
U5	Producer/36 yr. old/ Master's degree	15 year/780 decaire	Artuklu/Eskikale	Olive, Almond, Grape
U6	Producer/44 yr. old/ Associate degree	25 year/2500decaire	Kızıltepe/Doyran	Wheat, Cotton, Corn
S1	Industrialist/56 yr. old/ Bachelor degree	22 year	Organized Industry	Bulgur wheat, Lentil
S2	Industrialist/69 yr. old/ Primary school	20 year	Organized Industry	Bulgur wheat
S3	Industrialist/54 yr.old/ Bachelor degree	10 year	Organized Industry	Bulgur wheat, Flour
A1	Academician/ 40 yr. old	7 year/ Dr. Faculty Member	Mardin Artuklu Uni.	
A2	Academician / 46 yr. old	12 year/ Assoc. Dr.	Mardin Artuklu Uni.	
A3	Academician / 38 yr. old	7 year/ Dr. Faculty Member	Mardin Artuklu Uni..	
A4	Academician /44 yr. old	9 year/ Assoc. Dr.	Mardin Artuklu Uni.	
A5	Academician /46 yr. old	11year / Assoc. Dr.	Mardin Artuklu Uni..	
K1	Sen.Agric. Eng./42 yr. old		State agency	
K2	Sen.Agric. Eng./39 yr. old		State agency	
K3	Sen.Agric. Eng /43 yr. old		Kamu State agency	

Table 2 includes the characteristics of the people interviewed to reveal the economic effects of climate change on Mardin agriculture. The leading farmers interviewed operate in Mardin Center and Kızıltepe District. The academics contributing to the study work at Mardin Artuklu University and closely monitor agricultural activities. With the meetings held, it is aimed to determine what the policy priorities should be at the local level, while revealing the effects of climate change on Mardin agriculture.

## RESULTS and DISCUSSION

### Participants' perceptions of climate change

In the first part of the study, the climate change perceptions of the interviewees were tried to be measured. For this purpose, the question "What does climate change mean to you" was asked to the participants and it was shown in Table 3 by coding and descriptive analysis according to the answers given. As a result of the results obtained, it has been determined that climate change is perceived in one or more ways.

**Table 3.** Climate change perceptions of the participants

Perception	Participant
Drought	U2-U3-U4-U5-U6-S1-S2-A1-A3-A5-K1
Decreased precipitation/Irregular precipitation	U1-A3-S1-K3
Changing weather events	U5-S3-A1
Decreased snowfall	U3-A4
Increasing day and night temperature differences	K3
Decline of seasons	U2

When the answers given by the participants are examined, U1 expresses the climate change as direct precipitation, while U2 expresses the decrease in seasons, U5, S3 and A1 changes in weather events, U3 and A4 decreases the snowfall U2,U3,U4,U5,U6,S1,S2,A1,A3 and K1 expressed it as drought. Among the participants who associate climate change with precipitation, T1 said "Climate change is precipitation" while A3 answered "Climate change is the absence of precipitation or excessive or irregular precipitation". U2, with the statement "Climate change that has four seasons, has decreased to two, especially for our region, the summer months have increased, which means a very intense drought in the region", indicating that both seasons have decreased and drought. S3 "As agriculture depends on climate, it is directly affected by climate change. The climate is not good when it is very dry or very rainy", A1 "Climate change is the irregularity in precipitation" and U5 "Climate is the long-term average of weather events in a very large area. Moving from this definition, the direct or indirect activities of human beings cause climate change by disrupting the composition in the atmosphere, and he associated climate with the change of weather events. Expressing climate change as a decrease in snowfall, U3 said, "Our vineyards and cherries dry up because there is no rain or snow. I have been in this village since my childhood. For the last 15-20 years, there has been no rain as before, sometimes the snow used to be two meters, but the snow does not fall at all

anymore. The trees get the most water from the snow, and the snow helps to end most diseases and insects. When it didn't rain, diseases increased, insects increased, yields weren't left at all", while A4 replied, "One of the most important results of global climate change can be considered as snowfall reaching almost non-existent levels. It is known that the increase in the number of days covered with snow, especially after the autumn planting of wheat and legumes, results in the water needed by the plants in the long term, in the area close to the root, and prevents the occurrence of water stress. Considering that the snow cover feeds the root zone with slow and long-term filtration, it can be said that it reduces the effect of the drought to be experienced. A large proportion of the participants expressed climate change directly as drought. This situation can be interpreted as the most important effects of the events that occurred as a result of climate change on the province of Mardin are felt as the lack of precipitation, and the fact that the precipitations that occurred especially in the 2020-2021 period may have affected the perceptions of the participants.

#### **Effects of climate change on production activity**

Another point that is wanted to be put forward together with the interviews in the study is the effects of climate change on production activities. In this context, first of all, the effects of climate change on agricultural activities were asked, and the answers obtained are shown in Table 4.

**Table 4.** Opinions of the participants on the effects of climate change on agricultural activities

Effect	Participant
Decrease in yield and quality, no product can be obtained	U1-U4-U5-U6-S1-S2-S3-A1-A2-K1-K3
Reduction / termination of agricultural activities	U2-U3-U6-A2
Change of sowing and harvesting dates	U3-A4-K2-K3
Increasing immigration from rural areas	U6-A2
Increase in diseases and pests	U3-U5

U5 used the phrase on the yield and quality decrease caused by the drought lead to climate change: "The high temperatures experienced caused the fruits we produce to dry out and be damaged during the flowering phase. This problem, which was experienced at the very beginning of fruit growing, caused yield and quality losses in the harvest." P2 emphasized the effect of the difficulties experienced on the production processes of the farmers by using the phrase "The drought negatively affects the farmers who make their living from agriculture. If the product does not come, most of the farmers cannot pay their debts because they do not have any other income. Those who borrow money, those who borrow fertilizers, pesticides, and diesel are in foreclosure. Some people have to sell some of their land to pay off their debt. Those who have water also irrigate, but when they cannot pay their debts to TEDAŞ, they are also confiscated. In other words, If there is rain, and there is no drought, the farmer's problems will be very little, but if there is a drought, the farmer ends economically speaking." K2, on the other hand, drew attention to the changes in

planting and harvesting times regarding the effects of climate change on production activities, "Drought in recent years and changes in seasonal distribution of precipitation have led to changes in planting time and harvest time. Since the past, products have been planted and harvested on a certain date every year, especially at the end of the year. In 10 years, changes have occurred on these dates due to climate change. This situation causes yield losses in dry agricultural areas." U6 used the phrase "The main source of livelihood of the majority of the people is farming. On the one hand, the fields are divided by inheritance, and when drought comes, the nation quits farming. In other words, it has social effects as well as economic effects. People flee from the village."

#### **The economic effects of climate change on agricultural enterprises**

Another point to be examined together with the interviews is the economic effects of climate change on agricultural enterprises. The opinions expressed in response to the question asked about this subject are shown in Table 5.

**Table 5.** Opinions on the economic effects of climate change on agricultural activities

Effect	Participant	Example
Decrease in the value of agricultural production	U1-U2-U4-U5-U6-S1-S2-A1-A2-A3-K2-K3	Low quality values of the products produced / no products can be purchased
Increasing the energy and water consumption used in irrigation	U2-U6-A1-A5-K1-K3	The producer has to irrigate the product 5 times instead of 2 times. It may be necessary to drill wells up to 800 m to extract water.
Increased use of inputs (seeds, fertilizers)/Increased production costs	U2-U3-U5-A1-K3	As irrigation increases, the amount of fertilizer and seed used also increases.
Creating new investment costs	U3-A1	Drying of fruit trees
Decreased soil fertility	U2	Excessive irrigation reduces nutrients in the soil.

U2, who associates the impact of climate change on agricultural production with the decrease in agricultural production, increase in energy costs, and loss of soil fertility due to the increase in fertilizer use, said, "There is a drought or the yield of the products decreases, it becomes poor quality. This time, when the producer irrigates, there is excessive energy consumption. When you water too much, the soil becomes barren, and it needs more fertilizer, which means more cost. You will use the seed more, the fertilizer and the pesticide more. We can't pay for the electricity anyway, and if there is no rain, it will increase." A1, on the other hand, drew attention to the change in product pattern and new investment costs due to input and irrigation costs, "Record temperatures in the summer months create both economic and environmental negatives by creating the need for more irrigation in second crop cultivation, thus more energy needs and input costs. If the said effects continue for a long time, it will force the farmer economically, as it will require the

abandonment of the existing product pattern and switching to different products, as a result of which the adaptation process and new investment costs will be required." "The cost pressure created by climate change on agricultural enterprises should be seen as one of the possible expected economic effects, such as the decrease in the motivation of producers to make agricultural production in the long run, and the contraction in food supply and price increases. Considering the importance of the agricultural sector in terms of food safety and human life, it is possible to conclude that the issue should not be left to market owners and public support should be increased.

### **Effects of climate change on Agricultural Industrial Enterprises**

Another issue discussed in the study is the effects of climate change on agro-industrial enterprises. The answers given by the participants to the questions asked in this context are shown in Table 6.

**Table 6.** Opinions on the effects of climate change on agro-industrial enterprises

Effect	Participant
Rising raw material prices/increasing costs	S1-S2-S3
Increasing need for imported raw materials	S2-S3
Decreasing capacity utilization rate	S2-S3
Decreased competitiveness with businesses in other regions	S1
Decreased sales	S2
Decreased product quality	S2

S1 associates the economic impact of climate change on agriculture-industry enterprises with the decrease in agricultural production value, productivity losses and cost increases, and said, "Climate change has caused a decrease in precipitation in our region, which in turn affects the agricultural sector negatively as it leads to yield loss. Efficiency decreases, which causes the price of the raw material we use to rise. The prices of not only raw materials, but also other inputs, such as packaging, electricity, fuel, etc., increase. But we cannot raise the price of our final product at the same rate because when we do, we cannot compete with other companies. Recently, consumers

are turning to affordable products, so our profits are decreasing, which negatively affects us economically." S2, on the other hand, summarized the current situation, by evaluating the competitive pressure created by the impact of climate change on product quality and product prices: "If the climate is not good, our raw material, namely wheat, becomes scarce or its quality is low. Prices are also rising. We can't find a market because of quality, and our cost is increasing, so no one buys a poor quality product at a high price. Our sales are also declining." S3 explained the negative impact of the decrease in product quality caused by climate change on exports by



"We have to use quality raw materials in order to compete both in exports and in the domestic market, and the best quality durum wheat is obtained in Mardin as raw material. When the climate is bad, for example, our costs increase because wheat prices have risen excessively this year. Import products are both of poorer quality and it's cost is more expensive.. The biggest problem for us is the increase in costs and the difficulty in finding quality raw materials."

### Measures to take the effects of climate change

Another point of focus of the study is to reveal the measures taken against

climate change. In this context, the activities of producers, industrialists and public institutions are explained with the help of separate tables.

### Measures taken by producers against climate change

Table 7 shows the measures taken by the producers against climate change. Accordingly, producers take precautions such as insuring the crops, using pressurized irrigation systems, changing the crop pattern, transferring their lands to others, planting local varieties and using organic fertilizers.

**Table 7.** Measures taken by producers against the negative effects of climate change

Precaution	Participant	Example
Insuring products	U1-U2-U4-U6-	Agricultural insurance
Using pressurized irrigation systems	U2-U5-K3	Drip irrigation
Changing the product pattern/Sowing products that require less water	U4-U6-K3	Planting pistachios, Almonds, Olives instead of wheat
Handing over their land to others	U4	Lease to land owners with irrigation
Local varieties sow/sew	U5-	Anklet olives
Using organic fertilizers	U5	Olive pomace (olive pulp)
Doing nothing	U3-U4-U6	

When the responses given to the semi-structured questionnaires are examined, it is possible to say that the precautions taken by the producers against climate change and their awareness levels are related to their education levels. As a matter of fact, U6 made a statement about the measures taken against climate change by saying "As individuals, we cause different amounts of carbon emissions due to the place we live in and our way of life. In this case, the carbon footprint of each individual is different. Personally, in this case, I prefer to use less cars and more public transport. I recommend the producers, who have the opportunity and conditions, to benefit from solar energy as a renewable energy source. The increase in the presence of trees that absorb carbon dioxide and release oxygen is very important. In this regard, we support some farmers in setting up a garden. We

advise the producers to act with local varieties when setting up a garden against climate change." U1 used the expression "We get ideas from agricultural engineers from the Provincial Directorate of Agriculture, they try to guide us, but for example, they suggest products that require less water, like peanuts, soybeans, they don't have much market, so I don't want to plant them." by drawing attention to the irrigation costs of the product groups recommended for combating climate change. Similarly, U2 emphasized that the proposals made for combating climate change were mostly not adopted by the producers. U2 used the phrase " We tell our farmer friends that drip irrigation is better, but most of them say that drip irrigation is troublesome and it is easier for them to leave the water in the field." and underlined that cost concerns are the first priority for

the producer. Saying that the producers did not take any precautions against climate change, U4 argued that the state should resort to command control methods and that the climate problem should not be left to the preferences of individuals. As a matter of fact, U4 expressed an opinion as " We are not doing anything. Honestly, I don't think any farmer knows what you're talking about that causes climate change (referring to the factors that cause climate change) and no one takes individual measures for it. Even if they already know, I don't think anyone would compromise their comfort. People are accustomed to comfort, if the state is forced to do something, maybe they will adapt, otherwise no one will take any precautions." Similarly, U2 used the expression " In fact, the state should strictly prohibit irrigation (overflow irrigation) in

that way, and it is waste of water, and the water level is getting lower and lower (talking about the underground water level). The water is decreasing, there is no water wastage and less electricity is used in drip irrigation." U6 also stated that although he did not burn any stubble, he did not take any precautions individually.

#### **Activities of state agencies**

Table 8 presents the activities of state agencies on climate change. According to the statements of the interviewed managers, it is seen that state agencies work to raise awareness of the producers, carry out social responsibility projects, provide financial support, organize demonstration activities and carry out various projects in order to eliminate the negative effects of climate change on agricultural production in Mardin.

**Table 8.** Activities of state agencies on climate change

Activity	Participant	Example
Raising awareness of farmers	K1-K2-K3	Conscious irrigation, use of fertilizers, planting of alternative crops
Financial supports	K2-K3	There are supports for pressurized irrigation and solar energy use
social responsibility	K3	Afforestation campaigns
Demonstration activities	K3	Studies on how to produce products such as sesame cultivation and peanuts
Projects	K3	Rangeland improvement, Establishment of orchards

Drawing a general framework on these activities, K3 made a statement as " Awareness raising activities are carried out within our provincial borders, especially for products that are resistant to drought and have low water demand. Afforestation-research studies are carried out jointly with the relevant institutions (DSI, Forestry Directorate, Meteorology, University, etc.), and awareness raising studies are carried out on the harms of excessive irrigation. Solar energy and pressurized irrigation systems, which are renewable energy types, training-dissemination activities and support of these projects are implemented. Our producers are directed to measures to protect the soil by applying alternating

farming system and minimum tillage, to the production of drought-resistant species and varieties with low water consumption despite climate changes manifested by lack of precipitation. Alternative crop cultivation projects (pistachio, olive, almond, lavender, lentil and soybean projects) are implemented."

#### **Recommendations for reducing the effects of climate change**

Table 9 summarizes the opinions of the interviewed participants on the measures to be taken to reduce climate change. One of the measures to be taken to reduce the impact of climate change on agricultural production is the dissemination of alternative product patterns.

**Table 9.** Recommendations for reducing the effects of climate change

Suggestion	Participant
Creation of alternative product patterns	A1-A2-A4-A5-K1-K2-K3
Prevention of stubble burning by planting stubble	A2-A3-A5
Increasing farmer training activities	A1-A3-K2
Preference of pressure irrigation systems	K3-A5
Increasing existing supports	A1-A4
Use of alternative energy sources (Solar Energy etc.)	U5
Completion of the GAP	S2
Compliance with the EU Green Deal	A5

In this context, K3 said that " products that need less water (soybeans, lavender, peanuts, sesame, etc. must be grown." However, at this point, A1 mentioned the importance of implementing active policies that are not limited to education and awareness-raising activities of the state by saying "It is necessary to determine new product patterns for each region in accordance with the changing climatic conditions and to train the farmers on the cultivation of these products." A5 also added that the awareness level of young farmers about environmental problems is higher by saying "In order for the new products to be added to the product pattern to be adopted by the farmers, it is required to be supported and encouraged by the state for a certain period of time. Controlled production systems should be supported (100% subsidization of these investments, etc.)". In this context, he argued in A3 that "deterrent measures should be taken" in order to eliminate the problem of stubble burning, which is another important problem in the region. U5 stated that renewable energy sources such as solar energy should be used, and S2 underlined that the completion of the GAP is essential for the region's agriculture and economy. As a matter of fact, S2 expressed his concerns and solution proposal by using his statement " If this continues, God forbid, we will all starve. If there is no wheat, there is no bulgur or flour. We rank first in the world in bulgur export, but if the climate continues like this, we will not have a chance to compete in the coming years due to price and quality. The state needs to finish the GAP as soon as possible and open up irrigation opportunities to farmers."

## CONCLUSION

Most of the participants directly associated climate change with precipitation and stated that they felt the effect of precipitation regime change and drought in the region. In this respect, the effect of climate change in Mardin province is perceived together with the change of agricultural activities and drought. The increase in the irrigated areas and the number of irrigation with the experienced drought causes both the barren lands and the increase in the use of inputs, resulting in an increase in production costs and an increase in energy consumption. For this reason, for agricultural producers, the pressure of drought on irrigation and energy costs takes precedence over environmental concerns. The decrease in supply with increasing costs increases both the prices and the import of raw materials needed by the agriculture-based industry. As a result, the cost and demand pressure in agricultural production harms both the producer and the consumer. Another effect that comes with climate change is that, with the decrease in product efficiency and product quality, the current production becomes uncompetitive in domestic and foreign markets and the situation increases in economic difficulties for the agriculture-based industry in the region. The basic adaptation strategy developed by manufacturers against climate change is to change the product pattern. This situation shows itself with the increase in pistachio and almond cultivation areas in the plain region of the province in recent years. Although the conversion of field crops such as wheat, corn and barley into horticultural crops will provide savings in irrigation and energy use, it should also be

taken into account that the aforementioned products, which are called strategic products, will reduce the cultivation areas and therefore the production. However, in order to find a more comprehensive solution to the problem, it is seen that there is a need to increase public support for the use of renewable energy sources, which is a costly investment area, and the transition to drip irrigation method. It is also understood that control mechanisms should be developed and deterrent measures should be taken in order to prevent applications such as stubble burning, which manufacturers consider less costly and more effortless. Other important policies are the dissemination of training activities for the producers to understand the importance of climate change and the completion of the GAP in order for the producer to get rid of the cost pressure.

#### ACKNOWLEDGMENT

This study was presented as a notification at the 4th Kahramanmaraş Management, Economy and Politics Congress (2021).

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