Chapter 13 Impacts of Climate Change on Agricultural Production in Arid Areas: Economic Analysis of Climate Changes on Agricultural Production Systems and Identification of Policy and Institutional Measures in Cukurova and Central Anatolia Regions

Onur ERKAN*   Ufuk GÜLTEKİN*   Cennet OĞUZ**

** Cukurova University, Faculty of Agriculture, Department of Agriculture Economics, Adana, TURKEY*
*** Selcuk University, Faculty of Agriculture, Department of Agriculture Economics, Konya, TURKEY*

1. Introduction

Current evidence indicates that since the mid 19th century, the average surface temperature of the Earth has risen by between 0.4°C and 0.8°C. The warming trend has been most pronounced during the past decade and in higher latitudes. Ocean temperatures are also rising, expanding the volume of water, and that expansion, combined with water from melting glaciers, has raised global sea level by about 10 to 20 centimeters over the past century. Although scientists have improved their understanding of the atmosphere, oceans, and climate in recent years, they are uncertain about whether the warming that has occurred has caused more extreme weather, such as more and bigger hurricanes, floods, and droughts. On the other hand, there are uncertainties about how will policies to control emissions of greenhouse gases or to encourage technological developments affect the accumulation of gases in the atmosphere? And how much will those policies cost? (CBO, 2003).

High temperatures will be accompanied by rising sea levels and more frequent occurrence of extreme weather events such as floods, droughts and storms. We are now experiencing these extreme weather events in many countries. These events might occur more frequently and hazardous in the coming years.

The latest unforecasted events in the climate show that the world's climate is most probably changing. The floods in Germany, in Hungary and in Turkey in 2002; hurricanes in USA (Hurricane Katrina) have killed many people and set off alarm bells among the people in these countries. In late 2006, the flooding followed torrential rain and affected mainly the south-east, but also southern and western Turkey and caused for the deaths of more than 40 people.

According to Synthesis Report of IPCC, 2001; extreme events are currently a major source of climate-related impacts. For example, heavy losses of human life, property damage, and other environmental damages were recorded during the El Niño event of the years 1997–1998. The impacts of climatic extremes and variability are a major concern. Preliminary indications suggest that some social and economic systems have been affected by recent increases in floods and droughts, with increases in economic losses for catastrophic weather events. Because these systems are also affected by changes in socio-economic factors such as demographic shifts and land use changes, quantifying the relative impacts of climate change (either anthropogenic or natural) and of socio-economic factors is difficult. For example, direct costs of global catastrophic weather-related losses, corrected for inflation, have risen an order of magnitude from the 1950s to the 1990s (Figure 1), and costs for non-catastrophic weather events have grown similarly. The number of weather-related catastrophic events has risen three times faster than the number of non-weather-related events, despite generally enhanced disaster preparedness. Part of this observed upward trend in weather-related losses over the past 50 years is linked to socio-economic factors (e.g., population growth, increased wealth, urbanization in vulnerable areas), and part is linked to regional climatic factors (e.g., changes in precipitation, flooding events).

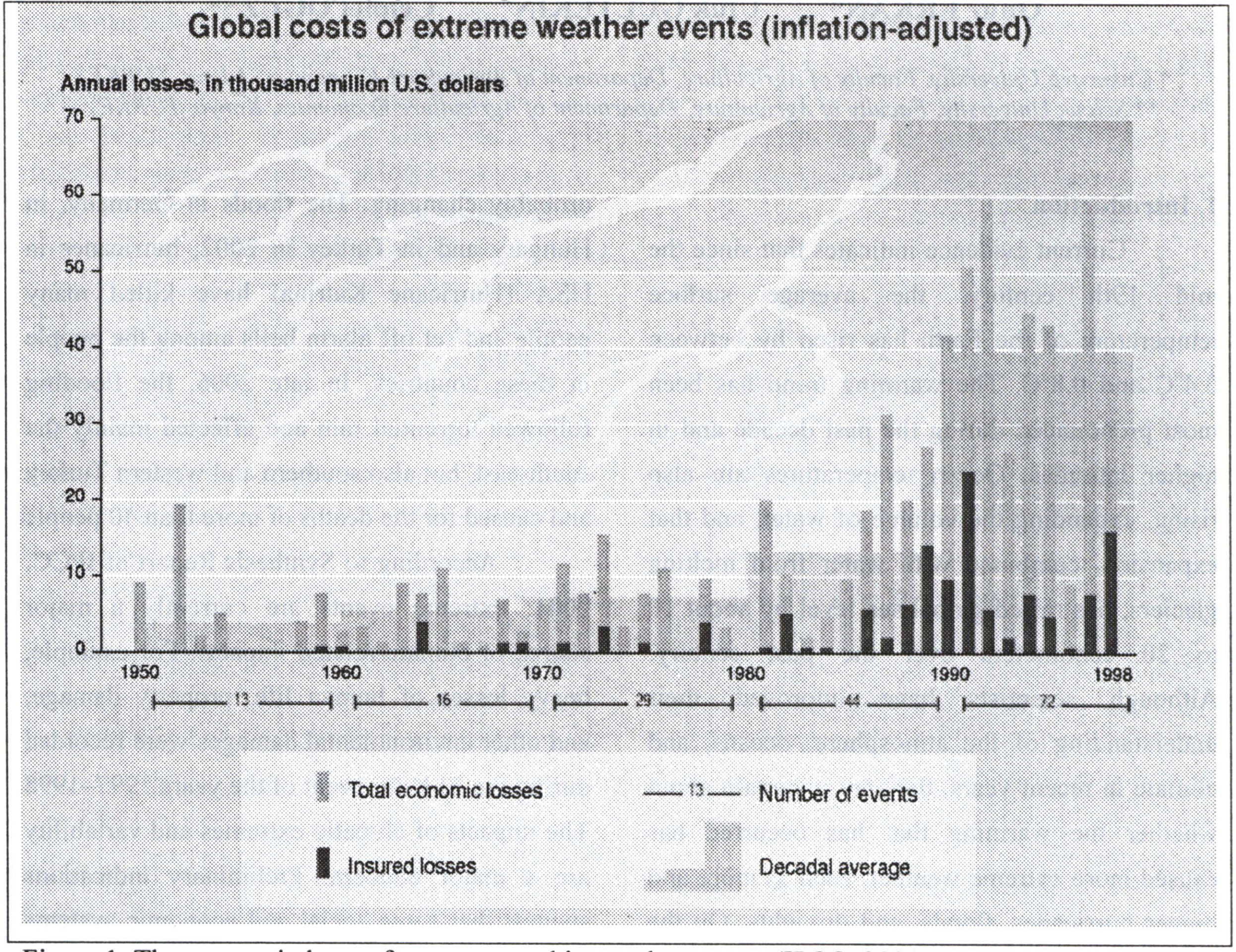


Figure 1: The economic losses from catastrophic weather events (IPCC, 2001a).

The scientific evidence on global climate change and especially on global warming is now stronger than ever. The forecast studies in relation to global warming show that the temperature of the world will rise between 0.3 to 1.3 degrees Celsius during the next 30 years. Another recent study projected an increase in the average global temperature of 2.4°C between 1990 and 2100, with a 95 percent chance that the change will be between 1.0°C and 4.9°C (CBO, 2003).

Some other scientists (Darwin et al, 1995), evaluated for global-climate-change scenarios. They were derived from results projected by meteorological models at the Goddard Institute for Space Studies, the Geophysical Fluid Dynamics Laboratory, the United Kingdom Meteorological Office, and Oregon State University and embody a range of average global temperature and precipitation changes (2.8-5.2 °C and 7.8-15.0 percent, respectively).

Similarly, according to "pseudo warming ver.3" data calculated by Climate sub-group of ICCAP project shows that temperature will rise between 2.3 °C – 3.8 °C and precipitation will decrease 58mm – 266 mm in the project area of Adana and Konya (Figure 2).

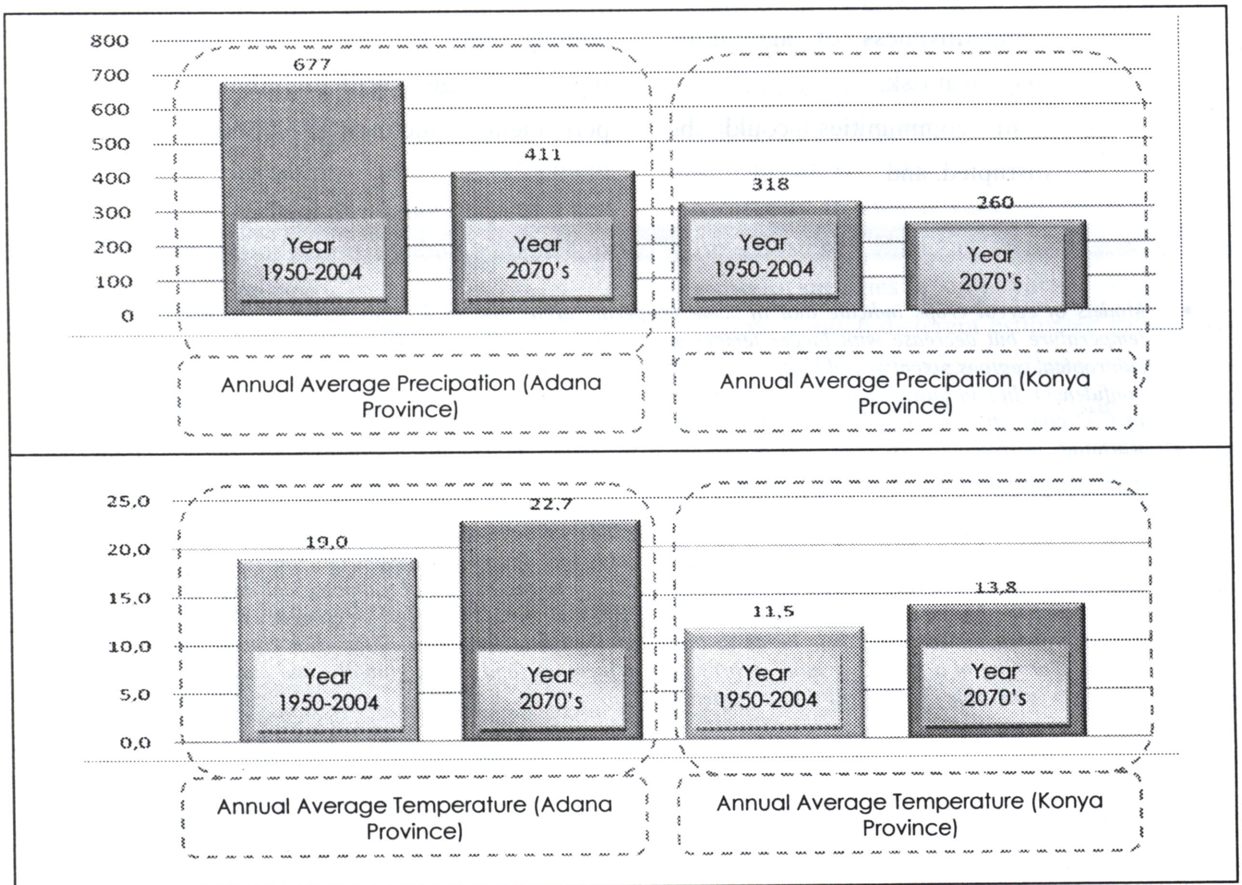


Figure 2. Annual Precipitation and Temperature Changes in Adana and Konya.

Source: (1) Station data from "Turkish State Meteorological Sevice" (1950-2004)
(2) Estimations are calculated by the authors from "RCM Pseudo Warming Outputs ver. 3"

The changes in climate will also affect agriculture. Although scientists are uncertain about the impact of the climate changes on agriculture, they agree on some likely effects. Some scientists claim that global warming could increase water supply in some water-scarce areas and hence increase crop yields in temperate and in some subtropical zones. It is claimed that higher crop yields could result from the carbon dioxide fertilizer effect. However, to get this positive effect, the existence of a certain amount of water or nitrogen in the soil is necessary.

On the other hand, rising temperatures and frequent extreme weather events will cause damages to agricultural production but agriculture will also suffer from increased pests and diseases. And also soil is expected to erode and degrade due to heavy rains and storms. Moreover livestock and fish production systems will also suffer from rising temperatures and extreme weather events (Box 1). The United Nations' Intergovernmental Panel on Climate

Change (IPCC) forecasts that crop yields will decrease and flooding risk will increase in most tropical and subtropical regions.

This means that, for some regions,

- the long-term productivity and competitiveness of agriculture may be at risk,
- farm communities could be disrupted, and
- conflicts over environmental impacts of agriculture on land and water resources could become increasingly contentious.

We are expecting climate changes in the coming years. But we are not certain about the type of changes. Will this climatic changes be permanent or fluctuating? Nobody knows...

Box 1. *Agricultural effects of climate change if no climate policy interventions are made.*

- *Models of cereal crops indicate that in some temperate areas potential yields increase for small increases in temperature but decrease with larger temperature changes (medium to low confidence). In most tropical and subtropical regions potential yields are projected to decrease for most projected increases in temperature (medium confidence). In mid-latitudes, crop models indicate that warming of less than a few °C and the associated increase in C02 concentrations will lead to generally positive responses and generally negative responses with greater warming. In tropical agricultural areas, similar assessments indicate that yields of some crops would decrease with even minimal increases in temperature because they are near their maximum temperature tolerance. Where there is also a large decrease in rainfall in subtropical and tropical dryland/rainfed systems, crop yields would be even more adversely affected. Assessments that include autonomous agronomic adaptation (e.g., changes in planting times and crop varieties) tend to project yields less adversely affected by climate change than without adaptation. These assessments include the effects of C02 fertilization but not technological innovations or changes in the impacts of pests and diseases, degradation of soil and water resources, or climate extremes. The ability of livestock producers to adapt their herds to the physiological stresses associated with climate change is poorly known. Warming of a few °C or more is projected to increase food prices globally, and may increase the risk of hunger in vulnerable populations (low confidence).*

	Year		
	2025	**2050**	**2100**
CO_2 concentration	405-460 ppm	445-640 ppm	540-970 ppm
Global mean temperature change from the year 1990	0.4-1.1°C	0.8-2.6°C	1.4-5.8°C
Global mean sea-level rise from the year 1990	3-14 cm	5-32 cm	9-88 cm
Agricultural Effect			
Average crop yields*	• Cereal crop yields increase in many mid- and high-latitude regions (low to medium confidence). • Cereal crop yields decrease in most tropical and subtropical regions (low to medium confidence).	• Mixed effects on cereal yields in mid- latitude regions. • More pronounced cereal yield decreases in tropical and subtropical regions (low to medium confidence).	• General reduction in cereal yields in most mid- latitude regions for warming of more than a few °C (low to medium confidence).
Extreme low and high temperatures	• Reduced frost damage to some crops (high confidence). • Increased heat stress damage to some crops (high confidence). • Increased heat stress in livestock (high confidence).	• Effects of changes in extreme temperatures amplified (high confidence).	• Effects of changes in extreme temperatures amplified (high confidence).
Incomes and prices		• Incomes of poor farmers in developing countries decrease (low to medium confidence).	• Food prices increase relative to projections that exclude climate change (low to medium confidence).

*) These estimates are based on the sensitivity of the present agricultural practices to climate change, allowing (in most cases) for adaptations based on shifting use of only existing technologies.

Source: IPCC, 2001a.

In addition, the time horizon for climate change is long. The climate impacts of decisions made in the next decade or two will be felt over the next century and beyond. As a result, technology and, more specifically, improvements in the rate and direction of technological change, will play a very important role. Three aspects of technology can be distinguished (IPCC, 2001b):

- invention (the development, perhaps in a laboratory, of a new production method, product, or service),
- innovation (the bringing of new inventions to the market), and
- diffusion (the gradual adoption of new processes or products by firms and individuals).

Whether and how changes in a crop variety are specified in a study can have a large impact. Studies conducted of wheat response in Australia found impacts ranging from -34 to +65% for the same climate scenario and site depending on which known and currently grown wheat cultivar was specified in the crop model. Similarly, another research concluded that the severe yield losses in South, Southeast and East Asia for rice in many scenarios was due to a threshold temperature effect that caused spikelet sterility but that genetic variation with regard to the threshold likely provided significant opportunity to switch varieties as temperatures rose (Box 2). Thus, an impact analysis that narrowly specifies a crop variety is likely to generate a much different estimated impact than an analysis that specifies responses on the basis of the genetic variation across existing cultivars. Some studies have attempted to evaluate how future crop breeding may change the range of genetic variability available in future varieties (Reilly, 1996).

Box 2. Regional crop yield for 2xCO_2 GCM equilibrium climates.

Region	Crop	Yield impact (%)	Countries studied/comments
Latin America	maize	-61 to increase	Argentina, Brazil, Chile, Mexico. Range is across GCM scenarios, with and without the CO_2 effect.
	wheat	-50 to -5	Argentina, Uruguay, Brazil. Range is across GCM scenarios, with and without the CO_2 effect.
	soybean	-10 to +40	Brazil. Range is across GCM scenarios, with CO_2 effect.
Former Soviet Union	wheat grain	-19 to +41 -14 to +13	Range is across GCM scenarios and region, with CO_2 effect.
Europe	maize	-30 to increase	France, Spain, N Europe. With adaptation, CO_2 effect. Longer growing season; irrigation efficiency loss; northward shift.
	wheat	increase or decrease	France, UK, N Europe. With adaptation, CO_2 effect. Longer season: northward shift, greater pest damage;
	vegetables	increase	Lower risk of crop failure.
North America	maize	-55 to +62	USA and Canada. Range across GCM scenarios and
	wheat	-100 to +234	Sites with/without CO_2 effect.
	soybean	-96 to +58	USA. Less severe or increase in yield when CO_2 effect and adaptation considered.
Africa	maize	-65 to +6	Egypt, Kenya, South Africa, Zimbabwe. With CO_2 effect, range across sites and climate scenarios.
	millet	-79 to -63	Senegal. Carrying capacity fell 11-38%.
	biomass	decrease	South Africa; agrozone shifts.
South Asia	rice maize wheat	-22 to +28 -65 to-10 -61 to +67	Bangladesh, India, Philippines, Thailand, Indonesia, Malaysia, Myanmar. Range over GCM scenarios, and sites; with CO_2 effect; some studies also consider adaptation.
Mainland China and Taiwan	rice	-78 to +28	Includes rainfed and irrigated rice. Positive effects in NE and NW China, negative in most of the country. Genetic variation provides scope for adaptation.
Asia (other) and Pacific Rim	rice	-45 to +30	Japan and South Korea. Range is across GCM scenarios. Generally positive in northern Japan; negative in south.
	pasture	-1 to +35	Australia and New Zealand. Regional variation.
	wheat	-41 to +65	Australia and Japan. Wide variation, depending on cultivar.

Source: Reilly, 1996.

It is almost clear that the impact of climatic changes will be different in different geographic regions. For example 2°C temperature increase will result different impacts on continental and subtropical climatic zones. Presently scientists from different disciplines are conducting researches in different parts of the world in order to better understand the impact of climate changes on agriculture and the role of agriculture on climate changes. A multidisciplinary research is needed to explore the interrelations between climatic events and their impact on soil structure, irrigation sources, plant yields and quality, livestock yields, farm structure and income etc. in different agro-climatic zones of the world. This subproject which covers the socio-economic aspects of the impact of climate change on agriculture is a part of multidisciplinary research.

The purposes of this subproject are:

- to identify the effect of global warming on economic structure and economic results of farms,
- to determine the impact of global warming on soil fertility, crop yields, cropping patterns, water availability/use/conservation, new technology,
- to understand farmers' perception and behavior concerning natural resources and agricultural production.
- to identify necessary policies and institutional measures to cope with global warming.

2. Material and Method

2.1. Material

Table 1. Number of interviewed farmers in 2006

The main material that is used in this research is obtained from the questionnaire that is applied to the farmers by the research team. The questionnaire was pretested in the two research provinces before its application to sample farmers. Also some secondary data such as reports and statistics were used to facilitate and to support the research.

2.2. Method

Primary data were collected from two different geographic zones: the first zone is subtropical zone which covers the Cukurova region that is in the east Mediterranean region. The second region is selected from Central Anatolia which represents the continental climate.

Adana province was selected to represent the subtropical zone and Konya province was selected to represent continental climate.

2.2.1. Selection of Villages

Two irrigated and two rainfed villages were selected from the plain part of Adana province to represent subtropical zone. Five irrigated and two rainfed village were selected from the plain part of Konya province in the Central Anatolia.

The "judgement sampling" method was used in selecting the villages. Soil classes, cropping pattern, livestock situation, agricultural production techniques, economic structure and distribution of farms were taken into consideration as criteria in representing the zones.

The names of irrigated and rainfed villages from two provinces are given below:

ADANA				KONYA			
Irrigated		Rainfed		Irrigated		Rainfed	
Name of Village	Number of Quest.	Name of Village	Number of Quest.	Name of Village	Number of Quest.	Name of Village	Number of Quest.
Kadıköy	22	Yeniyayla	18	İ. Çumra	10	Sarayönü	10
Taşcı	18	Çiçekli	14	Beylerce	7	Çeşmelisebil	17
TOTAL	**40**	**TOTAL**	**32**	Okçu	7	**TOTAL**	**27**
				Karkın	4		
				Merkez	7		
				TOTAL	**35**		

2.2.2. Selection of Farmers

The farms in the villages were stratified according to farm size groups. From each group a representative number of farmers were interviewed. The farmers were selected randomly and those who are willingly and voluntarily cooperate with the researches were interviewed.

2.2.3. Analysis of Data

Appropriate computer programs such as SPSS was be used in the analysis of the data.

3. Results and Discussion

At the beginning of the ICCAP Project the objectives of the socio-economic subgroup were determined as follows:

a) to identify the effect of global warming on economic structure and economic result of farms,
b) to determine the impact of global warming on soil fertility, crop yields, cropping patterns, water availability/use/conservation, new technology,
c) to understand farmers' perception and behavior concerning natural resources and agricultural production,
d) to identify necessary policies and institutional measures to cope with global warming.

The objectives of (a) and (b) could not been accomplished because the accomplishment of these objectives depended on the outputs of climate, vegetation and crop productivity subgroups.

Our group needed information about how the temperature and precipitation will change in the future and how these changes will affect the present crops and livestock, and what are the probable substitutes of these crops and livestock in order to determine the effect of global warming on cropping pattern, crop yields, economic structure and economic result of the farms.

The knowledge which are necessary to accomplish the objectives of (a) and (b) have not been produced until November 2006.

Therefore our subgroup focused its efforts to objectives (c) and (d).

The data collected from the farmers in Adana and Konya provinces were grouped as irrigated and rainfed agriculture and the findings of the research are presented accordingly.

3.1. Adana Province

3.1.1. Irrigated Villages of Adana Province

In the first part of this section, some socio-economic indicators of the farms are given. In the second part, farmers' perception and behavior concerning climate change were examined.

3.1.1.1. Some Socio-Economic Indicators of the Irrigated Farms

Distribution of interviewed farmers by farm size groups is given in Table 2.

Table 2. Distribution of farms by farm size groups

Farm size groups (da)	Group Code	Quantity	%
1-75	1	15	37,5
76-150	2	16	40,0
151 +	3	9	22,5
Total		40	100,0

One typical socio-economic indicator of the surveyed farmers is the distribution of farm managers by age groups. The ages of the farm managers vary between 25 and 70. There are farm managers from all age groups (Table 3).

Table 3. Distribution of farm managers by age groups

Age groups	Group Code	Quantity	%
25-45	1	15	37,5
46-55	2	17	42,5
56 +	3	8	20,0
Total		40	100,0

Education level is another socio-economic indicator of the research area. The majority of the farmers are primary school graduates. There are also secondary and high school graduates but there are not any agricultural vocational school graduates among the farmers (Table 4).

Table 4. Education level of farm managers

Group Code	Education level	Quantity	%
1	Literate	2	5,0
2	Primary school	21	52,5
3	Secondary school	10	25,0
4	High school	7	17,5
Total		40	100,0

The average size of the irrigated farms is 130,9 decars. In the investigated villages, the more the farm size increases, the more the number of plots and average plot size increases (Table 5).

Table 5. Average farm size, number of plots and average plot size

Farm size groups	Average Farm Size (da)	Number of plots	Average plot size (da)
1	30,1	1,9	20,5
2	108,2	3,9	34,3
3	338,9	5,9	59,1
Mean	130,9	3,6	34,7

Cropping pattern of the farmers reflect their agricultural production activities under irrigated conditions. Farmers in the research area prefer diversified farming rather than specialized farming. Wheat, maize, vegetables and citrus are major enterprises of the farmers. Groundnut, watermelon and cotton are also important enterprises of the research area (Table 6).

Table 6. Size of cultivated area by crops (da)

Farm size groups	Maize	Wheat	Vegetable	Citrus	Groundnut	Watermelon	Cotton	Barley	Total
1	3,0	14,5	7,1	3,2	2,3	-	-	-	30,1
2	60,1	21,1	14,3	2,5	4,1	2,5	2,4	1,2	108,2
3	250,5	17,2	31,2	31,7	-	5,5	2,8	-	338,9
Mean	81,5	17,8	15,4	9,3	2,5	2,3	1,6	0,5	130,9

3.1.1.2. Farmers' Perception and Behavior Concerning Climate Change

Farmers' perception and behavior concerning climate change have been examined as temperature increase and precipitation decrease. The answers of the farmers reflect how they perceive climate change and how they react towards climate change.

3.1.1.2.1. Farmers' Perception Concerning Temperature

Forty percent of the farmers think that the temperature has increased in the last 20 years. And 30 % of the farmers believe that the temperature tend to increase. 20 % of the farmers say that the temperature has not changed. Only 10 % of the farmers say that the temperature has decreased (Table 7). As can be seen from these figures the majority of the farmers think that the temperature has started to increase in the last 20 years.

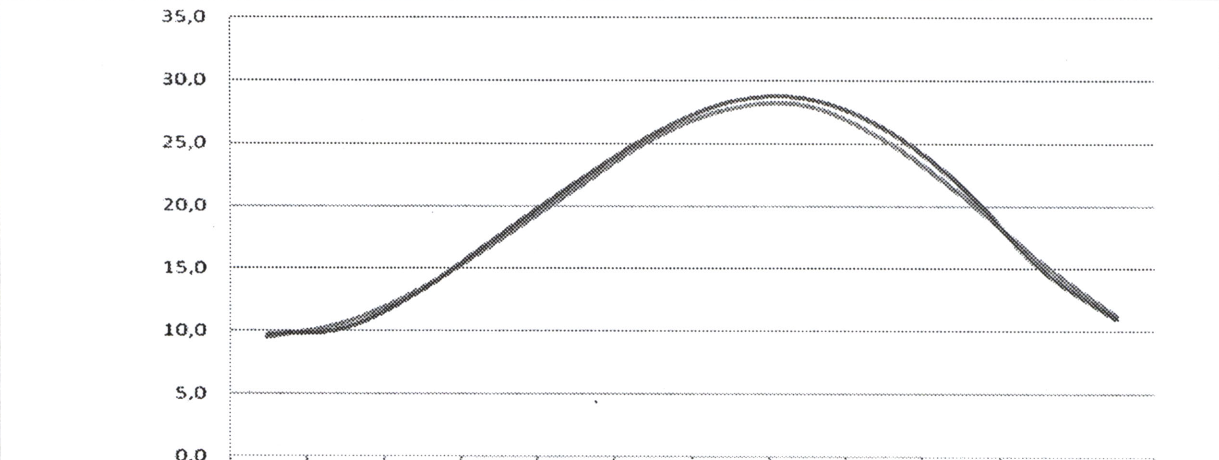
Table 7. Farmers' perception concerning temperature in the last 20 years

Age groups	Temperature									
	Increased		Decreased		Not Changed		Tend to increase		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%
1	7	46,7	2	13,3	5	33,3	1	6,7	15	100,0
2	7	41,2	1	5,9	2	11,7	7	41,2	17	100,0
3	2	25,0	1	12,5	1	12,5	4	50,0	8	100,0
Total	16	40,0	4	10,0	8	20,0	12	30,0	40	100,0

Farmers reported that the temperature was very high in 1994, 1997, 2001 and 2002. And due to high temperatures in June and July in these years maize did not pollinate adequately. Also in these years citrus trees were damaged due to high temperatures.

On the other hand, "Turkish State Meteorological Service" data from 1950 to 2004 show that monthly and yearly temperature have increased in the last 25 years. Average monthly temperature was calculated 18.9 °C during the 1950-1980, and it rose up to 19.1 °C in the period of 1981-2004 (Figure 3 and Figure 4).

The results of the analyses of the last fifty years' meteorological data confirm the farmers' views concerning temperature increase.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
1950-1980	9,5	10,7	13,4	17,2	21,3	25,3	27,7	28,0	25,3	21,0	15,7	11,3
1981-2004	9,7	10,2	13,2	17,5	21,8	25,7	28,3	28,5	26,3	21,7	15,2	11,0

Figure 3. Average Temperature in Adana (Monthly, °C)
Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

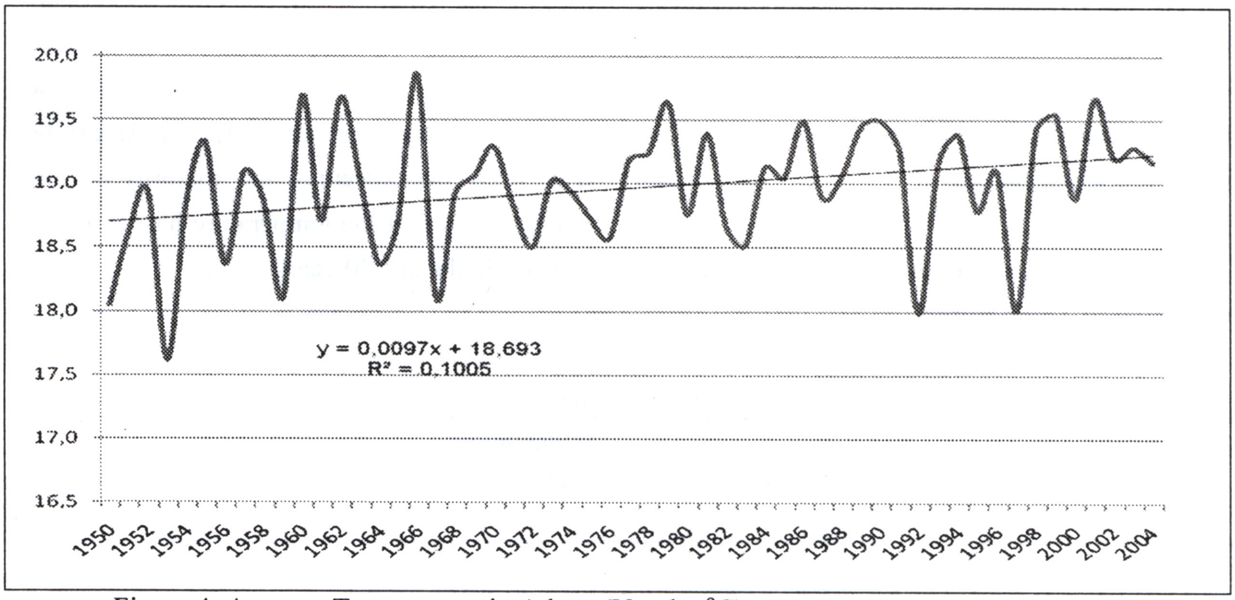


Figure 4. Average Temperature in Adana (Yearly, °C)
Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

3.1.1.2.2. Farmers' Perception Concerning Precipitation

Farmers think that the precipitation has decreased in the last 20 years. 75% of the farmers say that the precipitation has decreased but 17,5% of the farmers think that the precipitation tend to decrease. Only 5 % of the farmers say that the precipitation has not changed and one farmer said that he had no idea about the changes in the amount of precipitation. These figures indicate that the majority of the farmers think that the precipitation is decreasing (Table 8).

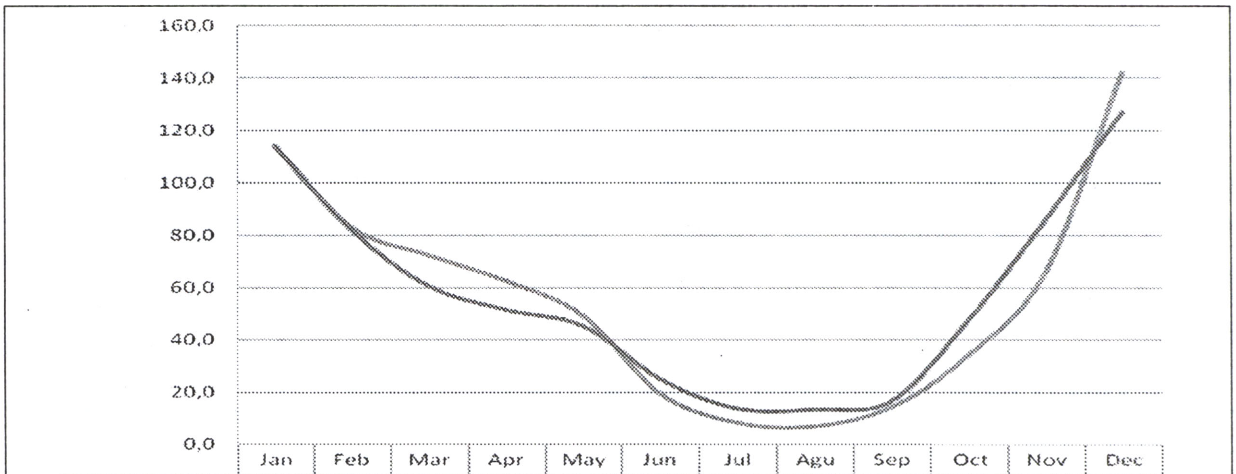
Table 8. Farmers' perception concerning precipitation in the last 20 years

Age groups	Precipitation									
	Decreased		Not Changed		Tend to decrease		No Idea		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%
1	11	73,3	2	13,3	1	6,7	1	6,7	15	100,0
2	14	82,4	0	0,0	3	17,6	0	0,0	17	100,0
3	5	62,5	0	0,0	3	37,5	0	0,0	8	100,0
Total	30	75,0	2	5,0	7	17,5	1	2,5	40	100,0

In addition to these views, some of these farmers added that precipitation is fluctuating by years. They said that in some years there had been good rainfall, but in some other years rainfall was short.

Some other farmers believe that seasons and rainy days are shifting. They said in the past in April there were 20-25 rainy days, but this does not exist any more. They now believe that the number of rainy days are decreasing. They mentioned that 1970, 1973, 1974, 1985, 1987, 1990, 1996, 2001, 2002, 2003 and 2004 were drought years and in some years they irrigated the wheat which is not the case in the other years. There is a great consistency between meteorological data and farmers' statements concerning drought years.

"Turkish State Meteorological Service" data from 1950 to 2004 show that monthly rainfall decreased in March, April and May in last 25 years. But, on the other hand, average yearly precipitation was calculated 657 mm during the 1950-1980, and it rose up to 663.7 mm in the period of 1981-2004 (Figure 5 and Figure 6).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
1950-1980	113,6	82,9	72,2	62,4	49,1	19,5	8,2	6,9	14,3	34,2	66,0	142,0
1981-2004	114,1	81,9	60,6	51,5	45,2	25,1	13,8	13,4	16,8	47,8	86,0	126,9

Figure 5. Average Precipitation in Adana (Monthly, mm)

Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

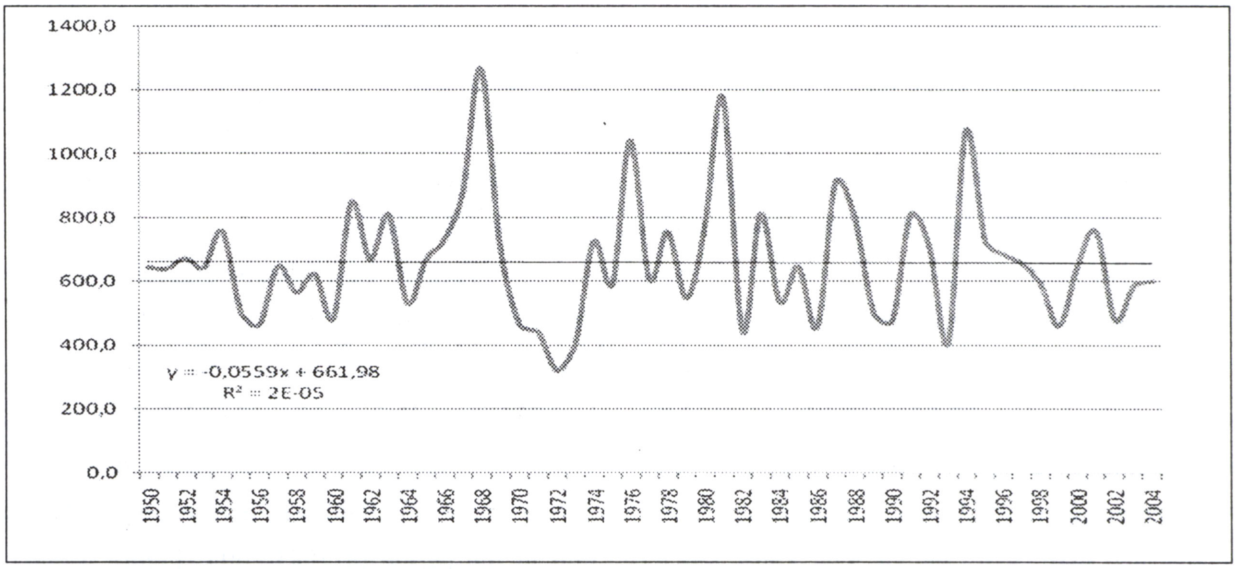


Figure 6. Average Precipitation in Adana (Yearly, mm)

Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

3.1.1.2.3. Farmers' Perception Concerning Moisture

Majority of the farmers believe that the moisture has increased in the last 20 years. Some farmers think that the moisture has not changed and some farmers claim that the moisture has decreased (Table 9).

Table 9. Farmers' perception concerning moisture in the last 20 years

Age groups	Moisture							
	Increased		Decreased		Not Changed		Total	
	Q	%	Q	%	Q	%	Q	%
1	11	73,3	0	0,0	4	26,7	15	100,0
2	11	64,8	3	17,6	3	17,6	17	100,0
3	7	87,5	0	0,0	1	12,5	8	100,0
Total	29	72,5	3	7,5	8	20,0	40	100,0

Many farmers explain the increase in moisture with the examples of increases in the fungal diseases in the crops. They say "we used to produce watermelon and cucumber 30 years ago, but it is not possible to grow these crops now due to fungal diseases".

However, farmers think that the main reason of moisture increase is not climate change, it is due to Seyhan dam and irrigation channels. As they explained the water in the dam and in the irrigation channels had increased the moisture in the air.

3.1.1.3. Changes in Agricultural Production Due to Climate Change

3.1.1.3.1. Changes in Cropping Pattern Due to Climate Change

Many farmers believe that the climate change (if any) did not affect cropping pattern (Table 10). They say that the crop changes came mainly from crop prices and technology. High and reliable prices of crops are the most influential factors in deciding what to grow. Also technologically improved cultivars were preferred by the farmers. This is because these cultivars have higher yields and have higher quality and are more resistant to pests and diseases.

Table 10. Farmers' crop change due to climate change

Age groups	Crop change							
	Same crop		Changed crop		Changed variety		Total	
	Q	%	Q	%	Q	%	Q	%
1	14	93,3	1	6,7	0	0,0	15	100,0
2	14	82,3	1	5,9	2	11,8	17	100,0
3	6	75,0	1	12,5	1	12,5	8	100,0
Total	34	85,0	3	7,5	3	7,5	40	100,0

3.1.1.3.2. Changes in Cultivation Methods (Planting Time) Due to Climate Change

Some farmers said that they had made some changes in the planting time of maize because of the negative impact of high temperatures in June and July maize production. According to these farmers high temperatures in June and July have a negative impact on pollination in maize. As farmers said, cotton and maize had been planted at the end of March and early April in the past, but in recent years cotton and maize have been planted in late February and early March.

Table 11. Changes in planting time due to climate changes

Age groups	Planting time					
	Not Changed		Changed		Total	
	Q	%	Q	%	Q	%
1	6	40,0	9	60,0	15	100,0
2	9	52,9	8	47,1	17	100,0
3	5	62,5	3	37,5	8	100,0
Total	20	50,0	20	50,0	40	100,0

Some farmers think that the planting time of wheat has also changed due to climate change. They say that in the past wheat was planted in October but in the last 25 years wheat is planted in November due to the climate change (Table 11).

Yet all farmers do not agree with the views of farmers explained above. Some farmers think that the planting time depends on climatic conditions and it shifts forwards or backwards depending on rains.

3.1.1.3.3. Changes in Fertilizer – Pesticide Use Due to Climate Changes

Almost all farmers agree that the changes in fertilizer and pesticide use are not related to climate change.

Many farmers did not change the quantity and the type of fertilizer and pesticide in the last 25 years (Table 12). However, some farmers said that they had increased the amount of fertilizer and pesticide use in irrigated agriculture. The main reason behind the increased amount of fertilizer use is technological change in production. The new seed cultivars of maize and cotton require much higher amount of fertilizer use in order to give higher yields. The pesticide use is varying depending on the pests and diseases observed during the production. For example only one farmer has changed the kind of fertilizer and pesticide in irrigated agriculture.

Table 12. Changes in fertilizer-pesticide use

Age groups	Fertilizer-pesticide change									
	Not Changed		Increased		Decreased		Changed fert.-pest.		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%
1	7	46,7	8	53,3	0	0,0	0	0,0	15	100,0
2	9	52,9	5	29,4	2	11,8	1	5,9	17	100,0
3	7	87,5	1	12,5	0	0,0	0	0,0	8	100,0
Total	23	57,5	14	35,0	2	5,0	1	2,5	40	100,0

3.1.1.3.4. Changes in the Number of Irrigation Due to Climate Change

The majority of the farmers stated that number of irrigation had not changed in the last 25 years (Table 13). Only 12,5% of the farmers claim that the number of irrigation has increased from 4 to 7 due to increased temperature in climate.

Table 13. Changes in number of irrigation due to climate changes

Age groups	Number of irrigation					
	Not Changed		Increased		Total	
	Q	%	Q	%	Q	%
1	14	93,3	1	6,7	15	100,0
2	15	88,2	2	11,8	17	100,0
3	6	75,0	2	25,0	8	100,0
Total	35	87,5	5	12,5	40	100,0

3.1.1.3.5. Farmers' Preferential Crops Due to Climate Change

Farmers response in crop production due to climate change was examined in two parts:

1) Preferred crops when temperature rises,

2) Preferred crops when precipitation decreases.

Sixty-five percent of the farmers say that if temperature rises significantly, they substitute heat resistant crops such as cotton, sesame, barley, olive, chickpea and grape. Farmers also mentioned that they had been ready to produce crops that are recommended by extension staff or scientists (Table 14)

.

Table 14. Preferred crops if temperature rises

Age groups	Preferred crops											
	No idea		Heat resistant crops		Cotton		Same Crop		Sesame		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
1	2	13,3	9	60,0	2	13,3	1	6,7	1	6,7	15	100,0
2	0	0,0	13	76,5	2	11,8	2	11,8	0	0,0	17	100,0
3	1	12,5	4	50,0	3	37,5	0	0,0	0	0,0	8	100,0
Total	3	7,5	26	65,0	7	17,5	3	7,5	1	2,5	40	100,0

Farmers' response to decreases in precipitation is the same as temperature increase. In other words, the majority of the farmers put "temperature increase and precipitation decrease" in the same basket. This is generally the case when global warming or climate change is discussed. Farmers would prefer drought resistant crops such as barley, olive, cotton, sesame and grape if precipitation decreases (Table 15).

Table 15. Preferred crops if precipitation decreases

Age groups	Preferred crops											
	No idea		Drought resistant crops		Cotton		Same Crop		Sesame		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
1	3	20,0	9	60,0	1	6,7	1	6,7	1	6,7	15	100,0
2	0	0,0	13	76,5	2	11,8	2	11,8	0	0,0	17	100,0
3	2	25,0	4	50,0	2	25,0	0	0,0	0	0,0	8	100,0
Total	5	12,5	26	65,0	5	12,5	3	7,5	1	2,5	40	100,0

Farmers think that the most sensitive crop to temperature increase is wheat. Many farmers believe that wheat would disappear in the region if temperature rises and prepetition decreases. They said that maize would also be affected from high temperatures because of the negative effect of high temperature on pollination. Some farmers believe that citrus and vegetable production would also be negatively affected by high temperatures. Many farmers stated that cotton production would increase as long as there is enough water in the irrigation channels. On the other hand, some farmers think that temperature increase will make a positive effect on cotton and groundnut. They also believe that technological development in crop production will overcome these problems in the future.

3.1.1.3.6. Changes in Production Techniques if Temperature Rises

The farmers' response to temperature increase is examined for two important crops of the region. These crops are wheat and maize[1]. In the subsequent sections farmers' reaction towards wheat and maize production practices will be examined.

An important field experiment was conducted during 2001-2003 period in Adana province, to evaluate the response of 11 selected spring bread wheat genotypes to seasonal climate difference in Çukurova region (Yücel et al., 2005). Results of the field experiment showed that temperature, rainfall and sowing time have very important role in wheat yield (Box 3).

[1] The majority of the farmers think that cotton and citrus will not be negatively influenced by increased temperature.

Box 3. *Response to Seasonal Climate Difference of Selected Bread Wheat (T. aestivum L.) Genotypes in a Mediterranean Environment*

Technical Information (General):

- *1 °C temperature increase above normal temperature values in the grain filling period causes 4 mg decrease in grain weight. Temperatures above 35 °C significantly decreases the grain yield of wheat. 1 °C temperature increase above the optimum interval 15-20 °C causes 3-4 % yield losses.*

		Year			
		2000-2001	**2001-2002**	**2002-2003**	
Phenology (Average)	• Sowing date	18 Nov.	15 Jan.	23 Nov.	
	• Flowering date	8 Dec.	29 Jan.	1 Dec.	
	• Earring date	19 Mar.	16 Apr.	7 Apr.	
	• Physiologic maturity date	11 May.	19 May.	14 May.	
	• Growing season(days)[1]	174	124	172	
Precipitation (mm)	• Vegetative period 2	142.5	152.7	366.4	
	• Grain filling period 3	86.1	60.0	61.1	
	• Growing season 1	228.6	212.0	427.5	
Average maximum temperature during grain filling period (°C)	• April	25.0	21.6	22.6	
	• May	24.1	26.3	34.7	
Number of maximum temperature days and relative humidity during grain filling period	• >30 °C (max)	4	0	14	
	• <50% (mean)	5	2	13	
High temperature index during grain filling period (degree/day)	• >30 °C	131.7	0.0	484.8	
Total temperature (degree/day)	• Germinate - Ear	1178.3	1074.9	1314.0	
	• Ear – Physiologic maturity	1001.6	637.2	753.2	
	• Growing season 1	2179.9	1712.1	2067.2	
Climate Data (Monthly average)					Long Period Average (last 77 years)
Precipitation (mm)	• March	46.6	40.3	92.3	65.8
	• April	8.8	88.8	61.1	52.5
	• May	130.4	22.0	14.8	47.0
Temperature (°C)	• March	16.5	14.7	11.5	13.1
	• April	18.7	16.5	17.1	17.2
	• May	21.8	21.4	24.5	21.4
Humidity (%)	• March	73.5	67.4	64.0	65.0
	• April	67.9	76.0	68.9	65.0
	• May	60.2	68.3	56.1	67.0
Yield (ton/ha)		**6.17**	**5.89**	**7.08**	

1: Planting- Physiologic maturity, 2: Germination-Heading, 3: Heading- Physiologic maturity

- Planting could not be applied in optimum period due to intensive rainfall in 2001-2002 periods.
- The average of all genotypes showed great variation depending on planting time and seasonal climatic differences. The average yields of all genotypes were low in 2002. In this year, the average temperature in April and May in grain filling period was lower as compared to 2001 and 2003.
- The reason of low yields of 2001 as compared to 2003 are as follows;
  - Precipitation fell down to 8.8 mm in April in grain filling period and 142.5 mm in the vegetative period. These values are 61.1 mm and 366.4 mm in 2003 respectively.
  - The average temperature of March 2001 is higher than 2003 March average temperature.

Source: Yücel et al. 2005.

3.1.1.3.6.1. Changes in Production Technique of Wheat if Temperature Rises

Seventy-two percent of the wheat growers said that they would not make any change in soil cultivation methods if temperature rises (Table 16). Some farmers said that they would apply less cultivation in order to keep moisture in the soil. Some other farmers said that they would change soil cultivation methods as recommended by the scientists.

Table 16. Changes in Production Technique of Wheat if Temperature Rises

	No Idea		No Changes		Less cultivates		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	1	4,0	18	72,0	3	12,0	3	12,0	-	-	-	-		
Seed quantity	1	4,0	17	68,0	-	-	-	-	-	-	7	28,0		
Seed variety	1	4,0	22	88,0	-	-	2	8,0	-	-	-	-		
Quantity of fertilizer use	1	4,0	13	52,0	-	-		-	11	44,0	-	-		
Type of fertilizer use	1	4,0	23	92,0	-	-	1	4,0	-	-	-	-	25	100,0
Quantity of pesticide use	1	4,0	18	72,0	-	-	-	-	4	16,0	2	8,0		
Type of pesticide use	1	4,0	24	96,0	-	-	-	-	-	-	-	-		
Irrigation method	1	4,0	19	76,0	-	-	5	20,0	-	-	-	-		
Number of irrigation	1	4,0	1	4,0	-	-	-	-	-	-	23	92,0		

Sixty-eight percent of the farmers would not change the amount of seed if temperature rises. But 28% of the farmers said that they would increase the amount of seed if temperature rises.

Eighty-eight percent of the farmers will not change the seed cultivar even if temperature rises. They say that there is no alternative cultivar of wheat that can be produced under high temperature conditions. Only 8% of the farmers say that they will change their present wheat cultivar if temperature rises.

Fifty-two percent of the farmers said that they would not change the quantity of fertilizer they use in wheat production if temperature rises. However, the response of different farm size groups to this question is different. As the farmers get older they become more responsive to the quantity of fertilizer used in wheat production if temperature rises. The majority of the young farmers (88,9%) would not change the amount of fertilizer but all old farmers (100,0%) would decrease the amount of fertilizer used in wheat production if temperature rises.

Ninety-two percent of the farmers said that they would not change the type of fertilizer that is used in wheat production if temperature rises. Farmers think that type of fertilizer has no relation with temperature.

Normally pesticide use in wheat production in Adana is very limited. The majority of the farmers think that the temperature increase would not effect the quantity of pesticide use in wheat production. In general pesticide is used in seed treatment in wheat production. Other pesticides are used occasionally. Therefore many farmers do not expect any change in pesticide use if temperature rises. However, there are some farmers who think that the quantity of pesticide use decreases in hot weathers. Some farmers think that the quantity of pesticide use increases if temperature rises.

Almost all farmers think that the type of pesticide use would not change in wheat production if temperature rises.

Wheat is irrigated very seldomly in years when the rainfall is short. Two different methods are used to irrigate wheat in the region. 1) Border irrigation, 2) Sprinkler irrigation.

Seventy-six percent of the farmers said that the irrigation method would not change if temperature rises and 20% of the farmers think that irrigation methods would change.

Ninety-two percent of the farmers think that the number of irrigation would increase if temperature rises. Only 4% of the farmers think that the number of irrigation would not change even if temperature rises.

3.1.1.3.6.2. Changes in Production Technique of Maize if Temperature Rises

Eighty-one percent of the maize growers think that soil cultivation methods would not change if temperature rises. These farmers believe that there is no relation between soil cultivation methods and temperature increase. But some farmers, especially the old ones, think that there would be some changes in the cultivation methods if the temperature rises (Table 17).

Table 17. Changes in Production Technique of Maize if Temperature Rises

	No Idea		No Changes		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	1	6,3	13	81,2	2	12,5	-	-	-	-	16	100
Seed quantity	1	6,3	14	87,5	-	-	-	-	1	6,3		
Seed variety	1	6,3	15	93,8	-	-	-	-	-	-		
Quantity of fertilizer use	1	6,3	12	75,0	-	-	3	18,8	-	-		
Type of fertilizer use	1	6,3	14	87,4	1	6,3	-	-	-	-		
Quantity of pesticide use	1	6,3	13	81,3	-	-	2	12,5	-	-		
Type of pesticide use	1	6,3	15	93,8	-	-	-	-	-	-		
Irrigation method	1	6,3	8	50,0	7	43,8	-	-	-	-		
Number of irrigation	1	6,3	15	93,8	-	-	-	-	-	-		

Eighty-seven percent of the maize growers said that the seed quantity would not change if temperature rises. One maize grower stated that the seed quantity might increase if temperature rises.

Almost all maize producers say that they will not change the seed variety even if temperature rises.

Seventy-five percent of the maize producers states that they will not change the quantity of fertilizer they use in maize production if temperature rises. Approximately 19% of the farmers say that they will decrease the amount of fertilizer they use in maize production.

The majority of the farmers do not think to change the type of fertilizer they use in maize production if temperature rises. Only one maize producer said that he would change the type of fertilizer.

The majority of the maize producers do not think to change the quantity and the type of pesticide they use in maize production if temperature rises.

Fifty percent of the maize producers do not think to change the method of irrigation if temperature rises. On the other hand 43.7% of maize producers said that they would change the method of irrigation towards water saving methods.

Ninety-three percent of the maize producers think that there is no need to increase the number of irrigation if irrigation is applied effectively.

3.1.1.3.7. Response of Farmers if Precipitation Decreases

3.1.1.3.7.1. Changes in Production Technique of Wheat if Precipitation Decreases

What is the reaction of wheat producers in cultivation methods if precipitation decreases? Fifty-six of the wheat producers said that they would not change cultivation methods. Because these farmers believe that the present cultivation methods are the most appropriate methods for their soils. Some farmers said that they would apply less cultivation in order to keep moisture in the soil. Some other farmers said that they would change the cultivation methods. But these farmers do not know what type of cultivation is needed when precipitation decreases. On the other hand only one wheat producer said that he would prefer deep plowing in order to accumulate water in the soil (Table 18).

Table 18. Changes in Production Technique of Wheat if Precipitation Decreases

	No Changes		Deep cultivates		Less cultivates		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	14	56,0	1	4,0	6	24,0	4	16,0	-	-	-	-	25	100,0
Seed quantity	13	52,0	-	-	-	-	-	-	3	12,0	9	36,0		
Seed variety	23	92,0	-	-	-	-	2	8,0	-	-	-	-		
Quantity of fertilizer use	10	40,0	-	-	-	-	-	-	15	60,0	-	-		
Quantity of pesticide use	22	88,0	-	-	-	-	-	-	2	8,0	1	4,0		
Irrigation method	19	76,0	-	-	-	-	5	24,0	-	-	-	-		
Number of irrigation	1	4,0	-	-	-	-	-	-	-	-	24	96,0		

Fifty-two percent of the farmers do not think to change the quantity of seed if precipitation decreases. These farmers think that increasing or decreasing the quantity of seed would not affect the yield of wheat if precipitation decreases. Some farmers think that more seed is necessary to obtain the same amount of yield when precipitation decreases. But there are some farmers who believe sparse planting (less seed) gives better result because dense planting causes more water consumption.

The findings of the research in the irrigated regions of Adana show that 92% of the farmers are not going to change the variety of wheat even if precipitation decreases. Farmers say if droughts become more persistent than they would think of changing variety of wheat or changing crop i.e. barley.

Sixty percent of the wheat producing farmers say that they will decrease the amount of fertilizer in wheat production if precipitation decreases. They also mentioned that the amount of fertilizer that would be used would depend on annual rainfall. On the other hand, 40% of the farmers said that they would not change the quantity of fertilizer unless there would be a serious and continuous decreases in the precipitation.

All wheat producers say that they are not going to change the type of fertilizer if precipitation decreases.

The majority of the farmers do not think to change the quantity of pesticide they use in wheat production if precipitation decreases. Farmers do not see much relation with precipitation and pests. But some farmers think that there might be some relation between precipitation and diseases.

All wheat producing farmers said that they would not change the type of pesticide if precipitation decreases.

Seventy-six percent of the wheat producers stated that they would not change the method of irrigation if precipitation decreases. They believe that present methods of irrigating wheat are efficient as long as there is enough water in the irrigation channels. Twenty-four percent of the farmers mentioned that more efficient irrigation methods should be preferred.

Ninety-six percent of the wheat producers say that they will increase the number of irrigation in wheat production if precipitation decreases. Only one farmer objected to increase the number of irrigation. He believes that method and timeliness of irrigation is more important than the number of irrigation in wheat production.

3.1.1.3.7.2. Changes in Production Technique of Maize if Precipitation Decreases

Maize is grown under irrigated conditions in the Adana region. Therefore its production practices would not be influenced as much as wheat when precipitation decreases.

The majority of the maize producers say that they will not change the soil cultivation methods in maize production if precipitation decreases. These farmers do not see any relation between cultivation methods and the quantity of precipitation because maize is grown under irrigated conditions (Table 19). Only two farmers say that they will change the cultivation methods if precipitation decreases.

Table 19. Changes in Production Technique of Maize if Precipitation Decreases

	No Changes		Changes		Decreases		Total	
	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	14	87,5	2	12,5	-	-	16	100,0
Seed variety	14	87,5	2	12,5	-	-		
Quantity of fertilizer use	13	81,2	-	-	3	18,8		
Quantity of pesticide use	15	93,8	-	-	1	6,3		
Irrigation method	9	56,3	7	43,7	-	-		

All maize producers stated that they would not change the quantity of seed if precipitation decreases.

Eighty-seven percent of the maize producers mentioned that they would not change the seed variety if precipitation decreases. Only two maize producers consider changing the seed variety if precipitation decreases. However these farmers could not explain the reason(s) of variety change.

Eighty-one percent of the maize producers mentioned that they would not change the quantity of fertilizer if precipitation decreases. 18.8% of the farmers think that the quantity of fertilizer should be decreased in planting time if precipitation decreases.

All maize producers say that there is no need to change the type of fertilizer if precipitation decreases.

Ninety-four percent of the maize producers believe that there is no need to change the quantity of pesticide if precipitation decreases. These farmers do not see any relation between quantity of pesticide use and precipitation decrease.

Fifty-six percent of maize producers do not think to change the irrigation methods in maize production. But 43.7% of the maize producers prefer to change irrigation methods and use water-saving methods in production. They also mentioned that changing irrigation method depend on the costs of application.

3.1.1.4. Changes in Livestock Production if Temperature Rises

There are 8 farmers that have livestock (cattle). These farmers have different ideas to cope with higher temperatures. Some of them think to change feeding material and also give less feed. Others think to make amendments in order to provide more aeration and installing ventilators in the barns. One farmer said that he would sell the present animals and buy heat resistant animals.

3.1.2. Rainfed Villages of Adana Province

Some socio-economic indicators and farmers' perception and behavior concerning climate change were examined for rainfed farms of Adana province in the subsequent section.

3.1.2.1. Some Socio-Economic Indicators of Rainfed Farms

Distribution of the interviewed farmers by farm size groups is given in Table 20.

Table 20. Distribution of farms by farm size groups

Farm size groups (da)	Group Code	Quantity	%
-75	1	12	37,5
76-150	2	11	34,4
151 +	3	9	28,1
Total		32	100,0

Distribution of farm managers by age groups is given in Table 21. The ages of the farm managers vary between 27 and 72. It is useful to interview with farmers from all age groups, especially elder farmers, to learn from their past experience regarding climatic events.

Table 21. Distribution of farm managers by age groups

Age groups	Group Code	Quantity	%
25-45	1	9	28,1
46-55	2	14	43,8
56 +	3	9	28,1
Total	-	32	100,0

Fifty percent of the farm managers are primary school graduates. There are some secondary and high school graduates but there are not any agricultural vocational school graduates among the farm managers (Table 22).

Table 22. Education level of farm managers

Group Code	Education level	Quantity	%
1	Literate	4	12,5
2	Primary school	16	50,0
3	Secondary school	9	28,1
4	High school	3	9,4
Total		32	100,0

The average size of rainfed farms is 124,5 decares. In the rainfed villages, the more the farm size increases, the more the number of plots and average plot size increases (Table 23).

Table 23. Average farm size, number of plots and average plot size

Farm size groups	Average Farm Size (da)	Number of plots	Average plot size (da)
1	29,6	1,82	17,4
2	113,6	4,64	33,9
3	267,7	8,56	37,1
Mean	124,5	4,63	28,1

Cropping pattern shows how land is used for production under rainfed conditions. Wheat and sunflower are the two major crops in the research area. Farmers also produce some barley, cotton, pea and olive under rainfed conditions (Table 24). All farm size groups produce wheat, sunflower and barley but production of pea and olive is not widespread in the rainfed villages.

Table 24. Size of cultivated area by crops (da)

Farm size groups	Wheat	Sunflower	Barley	Cotton	Pea	Olive	Total
1	15,5	6,18	7,3	-	-	-	29,6
2	66,5	22,7	15,0	9,1	-	0,3	113,6
3	148,9	97,1	0,5	11,1	10,0	-	267,7
Mean	70,1	37,3	7,81	6,3	2,8	0,3	124,5

3.1.2.2. Farmers' Perception and Behavior Concerning Climate Change

3.1.2.2.1. Farmers' Perception Concerning Temperature

Eighty-four percent of the farmers think that the temperature has increased in the last 20 years. And 6,3% of the farmers say that the temperature is only tending to increase (Table 25). There is an important consistency between farmers' views and meteorological data (Figure 3 and 4)

Table 25. Farmers' perception concerning temperature in the last 20 years

Age groups	Temperature							
	Increased		Not Changed		Tend to increase		Total	
	Q	%	Q	%	Q	%	Q	%
1	9	100,0	-	-	-	-	9	100,0
2	12	85,7	2	14,3	-	-	14	100,0
3	6	66,7	1	11,1	2	22,2	9	100,0
Total	27	84,4	3	9,4	2	6,3	32	100,0

Some of the farmers stated that the planting time of wheat had not changed within the last 20 years but harvesting time had shifted from June to May due to the increased temperature.

3.1.2.2.2. Farmers' Perception Concerning Precipitation

Eighty-seven percent of the farmers think that the precipitation has decreased in the last 20 years. Also, 9,4 % of the farmers believe that the precipitation will tend to decrease in the coming years (Table 26).

Table 26. Farmers' perception concerning precipitation in the last 20 years

Age groups	Precipitation							
	Increased		Decreased		Tend to decrease		Total	
	Q	%	Q	%	Q	%	Q	%
1	-	-	9	100,0	-	-	9	100,0
2	-	-	12	85,7	2	14,3	14	100,0
3	1	11,1	7	77,8	1	11,1	9	100,0
Total	1	3,1	28	87,5	3	9,4	32	100,0

Many farmers say that in the years 1971, 1973, 1974, 1980, 1984, 1986, 1988, 1989, 1991, 1994, 2000, 2003, and 2004 the precipitation was short and crops were damaged by droughts. Farmers' observations are to a large extent consistent with meteorological data (Figure 5 and Figure 6).

Some farmers claim that there were shifts in the seasons and some farmers say that there has been increase in the irregularities in the precipitation.

Some farmers said that winter seasons had been very rainy in the past and wells used to have plenty of water. This means that in recent years wells are almost dry.

3.1.2.2.3. Farmers' Perception Concerning Moisture

Seventy-five percent of the farmers think that moisture has increased in the last 20 years. Also 9,4% of the farmers believe that moisture tend to increase in the coming years. But there are some farmers who believe neither the moisture has decreased nor changed in the last 20 years (Table 27)

Table 27. Farmers' perception concerning moisture in the last 20 years

Age groups	Moisture									
	Increased		Decreased		Not Changed		Tend to increase		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%
1	8	88,9	1	11,1	-	-	-	-	9	100,0
2	11	78,6	1	7,1	1	7,1	1	7,1	14	100,0
3	5	55,6	2	22,2	-	-	2	22,2	9	100,0
Total	24	75,0	4	12,5	1	3,1	3	9,4	32	100,0

3.1.2.3. Changes in Agricultural Production Due to Climate Change

3.1.2.3.1. Changes in Cropping Pattern

All farmers think that the climate change (if any) did not affect cropping pattern in rainfed agriculture in the last 20 years. Farmers said that they had been producing the same crops for a long time but only changed the variety of them with the expectation of getting higher yields and higher quality. They did not make any change in the cropping pattern due to the changes in the climate. Farmers also mentioned that their decision on cropping pattern was mostly affected by the market prices of the crops.

3.1.2.3.2. Changes in Cultivation Methods Due to Climate Change

The majority of the farmers did not change the cultivation methods due to climate change. There are some farmers who made deep ploughing to accumulate more water in the soil to protect him against short rainfalls. One farmer decreased the number of cultivation to prevent moisture losses in the soil (Table 28).

Table 28. Changes in cultivation methods due to climate changes

Age groups	Cultivation methods							
	Not Changed		Deep cultivated		Less cultivated		Total	
	Q	%	Q	%	Q	%	Q	%
1	9	100,0	-	-	-	-	9	100,0
2	11	78,6	2	14,3	1	7,1	14	100,0
3	9	100,0	-	-	-	-	9	100,0
Total	29,0	90,6	2	6,3	1	3,1	32	100,0

3.1.2.3.3. Changes in Fertilizer-Pesticide Use Due to Climate Change

Many farmers said that they had not changed the quantity and the type of fertilizer they use under rainfed conditions. They mentioned that some changes had occurred in pesticide use due to unexpected pests and diseases. Some farmers changed the type and amount of fertilizer due to irregular climatic events. They decreased the amount of fertilizer due to irregular climatic events, especially when the precipitation is short (Table 29).

Table 29. Changes in fertilizer-pesticide use

Age groups	Fertilizer-pesticide change							
	Not Changed		Decreased		Changed fert.-pest.		Total	
	Q	%	Q	%	Q	%	Q	%
1	7	77,8	-	-	2	22,2	9	100,0
2	8	57,1	2	14,3	4	28,5	14	100,0
3	7	77,8	1	11,1	1	11,1	9	100,0
Total	22	68,7	3	9,4	7	21,9	32	100,0

3.1.2.3.4. Farmers' Preferential Crops Due to Climate Change

Farmers' response to climate change was examined in two parts:

1) Preferred crops when temperature rises,

2) Preferred crops when precipitation decreases.

Forty-seven percent of the rainfed agriculture farmers said that they would prefer to produce heat resistant crops such as cotton, barley and sunflower. Thirty-seven percent of the farmers say that they did not have any idea regarding heat resistant crops and therefore would follow the recommendations of extension agents (Table 30).

Table 30. Preferred crops if temperature rises

Age groups	Preferred crops													
	No Idea		Heat resistant crops		Cotton		Same Crop		Wheat		Sunflower		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
1	6	66,7	2	22,2	-	-	1	11,1	-	-	-		9	100,0
2	3	21,4	10	71,4	1	7,1	-	-	-	-	-		14	100,0
3	3	33,3	3	33,3	1	11,1	-	-	1	11,1	1	11,1	9	100,0
Total	12	37,5	15	47,0	2	6,3	1	3,1	1	3,1	1	3,1	32	100,0

Farmers' response to decrease in precipitation is similar to temperature increase. Forty-seven percent of the farmers said that they would prefer drought resistant crops such as barley, cotton and sunflower if precipitation decreases (Table 31).

Table 31. Preferred crops if precipitation decreases

Age groups	Preferred crops													
	No Idea		Drought resistant crops		Cotton		Same Crop		Wheat		Sunflower		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
1	6	66,7	2	22,2	-	-	1	11,1	-	-	-		9	100,0
2	3	21,4	10	71,4	1	7,1	-	-	-	-	-		14	100,0
3	4	44,4	3	33,3	-		-	-	1	11,1	1	11,1	9	100,0
Total	13	40,6	15	47,0	1	3,1	1	3,1	1	3,1	1	3,1	32	100,0

The majority of the farmers think that all the present crops would be negatively affected if temperature rises and precipitation decreases. In this case farmers prefer to substitute olive and grape production which are resistant to heat and drought. Also many farmers rely on the advices of scientists.

3.1.2.3.5. Changes in Production Techniques if Temperature Rises

Farmers' response to temperature increase was examined for two important enterprises in the rainfed agriculture villages. These enterprises are wheat and livestock.

3.1.2.3.5.1. Changes in Production Technique of Wheat if Temperature Rises

Seventy-two percent of the wheat producers in the rainfed villages said that they would not make any change in the soil cultivation methods of wheat production if temperature rises. This is exactly the some percentage of wheat producers of irrigated villages. Some farmers said that they would decrease the number of tillage to keep the moisture in the soil (Table 32).

Table 32. Changes in Production Technique of Wheat if Temperature Rises

	No Changes		Deep cultivates		Less cultivates		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	21	72,4	1	3,4	3	10,3	4	13,8	-	-	-	-	29	100
Seed quantity	22	75,9	-	-	-	-	-	-	4	13,8	3	10,3		
Quantity of fertilizer use	14	48,3	-	-	-	-	-	-	15	51,7	-	-		
Quantity of pesticide use	26	89,7	-	-	-	-	-	-	3	10,3	-	-		

One farmer said it is better to cultivate the soil deeply to conserve more water in the soil. He also mentioned that deep cultivation is expensive.

Seventy-six percent of the wheat producers said that they would not change the quantity of seed if temperature rises. These farmers do not see any relation between the quantity of seed and temperature. But there are some farmers who prefer to use less quantity of seed and there are some other farmers who think to use more seed. None of the wheat producers think to change the seed variety if temperature rises.

More than half of the wheat producers said that they would decrease the quantity of fertilizer if temperature rises. Forty-eight percent of the wheat producers claim that there was no need to change the quantity of fertilizer if temperature rises.

The majority of the wheat producers think that they would not change the quantity of pesticide they use in wheat production if temperature rises. On the other hand 10% of the wheat producers think that less pesticide was needed in hot and dry weathers. All farmers also mentioned that there had been no need to change the type of pesticide if temperature rises.

3.1.2.3.6. Response of Farmers If Precipitation Decreases

3.1.2.3.6.1. Changes in the Production Technique of Wheat if Precipitation Decreases

Fifty-eight percent of the wheat producers do not think to change the soil cultivation methods if precipitation decreases (Table 33). Some farmers claim that it was necessary to apply less cultivation to keep the moisture of soil inside. Some farmers believe that some changes are needed in soil cultivation methods to keep the moisture inside, but they do not know what type of cultivation is appropriate in order to achieve this goal.

Table 33. Changes in the Production Technique of Wheat if Precipitation Decreases

	No Changes		Deep cultivates		Less cultivates		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	17	58,7	1	3,4	5	17,2	6	20,7	-	-	-	-	29	100
Seed quantity	18	62,1	-	-	-	-	-	-	6	18,8	5	15,6		
Quantity of fertilizer use	9	31	-	-	-	-	-	-	20	69	-	-		
Quantity of pesticide use	27	93,1	-	-	-	-	-	-	2	6,9	-	-		

Although sixty-two percent of the wheat producers say that the quantity of seed would not change if precipitation decreases, some farmers claim that the seed quantity should be decreased and some others say that the seed quantity should increase.

Sixty-nine percent of the wheat producers believe that the quantity of fertilizer should be decreased if precipitation decreases. These farmers say that fertilizer was useful only if there was enough moisture in the soil. Other farmers say that small decreases in the yearly precipitation was not important as long as wheat gets enough water in the growth period.

The majority of the wheat producers think that there was no need to change the quantity of pesticide if precipitation decreases. These farmers do not see strong relation between the present level of precipitation and pests and diseases.

3.1.2.4. Changes in Livestock Production if Temperature Rises

There are 23 livestock producers out of 32 among the rainfed farmers. Ninety-one percent of these farmers do not have any idea about what type of change is needed in animal races if temperature rises. However 73.9% of the farmers said that they would make some amendments in the barns to provide more aeration. Sixty-five percent of the farmers said that they would change the feeding system. Some farmers said they would wash animals more frequently if temperature rises.

3.1.2.5. Overall Opinion of Wheat Producers of Adana Concerning Climate Change

The most important crop of the rainfed area of the Adana province is wheat. Wheat producers have the following opinions concerning climate change:

- High temperature in the soil during planting time is dangerous. Because high temperatures kill the seed.
- High temperatures during the pollination period is dangerous. This period is April 10-15.
- The amount of total precipitation is not very important. The amount of precipitation in November, December, February, March and April is very important. If it rains in adequate amount in these months yield of wheat is high.

- Heavy rains in April and May are dangerous in wheat production.
- New Technologies in agricultural production could overcome the expected problems of temperature increase and precipitation decrease.
- Seasons are fluctuating i.e. in some years winter comes late and in some years winter comes early.
- Irregular climatic events such as heavy and unexpected rains are increasing.
- If temperature rises and precipitation decreases significantly agricultural production will be negatively affected and migration from rural to urban areas will start.

3.2. Konya Province

3.2.1. Irrigated Villages of Konya Province

In the first part of this section, some socio-economic indicators of the farms are given. In the second part farmers' perception and behavior concerning climate change were examined.

3.2.1.1. Some Socio-Economic Indicators of Irrigated Farms

Distribution of interviewed farmers by farm size groups is given in Table 34. Total number of interviewed farmers is 35 from three different farm size groups.

Table 34. Distribution of farms by farm size groups

Farm size groups (da)	Group Code	Quantity	%
1-150	1	18	51,43
151-300	2	10	28,57
301-+	3	7	20,00
Total		35	100,00

Grouping farmers by age groups is important for reflecting the past and present experience of different age groups. Distribution of interviewed farm managers by age groups is given in Table 35.

Table 35. Distribution of farm managers by age groups

Age groups	Group Code	Quantity	%
30-45	1	19	54,29
46-55	2	12	34,29
56 +	3	4	11,43
Total	-	35	100,00

Education level plays, in most cases, an important role in perceiving and interpreting climatic events. There are farmers from different education levels including university graduates. (Table 36).

Table 36. Education level of farm managers

Group Code	Education level	Quantity	%
1	Literate	1	2,86
2	Primary school	10	28,57
3	Secondary school	11	31,43
4	High school	10	28,57
5	University	3	8,57
Total		35	100,00

The average farm size is 176,1 decares. The number of plots and average plot size by farm size groups are given in Table 37.

Table 37. Average farm size, number of plots and average plot size

Farm size groups	Average Farm Size (da)	Number of plots	Average plot size (da)
1	80,4	3,4	23,4
2	190,4	6,9	29,0
3	401,6	8,7	46,2
Mean	176,1	5,5	29,6

Cropping pattern of irrigated farms is given in Table 38. The figures in the table show that farmers prefer diversified farming in irrigated agriculture.

Table 38. Size of cultivated area by crops (da)

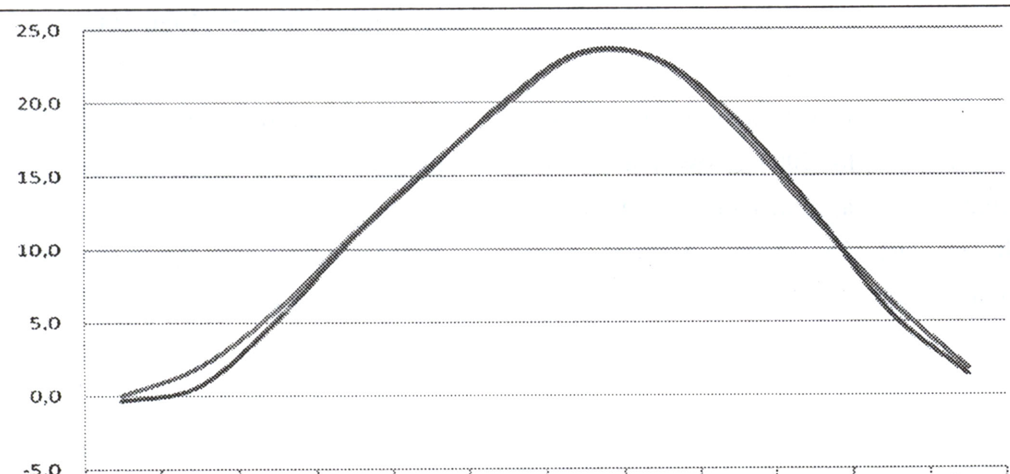
Crops	Farm size groups			Mean
	1	2	3	
Wheat	43,8	64,1	131,9	67,2
Sugar beet	19,7	48,0	133,7	50,6
Barley	3,9	7,2	28,3	9,7
Beans	2,6	12,9	39,4	12,9
Maize	2,3	5,9	16,4	6,2
Fallow land	3,1	10,7	12,1	7,1
Melon	2,5	4,3	0,0	2,5
Pumpkin	1,7	8,8	6,4	4,7
Tomato	0,6	6,0	5,7	3,1
Potato	0,0	4,0	26,3	6,4
Clover	0,0	16,8	1,3	5,1
Poplar	0,0	1,7	0,0	0,5
Cucumber	0,3	0,0	0,0	0,1

Wheat, sugar beet, beans and barley are the most important enterprises. There are also some vegetables such as tomato, potato and cucumber. It should be mentioned that the whole land is not irrigated on the farms. There are some rainfed land and this land is fallowed to accumulate water in the soil for next years' production.

3.2.1.2. Farmers' Perception and Behavior Concerning Climate Change

Based on their experience and knowledge all of the farmers claim that the temperature has increased and precipitation has decreased in the last 20 years.

But, on the other hand, "Turkish State Meteorological Service" data from 1950 to 2004 show that monthly and yearly temperature have decreased in the last 25 years. Average monthly temperature was calculated 11.6 °C during the 1950-1980, and it went down to 11.3 °C in the period of 1981-2004. The result of the analyses of the last fifty years' meteorological data shows that temperature has decreased in Konya (Figure 7 and Figure 8)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
1950-1980	0,0	2,0	5,8	11,1	15,7	19,9	23,3	22,7	18,1	12,2	6,4	1,8
1981-2004	-0,4	0,6	5,1	10,9	15,5	20,1	23,4	22,8	18,7	12,5	5,6	1,4

Figure 7. Average Temperature in Konya (Monthly)

Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

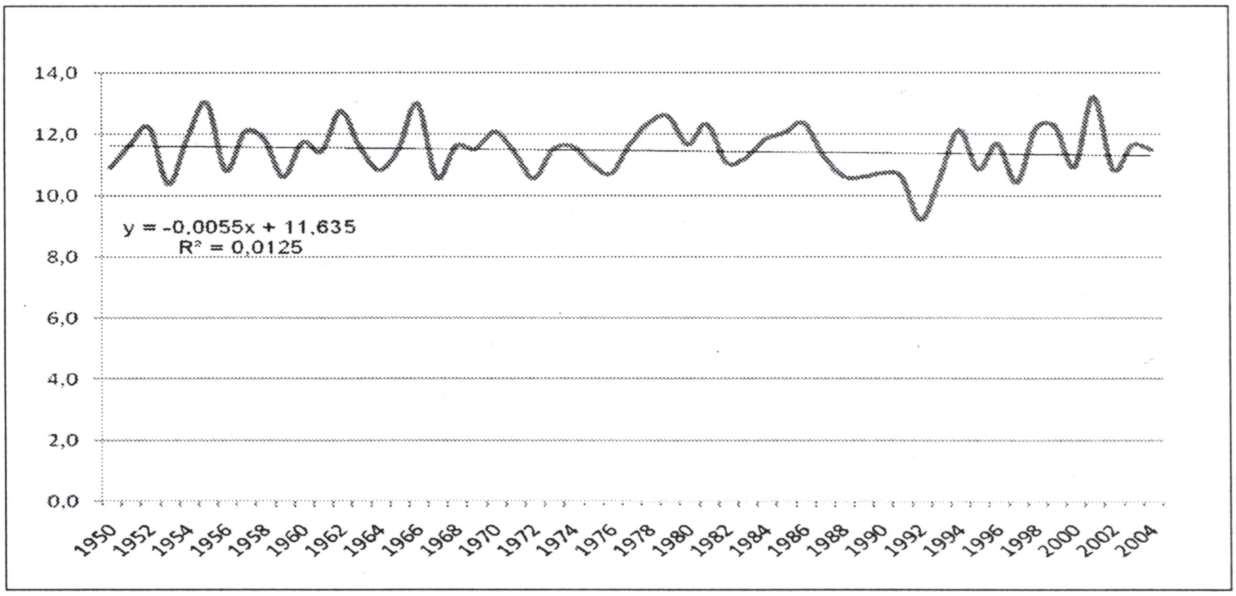
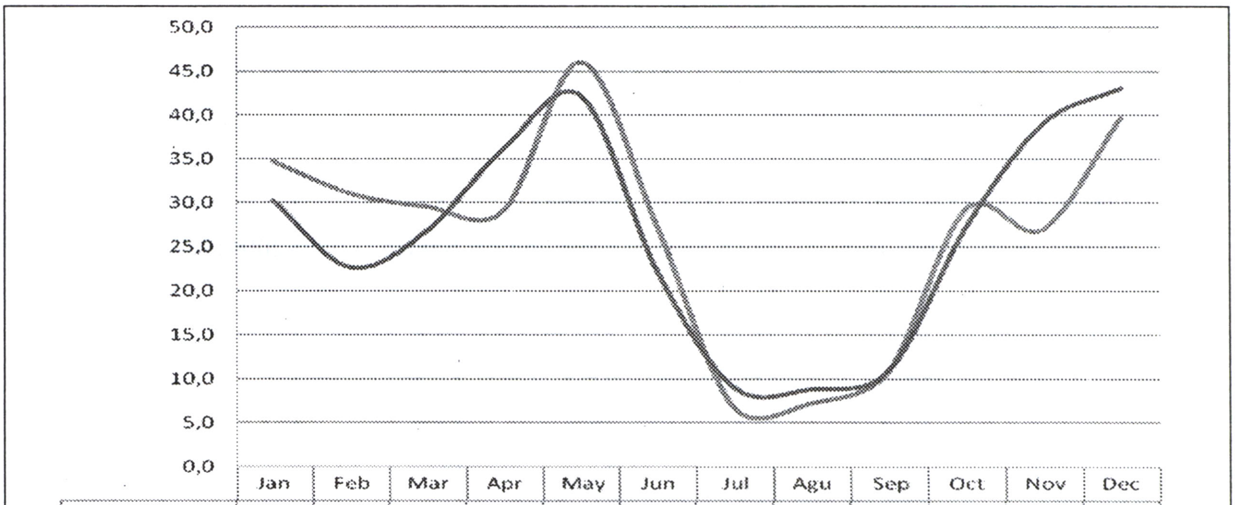


Figure 8. Average Temperature in Konya (Yearly)
Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

"Turkish State Meteorological Service" data from 1950 to 2004 show that monthly precipitation decreased in January, February and March in last 25 years. Average yearly precipitation was calculated 315 mm during the 1950-1980, and it went down to 312.2 mm in the period of 1981-2004. But, on the other hand, the result of the analyses of the last fifty years' meteorological data shows that precipitation has increased in Konya (Figure 9 and Figure 10).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
1950-1980	34,7	31,0	29,5	29,0	46,0	27,2	6,7	7,2	10,9	29,3	26,9	39,6
1981-2004	30,2	22,7	26,7	36,2	42,2	22,3	9,1	8,9	11,0	27,3	39,1	43.1

Figure 9. Average Precipitation in Konya (Monthly)
Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

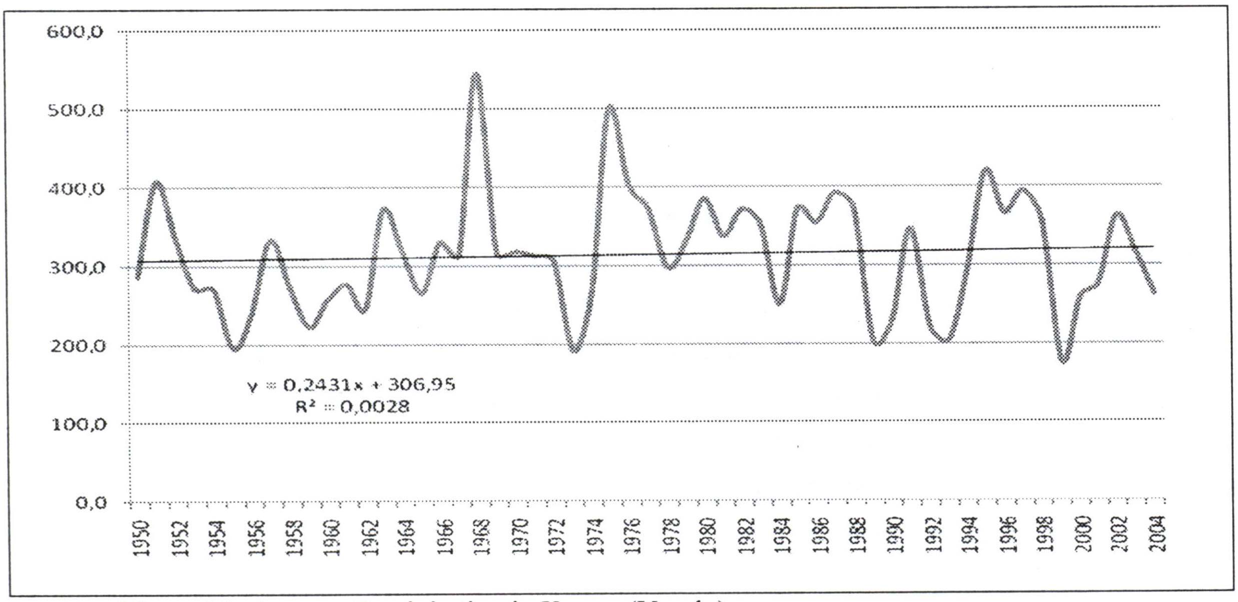


Figure 10. Average Precipitation in Konya (Yearly)

Source: Station data from "Turkish State Meteorological Sevice" (1950-2004)

Concerning the moisture, only one farmer said that the moisture had not changed but the others claimed that the moisture had decreased in the last 20 years.

Also all farmers claimed that underground water level had declined in the last 20 years. As a result the cost of irrigating crops had increased and farmers had started to change their irrigation systems from present methods to sprinkler and drip irrigation methods.

3.2.1.3. Changes in Cropping Pattern Due to Climate Change

Eighty percent of the farmers stated that they had not changes their crops because of climate changes. But 20% of the farmers reported that they had changed the crops because of the changes in climate and had started to produce maize and beans. These farmers think that maize and beans were more suitable for high temperatures.

3.2.1.4. Changes in Fertilizer – Pesticide Use Due to Climate Change

Seventy-one percent of the farmers said that the quantity of the fertilizer and pesticide used in agriculture had changed due to climate change (Table 39). Some of these farmers said that they had increased the quantity of fertilizer–pesticide, some other had decreased.

Table 39. Changes in fertilizer-pesticide use

Age groups	Fertilizer-pesticide change					
	Not Changed		Changed		Total	
	Q	%	Q	%	Q	%
1	7	36,8	12	63,2	19	100,0
2	2	16,7	10	83,3	12	100,0
3	1	25,0	3	75,0	4	100,0
Total	10	28,6	25	71,4	35	100,0

On the other hand 28.6% of the farmers did not make any change in the amount of fertilizer–pesticide they had used in production.

3.2.1.5. Changes in Cultivation Methods (Planting time) Due to Climate Change

3.2.1.5.1. Changes in Production Techniques If Temperature Rises

The farmers' response to temperature increase is examined for two important crops of the region. These crops are wheat and maize.

3.2.1.5.1.1. Changes in Production Technique of Wheat If Temperature Rises

Fifty-one percent of the wheat producers say that they would not make any change in soil cultivation methods if temperature rises (Table 40). Forty-nine percent of the farmers expect that there has to be a change in the soil cultivation methods if temperature rises.

Table 40. Changes in Production Technique of Wheat If Temperature Rises

	No Changes		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	18	51,4	17	48,6	-	-	-	-	35	100,0
Seed quantity	18	51,4	-	-	15	42,9	2	5,7		
Seed variety	32	91,4	3	8,6	-	-	-	-		
Quantity of fertilizer use	12	34,3	-	-	23	65,7	-	-		
Irrigation method	4	11,4	31	88,6	-	-	-	-		
Number of irrigation	13	37,1	-	-	1	2,9	21	60,0		

Fifty-one percent of the wheat producers stated that they would use the same quantity of seed even if temperature rises. On the other hand a significant number of farmers claim that the seed quantity should decrease if temperature rises.

The majority of the farmers are not thinking to change the present seed variety if temperature rises. Farmers say that there was not heat resistant wheat seed variety in the market, some farmers, especially the elder ones claim that the seed variety of wheat should change if temperature rises.

Sixty-six percent of the farmers think that the quantity of fertilizer used in wheat production decreases if temperature rises. All of the elder farmers stated that the quantity of fertilizer used in wheat production should decrease if temperature rises. Thirty-four percent of the farmers say that there was no need to change the quantity of fertilizer in wheat production.

Almost all wheat producers think that the type of fertilizer, quantity of pesticide and the type of pesticide would not change in wheat production if temperature rises.

But 88.6% percent of the farmers believe that the irrigation method would change if temperature rises. Here again all the elder farmers claim that the irrigation methods would change.

Sixty percent of the farmers think that the number of irrigation would increase if temperature rises. These farmers say that higher temperatures would cause water losses through evaporation and hence more irrigation would be needed. However, there are some farmers who believe in the efficiency of irrigation. These farmers claim that if irrigation is applied properly there is no need to increase the number of irrigation.

3.2.1.5.1.2. Changes in the Production Technique of Maize If Temperature Rises

Maize has become an important enterprise in the irrigated areas in recent year. Because of the limitations in the cultivated areas of sugar beet, some farmers have been inclined to produce maize on the irrigated land.

Sixty-five percent of the maize growers say that they would not change the cultivation methods of maize if temperature rises (Table 41). The other group thinks that a change in cultivation method might be needed if temperature rises.

Table 41. Changes in the Production Technique of Maize If Temperature Rises

	No Changes		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	23	65,7	12	34,3	-	-	-	-	35	100
Seed quantity	20	57,1	-	-	14	40,0	1	2,9		
Quantity of fertilizer use	18	51,4	-	-	17	48,6	-	-		
Quantity of pesticide use	22	62,9	-	-	12	34,3	1	2,9		
Irrigation method	14	40,0	21	60,0	-	-	-	-		

Fifty-seven percent of the maize growers think that the quantity of seed would not increase if temperature rises. But some of the farmers told that the quantity of seed should decrease if temperature rises.

Almost all farmers agree that the variety of seed would not change if temperature rises.

Fertilizer is an important input in maize production. All farmers do not agree on the quantity of fertilizer that should be used if temperature rises. Fifty-one percent of the maize growers claim that fertilizer quantity would not change. The other group (48.6%) says that the fertilizer quantity should decrease. All farmers agree that type of fertilizer would not change if temperature rises.

There is not a concercus among farmers about the quantity of pesticide use in maize production if temperature rises. Sixty-three percent of maize growers say that the quantity of pesticide used in maize production would not change. Thirty-four percent of the maize growers claim that pesticide use would decrease.

Almost all farmers agree that the type of pesticide would not change if temperature rises.

Water is very important in maize production. Increased temperature is expected to increase the number of irrigation and method of irrigation. Sixty percent of the farmers think that irrigation methods would change if temperature rises. The other farmers say that the present methods would remain.

All farmers do not agree on the number of irrigation. Fifty-seven percent of the farmers say that the number of irrigation would not change even if temperature rises. Others claim that since the temperature rises, the number of irrigation should rise.

3.2.1.5.2. Response of Farmers if Precipitation Decreases

3.2.1.5.2.1. Changes in Production Technique if Precipitation Decreases

Farmers' response to precipitation decrease is examined for wheat and maize. Farmers' response to sugar beet production technique was not examined because the production of this crop is completely under the control of Sugar Company.

3.2.1.5.2.1.1. Changes in the Production Technique of Wheat if Precipitation Decreases

Fifty-one percent of the wheat farmers say that they would not change the soil cultivation methods if precipitation decreases. Forty-eight percent of the wheat farmers claim that the cultivation method should change and shallow cultivation would be more appropriate under rainfed and unsufficient irrigation conditions (Table 42)

.

Table 42. Changes in the Production Technique of Wheat if Precipitation Decreases

	No Changes		Changes		Decreases		Increases		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	18	51,4	17	48,6	-	-	-	-	35	100
Seed quantity	18	51,4	-	-	16	45,7	1	2,9		
Seed variety	32	91,4	3	8,6	-	-	-	-		
Quantity of fertilizer use	13	37,1	-	-	22	62,9	-	-		
Quantity of pesticide use	17	48,6	-	-	18	51,4	1	2,9		
Irrigation method	9	25,7	26	74,3	-	-	-	-		

How will the farmers respond to the quantity of seed if precipitation decreases? Fifty-one percent of the wheat producers say that the quantity of seed would remain the same. Whereas 45.7% of the farmers claim that the quantity of seed would decrease if precipitation decreases.

Which variety of seed should be used if precipitation decreases? Ninety-one percent of the farmers say that the variety of wheat would not change. On the other hand some farmers (8.6%) claim that the variety should change under rainfed conditions.

What kind of changes occur in the quantity of fertilizer in wheat production if precipitation decreases? Sixty-three percent of the wheat farmers say the quantity of fertilizer would decrease under rainfed conditions if precipitation decreases. Thirty-seven percent of the wheat producers claim that the quantity of fertilizer should remain the same if precipitation decreases.

Does the quantity of pesticide change in wheat production if precipitation decreases? Fifty-one percent of the farmers say that the quantity of pesticide would decrease and forty-eight percent of the farmers claim that the quantity of pesticide would remain the same.

Will the irrigation method change if precipitation decreases? Seventy-four percent of the wheat farmers say that the irrigation methods should change and more efficient water-saving methods should be introduced into farming. These farmers think that water reservoirs would not be well-fed and water capacity would decrease if precipitation decreases. Twenty-five percent of the wheat producers claim that the present methods could remain the same as long as they were used efficienty.

Also majority of the wheat farmers think that the number of irrigation would increase if precipitation decreases.

3.2.1.5.2.1.2. Changes in the Production Technique of Maize if Precipitation Decreases

Maize is grown under irrigated conditions in the Konya province.

Do the farmers change cultivation methods in maize production if precipitation decreases? Sixty-five percent of the farmers say that they would not change the cultivation methods if precipitation decreases. These farmers do not see any relation between a decrease in precipitation and cultivation methods since maize is irrigated. Thirty-four percent of the farmers say that the cultivation methods should change (Table 43).

Table 43. Changes in the Production Technique of Maize if Precipitation Decreases

	No Changes		Changes		Increases		Total	
	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	23	65,7	12	34,3	-	-	35	100
Irrigation method	15	42,9	20	57,1	-	-		
Number of irrigation	20	57,1	-	-	15	42,9		

Do the quantity and the variety of seed change in maize production if precipitation decreaes? The majority of the maize producers say that the quantity and the variety of seed would not change if precipitation decreaes.

Do the farmers change the quantity and the type of fertilizer in maize production? Many farmers believe that it is not necessary to change the quantity and the type of fertilizer in maize production if precipitation decreases.

Similarly many farmers think that the quantity and type of pesticide would remain the same if precipitation decreaes.

Do not farmers change the irrigation methods and number of irrigation if precipitation decreases? Fifty-seven percent of the farmers say that the irrigation methods would change and water-saving methods would be prefered.

What is the opinion of farmers about the number of irrigation in maize production if precioitation decreases? Fifty-seven percent of the farmers say that they would not change the number of irrigation. Whereas 43% of the farmers think that it would be necessary to increase the number of irrigation if precipitation decreases.

3.2.2. Rainfed Villages of Konya Province

In the first part of this section, some socio-economic indicators of the, surveyed farms are given. In the second part farmers' perception and behavior concerning climate change will be examined.

3.2.2.1. Some Socio-Economic Indicators of Rainfed Farms

Distribution of interviewed farmers by farm size groups is given in Table 44. Farms are distributed evenly among farm size classes and each class has enough interviewed farmer to represent that class. Total number of interviewed farmer to represent that class. Total number of interviewed farmers is 27.

Table 44. Distribution of farms by farm size groups

Farm size groups (da)	Group Code	Quantity	%
1-150	1	7	26,0
151-300	2	10	37,0
301-+	3	10	37,0
Total		27	100,0

In order to reflect the views and experience of different age groups, farm managers were grouped in 3 classes and the distribution of farm managers by age groups is given in Table 45.

Table 45. Distribution of farm managers by age groups

Age groups	Group Code	Quantity	%
30-45	1	9	33,3
46-55	2	15	55,6
56 +	3	3	11,1
Total	-	27	100,00

Generally speaking education level is important in percieving and interpreting climatic events. There are farmers from different education level including university graduate (Table 46).

Table 46. Education level of farm managers

Group Code	Education level	Quantity	%
1	Literate	-	-
2	Primary school	17	63,0
3	Secondary school	6	22,2
4	High school	3	11,1
5	University	1	3,7
Total		27	100,0

The average farm size is 314,2 decares. The number of plots and average plot size by farm size groups are given in Table 47.

Table 47. Average farm size, number of plots and average plot size

Farm size groups	Average Farm Size (da)	Number of plots	Average plot size (da)
1	67,1	3,7	18,1
2	231,8	7,8	29,7
3	569,6	10,8	52,7
Mean	314,2	7,9	40,0

Cropping pattern of rainfed farms is given in Table 48. There is only one important crop. That is wheat. There is some barley for the animals. An important part of the cultivated land is allocated for fallow to accumulate moisture in the soil for the next year's production.

Table 48. Size of cultivated area by crops (da)

Farm size groups	Wheat	Barley	Fallow	Other*	Total
1	31,0	4,0	32,1	0,0	67,1
2	131,1	4,0	92,0	4,7	231,8
3	310,0	0,0	252,3	7,3	569,6
Mean	171,4	0,3	136,3	4,5	314,2

* Unused land

3.2.2.2. Farmers' Perception and Behavior Concerning Climate Change

Just like the irrigated agriculture farmers of Konya province, the majority of the rainfed agriculture farmers say that the temperature has increased and precipitation has decreased (Table 49 and 50).

Table 49. Farmers' perception concerning temperature in the last 20 years

Age groups	Temperature					
	Increased		Not Changed		Total	
	Q	%	Q	%	Q	%
1	9	100,0	0	0,0	9	100,0
2	12	80,0	3	20,0	15	100,0
3	3	100,0	0	0,0	3	100,0
Total	24	88,9	3	11,1	27	100,0

Table 50. Farmers' perception concerning precipitation in the last 20 years

Age groups	Precipitation					
	Decreased		Not Changed		Total	
	Q	%	Q	%	Q	%
1	9	100,0	0	0,0	9	100,0
2	14	93,3	1	6,7	15	100,0
3	3	100,0	0	0,0	3	100,0
Total	26	96,3	1	3,7	27	100,0

The views of farmers concerning moisture are different. Approximately half of the farmers say that the moisture had declined but the other half claimed that the moisture had not changed.

3.2.2.3. Changes in Production Systems Due to Climate Change

All farmers mentioned that they had not changed their crop because of climate change. Most of the farmers said that they had been growing wheat for a long time. Wheat had not been replaced by other crops.

Farmers occasionally had produced lentil and cumin depending on market conditions. Farmers also mentioned that they had changed the variety of wheat as new and high yielding varieties developed by research organizations come to market.

Most of the farmers did not change cultivation methods because of changes in the climate. Some farmers claim that the spring plowing had shifted from April to March.

Farmers stated that they had not made any change in the quantity and the type of fertilizer and pesticide because of persistent changes in the climate. They say that they changed the quantity of fertilizer depending on weather conditions especially the precipitation.

The majority of the farmers agree that changes in planting time (September, October, November) and harvesting time (June, July) had been related to precipitation time in autumn.

Concerning the livestock production farmers had not made any change in animal races, feeding system, and barn amendment because of the changes in climate.

To summarize, farmers pointed out the following vies:

- Temperature is increasing and precipitation is decreasing.
- They did not make any change in the production systems because of climate changes.
- If temperature increases and precipitation decreases, the best solution would be irrigation. Otherwise some farmers think to apply two-year fallow (fallow-fallow-crop) system.
- Scientists might recommend some crops that are suitable to climatic conditions.

3.2.2.4. Changes in Production Technique if Temperature Rises

Farmers' response to temperature increase is examined for wheat only. Because wheat is the most important crop of rainfed agriculture.

3.2.2.4.1. Changes in Production Technique of Wheat if Temperature Rises

Sixty-three percent of the farmers say that they would not change the cultivation methods of the wheat production. Thirty-seven percent of the farmers claimed that there had to be some changes in the cultivation methods if temperature rises (Table 51).

Table 51. Changes in Production Technique of Wheat if Temperature Rises

	No Changes		Changes		Decreases		Total	
	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	17	63	10	37	-	-	27	100
Seed variety	20	74,1	7	25,9	-	-		
Quantity of fertilizer use	11	40,7	-	-	16	59,3		

Which variety of wheat seed should be used if temperature rises is an important issue for the wheat producers. Seventy-four percent of the farmers say that there was no alternative variety. But 25.9% of the farmers claim that the variety of wheat should change if temperature rises. On the other hand, the majority of the farmers agree that the quantity of wheat seed would not change if temperature rises.

What kind of changes occur in the quantity of fertilizer if temperature rises? Fifty-nine percent of the wheat producers say that the quantity of fertilizer would decrease. Forty percent of the farmers said it would remain the same quantity.

Almost all farmers do not expect any change in the type of fertilizer if temperature rises.

The majority of the wheat producers think that the type and quantity of the pesticide would not change if temperature rises.

3.2.2.4.2. Changes in Production Technique of Wheat if Precipitation Decreases

Farmers have different views in relation to cultivation methods. Fifty-five percent of farmers do not think to change the cultivation methods if precipitation decreases. Forty-four percent of the farmers claim that there must be a change towards water conserving methods if precipitation decreases (Table 52).

Table 52. Changes in Production Technique of Wheat if Precipitation Decreases

	No Changes		Changes		Decreases		Total	
	Q	%	Q	%	Q	%	Q	%
Soil cultivation methods	15	55,6	12	44,4	-	-	27	100
Quantity of fertilizer use	9	33,3	-	-	18	66,7		

The majority of the farmers do not think to change the variety and the quantity of seed in wheat production if precipitation decreases.

What is the farmers' opinion about the quantity of fertilizer used in wheat production. Sixty-six percent of the wheat producers say that the quantity of fertilizer would decrease if precipitation decreases. On the other hand almost all wheat growers agree that the type of fertilizer would not change.

Almost all farmers think that there would be no need to change the quantity and the type of pesticides if an unexpected disease or pests emerge.

4. Identification of Policy and Institutional Measures

The scientific findings of different organizations on global climate change and especially on global warming show that the world's climate is most probably changing. Although we are not certain about the type of climatic changes we have to identify policies and institutional mesasures to cope with global warming.

In Turkey, there are several organizations working directly or indirectly on climate change. These organizations are:

- The Ministry of Environment and Forestry,
- The Ministry of Agriculture and Rural Affairs,
- State Planning Organization,
- Universities,
- Research Institutes,
- The General Directorate of State Meteorological Affairs
- Some NGOs.
- Ministry of Foreign Affairs,
- Ministry of Transportation,
- Ministry of Industry and Trade,
- Ministry of Energy and Natural Resources,
- Ministry of Public Works.

These organizations are working separetely. In order to provide efficient collaboration between several ministries and NGOs the "Climate Change Coordination Committee" was set up in 2004. The regular meeting of this commitee is once in a year.

Lack of efficient collaboration among these organizations hinder the application of multidisciplinary and productive works. Therefore a new institute or center is needed to deal with global warming issues.

On the other hand, in developed countries there are institutes or centers that work on climate change only. Some of these organizations are given below:

Table 53. Some institutes or centers that work on climate change in developed countries

Country	Name of the Institutions
USA	• Ocean and Climate Change Institute • The Climate Change Institute • The National Institute for Climatic Change Research • International Research Institute for Climate and Society • The Institute for Research on Climate and Its Societal Impacts
Japan	• Centre for Climate System Research • National Institute for Environmental Studies • National Institute of Agro-Environmental Sciences • Institute for Global Change Research • Institute for Global Environmental Strategies • Meteorological Research Institute
UK	• The Environmental Change Institute • Tyndall Centre for Climate Change Research
Germany	• The Potsdam Institute for Climate Impact Research
Canada	• The Canadian Institute for Climate Studies
Danmark	• The National Environmental Research Institute
Italy	• Institute for Environment and Sustainability
Australia	• The Climate Institute of Australia

4.1. Policies Related to Global Warming

Scientific studies show that Green House Gases (GHGs) play an important role in global warming. Main sources of GHGs in agricultural are especially stubble burning, rice production, livestock production and manure fertilizer use. These activities cause plenty of CO_2, CH_4 and N_2O emmissions which have significant impact on global warming.

According to the study conducted by SIS (State Institute of Statistics) the share of agricultural sector in CO_2 emission is around 10-15 % in Turkey (Egemen, 2004). This amount is not very high and is decreasing by years. This situation might influence the decision-makers not to take serious measures to prevent GHGs emissions in the agricultural sector.

Tools, to cope with global warming, could be classified into three groups:

1) Legal,

2) Economic and Financial,

3) Training

Legal instruments include laws, by-laws and regulations. The most important law is The Environment Law that was approved in 1983. The other laws related to agricultural sector are Agricultural Protection and Quarantine Law, General Hygiene Law, Underground Water Law, National Parks Law, Pasture Law, Soil Protection and Land Use Law.

There are some by-laws directly or indirectly related to global warming. Some of them are given below:

- Soil Pollution Control
- Water Pollution Control
- Air Pollution Control
- Environmental Impact Assessment
- Afforestation
- Protection of Waters Against Agriculture Based Nitrate Pollution
- Protection and use of Agricultural Lands
- Protection of Wetlands

Turkey also undersigned many international agreements related to agriculture and environment. Some of them are given below:

- United Nations Framework Convention on Climate Change
- Convention on Biological Diverstiy
- United Nations Convention to Combat Desertification

The present legal instruments are well-designed and satisfactory in terms of content to prevent air and water pollution. However existance of proper laws and by-laws do not solve the problem. The most important thing is the application of laws, by-laws and regulations. According to laws, by-laws and regulations there are strict rules to prevent air and water pollution but they do not work effectively in real life. For example burning stubble which causes air pollution is forbidden according to by-law, but almost all farmers burn stubble after harvesting wheat and maize. The reason is simple: the amount of fine is so small (20 YTL≈14 USD per decare) and therefore does not have deterrent effect on stubble burning[2].

Although the application of financial and legal measures to develop forestry areas are not direcly focused to combat with global warming, these are very important instruments to cope with global warming.

The Ministry of Environment and Forestry is providing substantial supports to

[2] The Ministry of Environment and Circular issued on 07.06.2006.

The Ministry of Environment and Forestry is providing substantial supports to private organizations and village administrations. These supports are in the form of tax reductions and cheap credit. In Turkey, 10.500 ha of land was afforested by private organizations and village administrations through these supports in 2005. In addition, The Ministry of Environment and Forestry has afforested 22.056 ha in the same year (SPO, 2006).

It is clear that the existing training programs related to global warming is not efficient and many people do not understand why global warming is important to the country. Therefore training is needed for people of all ages.

What can be done to train people with respect to global warming? For training to be an efficient tool in fighting against global warming appropriate training programs should be propered for the people from different categories i.e. children, adults, less-educated, city people, rural people.

The aim of this training should be to increase the consciousness and awareness of people towards global warming. If the Turkish farmers are well-trained concerning the dangers of stubble burning, it is obvious that they do not burn stubbles.

Both governmental and organizations and NGOs can play a very important role to accomplish this task. Conducting scientific researches, organizing training programs, organizing meetings and similar activities would increase the consciousness of all people.

5. Conclusions

In recent years a sudden increase in the number of unforcasted climatic events such as floods, droughts, storms and hurricanes drew the attention of world people to the problem of global warming. In 2002, the floods killed many people in Germany, Hungary and Turkey. In late 2006, the floods have killed more than 40 people in the Southeast Anatolia Region of Turkey and hundreds of families left their hauses in order to escape from floods in Istanbul and Izmir. These unforcasted climatic events are strong indicators of climate change. In the USA, Japan, Germany, Canada and Israil researches in relation to global warming have been accelerated. The forecast studies concerning global warming show that the temperature of the world will rise between 0.3 to 1.3 degrees Celsius during the next 30 years.

A climate forecast study conducted under the ICCAP project show the temperature will rise between 2.3 ^{o}C – 3.8 ^{o}C and precipitation will decrease 58 mm – 266 mm by 2070 in the project area of Konya and Adana provinces respectively.

These changes in climate are also affecting agriculture. Scientists are not certain about the impact of the climate change on agriculture. Some scientists claim that global warming could increase water supply in some water-scarce areas and hence increase crop yields in temperate and in some subtropical zones. Some other scientists say that rising temperatures and frequent extreme wheather events would cause demages to agricultural production.

It is clear that frequent extreme wheather events such as storms, hails would cause demages in agricultural production in every agro-ecological zone. However, temperature increase and precipitation decrease are expected to have different impact in agricultural production in different agro-ecological zones.

This study was conducted to understand the farmers' perception and behaviour concerning climate change and to identify necessary policies and institutional measures to cope with global warming.

To accomplish the objectives of the reaearch 72 questionnaires in Adana and 62 questionnaires in the Konya province under irrigated and rainfed production conditions were applied.

In order to identify necessary policies and institutional measures all legislative instruments (law, by-laws, and regulations), economic and financial instruments (taxes, fees, penalties) and training activities of related organizations were examined.

The opinion of farmers reflect how they percieve climate change and how they react towards climate change.

The majority of the Adana and Konya farmers (both irrigated and rainfed), think that temperature has increased in the last 20 years and it tends to increase in the future. Similarly most of them think that the precipitation has decreased and it tends to decrease in the future. Concerning humidity Adana and Konya farmers have different opinions. According to Adana farmers humidity has increased but Konya farmers claim that humidity has decreased.

All Adana and Konya farmers (irrigated and rainfed) agree that the cropping pattern has not changed due to climate change in the last 20 years. Changes that occured in the cropping pattern in the research area were found to be related to the profitibility of the enterprises.

Most of the farmers in Adana and Konya stated that the production technique (cultivation method, amount and variety of seed, amount and kind of fertilizer and pesticidies, method and number of irrigation) had not changed due to climate change in the last 20 years.

Which crops will be produced by the farmers if temperature rises and precipitation decreases? Farmers are not very sure about cropping pattern if temperature rises and precipitation decreaes. Many farmers stated that they would produce heat and drought resistant crops such as cotton in Adana and barley in Konya.

What kind of changes will occur in the production technique of crops if temperature increases and precipitation decreases? Majority of Adana and Konya farmers think that soil cultivation methods, seed quantity and variety, pesticide quantity and type will not change. Farmers stated that number of irrigation would increase and method of irrigation would change. Farmers also agree that the quantity of fertilizer used in production would decrease under rainfed conditions.

In Turkey there are several governmental and nongovernmental organizations dealing with certain aspect of climate change. It should be mentioned that there is not a satisfactory cooperation between these organizations. Therefore there is a need to set up a unit (Institute or Center) that will deal with global warming issues to institutionalize this important issue. The examples of this organization could be seen in the USA, Japan, UK, Germany, Italy, Australia and some other countries.

It seems that the present level of GHGs emissions from agricultural sector in Turkey is not very high and has a tendency towards decline. This is probably the reason why there is not an upper limit of fertilizer and manure use per unit of land.

Turkey has different agro-ecological zones. It is obvious that the impact of climate change would be different in different zones. Most probably in some zone the impact of climate change would be negative but in some other zone it would be positive.

Taking these differences into consideration researches in these zones should be conduted and policies should be identified according to the characterities of each zone. Because policy measure which is suitable to cope with global warming in a certain zone may have a hazardoues effect in other zone.

Observations show that the existance of a policy measure is not important as long as it is applied and monitored properly. The typical example of this event is "stubble burning" in the research area. It is forbidden to burn stubbles and farmers should pay fine. But majority of the farmers burn stubbles because the rules are not applied properly.

Finally it should be mentioned that training is very important. To understand the importance of global warming training is needed for people of all ages and different categories. Governmental and nongovernmental organizations could collaborate to train people.

6. References

CBO, 2003. The Economics of Climate Change: A Primer. The Congress of the United States, Congressional Budget Office Publications (www.cbo.gov). USA.

Darwin, R., Trigas, M., Lewandrowski, J., Raneses, A., 1995. World Agriculture and Climate Change: Economic Adaptations. 1995, Natural Resources and Environment Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 703.

Egemen, N., 2004. Ankara İklim Değişikliği Konferansı (Ankara Climate Change Conference). 1-3 September 2004, Hotel Dedeman Ankara, Turkey.

IPCC, 2001a: Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Integovernmental Panel on Climate Change [Watson, R.T. and the Core Writing Team (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 398 pp.

IPCC, 2001b: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. [Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp.

Reilly, J., 1996. Global climate change and agricultural production: direct and indirect effects of changing hydrological soil and plant physiological processes [Bazzaz, F., Sombroek, W (eds.)]. John Wiley & Sons Ltd publication, Baffins Lane, Chichester, West Sussex PO19 1UD, England.

SPO (State Planning Organization), 2006. Dokuzuncu 5 Yıllık Kalkınma Planı (2007-2013), Ormancılık Özel İhtisas Komisyonu Raporu, (http://www.ogm.gov.tr/apk_belge.htm).

Yücel, C., Altınbaş, S., Yıldırım, M., Topal, M., Yağbasanlar, T., Genç, İ., Özkan, H.,

2005. Bir Akdeniz Çevresinde Seçilmiş Ekmeklik Buğday Genotiplerinin (*T. aestivum L.*) Mevsimsel İklim Farklılıklarına Tepkisi (Response to Seasonal Climate Difference of Selected Bread Wheat (*T. aestivum L.*) Genotypes in a Mediterranean Environment). Türkiye VI. Tarla Bitkileri Kongresi, 5-9 Eylül 2005, Antalya, Turkey.