Applied Fruit Science (2024) 66:475–483
https://doi.org/10.1007/s10341-023-01021-4

ORIGINAL ARTICLE / ORIGINALBEITRAG

Exploring Kiwi Fruit Producers' Climate Change Perceptions

Ismail Bulent Gurbuz[1] · Gulay Ozkan[1] · Simge Er[1]

Received: 31 July 2023 / Accepted: 18 December 2023 / Published online: 6 February 2024
© Der/die Autor(en), exklusiv lizenziert an Springer-Verlag GmbH Deutschland, ein Teil von Springer Nature 2024

Abstract
Climate change is one of the biggest problems of our time and has a significant impact on the natural ecosystem. Although efforts are being made to reduce the negative effects of droughts and other extreme natural events, they are increasing. Rising temperatures and decreasing rainfall are among the most common of these events. Agriculture is one of the sectors most affected. As a result, the food chain is disrupted. Farmers need to be aware of climate change and take adaptation measures to minimize these disruptions. The study examines the factors that influence kiwifruit producers' perceptions, their problems and their fight against climate change. The study also examines how these factors affect yields in Kastamonu, northern Turkey. The data consists of a survey of 65 kiwi producers. The data was analyzed using Statistical Package for the Social Sciences (SPSS) 28.0. Frequency analyses and binary logistic regression analyses were performed. According to the results of the study, most farmers (67.7%) stated that the seasonal air temperature in their region had increased. The participants stated that operating costs would increase due to climate change. Producers believe that agricultural insurance and organic farming are essential for adapting to climate change. However, there is a linear relationship between the problems encountered in kiwi farming, the perception, struggle and future expectations of climate change and the expectation of a decline in kiwi productivity. By providing direct financial support to farmers, policymakers can encourage them to prevent and reduce the negative impacts of climate change.

Keywords Horticulture · Sustainability · Land use · Risk assessment · Yield

Introduction

Turkey's climatic and ecological conditions are suitable for the cultivation of various fruit varieties (Gul et al. 2020). Turkey is home to numerous fruit varieties such as apples, cherries, quinces and lemons, and there are climatically and ecologically favourable regions for kiwi cultivation. In addition, Turkey's climatic variations and fertile soils enable the application of conventional good agricultural practices (GAP) and organic farming. This makes the country the world leader in fruit production (Bayav 2022). This lead in fruit production contributes significantly to the country's economy and is an important source of income for farmers. However, some studies have calculated a decline in agricultural production of between 2.2 and 12.9% over the next 30 years due to climate change in the area (Akyuz 2019). In addition, climate change will harm Turkey's great advantage in fruit production.

The kiwi is a fruit from the Actinidiaceae family (Wu et al. 2022). It is cultivated in various parts of the world and has a high nutrient content (Xia et al. 2023). The kiwi is high in vitamin C but low in calories. The fruit also cures respiratory diseases such as asthma and cough (Gokdogan 2022). These benefits increase the demand for kiwis, especially during the winter months. With the rapid increase in demand for kiwifruit, its production has spread and increased in many countries, especially in China. Kiwis are native to the mountainous regions of central and south-west China (Kokkora et al. 2023). Their seeds were brought to New Zealand in 1904 and cultivation began (Richardson et al. 2018). China, New Zealand, Italy, Greece and Iran are the five largest kiwifruit producers in the world, accounting for 90% of global kiwifruit production (FAOSTAT 2022). Turkey ranks seventh in the world. Up to 74% of the country's production comes from the Eastern Marmara and Eastern Black Sea regions (TurkStat 2022).

✉ Ismail Bulent Gurbuz
bulent@uludag.edu.tr

[1] Department of Agricultural Economics, Faculty of Agriculture, Bursa Uludag University, Gorükle Campus, 16059 Nilufer, Bursa, Turkey

The kiwi has high climatic adaptability. However, it is susceptible to climatic events, strong winds and frost. Strong winds break the brittle shoots and reduce yield and quality. These weather-related disasters have recently increased in various parts of the world, making it difficult for farmers to grow kiwis and other fruits.

Climate is directly related to the growth processes of kiwifruit. Kiwis need the right temperature, rainfall and humidity, especially during growth. Climate change has a detrimental effect on growth processes. It leads to stunting, altered growing seasons, plant diseases and increased insect invasion (Bayrac and Dogan 2016). Constant exposure of the fruit to heat leads to sunburn, loss of texture and nutritional value (Parajuli et al. 2019). In addition, plants react differently to climate change depending on the species (Malhi et al. 2021).

Changes in temperature, precipitation and sunshine duration reduce the quality and quantity of yields (Malhi et al. 2021). Temperatures in Mexico have been reported to affect coffee yields, leading to a 34% decrease in coffee production (Gay et al. 2006). It is predicted that yields of agricultural products in arid regions worldwide will fall by 50% by 2050 and by 90% by 2100 (Li et al. 2009). Previous research suggests that high temperatures affect the flavour of fruit due to changes in sugar (apples and grapes), acidity (grapes), fruit firmness and fat content (avocado) (Moretti et al. 2010). Brazil, a South American country, will experience drought, and sugar cane, which is widely grown in that country, will be affected by the drought (Montgomery 2014). According to studies, the Mediterranean region, including Turkey, is one of the most affected regions (Sevim et al. 2022). Research shows that temperatures in the country will rise and below- and above-ground precipitation will increase.

According to studies, the Mediterranean region, including Turkey, is one of the most affected regions (Sevim et al. 2022). Research shows that temperatures in the country will rise, and below- and above-ground precipitation will increase. Research shows that temperatures in the country will rise and precipitation and underground and surface water resources will decrease (Soltekin et al. 2021). These climate changes will harm the ripening, heat and water requirements of the fruit (Aryal et al. 2020). For example, the quality and production of hazelnuts are expected to decline towards the middle of the century (Turkes 2020).

Studies on kiwifruit production and the effects of climate change on kiwifruit production are more likely to be found in the international literature, mainly from New Zealand (Müller et al. 2015; Cradock-Henry 2017; Tait et al. 2018) and China (Qin et al. 2021; Gao et al. 2022; Sarkar et al. 2022; Wang et al. 2021). Few studies have been conducted in Korea (Jeong et al. 2018; Kim and Koh 2019) and Mediterranean countries (Mazis et al. 2021; Bardi et al. 2022; Lai et al. 2022), and the expansion of kiwifruit production and increase in kiwifruit sales are not associated with an increase in research.

This study found that kiwifruit farmers' opinions, beliefs, and strategies to combat climate change have not been researched. Therefore, this gap will be filled using Kastamonu as an example.

Thus, the objectives of this study are as follows:

1. To highlight the challenges faced by Kiwi farmers as a result of climate change
2. To highlight Kiwi producers' perceptions of climate change
3. To highlight Kiwi producers' methods to combat climate change
4. To reveal the kiwi growers' belief about the future effects of climate change
5. To examine how the problems encountered in kiwi production, producer perceptions, control methods and future expectations affect farmers' kiwi yield perceptions

Materials and Methods

Study Area and Sample

Kastamonu is in the north of Turkey and has a 176 km coastline to the Black Sea. Two types of climates prevail in the province. The Black Sea climate prevails in the north and the continental climate in the southern parts. The monthly distribution of precipitation in Kastamonu is generally uniform. Winter precipitation accounts for 18% of the annual precipitation, while summer precipitation accounts for 27%. Most precipitation falls in the spring months. The average annual temperature in the province is 10.1 °C. The annual precipitation is 483.8 mm. The wettest month is May, with an average rainfall of 60 mm (Turkish State Meteorological Service 2023).

The enterprise data were obtained from the Agriculture Directorate of Kastamonu Province. The full census method was used. All operating farms were reached, and 65 kiwi farms were surveyed. Data were obtained through a face-to-face interview. The survey was conducted in the year 2022.

Data Analysis

Descriptive statistics were used to examine the relationships between each variable. In addition, binary regression was used to analyze the factors associated with climate change that affect kiwi yield. Binary logistic regression is used to determine the cause–effect relationship between the dependent variable and the independent variables when the dependent variable is binary. It shows the correlation between one or more explanatory variables and binary response vari-

ables. The explanatory variables can be either categorical or metric. The category studied in the dependent variable is generally coded Y = 1. Y = 0 means the other category (Hosmer and Lemeshow 2000).

The model is specified as below:

$$P\ (Y) = \frac{e^{ß_0 + ß_1 X_1 + \ldots + ß_n X_n}}{1 + e^{ß_0 + ß_1 X_1 + \ldots + ß_n X_n}}$$

where:

P: the probability of Y occurring
e: natural logarithm base
$ß_0$: interception at the y-axis
b_1: line gradient
$ß_n$: regression coefficient of X_n
X_1: predictor variable
X_1 predicts the probability of Y

In the logistic regression equation, P represents the probability of the event being observed. The ratio between the probability of an event under investigation and the probability of other events outside that event is called the odds ratio (OR). The logistic regression equation expresses the odds ratio as Exp(β). Since the odds ratio is the probability of an event occurring relative to the probability of it not occurring, exp(β_p) indicates how often variable Y is likely to be observed with the effect of variable Xp or by what percentage.

Results and Discussion

Demographic Characteristics of the Participants

Most of the kiwi farmers surveyed were male (92.3%). Almost all farmers were married (96.9%). More than half of the participants (55.4%) were over 50 years old and had completed primary school (56.9%). About one-third of the families had two or fewer members in their family. The proportion of provinces with five or more people was 23.1%. The size of agricultural households is declining in this region. Only one or two people in the families of 87.4% of the participants worked in agriculture. The majority of participants had 15 years or less experience in kiwi cultivation.

Kiwi plants grown at lower altitudes bear more fruit. The elevation of 72.3% of the farms was between 151 and 200 m. Similarly, Bostan and Gunay (2014) reported that 48% of kiwi plantations in Ordu, Turkey, were planted at altitudes between 0 and 250 m. The majority (58.5%) of farmers owned 1–5 decares (da) of land. A quarter of the farmers (26.2%) owned 0.1 ha or less. Uzundumlu et al. (2018) reported similar results from surveys in the neighbouring city; 33% of the kiwi cultivation areas in Rize were between 0.1 and 0.5 ha. Many farmers grow kiwi vines in their tea gardens. This trend is increasing, as Kiwi is a good source of income. In the survey, 78.5% of farms produced 36 kg/tree or more. Almost two-thirds (61.5%) of growers used early warning systems. More than half (53.8%) of the participants followed news and information via print media. Another third (33.8%) of producers learnt the news

Table 1 Problems encountered in kiwi cultivation

	1		2		3		4		$\overline{X}$
	N	%	*N*	%	*N*	%	*N*	%	
Storm	–	–	–	–	27	41.5	38	58.5	3.58
Frost	–	–	1	1.5	30	46.2	34	52.3	3.50
Flood	–	–	3	4.6	31	47.7	31	47.7	3.43
Rising input costs	–	–	1	1.5	36	55.4	28	43.1	3.41
Inability to sell the product at the desired price	–	–	1	1.5	36	55.4	28	43.1	3.41
Expensive fertiliser	–	–	2	3.1	36	55.4	27	41.5	3.38
Labour shortage	–	–	3	4.6	35	53.8	27	41.5	3.36
Decreased product quality	–	–	4	6.2	35	53.8	26	40.0	3.33
Not being aware of the state support	3	4.6	5	7.7	27	41.5	30	46.2	3.29
Landslide	1	1.5	12	18.5	25	38.5	27	41.5	3.20
Insect infestation	1	1.5	9	13.8	31	47.7	24	36.9	3.20
Plant diseases	–	–	8	12.3	37	56.9	20	30.8	3.18
Lack of connection with extension services	4	6.2	4	6.2	35	53.8	22	33.8	3.15
The land is not suitable for cultivation	3	4.6	3	4.6	39	60.0	20	30.8	3.16
Drought	1	1.5	17	26.2	31	47.7	16	24.6	2.95
Erosion	3	4.6	22	33.8	23	35.4	17	26.2	2.83

1 Not at all important, *2* Low importance, *3* Moderately important, *4* Very important

Table 2 Perceptions of producers about the effects of climate change (CC)

Perceptions	1		2		3		4		$\overline{X}$
	N	%	*N*	%	*N*	%	*N*	%	
CC increases frost occurrence	–	–	–	–	34	52.3	31	47.7	3.48
CC increases seasonal air temperature in our region	–	–	1	1.5	34	52.3	30	46.2	3.45
CC increases the amount of precipitation in the region	–	–	–	–	36	55.4	29	44.6	3.45
CC increases the occurrence of landslides, erosion, drought, floods and other extreme weather events	–	–	1	1.5	38	58.5	26	40.0	3.38
CC affects the beginning and end of precipitation times in the region	–	–	2	3.1	37	56.9	26	40.0	3.36
CC increases the occurrence of forest fires	–	–	7	10.8	28	43.1	30	46.2	3.35
CC increases crop losses	–	–	4	6.2	38	58.5	23	35.4	3.29
CC harms orchards	–	–	8	12.3	38	58.5	19	29.2	3.17
CC only matters to those engaged in agriculture	26	40.0	18	27.7	10	15.4	11	16.9	2.53

1 Strongly disagree, *2* Disagree, *3* Agree, *4* Strongly agree

from visual media and only 9.2% from government institutions. Bolat and Bakirci (2023) found that farmers followed the news through national television. The same study found that farmers also used the internet and social media.

Problems Encountered in Kiwi Cultivation

Table 1 shows the participants' opinions about their kiwi growing problems. Half of the problems in this section are due to the economy and half are due to climate change. It has been estimated that consumer problems would be economy-based in the short term. However, storms ($\overline{X}$= 3.58), frosts ($\overline{X}$ = 3.50) and floods ($\overline{X}$ = 3.43) scored at the top of the problems caused by climate change. Rising input costs ($\overline{X}$ = 3.41), inability to sell kiwi at the right price so that farmers can make a decent profit ($\overline{X}$ = 3.41), and fertiliser being expensive ($\overline{X}$ = 3.38) are other problems kiwi producers encounter. And they are not always climate-related. However, insect infestation ($\overline{X}$ = 3.38) and plant diseases ($\overline{X}$ = 3.38) are directly related to climate change. A similar study reported problems such as limited access to agricultural extension officers ($\overline{X}$ = 3.57), lack of agricultural support ($\overline{X}$ = 3.56), lack of timely weather information ($\overline{X}$ = 3.58), labour shortage ($\overline{X}$ = 3.65), unpredictable weather conditions ($\overline{X}$ = 3.90), and lack of access to water resources ($\overline{X}$ = 4.08). Other obstacles authors highlight that farmers face in combatting climate change are high input costs ($\overline{X}$ = 3.86), poor soil fertility ($\overline{X}$ = 3.81), limited access to agricultural markets ($\overline{X}$ = 3.64), lack of agricultural support ($\overline{X}$ = 3.56), and lack of credit opportunities ($\overline{X}$ = 3.48) (Karakas 2022). The problems of the farmers are global, and a global struggle is necessary because the individual opportunities of the farmers are insufficient. Bryan et al. (2013) emphasized the need for multiple stakeholders to act together at the national and international levels, including farmers, politicians, agricultural extension representatives, non-governmental organisations researchers and the private sector, to achieve successful adaptation. McNamara and Buggy (2017) reported that community-based adaptation (bottom-up practices) has become increasingly common in the adaptation field, as traditionally, top-down practices do not provide adequate and sustainable benefits for vulnerable communities. According to Schipper et all. (2014), community-based adaptation is defined as interventions that help communities adapt to climate change, and everyone has important duties individually.

Farmers' Perceptions About Climate Change

Table 2 shows how farmers think about the effects of climate change. All farmers agreed with the statement that climate change increases the occurance of frost ($\overline{X}$= 3.48). A remarkable 93.9% farmers ($\overline{X}$ = 3.29) agreed that climate change causes crop losses. In addition, 96.9% of the farmers ($\overline{X}$ = 3.36) agree that 'climate change affected the beginning and end of precipitation seasons' in their region. 98.5% agreed that 'climate change increased the occurance of landslides, erosion, drougt' floods and other ecxtreme events in their living enviuronment ($\overline{X}$ = 3.38). 46.2% of the producers ($\overline{X}$ = 3.35) strongly agreed with the statement "Climate change is causing an increase in forest fires". On the other hand, Akyuz (2019) found in his study that forests and green spaces will decrease. In the study by Oz (2019), 69.2% of the farmers observed that rain duration is either shortened or delayed. There are similarities between the current study and the studies in the literature. Tempera-

Table 3 Farmers' methods of fighting climate change

	1		2		3		4		$\overline{X}$
	N	%	*N*	%	*N*	%	*N*	%	
Purchasing farm insurance	–	–	1	1.5	15	23.1	49	75.4	3.73
Organic farming	–	–	–	–	28	43.1	37	56.9	3.56
Water management	–	–	–	–	29	44.6	36	55.4	3.55
Good agricultural practices	–	–	–	–	30	46.2	35	53.8	3.53
Land consolidation	–	–	1	1.5	28	43.1	36	55.4	3.53
Using a windbreak	–	–	1	1.5	28	43.1	36	55.4	3.53
Using disease-resistant cultivars	–	–	1	1.5	29	44.6	35	53.8	3.52
Choosing drought-tolerant varieties	–	–	4	6.2	25	38.5	36	55.4	3.49
Rainwater harvesting	–	–	3	4.6	27	41.5	35	53.8	3.49
Rearranging water distribution	–	–	1	1.5	32	49.2	32	49.2	3.47
Reduced tillage	1	1.5	9	13.8	27	41.5	28	43.1	3.26
Using green manure	2	3.1	18	27.7	22	33.8	23	35.4	3.01
Modifying the crop pattern	9	13.8	13	20.0	13	20.0	30	46.2	2.98
Using agricultural calendar	10	15.4	17	26.2	14	21.5	24	36.9	2.80

tures will rise due to climate change. This will lead to fires, and forests will be threatened with extinction. The most important reason why farmers say this is that climate change will make itself felt with the highest temperature increase. Moreover, rainfall is necessary for the growth of plants. For this reason, farmers notice the periods when precipitation starts and ends according to the seasons. For this reason, farmers notice a change in precipitation more quickly.

Fight Against Climate Change

Farmers value most about taking out crop insurance ($\overline{X}$ = 3.73) to fight climate change (Table 3). In addition, organic farming ($\overline{X}$ = 3.56), water management ($\overline{X}$ = 3.55) and switching to green fertilisers ($\overline{X}$ = 3.01) are the most critical methods in combating climate change. While applying the agricultural calendar ($\overline{X}$ = 2.80) is the traditional, most accessible, and cheapest method to implement, it scored as the least valued method in combating climate change.

Adaptation options in response to changes in temperature and rainfall in the middle hills of Himachal Pradesh, India, included changing crop variety, planting drought-resistant crops, constructing a water-harvesting system, and irrigation (Kimani and Bhardwaj 2015). Deressa et al. (2011) stated that a proper understanding of the problem of climate change by farmers is the first step that needs to be taken to solve the problem. A study conducted with 700 participants in India found that 80% of farmers understand climate change and try to choose the most appropriate means to combat climate change (Jha and Gupta 2021). Maize farmers in northern Benin apply most agricultural calendars and diversify their crops accordingly (Yegbemey et al. 2013). Of the farmers in Kenya, 33% changed crop varieties, 20% changed planting dates and 18% changed cropping patterns (Bryan et al. 2013). Farmers have also changed their fertiliser, soil and irrigation practices.

Current research and studies in the literature show that farmers are taking some precautions to combat climate change. However, farmers need more capital and information to adapt to climate change.

Farmers' Perceptions of Climate Change and Combat Methods

To examine the producers' kiwi yield losses due to climate change, factors were created to determine the producers' perceptions of climate change, the problems they encounter in the fight against climate change, the methods of struggle and their future expectations, which were detailed in the previous section. All the factors created within the scope of the research and statistical information are given in Table 4.

Table 4 Descriptive statistics on variables

Factors	Description	$\overline{X}$	SS	Min.	Max.	N
Problems	Problems in kiwi cultivation	35.39	0.453	2.45	4.25	16
Perceptions	Producers' perceptions of CC	30.35	0.179	2.57	3.40	10
Fight	Fight against CC	32.10	0.408	2.40	3.80	14
Future	Producers' thoughts on future CC	24.55	0.302	1.63	3.05	6

CC Climate change

Accordingly, it is seen that farmers are affected by the problems caused by climate change ($\overline{X}$ = 35.39). It is also seen that they are relatively knowledgeable about combating climate change ($\overline{X}$ = 32.10). However, the farmers are not very hopeful about the future fight against climate change and the effects of climate change ($\overline{X}$ = 24.55).

According to the research results that deal with the causes and consequences of climate change and ways to combat it, to determine the level of producers' knowledge about climate change, the topic that producers know the most about is the consequences of climate change ($\overline{X}$ = 2.50). This was followed by the causes of climate change ($\overline{X}$ = 2.39) and methods to combat climate change ($\overline{X}$ = 2.29) (1: I have little to no knowledge 5: I have very good knowledge) (Cankaya and Boz 2023).

Factors Influencing Kiwi Yield Losses

This study aimed to determine the factors influencing kiwi growers' attitudes towards climate change in Kastamonu province. The binary logistic regression model was used to determine the factors influencing kiwi growers in increasing or decreasing kiwi yield.

The bivariate logit models used to measure the yield of kiwifruit production generally performed well, and two of the four variables were significant. In particular, the chi-square value of the model measuring the factors affecting yield decline in kiwifruit production is 32.65, which is significant at the 99% confidence level, indicating that the use of the bivariate logit model is appropriate. Pseudo R^2 = 0.772, significant at the 99% confidence level, which is quite high for a multivariate analysis based on cross-sectional data.

The binary logistic regression analysis and findings of the factors affecting the decrease in kiwifruit production are given in Table 5.

There is a positive and statistically significant relationship at the 99% confidence level between the problems faced by farmers in kiwi cultivation and the decline in kiwi yield (β = 1.06; OR = 3.63; $p < 0.01$). The probability of kiwifruit yield decreasing increases 3.63 times for each unit increase in problems. A one-unit increase in kiwifruit cultivation problems increases the probability of a decrease in kiwifruit yields by 263.1% ([3.631 – 1] * 100 = 2.631 * 100 = 263.1). In other words, the yield decreases when production problems increase. The farmer's fight against climate change negatively impacted the kiwi yield at the 95% confidence level (β = –1.56; OR = 0.483; $p = 0.031$). In other words, as long as farmers adopt production methods to fight climate change, there will be no decrease in kiwi yield, and production will remain stable. A one-unit increase in climate change mitigation methods increases the probability that kiwi yield will remain stable by 2.07 (1-0.483), or 57.7% (1-0.359). In other words, the probability of a decrease in kiwi yield decreases by 57.7%.

A one-unit increase in farmers' perceptions of climate change reduces the probability of a decrease in kiwi yield. The effect is negative, but this relationship is not statistically significant (β = –0.15; OR = 0.117; $p = 0.190$). This suggests that if farmers perceive climate change as a risk and take precautions against it, the likelihood of a stable kiwifruit yield increases. The climatic events they expected in the coming years in the production regions had a positive effect on kiwifruit yield (β = 0.75; OR = 0.063; $p = 0.647$). In other words, the more the region is affected by climate change, the higher the probability of a decline in kiwifruit yields. However, this effect was not statistically significant.

In the study that investigated the adaptation behaviour of Vietnamese farmers to climate change, most participants believed that climate change will be more noticeable in the coming years (Tiet et al. 2022). The literature review revealed that producers in different regions perceive climate change, use coping methods and believe that it will worsen in the future. Compared to weather conditions in previous years, climate change will be more severe in the future.

Table 5 Factors affecting the decrease in kiwi production

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Problems	1.063	0.772	3.691	1	0.001**	3.631	1.975	3.772
Perceptions	–1.556	0.510	4.635	1	0.031*	0.483	0.000	0.508
Fight	–0.150	0.640	1.719	1	0.190	0.117	0.005	2.898
Future	0.750	0.728	1.026	1	0.311	0.063	0.195	1.701
Constant	2.995	0.711	0.210	1	0.047	0.018	–	–
Log-likelihood	–	–	151,259	–	–	–	–	–
LR ch^2	–	–	32,644	–	–	–	–	–
Prob > chi^2	–	–	0.000	–	–	–	–	–
Pseudo R^2	0.772		–	–	–	–	–	–

*$p < 0.05$; **$p < 0.01$

Climate change today and in the future is likely to be more drastic than in previous years. With increasing drought, groundwater and surface water will decrease. At the same time, climate change will lead to an increase in the salinity of the soil structure (Arora 2019). Insufficient irrigation of crops, soil degradation and other effects of climate change lead to lower crop yields.

Depending on how severely they are affected by climate change, producers perceive this differently. Therefore, farmers in different parts of the world may perceive to different degrees whether climate change is affecting production levels. Regardless of the extent of the impact, farmers need to be aware of climate change and take appropriate adaptation and mitigation measures. Perception of climate change impacts increases the likelihood of adaptation. High perception of climate change allows farmers to predict the damage that will occur on their farms. It also allows them to protect themselves from the effects of climate change by taking adaptation and mitigation measures (Ado et al. 2019). If farmers do not take precautions, they will inevitably suffer financial losses.

Conclusions

The study examines the factors that influence kiwifruit producers' attitudes towards climate change to provide knowledge to stakeholders.

The study concludes that farmers are aware of the climate and its effects, use their most favourable prevention methods and follow the news and weather conditions. Farmers stated that the seasonal air temperature is increasing. Growers believed that their income would decrease and they would suffer yield losses. Problems in kiwi cultivation, perceptions, the fight against climate change and future expectations explain the decline in kiwi productivity.

To slow down climate change and eliminate its negative effects, water, wind and solar energy should be utilised more than fossil fuels. Those implementing climate change-related projects should receive government support.

Farmers should be trained and encouraged to use renewable energy sources. Co-operatives and advisors should educate producers about the short and long-term effects of climate change. Provincial Directorates of Agriculture and Forestry should develop and implement measures to protect farmers from the effects of climate change, and it should be mandatory to adopt these measures in their regions. Agricultural engineers should explain to producers how they can protect themselves from climate events such as frost.

Even though more farmers are taking out crop insurance, all farmers should be encouraged to take out insurance and those who cannot afford it should be given financial assistance. The importance of a crop calendar should also be emphasized at every opportunity. In addition, access to meteorological data should be made easier for producers and they should be encouraged to do so. There are various government funds for farmers. However, these usually focus on improving the variety and quantity of produce. Support to promote organic farming and the use of fewer pesticides is very limited in terms of quantity and content. Although subsidies are granted nationwide for the expansion of renewable energies, there is no state support for the installation of renewable energy systems on farms. This support should be created, and farmers should be informed about it.

As with other studies, there are some limitations to this study. The study area includes only kiwi producers in Kastamonu. To verify these results, it would be helpful to extend the study to other farmers in the Turkish Black Sea region. In addition, there are limits to the number of researchers, time and money available for this study. The attitude of other fruit producers in the region towards climate change could not be analyzed.

Funding This research article has not received funding or financial support from any institution or organization.

Data Availability The datasets used during the current study are available from the corresponding author on reasonable request.

Conflict of interest I.B. Gurbuz, G. Ozkan and S. Er declare that they have no competing interests.

References

Ado AM, Leshan J, Savadogo P, Bo L, Shah AA (2019) Farmers' awareness and perception of climate change impacts: case study of Aguie district in Niger. Environ Dev Sustain 21:2963–2977. https://doi.org/10.1007/s10668-018-0173-4

Akyuz Y (2019) Analysis of farmer perception and behavior towards the climate change adaptation policies: the case of Kucuk Menderes Basin. Ege University (Dissertation, Ph.D. Thesis)

Arora NK (2019) Impact of climate change on agriculture production and its sustainable solutions Environmental Sustainability 2(2) 95-96 https://doi.org/10.1007/s42398-019-00078-w

Aryal JP, Sapkota TB, Khurana R, Khatri-Chhetri A, Rahut DB, Jat ML (2020) Climate change and agriculture in South Asia: adaptation options in smallholder production systems. Environ Dev Sustain 22(6):5045–5075. https://doi.org/10.1007/s10668-019-00414-4

Bardi L, Nari L, Morone C, Solomita M, Mandalà C, Faga MG, Migliori CA (2022) Kiwifruit adaptation to rising vapor pressure deficit increases the risk of kiwifruit decline syndrome occurrence. Horticulturae 8(10):906. https://doi.org/10.3390/horticulturae8100906

Bayav A (2022) Does farm size affect technical efficiency in apple-producing farms? A case study from Turkey. Erwerbs-Obstbau. https://doi.org/10.1007/s10341-022-00750-2

Bayrac HN, Dogan E (2016) Impacts of climate change on agriculture sector in Turkey. Eskisehir Osmangazi Univ J Econ Adm Sci 11(1):23–48

Bolat Y, Bakirci M (2023) Determination of knowledge and perception levels of agricultural producers on climate change in Erbaa

plain (Tokat). East Geogr Rev 27(48):37–48. https://doi.org/10.5152/EGJ.2022.22711
Bostan SZ, Gunay K (2014) The effects of altitude and direction on fruit quality of 'Hayward' (Actinidia deliciosa Planch) kiwifruit cultivar. Acad J Agric 3(1):13–22
Bryan E, Ringler C, Okoba B, Roncoli C, Silvestri S, Herrero M (2013) Adapting agriculture to climate change in Kenya: Household strategies and determinants. J Environ Manag 114:26–35. https://doi.org/10.1016/j.jenvman.2012.10.036
Cankaya D, Boz I (2023) Knowledge levels, experiences and future decisions of hazelnut farmers on climate change. ISPEC J Agric Sci 7(2):395–406. https://doi.org/10.5281/zenodo.8051018
Cradock-Henry NA (2017) New Zealand kiwifruit growers' vulnerability to climate and other stressors. Reg Environ Change 17(1):245–259. https://doi.org/10.1007/s10113-016-1000-9
Deressa TT, Hassan RM, Ringler C (2011) Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. J Agric Sci 149(1):23–31. https://doi.org/10.1017/S0021859610000687
FAOSTAT (2022) Crops and livestock products. https://www.fao.org/faostat/en/#data/QCL. Accessed 15 July 2023
Gao B, Yuan S, Guo Y, Zhao Z (2022) Potential geographical distribution of Actinidia spp. and its predominant indices under climate change. Ecol Inform 72:101865. https://doi.org/10.1016/J.ECOINF.2022.101865
Gay C, Estrada F, Conde C, Eakin H, Villers L (2006) Potential impacts of climate change on agriculture: A case of study of coffee production in Veracruz, Mexico. Clim Chang 79(3):259–288. https://doi.org/10.1007/s10584-006-9066-x
Gokdogan O (2022) Energy and economic efficiency of kiwi fruit production in Turkey: a case study from Mersin province. Erwerbs-Obstbau 64:55–60. https://doi.org/10.1007/s10341-021-00610-5
Gul M, Akpinar MG, Demircan V, Bal T, Yilmaz H, Arici SE, Polat M, Ormeci Kart MC, Acar M (2020) Evaluation of economic structure of cherry growing in Turkey. Erwerbs-Obstbau 62:13–20. https://doi.org/10.1007/s10341-019-00465-x
Hosmer DW, Lemeshow S (2000) Applied logistic regression. Wiley, New York
Jeong Y, Chung U, Kim KH (2018) Predicting future frost damage risk of kiwifruit in Korea under climate change using an integrated modelling approach. Int J Climatol 38(14):5354–5367. https://doi.org/10.1002/joc.5737
Jha CK, Gupta V (2021) Farmer's perception and factors determining the adaptation decisions to cope with climate change: evidence from rural India. Environ Sustain Indic 10:100112. https://doi.org/10.1016/j.indic.2021.100112
Karakas G (2022) Barriers to climate change adaptation of wheat producing farmers; the case of Corum province-Turkey. Turk J Agric Sci Technol 10(5):879–885. https://doi.org/10.24925/turjaf.v10i5.879-885.5104
Kim KH, Koh YJ (2019) An integrated modeling approach for predicting potential epidemics of bacterial blossom blight in kiwifruit under climate change. Plant Pathol J 35(5):459. https://doi.org/10.5423/PPJ.OA.05.2019.0140
Kimani NC, Bhardwaj SK (2015) Assessment of people's perceptions and adaptations to climate change and variability in mid-hills of Himachal Pradesh, India. Int J Curr Microbiol Appl Sci 4(8):47–60
Kokkora M, Koukouli P, Karpouzos D, Georgiou P (2023) Model application for estimation of Agri-environmental indicators of kiwi production: a case study in Northern Greece. Environments 10(4):69. https://doi.org/10.3390/environments10040069
Lai M, Cacchiarelli L, Russo C, Sorrentino A, Petriccione G (2022) Farmers' selection model in a club value chain: the case of the Agro-Pontino kiwifruit industry. Italian Rev Agric Econ 77(3):15–23. https://doi.org/10.36253/rea-13407
Li Y, Ye W, Wang M, Yan X (2009) Climate change and drought: a risk assessment of crop-yield impacts. Clim Res 39(1):31–46. https://doi.org/10.3354/cr00797
Malhi GS, Kaur M, Kaushik P (2021) Impact of climate change on agriculture and its mitigation strategies: a review. Sustainability 13(3):1318. https://doi.org/10.3390/su13031318
Mazis A, Litskas VD, Platis DP, Menexes GC, Anagnostopoulos CD, Tsaboula AD et al (2021) Could energy equilibrium and greenhouse gas emissions in agroecosystems play a key role in crop replacement? A case study in orange and kiwi orchards. Environ Sci Pollut Res 28:29421–29431. https://doi.org/10.1007/s11356-021-12774-4
McNamara KE, Buggy L (2017) Community-based climate change adaptation: a review of academic literature. Local Environ 22(4):443–460. https://doi.org/10.1080/13549839.2016.1216954
Montgomery SL (2014) Powers shaping global energy 21st century and beyond (Trans. Evra Gunhan Senol). TUBITAK Popular Science Books, Ankara
Moretti CL, Mattos LM, Calbo AG, Sargent SA (2010) Climate changes and potential impacts on postharvest quality of fruit and vegetable crops: a review. Food Res Int 43(7):1824–1832. https://doi.org/10.1016/j.foodres.2009.10.013
Müller K, Holmes A, Deurer M, Clothier BE (2015) Eco-efficiency as a sustainability measure for kiwifruit production in New Zealand. J Clean Prod 106:333–342. https://doi.org/10.1016/j.jclepro.2014.07.049
Oz F (2019) The factors affecting paddy farmers' perception and adaptation strategies to climate change in Corum province, Turkey [Master Thesis, 575144: Ondokuz Mayıs University. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp
Parajuli R, Thoma G, Matlock MD (2019) Environmental sustainability of fruit and vegetable production supply chains in the face of climate change: a review. Sci Total Environ 650:2863–2879. https://doi.org/10.1016/j.jclepro.2019.03.210
Qin Y, Shi X, Li X, Yan J (2021) Geographical indication agricultural products, livelihood capital, and resilience to meteorological disasters: evidence from kiwifruit farmers in China. Environ Sci Pollut Res 28:65832–65847. https://doi.org/10.1007/s11356-021-15547-1
Richardson DP, Ansell J, Drummond LN (2018) The nutritional and health attributes of kiwifruit: a review. Eur J Nutr 57:2659–2676. https://doi.org/10.1007/s00394-018-1627-z
Sarkar A, Wang H, Rahman A, Qian L, Memon WH (2022) Evaluating the roles of the farmer's cooperative for fostering environmentally friendly production technologies—a case of kiwi-fruit farmers in Meixian, China. J Environ Manag 301:113858. https://doi.org/10.1016/j.jenvman.2021.113858
Schipper EL, Ayers J, Reid H, Huq S, Rahman A (2014) Community-based adaptation to climate change: Scaling it up. Routledge
Sevim D, Varol N, Koseoglu O (2022) The effects of global climate change on olive cultivation and olive oil. Bursa Uludag Univ J Fac Agric 36(2):415–432. https://doi.org/10.20479/bursauludagziraat.1018517
Soltekin O, Altindisli A, Isci B (2021) Effects of climate change on viticulture in Turkey. J Ege Univ Fac Agric 58(3):457–467. https://doi.org/10.20289/zfdergi.882893
Tait A, Paul V, Sood A, Mowat A (2018) Potential impact of climate change on Hayward kiwifruit production viability in New Zealand. N Z J Crop Hortic Sci 46(3):175–197. https://doi.org/10.1080/01140671.2017.1368672
Tiet T, To-The N, Nguyen-Anh T (2022) Farmers' behaviours and attitudes toward climate change adaptation: evidence from Vietnamese smallholder farmers. Environ Dev Sustain 24:14235–14260. https://doi.org/10.1007/s10668-021-02030-7

Turkes M (2020) Impacts of climate change on food security and agricultural production: a scientific review. Aegean Geogr J 29(1):125–149

Turkish State Meteorological Service (2023) Cities & holiday resorts. https://www.mgm.gov.tr/eng/forecast-cities.aspx?m=KASTAMONU. Accessed 24 July 2023

TurkStat (2022) Kiwi production statistics. https://biruni.tuik.gov.tr/medas/?locale=tr. Accessed 15 July 2022

Uzundumlu AS, Bilgin K, Kurtoglu S, Ertek N (2018) Determining the main problems encountered in kiwi growing with factor and probit analyses: the case of Rize province. J Bus Econ Manag Res 1(2):71–92

Wang S, Qiu Y, Zhu F (2021) Kiwifruit (Actinidia spp.): A review of chemical diversity and biological activities. Food Chem 350:128469. https://doi.org/10.1016/j.foodchem.2020.128469

Wu Z, Li M, Zhong Y, Li L, Cheng D, Gu H, Guo X, Qi X, Chen J (2022) Overexpression of AcEXPA23 promotes lateral root development in kiwifruit. Int J Mol Sci 23(14):8026. https://doi.org/10.3390/ijms23148026

Xia H, Deng H, Li M, Xie Y, Lin L, Zhang H, Luo X, Lv X, Wang J, Liang D (2023) Chromosome-scale genome assembly of a natural diploid kiwifruit (Actinidia chinensis var. deliciosa). Sci Data 10(1):92. https://doi.org/10.1038/s41597-023-02006-4

Yegbemey RN, Yabi JA, Tovignan SD, Gantoli G, Kokoye SEH (2013) Farmers' decisions to adapt to climate change under various property rights: a case study of maize farming in northern Benin (West Africa). Land Use Policy 34:168–175. https://doi.org/10.1016/j.landusepol.2013.03.001

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.