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RESEARCH

Socioeconomic and Perceptual Drivers of Climate Change Impact Perceptions Among Peach Farmers: Evidence from Çanakkale, Türkiye

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Abstract
Climate change poses significant challenges to fruit production, particularly in perennial crops such as peaches, which are highly sensitive to temperature fluctuations and extreme weather events. This study examines peach farmers' perceptions of the negative impacts of climate change in Çanakkale province, Türkiye's leading peach-producing region, and identifies the socioeconomic and perceptual factors influencing these perceptions. Primary data were collected through face-to-face surveys with 209 peach farmers, and binary logistic regression analysis was employed to assess the determinants of perceived negative impacts. Results indicate that age, organizational membership, and the source of climate change information significantly shape farmers' perceptions. Older farmers were more likely to perceive negative impacts, suggesting that accumulated experience and exposure to climatic variability enhance risk awareness. Conversely, membership in agricultural cooperatives and producer organizations reduced the likelihood of perceiving adverse effects, possibly reflecting improved access to collective knowledge and adaptive strategies. Farmers who first learned about climate change through formal channels, such as television or institutional sources, demonstrated higher perception levels. Perceptual evaluations revealed that farmers predominantly attribute climate change to macro-level factors, such as industrial production, while attributing a limited role to agricultural activities. These findings underscore the importance of integrating farmers' perceptions into climate adaptation policies. Targeted awareness-raising programs for younger and non-organized farmers, strengthening agricultural organizations, and delivering region-specific climate information through formal channels are recommended to enhance adaptive capacity. By combining socioeconomic insights with perceptual assessments, this study provides evidence-based guidance for developing effective, participatory climate adaptation strategies in fruit production systems.

Keywords *Prunus persica* · Binary logistic regression · Agricultural organizations · Adaptation strategies · Farm households

Introduction

Climate change has evolved beyond being solely an environmental issue and has become a global crisis that directly threatens economic stability, food security, and social welfare. Although the impacts of climate change are often perceived as a contemporary phenomenon, their roots can be traced back to the Industrial Revolution of the late 19th century. The intensification of fossil fuel use following industrialization has increased the concentration of greenhouse gases in the atmosphere, leading to a marked rise in global temperatures. Indeed, it has been reported that since the Industrial Revolution, global surface temperatures have increased by an average of 0.08 °C per century, with the rate of increase nearly doubling over the past four decades (NOAA 2022). The fact that 2020 was recorded as the second warmest year since the beginning of instrumental measurements clearly illustrates the magnitude of climate change (NASA 2022; NOAA 2022).

Alongside global warming, environmental problems such as deforestation, excessive and unsustainable consumption, population growth, unplanned urbanization, air, water, and soil pollution, and increasing volumes of waste further complicate climate change and make it more difficult to manage (Slocum 2004; Wells et al. 2011; Connor

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et al. 2022). Therefore, climate change should be addressed not only as a physical process but also as a phenomenon shaped by economic, social, and behavioral dynamics (Arslan et al. 2021; Thøgersen 2021; UN 2022).

While human activities constitute the primary drivers of climate change, humans are also among the most severely affected by its consequences (Bonini et al. 2008; Boer and Aiking 2021). Carbon emissions resulting from energy use, industrial production, and agricultural activities play a decisive role in accelerating climate change. This underscores the importance of individual perceptions, awareness, and behaviors, in addition to technical and political solutions, in addressing climate change effectively (Gugulethu et al. 2013; Wicker and Becken 2013; Saleem et al. 2018).

Within this context, the agricultural sector stands out as one of the most vulnerable sectors to the impacts of climate change. Agricultural production, often described as an open-air factory, is directly dependent on climatic conditions and is therefore highly sensitive to temperature increases, irregular precipitation patterns, and extreme weather events (İnan 2016). Both mitigation of climate change and adaptation to its impacts are essential in agriculture, with farmers acting as the main stakeholders in this process. Farmers' ability to adopt adaptation and mitigation strategies is closely linked to how they perceive climate change, the extent to which they recognize associated risks, and how strongly they relate these impacts to their own production activities (Akyüz and Atış 2018; Tomlinson and Rhiney 2018; Ullah et al. 2018; Ado et al. 2019; Sorvali et al. 2021).

Fruit production is among the agricultural subsectors most affected by climate change. Fruit trees, which are based on perennial production systems, are particularly sensitive to temperature fluctuations and climatic anomalies. Frost events, droughts, storms, and extreme heat pose serious threats to yield, quality, and the long-term sustainability of production (Hayaloğlu 2018; Gökkür and Şahin 2020; Ministry of Agriculture and Forestry 2021). Consequently, understanding how climate change is perceived by fruit producers and accurately assessing its impacts are of vital importance for developing effective adaptation strategies.

As of 2021, Türkiye ranks seventh in global peach production with a total output of 674,136 t and a production area of 45,237 ha. Moreover, with an export value of approximately USD 170 million, Türkiye ranks second worldwide in peach and nectarine exports (Eurostat 2022). These figures highlight the strategic importance of peach production within Türkiye's agricultural economy. Çanakkale province, which ranks first in peach and nectarine production nationwide, accounted for 18.9% of total peach production and 24.8% of nectarine production in Türkiye as of 2020 (Çanakkale Provincial Directorate of Agriculture and Forestry 2020). Accordingly, Çanakkale represents a critical case study area for examining the impacts of climate change on fruit production.

The international literature includes numerous studies investigating farmers' awareness, perceptions, and adaptation behaviors related to climate change (Fleming and Vanclay 2010; Mengistu 2011; Basannagari and Kala 2013; Fujisawa and Kobayashi 2013; Ullah et al. 2018; Manh and Ahmad 2021). These studies consistently demonstrate that farmers' socioeconomic characteristics play a key role in shaping climate change perceptions and adaptation strategies. However, in the national literature, studies based on primary data that focus specifically on the climate change perceptions of farmers engaged in perennial fruit production remain limited (Akyüz and Atış 2018; Akyüz 2019).

A review of the literature indicates that while studies examining climate change perceptions among perennial fruit producers, such as peach and apple growers, have increased at the international level, there is a lack of up-to-date research focusing on how peach farmers in Türkiye perceive climate change and which socioeconomic factors shape these perceptions. In this respect, the present study aims to fill an important gap in the literature and to provide region-specific, evidence-based findings for policymakers.

The main objective of this study is to analyze peach farmers' perceptions of the impacts of climate change in Çanakkale province, Türkiye's leading peach-producing region, and to identify the socioeconomic determinants of these perceptions. To this end, original primary data were collected through face-to-face surveys conducted with peach farmers in Çanakkale. Beyond measuring current perception levels, the study also aims to indirectly contribute to increasing farmers' awareness of climate change. The findings are expected to inform the design of climate change adaptation policies in agriculture and to support the development of effective strategies at the regional level.

Materials and Methods

Data Collection Methods

This study was based on both primary and secondary data sources. Primary data were collected through face-to-face survey interviews conducted with peach farmers in Çanakkale province, Türkiye. Secondary data were obtained from official statistics, institutional records, and relevant reports related to peach production and climate change.

The primary data were gathered using a structured questionnaire designed to capture farmers' socioeconomic characteristics, agricultural production structure, and levels of awareness and perception regarding climate change. The

survey was administered through direct, in-person interviews, which aimed to enhance data quality, ensure response accuracy, and minimize potential misunderstandings.

The number of farmers to be surveyed was determined using proportional sampling methods. According to data from the Çanakkale Provincial Directorate of Agriculture and Forestry, the total number of farms engaged in peach production in Çanakkale province was 1529 in 2021. Based on a 90% confidence level and a 5% margin of error, the required sample size was calculated as 209 farmers. The proportional sampling formula used to determine the sample size is presented in Eq. 1:

$$n = \frac{N \cdot p\,(1-p)}{\left((-1) \cdot \sigma_p^2 + p(1-p)\right)} \quad (1)$$

where

n denotes the sample size,
N represents the population size,
p is the population proportion (assumed as 0.5), and
σ_p indicates the sampling error.

Based on this calculation, the sample size was determined to be 209 farmers. An examination of the district-level distribution of peach and nectarine production in Çanakkale province reveals that production is largely concentrated in Lapseki district. According to 2021 data, Lapseki serves as the primary production center for both peaches and nectarines in the province (Table 1). Therefore, production intensity was adopted as the main criterion in defining the study area.

Table 1 District-level distribution of peach and nectarine production in Çanakkale Province (2021)

District	Peach production* (t)	Share within province (%)	Nectarine production (t)	Share within province (%)
Lapseki	73,877	60.0	18,354	47.6
Central District	36,771	29.8	4732	12.3
Bayramiç	4258	3.5	13,156	34.1
Gelibolu	3646	3.0	743	1.9
Biga	1340	1.1	493	1.3
Eceabat	1196	0.9	291	0.8
Ayvacık	846	0.7	207	0.5
Ezine	654	0.5	497	1.3
Gökçeada, Çan, Yenice, and Bozcaada	616	0.5	70	0.2
Total	*123,204*	*100.0*	*38,543*	*100.0*

*Peach production excluding nectarines

Study Area and Sampling Design

According to 2021 data obtained from the Çanakkale Provincial Directorate of Agriculture and Forestry, Lapseki district accounts for 65.9% of all peach-producing farms and 66.9% of the total peach production area in the province (Table 2). In addition, 16 different peach and nectarine cultivars are grown in Lapseki, and Lapseki Peach has been granted geographical indication status. These characteristics make Lapseki district a scientifically appropriate and representative study area.

A total of 31 villages in Lapseki district are engaged in peach production. Based on data from the Lapseki Chamber of Agriculture, five villages (Umurbey, Gazi Süleymanpaşa, Yeniceköy, Cumhuriyet, and Tekke Çardak) were selected as the study area, as they collectively account for 54.2% of all peach farmers in the district. Survey implementation was concentrated in these villages due to their high producer density. The distribution of surveys across villages was conducted proportionally according to the number of farmers in each village, as presented in Table 3. This sampling approach ensured that the collected data adequately represent both production intensity and farmer characteristics within the study area.

Data Analysis Methods

Descriptive statistical methods, including frequencies and percentages, were employed to characterize the sociodemographic attributes of peach farmers. To analyze farmers' perceptions of climate change impacts and to identify the socioeconomic and perceptual factors influencing these perceptions, a binary logistic regression model was applied.

Logistic regression is a widely used statistical technique that allows for the examination of relationships between a categorical dependent variable and a set of categorical and/or continuous independent variables (Menard 2002; Tranmer and Elliot 2005). It serves as an effective alternative to linear regression when the dependent variable does not meet the assumption of normality, particularly when it consists of two or more categories. Due to its flexibility in assumptions, interpretability, and probability-based outputs, logistic regression has been extensively applied in agricultural economics and social science research (Hosmer and Lemeshow 2000; Özdamar 2013). It is also commonly used in studies analyzing farmers' perceptions, awareness, and behavioral responses.

Logistic regression is a special case of generalized linear models, in which the link function is the natural logarithm of the odds ratio. Depending on the measurement level of

Table 2 District-level distribution of peach-producing farms and cultivation area in Çanakkale Province (2021)

District	Number of farms	Share of total farms (%)	Cultivation area (ha)	Share of total area (%)
Lapseki	1007	65.9	1820.90	66.9
Central District	341	22.3	754.22	27.7
Bayramiç	46	3.0	32.37	1.2
Gelibolu	42	2.7	50.80	1.9
Eceabat	23	1.5	28.58	1.0
Biga	21	1.4	16.00	0.7
Ezine	18	1.2	8.96	0.4
Gökçeada	13	0.9	2.10	0.07
Ayvacık	11	0.7	4.00	0.1
Çan	4	0.3	0.27	0.01
Yenice	3	0.1	0.69	0.02
Bozcaada	–	–	–	–
Total	1529	100.0	2718.89	100.0

Source: Data obtained from the Çanakkale Provincial Directorate of Agriculture and Forestry (2021)

Table 3 Surveyed villages and distribution of questionnaires in Lapseki district of Çanakkale Province (2021)

Village name	Number of farmers	Share within all villages (%)	Share within selected five villages (%)	Number of questionnaires
Umurbey	222	16.6	30.7	64
Gazi Süleymanpaşa	177	13.3	24.5	51
Yeniceköy	138	10.3	19.1	40
Cumhuriyet	102	7.7	14.1	30
Tekke Çardak	83	6.2	11.6	24
Total of five villages	722	54.2	100.0	209
Total of remaining 26 villages	610	45.9	–	–
Total (31 villages)	1332	100.0	–	–

Source: Calculated based on data obtained from the Çanakkale Lapseki Chamber of Agriculture (2021)

the dependent variable, logistic regression can be classified into:

(i) Binary logistic regression for dichotomous outcomes
(ii) Nominal logistic regression for outcomes with three or more unordered categories
(iii) Ordinal logistic regression for ordered categorical outcomes (Hosmer and Lemeshow 2000; Menard 2002; Köksal 2011)

In this study, a binary logistic regression model was employed to analyze the socioeconomic and perceptual factors influencing the probability that peach farmers are negatively affected by climate change. The dependent variable was defined as farmers' perceived negative impact of climate change, measured directly through survey responses with a binary yes/no format (1 = negatively affected, 0 = not negatively affected). Independent variables included farmers' demographic characteristics (age, education level, farming experience), agricultural production characteristics (size of peach production area, membership in agricultural organizations), access to information (source from which climate change was first heard), and perceptual judgments regarding climate change (perceptions related to global population growth, increased conventional crop production, and industrial production as drivers of climate change) (Table 4).

The binary logistic regression model is specified as follows:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon \qquad (2)$$

where

P_i denotes the probability that the ith farmer is negatively affected by climate change,
β_0 is the intercept term,
β_k represents the coefficients of the independent variables,
X_k denotes the independent variables, and ε is the error term.

Table 4 Definition of variables used in the binary logistic regression model

Variable type	Variable name	Scale type	Coding and description
Dependent variable	Perceived impact of climate change	Nominal	1 = Negatively affected, 0 = not negatively affected
Independent variables	Age	Ordinal	1 = 21–40 Years, 2 = 41–50 years, 3 = 51–60 years, 4 = 61 years and above
	Farming experience	Ordinal	1 = Mean (34.5 years) and below, 2 = above the mean
	Peach production area (decares)	Scale	Continuous variable (in decares)
	Education level	Ordinal	1 = Literate only, 2 = primary school graduate, 3 = middle school graduate, 4 = high school graduate, 5 = university graduate
	Membership in producer organizations	Nominal	1 = Yes, 0 = no
	First source of information on climate change	Dummy	1 = Television, 0 = otherwise
	Perception that population growth increases climate change	Scale (Likert)	1 = Strongly disagree to 5 = strongly agree
	Perception that increased conventional crop production increases climate change	Scale (Likert)	1 = Strongly disagree to 5 = strongly agree
	Perception that increased industrial production increases climate change	Scale (Likert)	1 = Strongly disagree to 5 = strongly agree

The binary logistic regression model, adapted to the specific variables of this study, is presented in Eq. 3.

$$\ln\left(\frac{P\ (\text{Negatively Affected}_i)}{1-P\ (\text{Negatively Affected}_i)}\right) = \beta_0 + \beta_1\ (\text{Age}_i) + \beta_2\ (\text{Farming Experience}_i) + \beta_3\ (\text{Peach Production Area}_i) + \beta_4\ (\text{Education Level}_i) + \beta_5\ (\text{Membership in Producer Organizations}_i) + \beta_6\ (\text{First Source of Info}_i) + \beta_7\ (\text{Perception: Population Growth}_i) + \beta_8\ (\text{Perception: Conventional Crop}_i) + \beta_9(\text{Perception: Industrial Production}_i) \quad (3)$$

Variable definitions:

P (Negatively Affected_i) = probability that farmer i perceives negative impacts of climate change

Age_i = farmer's age (years)

Farming Experience_i = total years of agricultural experience

Peach Production Area_i = area under peach cultivation (da)

Education Level_i = formal education attainment

Membership in Producer Organizations_i = 1 if member, 0 otherwise

First Source of Info_i = 1 if first information on climate change via TV, 0 otherwise

Perception: Population Growth_i = perception that population growth increases climate change

Perception: Conventional Crop_i = perception that increased conventional crop production increases climate change

Perception: Industrial Production_i = perception that industrial production increases climate change

Nominal independent variables were included in the model using dummy variables, while Likert-scale perceptual variables were treated as continuous variables in line with the relevant literature. The model was estimated using the maximum likelihood estimation method. Coefficients were interpreted using odds ratios, Exp(β), allowing for an assessment of how a one-unit change in an independent variable affects the probability of perceiving negative impacts from climate change.

Model goodness-of-fit was evaluated using –2 Log Likelihood (–2LL), Cox and Snell R^2, and Nagelkerke R^2 statistics. Additionally, the Hosmer–Lemeshow goodness-of-fit test was applied to assess the consistency between observed and predicted values. The signs and magnitudes of coefficients and odds ratios were used to interpret whether independent variables increased or decreased the likelihood of farmers perceiving negative impacts from climate change.

Research Questions and Hypotheses

This study sought to answer the following research questions:

(i) What are the levels of awareness and perception of climate change among peach farmers?
(ii) Which socioeconomic and perceptual factors influence farmers' likelihood of being negatively affected by climate change?

In line with the international literature (Basannagari and Kala 2013; Fujisawa and Kobayashi 2013; Fujisawa et al. 2015; Ingrao et al. 2015; Ullah et al. 2017, 2018), the following hypotheses were tested:

H_1: There is a significant relationship between peach farmers' perceived climate change impacts and their age.
H_2: There is a significant relationship between peach farmers' perceived climate change impacts and their farming experience.
H_3: There is a significant relationship between peach farmers' perceived climate change impacts and their education level.
H_4: There is a significant relationship between peach farmers' perceived climate change impacts and the size of their peach production area.
H_5: There is a significant relationship between peach farmers' perceived climate change impacts and membership in agricultural organizations.
H_6: There is a significant relationship between peach farmers' perceived climate change impacts and the source from which they first learned about climate change.
H_7: There is a significant relationship between peach farmers' perceived climate change impacts and the perception that global population growth exacerbates climate change.
H_8: There is a significant relationship between peach farmers' perceived climate change impacts and the perception that increased conventional crop production exacerbates climate change.
H_9: There is a significant relationship between peach farmers' perceived climate change impacts and the perception that increased industrial production exacerbates climate change.

Results

Demographic Characteristics of Peach Farmers

The sociodemographic characteristics of the peach farmers included in the study are presented in Table 5. The results indicate that the vast majority of peach farmers are male (99.5%) and belong predominantly to middle and older age groups. Most farmers are aged 41 years and above, with the 51–60 age group being particularly prominent. The average age of the respondents is 53.6 years.

Educational attainment is generally low, with most farmers having completed primary or lower secondary education. The proportion of farmers with a high school education or higher is relatively limited. A substantial share of respondents possesses above-average experience in both general agricultural production and peach cultivation, with average farming experience of 34.5 years and average peach production experience of 31.6 years. Household size is typically four persons or more, with an average household size of 3.7 individuals.

The majority of farmers are members of agricultural cooperatives and producer organizations, indicating a relatively high level of organizational participation. In terms of income structure, most respondents do not have non-agricultural income sources, and peach production constitutes their primary means of livelihood. Income derived from peach production is concentrated mainly in the middle-income category, while production costs are largely below TRY 250,000. Occupational distribution shows that most respondents are full-time farmers.

Binary Logistic Regression Results on Perceived Climate Change Impacts

To assess the goodness-of-fit of the binary logistic regression model established to explain farmers' likelihood of being negatively affected by climate change, the Hosmer–Lemeshow goodness-of-fit test was applied. This test is commonly used to evaluate whether there is a statistically significant difference between observed and predicted values in logistic regression models. The test yielded a chi-square (χ^2) value of 14.281 with 8 degrees of freedom and a significance level of $p = 0.075$ (Table 6). Since the p-value exceeds 0.05, the null hypothesis cannot be rejected, indicating no statistically significant difference between observed and predicted values. Accordingly, the model demonstrates a good fit to the data and can be considered statistically valid and reliable.

The results of the binary logistic regression analysis are presented in Table 7. A binary logistic regression analysis was conducted to examine the factors affecting peach farmers' perceptions of the impacts of climate change. The

Table 5 Sociodemographic characteristics of peach farmers

Demographic characteristics	Frequency	Percentage (%)	Demographic characteristics	Frequency	Percentage (%)
Gender			Household size (mean = 3.7)		
Male	208	99.5	1–2 Persons	56	26.8
Female	1	0.5	3–4 Persons	95	45.5
Total	209	100	5 and above	58	27.8
Age groups (mean = 53.6)			Total	209	100
21–40	28	13.4	Social security status		
41–50	49	23.4	Bağ-Kur	153	73.2
51–60	83	39.8	Retirement fund	24	11.5
60 and above	49	23.4	None	20	9.6
Total	209	100	Other	12	5.7
Education level			Total	209	100
Literate only	1	0.5	Membership in agricultural cooperatives		
Primary school no completed	16	7.7	Member	139	66.5
Literate only	17	8.1	Non-member	70	33.5
Primary school graduate	96	45.9	Total	209	100
Middle school graduate	46	22.0	Membership in producer organizations		
High school graduate	38	18.2	Member	141	67.5
University graduate	12	5.7	Non-member	68	32.5
Total	209	100	Total	209	100
–	–	–	Agricultural experience (mean = 34.5 years)		
–	–	–	Below average	104	49.8
–	–	–	Above average	105	50.2
Peach farming experience (mean = 31.6 years)			Total	209	100
Below average	116	55.5	Occupation		
Above average	93	44.5	Farmer	175	83.7
Total	209	100	Other	34	16.3
Off-farm income			Total	209	100
Yes	82	39.2	Estimated total agricultural income (2022)		
No	127	60.8	≤ 250,000 TRY	89	53.9
Total	209	100	250,001–500,000 TRY	60	36.4
Estimated peach income (2022)			≥ 501,000 TRY	16	9.7
≤ 250,000 TRY	90	53.9	Total	165	100
250,001–500,000 TRY	62	37.1	Estimated total agricultural costs (2022)		
≥ 501,000 TRY	15	9.0	≤ 250,000 TRY	133	80.6
Total	167	100	250,001–500,000 TRY	28	17.0
Estimated peach production costs (2022)			≥ 501,000 TRY	4	2.4
≤ 250,000 TRY	137	84.0	Total	165	100
250,001–500,000 TRY	24	14.7	–	–	–
≥ 501,000 TRY	2	1.3	–	–	–
Total	163	100	–	–	–

Table 6 Hosmer–Lemeshow goodness-of-fit test results of the binary logistic regression model

Chi-square (χ^2)	Df	Sig.
14.281	8	0.075

dependent variable represents whether farmers were negatively affected by climate change (1 = negatively affected, 0 = not negatively affected). The overall model demonstrated modest explanatory power, with Cox and Snell R^2 = 0.092 and Nagelkerke R^2 = 0.160, indicating that the independent variables explain approximately 9.2% to 16.0% of the variation in farmers' perceptions. The model was statistically significant (χ^2 = 20.233, p = 0.017), suggesting

Table 7 Binary logistic regression results for factors affecting peach farmers' perceptions of climate change impacts

Variables	B	S.E.	Wald	Df	Sig.	Odds Ratio
Constant	1.303	2.179	0.358	1	0.550	3.680
Age	–0.532	0.266	3.995	1	0.046*	0.587
Farming experience	0.173	0.507	0.116	1	0.733	1.188
Peach production area	0.005	0.007	0.542	1	0.462	1.005
Education level	0.061	0.202	0.090	1	0.764	1.063
Membership in producer organizations	0.911	0.532	2.936	1	0.087+	2.488
First source of information on climate change	0.762	0.444	2.947	1	0.086+	2.142
Perception that population growth increases climate change	0.350	0.354	0.981	1	0.322	1.419
Perception that increased conventional crop production increases climate change	0.411	0.228	3.236	1	0.072+	1.508
Perception that increased industrial production increases climate change	–0.709	0.391	3.290	1	0.070+	0.492

*** $p<0.001$, ** $p<0.01$, * $p<0.05$, + $p<0.10$. Cox and Snell $R^2=0.092$, Nagelkerke $R^2=0.160$, $\chi^2=20.233$ ($p=0.017$)

that the set of predictors reliably distinguishes between farmers who perceive negative impacts and those who do not. Among the independent variables, age was found to have a statistically significant effect on the perception of climate change impacts (B = –0.532, $p<0.05$). The negative coefficient indicates that older farmers are less likely to perceive themselves as negatively affected. The odds ratio (OR = 0.587) suggests that with each increase in age category, the likelihood of perceiving negative impacts decreases by approximately 41.3%. From an agronomic perspective, this may reflect greater adaptation capacity, accumulated experience, or risk normalization among older farmers, leading to lower sensitivity to perceived climate-related threats. Other variables, including farming experience, peach production area, and education level, were not statistically significant predictors ($p>0.05$), indicating that these factors do not have a meaningful effect on farmers' perceptions in this model. This suggests that farm size and formal education alone do not directly shape perceived climate vulnerability in peach production systems. However, several variables showed marginal significance at the 10% level. Membership in producer organizations (B = 0.911, $p<0.10$, OR = 2.488) positively influenced the likelihood of perceiving negative impacts, suggesting that farmers who are members of such organizations are more likely to report being adversely affected. This finding suggests that organizational networks may enhance awareness through information exchange, extension services, or collective experience of climate-related production risks. Similarly, first source of information on climate change (television) was positively associated with perception (B = 0.762, $p<0.10$, OR = 2.142). This highlights the role of mass media in shaping risk perception, possibly by emphasizing extreme weather events or broader climate narratives relevant to agricultural production. Perception-related variables also exhibited marginal effects. Farmers who agreed that increases in conventional crop production contribute to climate change were more likely to perceive negative impacts (B = 0.411, $p<0.10$, OR = 1.508), implying that a stronger recognition of agriculture–climate linkages corresponds to higher perceived vulnerability in peach farming. In contrast, the belief that industrial production increases climate change had a negative coefficient (B = –0.709, $p<0.10$, OR = 0.492), indicating that stronger agreement with this statement is associated with a lower likelihood of perceiving personal negative impacts. This suggests that farmers attributing climate change primarily to external (non-agricultural) sources may perceive lower direct impacts on their own farming activities, possibly reflecting a cognitive distancing from on-farm risk factors. Other perception variables, such as the belief that population growth increases climate change, were not statistically significant. These findings suggest that sociodemographic characteristics, particularly age, play a key role in shaping farmers' perceptions, while institutional engagement (e.g., membership in organizations) and information sources may increase awareness of climate-related risks. The mixed effects of perception variables indicate that farmers' conceptual understanding of climate change drivers does not always translate into perceived personal impact.

Hypothesis Testing Results

The acceptance or rejection status of the hypotheses tested using the regression analysis is summarized in Table 8. Accordingly, hypotheses H_1, H_5, H_6, H_8, and H_9 were accepted, while H_2, H_3, H_4, and H_7 were rejected. These results indicate that age, organizational membership, information sources, and perceptions related to conventional agriculture and industrial production are key determinants of farmers' perceived climate change impacts.

Table 8 Acceptance and rejection of research hypotheses

Hypothesis	Description	Result
H_1	There is a difference between age and perception of climate change impacts	Accepted (5%)
H_2	There is a difference between farming experience and perception	Rejected
H_3	There is a difference between education level and perception	Rejected
H_4	There is a difference between peach production area and perception	Rejected
H_5	There is a difference between membership in producer organizations and perception	Accepted (10%)
H_6	There is a difference between source of climate change information and perception	Accepted (10%)
H_7	There is a difference between perception of population growth and perception	Rejected
H_8	There is a difference between perception of increased conventional production and perception	Accepted (10%)
H_9	There is a difference between perception of increased industrial production and perception	Accepted (10%)

Discussion

The findings of this study indicate that peach farmers' perceptions of being negatively affected by climate change are shaped not only by physical production conditions but also by a combination of socioeconomic characteristics, information sources, and cognitive evaluations related to climate change. Overall, the results are largely consistent with the international literature examining farmers' awareness and perceptions of climate change.

The statistical significance of age suggests that older farmers are more likely to perceive the adverse impacts of climate change. This may be attributed to their ability to compare current climatic conditions with past periods and to their greater exposure to long-term climatic variability. This finding is in line with previous studies reporting a positive relationship between age and climate change perception (Basannagari and Kala 2013; Ullah et al. 2017; Sorvali et al. 2021). In contrast, farming experience was not found to be statistically significant, indicating that experience alone may not be sufficient to shape climate change perceptions. Instead, perceptions may be more closely linked to the frequency and intensity of recent climatic anomalies rather than to the cumulative duration of agricultural activity. Similar results have been reported in studies identifying weak or insignificant relationships between farming experience and climate change perception (Tomlinson and Rhiney 2018).

The lack of statistical significance for education level suggests that climate change perception is influenced less by formal education and more by experiential learning and access to information channels. This finding supports arguments in the literature that the relationship between education and environmental perception in rural contexts is not always linear (Fleming and Vanclay 2010; Akyüz 2019).

Membership in agricultural organizations was found to reduce the likelihood of perceiving negative impacts from climate change. This result highlights the role of farmer organizations in enhancing access to information, facilitating collective learning, and strengthening adaptive capacity. It is consistent with previous research emphasizing the importance of institutional and organizational support in the climate change adaptation process (Ali and Erenstein 2017; Manh and Ahmad 2021).

The significance of the source from which farmers first learned about climate change underscores the importance of information access and communication pathways in shaping perception. Farmers who obtained information from formal and institutional sources tended to perceive climate change as a more concrete and direct threat. This finding aligns with earlier studies emphasizing the influence of information sources on climate change awareness and risk perception (Fujisawa and Kobayashi 2013; Ullah et al. 2018).

With regard to perceptual variables, the finding that the perception of increased industrial production as a driver of climate change raises the likelihood of perceived negative impacts suggests that farmers tend to associate climate change with global and macro-level processes. Conversely, the negative association between the perception that conventional agricultural production exacerbates climate change and perceived negative impacts indicates a limited tendency among farmers to view their own farming practices as contributors to climate change. This pattern reflects a form of externalization, whereby responsibility for climate change is attributed primarily to sectors outside agriculture. Similar tendencies have been documented in studies conducted in different country contexts (Ingrao et al. 2015; Ullah et al. 2017).

Conclusion and Policy Implications

This study examined peach farmers' perceptions of negative climate change impacts and the socioeconomic determinants shaping these perceptions in Çanakkale province, Türkiye's leading peach-producing region. Based on primary data and binary logistic regression analysis, the findings demonstrate that farmers' climate change perceptions are influenced not only by production scale or physical conditions but also by age, organizational participation, access to information, and cognitive assessments of the drivers of

climate change. Older farmers perceive the negative impacts more strongly, whereas membership in agricultural organizations reduces the likelihood of perceiving such impacts. Additionally, the source of information through which farmers first learned about climate change plays a key role in shaping perceptions. Farmers tend to associate climate change primarily with macro-level factors, such as industrial production, while attributing a relatively limited role to agricultural activities.

These findings suggest that climate change adaptation policies in agriculture should extend beyond technical measures alone. There is a need for targeted awareness-raising programs for younger and non-organized farmers, which could include training on digital agriculture tools, climate-based decision support systems, drought-tolerant rootstocks, and water-saving irrigation practices. Strengthening agricultural cooperatives and producer organizations can further enhance adaptive capacity by improving information flow and collective learning. Delivering region-specific and crop-oriented climate information through formal and institutional channels can increase farmers' awareness and preparedness. Integrating farmers' perceptions into climate adaptation policies can improve the effectiveness and adoption of adaptation measures in fruit production systems.

For future research, longitudinal or panel data studies could track changes in farmers' perceptions and adaptation behaviors over time. Comparative analyses across different fruit and crop groups would provide insights into sector-specific vulnerabilities. Additionally, studies linking perceived climate change impacts to actual adaptation actions on farms would help identify the effectiveness of awareness-raising and extension programs. These directions can provide a stronger evidence base for designing practical, policy-relevant interventions that enhance resilience in agricultural systems under climate change.

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Data Availability The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing interests The authors declare no competing interests.

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