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Dairy Farmers' Perceptions and Adaptation Strategies Towards the Effects of Climate Change in Southern Marmara Region of Türkiye

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ABSTRACT

The study aims to determine dairy farmers' perceptions of Climate-related risks, their adaptation strategies, and the factors affecting their decisions about adaptation strategies in the Southern Marmara Region of Türkiye. Data was collected from 379 dairy farmers by proportional sampling method. The survey was performed between October and December 2023. Descriptive statistics and probit models were used in the evaluation of the data. The majority of dairy farmers had a high perception of heavy storms. Changing the feed ratio seasonally was the most widespread adaptation strategy employed by dairy farmers. It was followed by diversification of animal production activities (sheep and goat), livestock insurance, and diversity of feed crops. Among these adaptation strategies, changing the feed ratio seasonally was the most preferred adaptation strategy in the study area. In contrast, the diversity of feed crops was the least chosen adaptation strategy. The probit model results showed that dairy farmers' age and household size had a negative and statistically significant impact on their decisions about all adaptation strategies. These results of the study stated that most dairy farmers perceived the rise in temperatures and decline in rainfall as noticeable changes in climate. Few dairy farmers used advanced agricultural applications to deal with the negative impacts of climatic change and many dairy farmers continued use to simple adaptation measures. As a result, the present study findings can shed light on policy/decision makers in agricultural research, practices regarding the climate change impact on dairy farming, and new studies in the literature.

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Türkiye'nin Güney Marmara Bölgesindeki Süt Üreticilerinin İklim Değişikliğinin Etkilerine Yönelik Algıları ve Adaptasyon Stratejileri

ÖZET

Çalışma, Türkiye'nin Güney Marmara Bölgesindeki süt üreticilerinin iklim kaynaklı risklere ilişkin algılarını, adaptasyon stratejilerini ve adaptasyon stratejilerine ilişkin kararlarını etkileyen faktörleri belirlemeyi amaçlamaktadır. Veriler, oransal örnekleme yöntemiyle 379 süt üreticisinden toplanmıştır. Anketler Ekim-Aralık 2023 tarihleri arasında gerçekleştirilmiştir. Verilerin değerlendirilmesinde tanımlayıcı istatistikler ve probit model analizi kullanılmıştır. Süt üreticilerinin çoğunluğunun şiddetli fırtınaya ilişkin algısı yüksektir. Yem rasyonunu mevsimsel olarak değiştirmek, süt üreticileri tarafından kullanılan en yaygın adaptasyon stratejisidir. Bu stratejiyi, hayvansal üretim faaliyetlerinin çeşitlendirilmesi, hayvancılık sigortası ve yem bitkilerinin çeşitliliği izlemiştir. Bu adaptasyon stratejileri arasında, yem rasyonun mevsimsel olarak değiştirilmesi, araştırma alanında en çok tercih edilen adaptasyon stratejisi iken yem bitkileri çeşitliliği en az seçilen adaptasyon stratejisi olmuştur. Probit modeli sonuçları, süt üreticilerinin yaşının ve hane büyüklüğünün tüm adaptasyon stratejilerine ilişkin kararlarında

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negatif ve istatistiksel olarak önemli bir etkisinin olduğunu göstermiştir. Bu çalışmanın sonuçları, çoğu süt üreticisinin sıcaklıklardaki artışı ve yağıştaki azalmayı iklimde gözle görülür değişiklikler olarak algıladığını ortaya koymuştur. İklim değişikliğinin olumsuz etkileriyle başa çıkmak için az sayıdaki süt üreticisi gelişmiş tarım uygulamalarını kullanmakta ve birçok süt üreticisi basit adaptasyon önlemlerini kullanmaya devam etmektedir. Sonuç olarak, mevcut çalışmanın bulguları tarımsal araştırmalarda politika/karar vericilere, süt hayvancılığında iklim değişikliğinin etkilerine ilişkin uygulamalara ve literatürdeki yeni çalışmalara ışık tutabilir.

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INTRODUCTION

Globally, the change of climate is one of the most important environmental menaces in terms of all life forms, including humans, plants and animals (Akyüz & Atış, 2018; Hayran et al., 2021). Specifically, the adverse effects of climate change (drought, flood etc.) have increased even more in recent years. The Intergovernmental Climate Change Panel (IPCC) report stated to increase by 2.5-3°C of average temperatures by 2050 (IPCC, 2017). According to this report, climate change will have the highest impact on agriculture and socio-economic development (IPCC, 2017; Fahad & Wang, 2020). Since agricultural activity is dependent on natural conditions, it can be inferred that plant and animal production processes are highly prone to climate change (Abid et al., 2019, Eştürk & Mert, 2022). Furthermore, climate change effects are more serious in regions, especially due to the weak adaptability capacity of developing regions (Baloch et al., 2022). This situation is causing great concern, especially among farmers in rural areas. For this reason, farmers must be aware of the climate impact on agricultural activities and decide on agriculture to prevent any negative effects. In this context, it is necessary to determine the perceptions of farmers regarding this change, their response to this change and the factors that influence their preferences for adapting precautions (Zhang et al., 2020; Hayran et al., 2021).

Dairy farming activity, which is a significant branch of the livestock sector, also plays a major role in creating employment opportunities for people living in rural areas as well as providing basic food to people for Türkiye and the world (Ata et al., 2021). However, the Mediterranean basin is predicted to become warmer and drier in the future because of the increase in temperature and decrease in rainfall (IPCC, 2017). Therefore, the risk-group countries that will face climate change include Türkiye, which is in this basin. For this reason, the measuring of dairy farmers' adaptation to climate change and the interplay between climate change and dairy farming is of great importance. South Marmara Region (TR22 region) also known as Northwest Türkiye encompasses the sub-region of Balıkesir province located under the West Marmara Region which is one of the regions of Türkiye (TURKSTAT, 2022). This region is important for dairy farming activity. It is formed in Balıkesir and Çanakkale provinces and has a 5.1% share of the total animal population (bovine). About 6.3% of the total milk production of Türkiye is produced in this region (TURKSTAT, 2022).

The data of Türkiye on weather events in the past decade has revealed that floods, storms and heavy rain events are more common, especially in these provinces (RTMEU, 2018). For this reason, farmers' production activities in these provinces are being negatively impacted by this reason daily. In Türkiye, the findings of the coastal vulnerability index method that is implemented in all the coastal areas have shown that these provinces with delta areas are among the riskiest provinces in Türkiye (GMKA, 2014). According to environmental change scenarios, animals may face severe and extreme weather events that can result in death and production losses (Koyuncu, 2017). Thus, it is rather important to define the perceptions of dairy farmers and adaptation strategies towards the implications related to climate change in this region where dairy farming potential is high. Although there is a significant field of study in the literature on farmers' perceptions and their adaptations regarding climate change, most national and international studies are generally related to crop production (Bryan et al., 2013; Hayran et al., 2021; Jeder et al., 2021; Baloch et al., 2022). However, the research on livestock, particularly in dairy farming, is limited. Some of these studies investigated farmers' perceptions, adaptation and attitudes related to climate change (Koç & Uzmay, 2019; Ata et al., 2021; Koç & Uzmay, 2021). A study in southwest Iran evaluated the

adaptability of producers (livestock) to climate change (Karimi et al., 2018). In a few studies, it has been investigated the impact of heat stress on animal production and the effects of climate change, particularly in dairy farming (Yaslıoğlu & İlhan, 2016). In this context, there is no research on the factors that affect dairy farmers' adaptation strategies in Türkiye. Therefore, it is necessary to investigate this issue. Concerning the significance of the TR22 region and its present negative situation (the risky region in terms of climate change effects), as well as the current gap in the study area, the current study is aimed at defining the perceptions of dairy farmers regarding climate-related risks, their adaptation strategies and factors that impact their decisions regarding adaptation strategies. The findings can contribute to policy and decision-makers in agricultural research and practices regarding dairy farming and climate change and can help shape the measures that can be taken to cope with extreme weather events. The study intended to answer three research questions;

1 How do dairy farmers perceive climate-related risks?

2-Which adaptation strategies do they use to minimise the adverse effects of climate change?

3 What are the factors affecting dairy farmers' decisions about adaptation strategies?

Research hypotheses

The current study has a hypothesis according to the conceptual framework and model.

H1: Socio-demographic (e.g., household size, land ownership) and socio-economic factors (e.g., age, income) have a significant impact on dairy farmers' decisions on adaptation strategies.

The conceptual framework

The study's methodology was developed by considering previous literature (Fahad & Wang, 2018; Koç & Uzmay, 2021; Baloch et al., 2022). Figure 1 presents factors that influence dairy farmers' decisions on adaptation strategies. The framework for this study was created with the consideration of risk perception, which is a significant factor for dairy farmers. In addition, some socio-demographic and socio-economic factors were also considered.

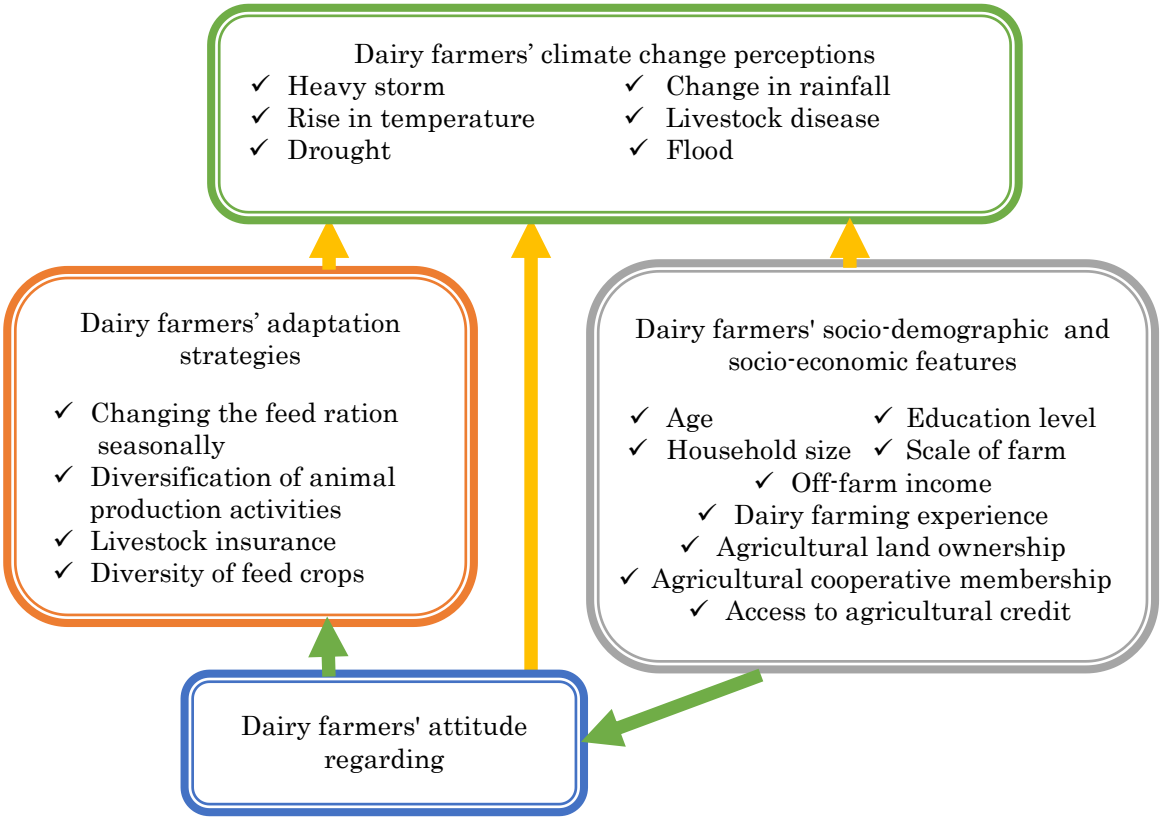

Figure1. Factors affecting dairy farmers' decisions on adaptation strategies
Şekil 1. Süt üreticilerinin adaptasyon stratejilerine ilişkin kararlarını etkileyen faktörler

MATERIAL and METHOD

The study area and the sample size

The present study consists of the responses obtained from dairy farmers in two provinces of the TR22 region (Figure 2). This region was chosen as a study area since the current region has a strategic importance in dairy farming, two provinces in this region are among the risky provinces damaged by

climate change effects, and there is no study performed related to this issue. The questionnaire for the study was completed from October 2023 to December 2023. Data collection was accomplished through a face-to-face interview technique. Ethics committee approval required for the study was obtained from the Ethics Committee of Çanakkale Onsekiz Mart University of School of Graduate Studies (2023-YÖNP-0672, Date: 05 October 2023, Decision no: 12/44).

Figure 2. The map of study area
Şekil 2. Araştırma alanının haritası

The total number of dairy farms in Balıkesir and Çanakkale provinces was provided by the records/data of the Directorate of Provincial Agriculture and Forestry (Anonymous, 2022). This number for Balıkesir (27,121 farms) and Çanakkale (14,511 farms) provinces was defined as 41,632 farms (TURKSTAT, 2022). Dairy farmers' number to be surveyed was defined by the proportional sampling method (Newbold, 1995). This is shown in the formula below;

$$n = \frac{N*p*q}{(N-1)*\sigma^2p + p*q} \quad , \quad \sigma^2p = r/Z_{\frac{\alpha}{2}} \qquad [1]$$

where n is the size of sampling, N is the number of farms in the population (41,632), σ^2p is the ratio of variance, p is the prediction rate (0.5), q is the probability of the examined situation not occurring (1-p), the error margin (0.05) is r and the critical value for α/2 (p=0.5, the critical value of Z for α= 0.05 is 1.96) is Z_(α/2). In case there is no estimate of the p ratio, the p and q ratios can be taken as 0.5 (Oğuz & Karakayacı, 2017; Koç & Uzmay, 2021). Since the characteristics of the dairy farms that constitute the main population were not known at the beginning, p = 0.5 was taken to maximize the sample size. Obtaining a maximum sample size is one of the aims of the study. The ratio of those who adapt to climate change was accepted as 0.5. Thus, the size of the sample was defined as 379. According to the proportionally distributed sample size, 247 and 132 surveys were applied to the dairy farmers in Balıkesir and Çanakkale provinces, respectively.

A multi-stage sampling technique was used to identify sample farms. Firstly, the districts with the highest milk production from the two provinces were determined. They have 43.6% of the dairy farms and milk production (44.7%) of the research region. The majority of farms (83%) in these districts are mixed farms. In addition, the daily milk yield is 24.12±7.18 L, the average milk yield is 4517.71 (kg/head/year) and the farms' average size is 38.21 hectares. Silage corn, oat, alfalfa, and vetch are grown in 63.32% of the land. Secondly, the ratio of interviews in these provinces was calculated concerning the share from the production of the districts; 65.2% from Altıeylül (90), Bigadiç (82), and Karesi (75) districts in Balıkesir province (247) and 34.8% from Biga (74), Yenice (41) and Çan (17) districts in Çanakkale province (132). Finally, it was decided to survey farms that have at least 5 and at most 100 dairy cows. Thus, farms were grouped into the following four categories according to the number of dairy cows: 5 to ≤20 (95 farms), 21 to ≤36 (95 farms), 37 to ≤52 (95 farms), and 53 to ≤100 (94 farms). Dairy farmers were randomly selected from these groups. While preparing the survey questions for the current study, some previous studies were considered (Fahad & Wang, 2018; Jeder et al., 2021; Koç & Uzmay, 2021; Baloch et al., 2022). The questionnaire for this study gathers information about the socio-demographic and economic factors of dairy farmers, as well as measures of their perceptions and adaptation strategies regarding climate change effects.

Empirical model

Probit model

Probabilistic models such as logit and probit are the most suitable methods used to predict discrete selection problems. These models are generally used to estimate the relationship between a two-way response variable (0 and 1 values) of the model and one or more predictors (Xu & Long, 2005; Bai et al., 2016). Accordingly, this method was implemented to define the factors that affect dairy farmers' decisions on adaptation strategies. It is as follows:

$$Y^* = X_i'\beta + \varepsilon \qquad [2]$$

Where, Y* is the dependent variable for the decision of adaptation strategy, Xi' is the explanatory variable, an unknown parameter is β and the error term is ε. It may be found as follows:

$$Y_{ij} = \alpha + \sum X_i \beta + \varepsilon \qquad [3]$$

Where Y_{ij} is the response variable and dairy farmers' decisions on adaptation strategies (j=3) are i_{th}. It gets a value of 1 if Y_i is greater than zero, and it gets a value of 0 if Y_i is less than 0.

$$Y_{ij} = \begin{cases} 0=Y<0, \text{ Dairy farmers don't show willingness to adaptation strategies} \\ 1=Y>0, \text{ Dairy farmers show willingness to adaptation strategies} \end{cases} \quad [4]$$

The parameter estimates are restricted to explaining each impact direction (coefficient β_k) and value (p) between dependent and independent variables. Therefore, they can not predict how much a certain independent variable affects a response variable. To measure exactly the size of the impact of a specific independent variable (X_k) on $P_r(Y_{ij}=1)$, marginal effects (y'_{ij}) are calculated. It may be shown as follows:

$$y'_{ij} = (P_r (Y_{ij}=1).1 - P_r(Y_{ij}=1)).\beta_k \quad [5]$$

The significance of the model (hypothesis testing)

To measure the goodness of fit of the model and its importance, the null hypothesis approach was used in the current research. It assumes that all of the parameters are equal to 0 and one of the coefficients is not equal to 0 (Peng et al., 2002).

$H_0 = \beta k = 0$; H_1= at least one $\beta k \neq 0$ [6]

In the model, the values of LR chi-square varied from 70.17 to 72.13 for adaptation strategies models. The chi-square probability was at the level of p=0.000. For all the models, the pseudo-R2 value varied from 0.14 to 0.18, and it can be assumed that this model fits the study.

Definition of variables for the model

The descriptive statistics results (min, max, frequency, percentage, mean, and standard deviation) regarding dairy farmers' socio-demographic and socio-economic features as well as adaptation strategies are shown in Table 1. In determining the explanatory variables (socio-demographic and socio-economic factors of dairy farmers), the previous literature was considered in the current study (Koç & Uzmay, 2021; Ata et al., 2021; Jeder et al., 2021; Baloch, 2022). In this context, the independent variables were determined as age, level of education, size of household, dairy farming experience, scale farm (dairy cows' number), off-farm income, agricultural land ownership, agricultural cooperative membership, and agricultural credit access. Adaptation strategies towards the impacts of climate change (changing the feed ration seasonally, diversification of animal production activities (sheep and goat), livestock insurance, and diversity of feed crops) were considered as dependent variables. STATA program, which is statistical software, was used in the analysis of this study data (StataCorp, 2005).

RESULTS and DISCUSSION

Dairy farmers' general features

Dairy farmers averaged 44.3 years of age, had a total of 6.76 years of education, had a household size of 3.31 persons, had 14.85 years of experience in dairy farming, and had 20.74 dairy cows (scale of farm). Many of them (68.1%) had off-farm income, 64.4% owned agricultural land, 61.2% were members of agricultural cooperatives and 57.3% had access to agricultural credit (Table 1).

Dairy Farmers' climate-related risk perceptions

Dairy farmers reported that the overall amount of rainfall has decreased over the years. In addition, they explained increases in heavy storms, temperatures (especially in the summer months), and excessive rainfall/flood and drought. According to the Seventh National Communication Report of Türkiye, especially in the last 10 years, these provinces in the research area have the provinces with the highest flood, storm and heavy rainfall events (RTMEU, 2018). This result is supported by the findings in the research area. Figure 3 illustrates dairy farmers' perceptions about climate change. These results revealed that most dairy farmers (70.7%) had a high perception of heavy storms while 19.3% and 10% of them had medium and low perceptions of heavy storms, respectively. For the changes in rainfall, 66.2% of dairy farmers had a high perception while 25.8% and 8% had a medium and a low perception, respectively. Similarly, 60.7% of dairy farmers had a high perception of the rise in the temperature while 28.2% and 11.1% of them had a medium and a low perception, respectively. In addition, many dairy farmers perceived heavy storms as a high threat among all the decisive factors of climate change. Also, these results showed that most dairy farmers perceived the rise in temperatures and decline in rainfall as noticeable changes in climate. Koç & Uzmay (2021) indicated that farmers in the Thrace region mostly perceived changes in climatic factors such as a reduction in precipitation and rising in temperature and drought in the last ten years. In a study performed by Sima et al. (2015), farmers explained that temperature increases during the summer months and drought becomes more severe. Therefore, the previous research results are in parallel with the findings obtained from the study area.

Dairy farmers' adaptation strategies

In the research area, dairy farmers prefer to apply some strategies to cope with the climate changes that they have faced in recent years. These strategies implemented by them can be listed as changing the feed ratio seasonally, diversification of animal production activities, diversity of feed crops, and livestock insurance. Accordingly, the most common

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Table 1. Descriptive statistics of variables
Çizelge 1. Değişkenlerin tanımlayıcı istatistikleri

Variables	Min.	Max.	n	%	Mean	[a]SD
Continuous variables						
Age (year)	28	63	379	100.0	44.30	9.63
Educational level (schooling year)	5	15	379	100.0	6.76	2.46
Household size (person)	2	6	379	100.0	3.31	1.09
Dairy farming experience (year)	7	29	379	100.0	14.85	5.07
Scale of farm (dairy cows' number) (head)	5	58	379	100.0	20.74	13.69
Categorical variables						
Off-farm income						
(Yes)	0	1	258	68.1	0.68	0.47
(No)			121	31.9		
Agricultural land ownership						
(Yes)	0	1	244	64.4	0.64	0.48
(No)			135	35.6		
Agricultural cooperative membership						
(Yes)	0	1	232	61.2	0.61	0.49
(No)			147	38.8		
Access to agricultural credit						
(Yes)	0	1	217	57.3	0.57	0.50
(No)			162	42.7		
Adaptation strategies						
Changing the feed ration seasonally						
(Yes)	0	1	138	36.4	0.36	0.48
(No)			241	63.6		
Diversification of animal production activities (sheep and goats)						
(Yes)	0	1	115	30.3	0.30	0.46
(No)			264	69.7		
Livestock insurance						
(Yes)	0	1	85	22.6	0.23	0.42
(No)			294	77.4		
Diversity of feed crops						
(Yes)	0	1	78	20.6	0.20	0.40
(No)			301	79.4		

[a]SD=Standart deviation

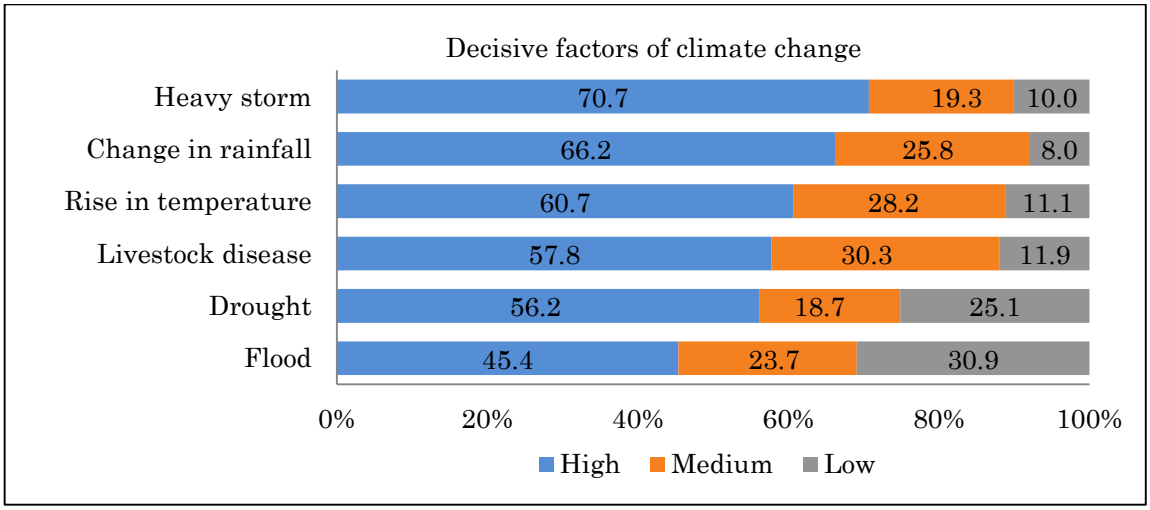

Figure 3. Dairy farmers' climate change perceptions
Şekil 3. Süt üreticilerinin iklim değişikliği algıları

The adaptation strategy preferred by dairy farmers is to change the feed ratio seasonally (36.4%). It was followed by diversification of animal production activities (30.3%) and livestock insurance (22.6%), respectively. In addition, the diversity of feed crops (20.6%) was the least implemented strategy by dairy farmers. These results revealed that few dairy farmers used advanced agricultural applications to deal with the negative impacts of climate change, and many dairy farmers continued to use simple adaptation measures. Koç & Uzmay (2021) stated that the most widely used application among adaptation methods is the use of supplementary nutrients (35.7%), ensuring bedding for livestock during extreme winter/cold (35%) and feed rations (32.9%). In a study performed in Jordan, it was reported that most dairy farmers (81.5%) apply the strategy of using proper ration to cattle in distinct production phases to decrease losses of feed (Ata et al., 2021). Amamou et al. (2018) stated that dairy farmers are focusing on increasing the capacity of water their livestock and improving livestock housing conditions. Considering previous studies' findings, these results indicate that the percentage of dairy farmers who implement adaptation strategies is quite low, and hence there is a need to enhance the tendency of these farmers to implement various adaptation strategies.

Factors affecting dairy farmers' decisions on adaptation strategies

The probit model approach findings used to define factors that affect dairy farmers' decisions about adaptation strategies are shown in Table 2. Since age is considered an indication of matriculation and experience, it has a significant influence on individuals' decisions (Ali & Rose, 2021). In this study, age had a negative and statistically significant impact on dairy farmers' decisions about all adaptation strategies. These results revealed that the increase in the age of dairy farmers by one year would decrease the possibility of being preferred by them as an adaptation strategy of changing the feed ration seasonally (-2.70%), diversification of animal production activities (-1.79%), livestock insurance (-1.34%) and diversity of feed crops (-1.21%). As age increases, dairy farmers are less likely to adapt to new adaptation measures, as indicated by these negative effects. Thus, a one-year increase in the age of dairy farmers would decrease the probability of adapting to a strategy regarding changing the feed ratio seasonally by 2.7%. Furthermore, these results revealed that most young dairy farmers chose a change the feed ration seasonally to adapt to the negative effects of climate conditions compared to older dairy farmers. Old dairy farmers were less likely to adopt these strategies than young dairy farmers, and giving up these practices was not easy for them. They were more familiar with traditional agricultural practices than young dairy farmers. In addition, young dairy farmers were more willing to adapt to new adaptation strategies. These results are backed by the findings of Mabe et al. (2014) and Baloch et al. (2022), which stated that elderly farmers are less likely to adapt and choose new adaptation precautions. However, they are not in line with the findings of Deressa et al. (2009), which stated that there is a positive relationship between farmers' age and adaptation to climatic change.

Education is considered a significant factor in farmers' decision-making process and influences their adaptation process. In addition, adaptation in agriculture is believed to be enabled by education because it allows farmers to access information about innovations that increase their benefits in agricultural production (Ali & Rose, 2021). Deressa et al. (2009) suggest that access to knowledge about advanced technologies and higher productivity are linked to higher education levels. Previous studies have demonstrated that farmers' education levels correlate positively with the adoption of advanced technologies, which can aid them in coping with climate change (Lin, 1991). The present study revealed that the educational level had a positive and statistically significant impact on dairy farmers' decisions about all adaptation strategies. The increase in the educational level of dairy farmers by one year would increase the possibility of being preferred by them as an adaptation strategy of changing the feed ration seasonally (6.49%), diversification of animal production activities (2.65%), livestock insurance (2.42%) and diversity of feed crops (2.05%). As educational levels increase, dairy farmers are more likely to adapt to new adaptation measures, as indicated by these positive effects. Thus, a one-year increase in the educational level of dairy farmers would increase the probability of adapting to a strategy regarding changing the feed ration seasonally by 6.49%. Furthermore, these results revealed that the majority of educated dairy farmers chose a change the feed ration seasonally to adapt to the negative effects of climate conditions compared to less educated dairy farmers. According to these results, educated dairy farmers were more likely to adopt these strategies than less educated dairy farmers. Also, the high literacy rate (secondary school and above) of most dairy farmers can be shown as the reason for this result. These results showed that educated dairy farmers were more likely to adopt strategies than less educated dairy farmers. Also, the high literacy rate (secondary school or above) of most dairy farmers can be cited as a reason for this result. Furthermore, these results revealed that the majority of educated dairy farmers chose to change their feed ration seasonally to adapt to the negative effects of

climate conditions. Baloch et al. (2022) stated that farm households' education level in Pakistan has a negative relationship with their adaptation strategy decision. This study's findings are consistent with the results of Bryan et al. (2013), who explained that farmers who have high educational levels may be more cautious about adopting new technologies and agricultural practices and in reply to shocks regarding the climate, they are not in line with the findings of Baloch et al. (2022).

The household size had a negative and statistically significant impact on dairy farmers' decisions about adaptation strategy regarding changing the feed ration seasonally and a positive and statistically significant impact on farmers' decisions about adaptation strategies regarding diversification of animal production activities, diversity of feed crops and livestock insurance. These results indicated that the increase in the number of family members by one person would decrease the possibility of being preferred by them as an adaptation strategy of changing the feed ration seasonally (-6.71%) while it would increase the possibility of being preferred by them as adaptation strategies of diversification of animal production activities (9.84%), livestock insurance (4.97%) and diversity of feed crops (7.99%). As the number of family members increases, dairy farmers are less likely to adapt to new adaptation measures expressed as changing the feed ration seasonally, as indicated by this negative effect. Thus, dairy farmers with small family sizes are more likely to choose the adaptation strategy of changing the feed ratio seasonally. However, as the number of family members increases, dairy farmers are more likely to adapt to new adaptation measures expressed as diversification of animal production activities, livestock insurance and diversity of feed crops, as indicated by these positive effects. Thus, dairy farmers with large family sizes are less likely to choose the adaptation strategy of diversification of animal production activities, diversity of feed crops and livestock insurance as an adaptation strategy. Furthermore, most dairy farmers with large family sizes chose a diversification of animal production activities to adapt to the negative effects of climate conditions. Deressa et al. (2009) stated that the increasing size of households did not significantly increase the likelihood of adaptation for most adaptation practices. The current study results are not congruent with the findings of Deressa et al. (2009) whereas they are in line with the results of Bryan et al. (2013), which explained that there is a positive association between household size and adaptation strategies. Many of the adaptations in agriculture can be positively related to the many years of farming experience. This experience develops the perceptions of potential benefits and helps to make adaptation decisions (Abid et al., 2019; Ali & Rose, 2021).

The experience in dairy farming had a positive and statistically significant impact on dairy farmers' decisions about adaptation strategies regarding diversification of animal production activities and livestock insurance. These results showed that the increase in farmers' dairy farming experience by one year would increase the possibility of being preferred by them as an adaptation strategy of diversification of animal production activities (2.55%) and livestock insurance (1.93%). As dairy farming experiences, dairy farmers are more likely to adapt to new adaptation measures, as indicated by these positive effects. Thus, a one-year increase in the dairy farming experience would increase the probability of adapting to a strategy regarding diversification of animal production activities by 2.55%. Furthermore, these results revealed that most farmers having more dairy farming experience chose a diversification of animal production activities to adapt to the negative effects of climate conditions compared to farmers having less dairy farming experience. Farmers having more dairy farming experience were more likely to adopt these strategies than farmers having less dairy farming experience. In addition to farm and off-farm income, one of the factors representing wealth in agriculture is livestock ownership. Furthermore, livestock plays a major role in ensuring factors (animal traction and manure) needed for agricultural productivity, especially the maintenance of soil fertility (Deressa et al., 2009). The scale of the farm (dairy cows' number) had a positive and statistically significant effect on dairy farmers' decisions about adaptation strategies regarding livestock insurance and diversity of feed crops. These results revealed that the increase in the scale of the farm (dairy cows' number) by one unit would increase the possibility of being preferred by them as an adaptation strategy of livestock insurance (0.59%) and diversity of feed crops (0.44%). As the scale of farms increases, farmers are more likely to adapt to new adaptation measures, as indicated by these positive effects. Thus, a one-unit increase in the scale of the farm would increase the probability of adapting to the strategy regarding livestock insurance by 0.59%. Furthermore, these results revealed that the majority of dairy farmers having more dairy cows chose livestock insurance to adapt to the negative effects of climate change compared to dairy farmers having fewer dairy cows. Dairy farmers having more dairy cows were less likely to adopt these strategies than dairy farmers having fewer dairy cows. These study results are consistent with those of Deressa et al. (2009), who stated that the ownership of livestock is positive regarding most of the adaptation alternatives.

Off-farm income is among the most important factors

that represent wealth in agriculture. It is assumed that there is a regular need for adequate financial well-being to adopt new agricultural technologies and practices (Knowler & Bradshaw, 2007). In the present study, off-farm income had a positive and statistically significant effect on dairy farmers' decisions about adaptation strategies regarding diversification of animal production activities and livestock insurance. These results revealed that the increase in dairy farmers' off-farm income by one unit would increase the possibility of being preferred by them as an adaptation strategy of diversification of animal production activities (16.06%) and livestock insurance (9.97%). As off-farm income increases, dairy farmers are more likely to adapt to new adaptation measures, as indicated by these positive effects. Thus, a one-unit increase in the off-farm income of dairy farmers would increase the probability of adapting to a strategy regarding diversification of animal production activities by 16.06%. Furthermore, these results revealed that the majority of dairy farmers who have off-farm income chose a diversification of animal production activities to adapt to the negative effects of climate conditions on dairy farmers without off-farm income. Dairy farmers who have off-farm income were more likely to adopt these strategies than dairy farmers without off-farm income. The findings of this study are in line with those of Deressa et al. (2009), which explained that non-farm income has a positive relationship with some adaptation measures. These study findings are supported by the results of Baloch et al. (2022) and Tiet et al. (2022), which found that households of farms that have non-farm income have a higher likelihood to adopt crop diversification as an adaptation strategy.

Land ownership is a natural heritage that must be protected for biodiversity and sustainable progress, and the main source of farmers' agricultural income (Jeder et al., 2021). It is recognized as a sign of the wealth of farmers, and farmers with bigger farms are expected to adopt more (Ali & Rose, 2021). In this study, land ownership had a positive and statistically significant impact on dairy farmers' decisions about adaptation strategies regarding diversification of animal production activities and livestock insurance. These results revealed that the increase in the agricultural land ownership of dairy farmers by one unit would increase the possibility of being preferred by them as an adaptation strategy for diversification of animal production activities (19.95%) and livestock insurance (14.32%). As agricultural land ownership increases, dairy farmers are more likely to adapt to new adaptation measures, as indicated by these positive effects. Thus, a one-unit increase in the agricultural land ownership of dairy farmers would increase the probability of adapting to a strategy regarding diversification of animal production activities by 19.95%. Furthermore, these results revealed that most dairy farmers having agricultural land ownership chose a diversification of animal production activities to adapt to the negative effects of climate conditions compared to dairy farmers without land ownership. Farmers who have agricultural land ownership were more likely to adopt these strategies than dairy farmers without land ownership. These results are supported by those of Abid et al. (2019) and Baloch et al. (2022), which found that there is a positive association between landholding and the probability of adaptation. However, these findings are inconsistent with those of Nabikolo et al. (2012), who explained that there is an adverse relationship between land ownership and adaptation measures.

Dairy farmers who have membership in agricultural cooperatives had a positive and statistically significant impact on dairy farmers' decisions about adaptation strategies regarding changing the feed ratio seasonally and diversity of feed crops. These results revealed that the increase in agricultural cooperative membership of dairy farmers by one unit would increase the possibility of being preferred by them as an adaptation strategy of changing the feed ratio seasonally (13.10%) and diversity of feed crops (15.19%). As agricultural cooperative membership increases, dairy farmers are more likely to adapt to new adaptation measures, as indicated by these positive effects. Thus, a one-unit increase in the agricultural cooperative membership of dairy farmers would increase the probability of adapting to a strategy regarding changing the feed ratio seasonally by 13.10%. Furthermore, these results revealed that the majority of dairy farmers with agricultural cooperative membership chose a change the feed ration seasonally to adapt to the negative effects of climate conditions compared to dairy farmers without agricultural cooperative membership. Dairy farmers with agricultural cooperative membership are less likely to adapt these strategies than dairy farmers without agricultural cooperative membership. Accessibility to agricultural credit resources is a significant factor contributing to the increased adoption of new technologies and practices (Kandlikar & Risbey, 2000; Hassan & Nhemachena, 2008).

The access to agricultural credit had a negative and statistically important impact on dairy farmers' decisions about adaptation strategies regarding diversification of animal production activities, livestock insurance, and diversity of feed crops. These results showed that the increase in access to agricultural credit for dairy farmers by one unit would decrease the possibility of being preferred by them as an adaptation strategy of diversification of animal production activities (-17.91%), livestock insurance (-17.37%) and diversity of feed crops (-12.14%). As access to agricultural credit increases,

dairy farmers are less likely to adapt to new adaptation measures, as indicated by these negative effects. Thus, a one-unit increase in the access to agricultural credit of dairy farmers would decrease the probability of adapting to a strategy regarding diversification of animal production activities by 17.91%. Furthermore, these results revealed that most dairy farmers without access to agricultural credit chose a diversification of animal production activities to adapt to the negative effects of climate conditions compared to dairy farmers with access to agricultural credit. Dairy farmers with access to agricultural credit were less likely to adopt these strategies than dairy farmers without access to agricultural credit. In this context, it can attribute this result to two reasons. Firstly, it can be said that dairy farmers may have adequate financial resources (property, income) to cope with climate shocks. Secondly, dairy farmers' access to agricultural credit can offer financial relief for them. But at the same time, farmers must repay the amounts related to the loans they receive, and this obligation causes them to become indebted (Pakdemirli, 2019). Farmers are worried about repaying their debts because of this result. For this reason, it can be said that dairy farmers' tendencies towards agricultural credit during the adaptation process to climate change are quite low. This study's findings are compatible with the results of Baloch et al. (2022), which explained there is a negative relationship between access to credit and farmers' adaptation strategies. However, the current results are inconsistent with the findings of Mabe et al. (2014), Abid et al. (2019) and Deressa et al. (2009), which stated there is a positive association between credit practices and adaptation to climate change.

Table 2. Factors affecting dairy farmers' decisions on adaptation strategies
Çizelge 2. Süt üreticilerinin adaptasyon stratejilerine ilişkin kararlarını etkileyen faktörler

Independent variables	Adaptation Strategies											
	Changing feed ration seasonally			Diversification of animal production activities (sheep and goat)			Livestock insurance			Diversity of feed crops		
	Coef.	ME[b]	*p*	Coef.	ME[b]	*p*	Coef.	ME[b]	*p*	Coef.	ME[b]	*p*
Age	-0.0733* (0.0153)[a]	-0.0270	0.000	-0.0546* (0.0156)	-0.0179	0.000	-0.0505* (0.0168)	-0.0134	0.003	-0.0510* (0.0175)	-0.0121	0.004
Education level	0.1761* (0.0343)	0.0649	0.000	0.0804* (0.0339)	0.0265	0.018	0.0913* (0.0354)	0.0242	0.010	0.0866* (0.0372)	0.0205	0.020
Household size	-0.1820* (0.0662)	-0.0671	0.006	0.2986* (0.0676)	0.0984	0.000	0.1873* (0.0713)	0.0497	0.009	0.3367* (0.0759)	0.0799	0.000
Dairy farming experience	0.0241 (0.0240)	0.0088	0.316	0.0773* (0.0253)	0.0255	0.002	0.0727* (0.0269)	0.0193	0.007	0.0298 (0.0276)	0.0071	0.278
Scale of farm	0.0770 (0.0051)	0.0028	0.135	0.0067 (0.0052)	0.0022	0.201	0.0224* (0.0056)	0.0059	0.000	0.0187* (0.0057)	0.0044	0.001
Off-farm income	0.0787 (0.1554)	0.0288	0.612	0.5218* (0.1683)	0.1606	0.002	0.4027* (0.1802)	0.0997	0.025	-0.1980 (0.1757)	0.0487	0.260
Agricultural land ownership	0.0403 (0.1480)	0.0148	0.786	0.6497* (0.1615)	0.1995	0.000	0.5849* (0.1742)	0.1432	0.001	0.2660 (0.1719)	0.0607	0.122
Agricultural cooperative membership	0.3633* (0.1544)	0.1310	0.019	0.1423 (0.1571)	0.0464	0.365	0.2206 (0.1707)	0.0572	0.196	0.6923* (0.1885)	0.1519	0.000
Access to agricultural credit	0.0691 (0.1502)	0.0254	0.645	-0.5350* (0.1539)	-0.1791	0.001	-0.6320* (0.1669)	-0.1737	0.000	-0.4939* (0.1702)	-0.1214	0.004
Log-likelihood	-213.01467			-196.62729			-167.54665			-157.57538		
LR chi^2 (9)	72.13			71.96			70.83			70.17		
McFadden's Pseudo R^2	0.1448			0.1547			0.1745			0.1821		
Prob > chi^2	0.0000			0.0000			0.0000			0.0000		

*The significance level: *p<0.05; [a] values in parenthesis are the standard errors; [b]ME: Marginal effect the probit model*

CONCLUSION and RECOMMENDATIONS

In the present study, dairy farmers' perceptions of climate-related risks, their adaptation strategies and factors affecting their decisions about adaptation strategies have been analysed. Most dairy farmers (70.7%) had a high perception of heavy storms while 66.2% of dairy farmers had a high perception of change in rainfall. Among all the decisive factors of climate change, most dairy farmers perceived heavy storms and changes in rainfall as high-threatening factors. Dairy farmers are implementing strategies for adaptation to cope with negative impacts related to climate change. The most common adaptation strategy implemented by dairy farmers was changing

the feed ration seasonally (36.4%). It was followed by diversification of animal production activities (30.3%), livestock insurance (22.6%) and diversity of feed crops (20.6%). While diversity of feed crops was the least preferred adaptation strategy among these adaptation strategies, changing the feed ration seasonally was the most preferred adaptation strategy. Dairy farmers' age and access to agricultural credit had a negative relationship with their decision of adaptation strategies while dairy farmers' educational level, dairy farming experience, scale of farm, off-farm income, agricultural land ownership and access to agricultural credit had a positive relationship with their decision on adaptation strategies. The advantages of adaptation strategies and the importance of investing in risk-mitigating precautions are highlighted by these results. The lack of information on the negative impacts of climate change on dairy farmers should not be ignored. For this reason, more importance should be given to training and extension activities related to climate change adaptation among dairy farmers. Also, dairy farmers should be made aware of the benefits of adaptation strategies to be applied in the face of climate change by extension services and mass media, and they need to be informed about the significance of implementing these strategies by regional conditions. The tendency of dairy farmers to purchase livestock insurance is quite low in the research area. Thus, it is important to improve and disseminate livestock insurance practices. Losses caused by the negative effects of climate change can be included in this practice. The current study revealed that agricultural cooperative membership played a significant role in the selection of dairy farmers' adaptation strategies. Therefore, it is important to improve the efficiency of agricultural cooperatives during the adaptation process. They can support dairy farmers by helping them to access financial support or encouraging them to adapt. Although many dairy farmers are affected by changes in the climate and are worried about the future of dairy farming activities, they are less inclined towards adaptive strategies. According to this result, dairy farmers' adaptation to adaptation strategies cannot be increased by anxiety and perception of risk alone. This shows that socio-demographic and socioeconomic factors, as well as risk perceptions, have become more prominent. For this reason, a scientific and statistical infrastructure on climate change should be developed on a regional basis. Therefore, appropriate adaptation strategies should be determined. In this process, the cooperation from some stakeholders (such as the ministries and the media) should also be beneficial. Within the purposes of the present study, dairy farmers need to receive financial support so that they can minimize the negative impacts of climate change and adapt to it. Implementation of adaptation strategies within the scope of special and regional policy measures will provide to reduce adverse effects of climate change or to adapt to this situation may increase dairy farmers' tendency to adopt these strategies. In this context, policymakers can implement programs and training to increase awareness of dairy farmers about climate change by providing extension services.

Author's Contribution

Authors declare the contribution of the authors is equal.

Conflict of interests

The authors declare that there is no conflict of interest.

Ethics approval

This study was approved by the Ethics Committee of Çanakkale Onsekiz Mart University of School of Graduate Studies (2023-YÖNP-0672, Date: 05 October 2023, Decision no: 12/44).

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