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DETERMINANTS OF CLIMATE CHANGE ADAPTATION: WHEAT PRODUCERS IN YALVAÇ DISTRICT, TURKEY

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Abstract

The objective of this study is to analyze the factors determining wheat producers' adaptation to climate change in the Yalvaç district. Using a stratified random sampling method, 116 farmers were interviewed face-to-face. Binary logistic regression was applied to identify the factors influencing farmers' choices of adaptation measures. The results show that several factors significantly affect producers' adaptation decisions, including access to agricultural credit, the use of non-family labor, receipt of climate alerts, interaction with agricultural authorities, and soil analysis. These factors play a crucial role in the adoption of adaptive practices such as increasing fertilizer doses, crop rotation, and changing wheat varieties. This research provides critical insights for shaping agricultural policies aimed at improving the resilience of producers to climate change and enhancing their adaptive capacity.

Key words: *determinants, adaptation, wheat, producers, Turkey*

INTRODUCTION

In the global context, wheat stands out as one of the most widely produced and consumed cereals across the world [39]. It serves as a critical source of employment and wealth creation for numerous communities involved in its cultivation. However, its productivity and supply are severely threatened by climatic factors such as drought, temperature fluctuations, and irregular precipitation patterns [22]. According to [24], the growth and development of wheat are compromised by increased evapotranspiration caused by rising temperatures and drought conditions. Over the past decades, several wheat-producing countries have faced challenges related to climatic conditions.

Scientists tried to find solutions to mitigate the negative impact of climate change. [17] assessed and compared the drought tolerance of some wheat varieties in Romania, in order to chose the most resistant ones and recommend them to be cultivated by farmers. [8] used NDVI in monitoring the wheat crop vegetation, the carbon storage and the yield level on the chernozemic soils from South Romania. [28] adapted the technology of winter wheat in the conditions of climate change in Dobrogea region, the most droughty area of the South Romania in order to sustain yield and economic efficiency.

Turkey, one of the major producers, has also been impacted by these climatic variations, which have negatively affected wheat yields. In particular, rising temperatures (>30°C) and water stress (<40 mm) have posed significant threats to wheat production [22]. Additionally, cold winter temperatures and high spring temperatures have reduced yields [39]. In Turkey's Mediterranean region, climate change has led to decreased precipitation, soil erosion, and declining wheat yields [11]. The Yalvaç district, located in this region, has experienced an increase of over 15 days of hot days and nights over the past century. Projections for 2070 predict a 6°C rise in summer temperatures and a 20% reduction in winter precipitation [29, 11]. As a result, producers are compelled to implement adaptive measures to combat the effects of climate change and sustain wheat production.

According to [25], climate change adaptation is a continuous and evolving process aimed at mitigating the negative impacts of climate conditions. It involves a socio-economic and behavioral transformation by farmers to reduce the intensity of climate change effects

[38]. Adaptation can be either planned or spontaneous: planned adaptation is implemented before the impacts become apparent, while spontaneous adaptation is a reactive response to an unexpected climate crisis [36, 20]. The choice of adaptation measures is often influenced by the expected utility or satisfaction for the producer [37]. This choice can also be shaped by various factors, including socio-economic, human, natural, and institutional conditions, as well as the availability of production and marketing infrastructure. Although numerous studies have examined the determinants of climate change adaptation, including those in Turkey and other regions [1, 16, 27, 21, 32, 4], very little research has focused on the Yalvaç district.

This study fills that gap by investigating the determinants of wheat producers' adaptation in this region. It will serve as a decision-making tool for agricultural policymakers during the formulation of strategies to support farmers in overcoming adaptation barriers.

MATERIALS AND METHODS

The data used in this research were collected through face-to-face interviews with wheat producers in the Yalvaç district. Both closed and open-ended questions addressing socioeconomic, institutional, and other relevant aspects were asked of the farmers. To determine the sample size, an anonymous list of wheat production areas, drawn from the provincial producer registration system, was utilized. The stratified random sampling method was employed to establish the sample size [40].

$$n = \frac{\sum(N_h * S_h)^2}{N^2 D^2 + \sum N_h {S_h}^2} \qquad ....(1)$$

In this context: n represents the sample size; N is the total number of units (after excluding producers with less than one decare from the total of 2,308, the new N becomes 2,247); N_h is the number of units in stratum h; S_h is the standard deviation of stratum h; D is calculated as d/Z, where d is the deviation from the mean, and Z represents the number of degrees of freedom in the t-distribution diagram (N-1).

The z-value corresponds to a certain confidence level 95% confidence with a margin of error of 5%.

$$n = \frac{(19{,}352)^2}{(2{,}247)^2\left(\frac{1.50}{1.96}\right)^2 + (256{,}933.7)} \text{ ; n=116}$$

A binary logistic regression model was used to identify the various factors likely to influence the adaptation measures adopted by farmers to cope with the effects of climate change.

The dependent variable (Yi), representing the climate change adaptation measure, is binary: it takes the value 1 if the farmer adopts the measure and 0 otherwise [1, 41, 21].

The adaptation measures implemented by farmers include changing wheat varieties, adjusting fertilizer and pesticide doses, crop rotation, and monitoring weather information. Wheat producers adopt one or more of these adaptation measures only if they perceive a reduction in climate risk and/or an improvement in their agricultural income.

The empirical form of the logistic regression model is as follows:

$$Yi = bo + bi \sum_{i=1}^{n} Xi + ei \qquad ....(2)$$

where: b_0 represents the constant term; b_i: represents the set of coefficients, X_i denotes the set of independent variables, and e_i is the error term.

The independent variables (X) include variables related to natural, economic, human, and institutional resources, as well as the availability of production and marketing infrastructure and social capital (Table 1).

The analysis of tolerance (TOL) and variance inflation factor (VIF) was used to eliminate multicollinear independent variables.

Table 1. Description of explanatory variables

	Variable	Description	Mean	S.D
Economic resources	Income diversification	1-Yes, 2-No	0.63	0.49
	Use of agricultural credit or financial tools	1-Yes, 2-No	0.61	0.49
	Use of agricultural subsidies	1-Yes, 2-No	0.97	0.18
	Monthly earnings	TL	10,743.53	4,187.90
	Age	Years	45.63	9.68
Human Resources	Years of experience	Years	22.28	9.94
	Take part in seminars or training courses on climate change	1-Yes, 2-No	0.03	0.16
	Farm visits by agricultural engineers to provide information	1-Yes, 2-No	0.62	0.49
	Use of labor other than family labor	1-Yes, 2-No	0.46	0.50
Resources for production and marketing infrastructure	Use of certified seeds	1-Yes, 2-No	0.81	0.40
	Receive warnings about climate change	1-Yes, 2-No	0.84	0.36
Institutions resources	Se rendre à la direction départemental/provinciale de l'agriculture	1-Yes, 2-No	0.95	0.22
Social capital resources	Be a member of agriculture-related social networks	1-Yes, 2-No	0.47	0.50
	Membership of agricultural groups	1-Yes, 2-No	0.28	0.45
	Discuss climate change challenges within cooperatives	1-Yes, 2-No	0.22	0.45
Natural resources	Farm fertility	1-Yes, 2-No	0.86	0.35
	Soil analysis	1-Yes, 2-No	0.33	0.47
	Use of renewable energy sources	1-Yes, 2-No	0.09	0.28
	Violent winds in the village in the last 10 years	1-Yes, 2-No	0.47	0.50
	Hurricane in the village in the last 10 years	1-Yes, 2-No	0.03	0.18
	Flooding in the last 10 years	1-Yes, 2-No	0.27	0.44

Source: Results of the survey.

RESULTS AND DISCUSSIONS

Analysis of determinant characteristics

Economic resources

Diversifying income sources is an effective adaptation strategy in response to the impacts of climate change, as it allows producers to mitigate the risks associated with relying on a single activity. Among the respondents, 63% engage in various forms of diversification. Some achieve this through livestock farming (36%), while others pursue commerce (21%). According to [35], crop rotation also enables farmers to diversify their income sources. However, due to the small size of farms and low productivity in certain regions, [9] recommend that non-agricultural activities serve as a supplementary source of income diversification. Diversifying income sources, whether through expanding agricultural activities or exploring non-agricultural opportunities, helps enhance the economic resilience of producers against climate disruptions and other risks. It also provides a pathway to greater financial security for farming households, thereby supporting their long-term economic stability.

In the survey, 61% of the interviewed producers utilized agricultural credit for wheat production, and 52% of them were indebted as a result. This high percentage of agricultural credit usage highlights the need for financing wheat production in the Yalvaç district. Similar results have been observed in the Uşak province, where 49% of producers also used agricultural credit for wheat cultivation [30]. In the Chinese province of Sichuan, farmers use agricultural credit to increase their cereal production by investing in agricultural technologies that mitigate the effects of climate change [19]. Regarding Turkish state agricultural subsidies, a large majority of the surveyed producers (96.6%) believe these supports are beneficial. The most advantageous subsidies pertain to diesel and fertilizers. This positive perception of public subsidies, particularly those related to fuels and fertilizers, underscores their importance to producers and their favorable impact on farm profitability and productivity.

Human resources

Over the past five years, only 2.6% of the surveyed producers have attended courses, seminars, or training sessions related to climate change. These sessions mainly focused on water resource management and drought mitigation. These results highlight an increasing need for specialized climate change training programs for producers. The low participation rate in current training suggests that there is a need to strengthen and expand these initiatives, with a particular emphasis on crucial topics such as the use of drought-resistant seeds. Enhanced awareness and better access to such training will strengthen producers' capacity to cope with the effects of climate change. [10] take a similar approach, revealing that in Tokat province, only 1.5% of participants attended climate change training. Research conducted in Burundi also found that a lack of training and information on climate and adaptation strategies are major barriers to farmers' adaptation to climate change [7]. Furthermore, according to a survey by the Ministry of Agriculture and Forests, 94% of producers believe it would be beneficial for the ministry to organize specific training on managing climate change impacts to improve farmers' adaptation capacity [38]. Agricultural technicians' visits to farms play a crucial role in sharing information and providing technical advice to producers. According to the survey, 62% of the farmers interviewed reported having received visits from agricultural technicians of the provincial agriculture directorate during the 2021-2022 growing season. These visits mainly focus on technical aspects of production, such as fertilization, spraying, and pest control. However, topics related to climate change are rarely addressed during these visits. This lack of discussion on climate issues indicates a gap in integrating climate change concerns into the advisory services offered to farmers, despite their increasing importance.

[15] support this view by revealing that farmers visited by extension agents are very unlikely to implement climate change adaptation measures. Additionally, a survey by [10] in Tokat province reveals that information provided by the Provincial Directorate of Agriculture and Forests is considered insufficient by producers. They also criticize the overly bureaucratic nature of the institution and the absence of agents in the field. These criticisms underscore the need for provincial agricultural services to enhance their presence with farmers and improve the quality of assistance provided, to better meet the needs of operators and tailor recommendations to local realities.

The migration of young people from rural areas to cities in search of better living conditions directly impacts the availability of labor on farms [2]. Indeed, only 46% of the surveyed farmers reported using non-family labor for wheat production. The reliance on external labor indicates a difficulty in maintaining a sufficient local workforce. This decline in labor availability makes it more challenging to implement robust measures to address the effects of climate change. Adaptation strategies often require additional efforts in management and implementation, which are difficult to achieve without an adequate labor force. Thus, rural depopulation not only weakens farm operations but also reduces their capacity to adapt to climate-related challenges.

Production and marketing infrastructure resources

In Turkey, subsidies for the use of certified seeds, established since 2004 [12], have had a significant impact on agricultural practices. Indeed, 81% of the surveyed producers used certified wheat seeds during the 2021-2022 growing season. This high adoption rate reflects the success of the support policy, which has encouraged farmers to choose certified seeds. These seeds offer several benefits, including better resistance to drought, insects, and diseases, which contributes to reduced production costs while improving wheat yield and quality. This result highlights the importance of public policies in enhancing agricultural practices and farm resilience to climate challenges. The importance of staying informed about climate variations is underscored by the fact that 95% of farmers regularly monitor weather forecasts. Among them, 48% receive alerts from the meteorological office, while 46% obtain information through the provincial agricultural directorate. This underscores the crucial role of these institutions in providing accurate and accessible climate information. It is essential for them to provide producers with updated data that enables them to plan and adapt their agricultural practices effectively based on changing weather conditions.

Institutional resources and social capital

Among the surveyed producers, 39% use the internet to search for information on climate change. This use allows them to access a variety of resources, including real-time weather data, scientific reports, and practical advice. Meanwhile, 26% of the producers obtain information through television, indicating that traditional media continue to play a significant role in disseminating information, particularly for certain segments of producers. Additionally, 95% of the producers report turning to the provincial agricultural directorate for advice on managing their farms, with 57% of them consulting this institution more than three times a year. Other sources, such as fellow producers, neighbors, and extension centers, are also utilized. These findings align with the work of [13, 14, 31], which demonstrate that farmers receive climate change information through radio programs, cooperatives, and agricultural extension centers.

Nearly half of the producers (47.4%) are members of agricultural-related social networks, with a predominance of Facebook and WhatsApp groups. Additionally, a large majority (81%) of producers are affiliated with an agricultural cooperative in their village, primarily with the village development cooperative (67%). However, only 28% of producers report that climate change issues are addressed within their cooperative. This suggests that agricultural cooperatives are not perceived as central venues for obtaining information or participating in discussions on this crucial topic. Therefore, it is necessary to enhance engagement with climate change issues within these organizations. Nevertheless, as highlighted by [18, 34], farmers who are members of a cooperative are generally more likely to share their knowledge, innovative ideas, and problems, and to adopt agricultural practices that are adapted to the impacts of climate change, underscoring the importance of these organizations in disseminating best practices.

Natural resources

To continue farming despite the effects of climate change, 42.2% of the producers surveyed reported renting agricultural land, while 13.8% purchased land and 12.9% sold land over the past decade. Additionally, 31% of producers neither bought, sold, nor rented land. Although the majority of producers (86.2%) perceive their soil as fertile, only 33% have conducted soil analyses. This low rate of soil testing highlights an increased need for awareness about the benefits of this practice, particularly regarding more efficient resource management and optimal fertilizer use. In fact, 16% of farmers reported reducing their fertilizer purchase costs through soil testing, illustrating a willingness to improve their agricultural practices based on soil characteristics. Better soil management can also contribute to climate change adaptation by strengthening farm resilience. Furthermore, 25% of producers indicated they use wood for domestic purposes. If this practice continues, it may exacerbate pressure on natural resources and contribute to forest degradation, worsening the effects of climate change. Less than 10% of surveyed producers use renewable energy on their farms, indicating a low commitment to more sustainable practices. However, renewable energy is crucial for reducing greenhouse gas emissions and mitigating climate change impacts. Additionally, 45% of producers reported experiencing strong winds in their villages over the past decade, and 27% mentioned flooding. Extreme weather events are perceived by 27% of producers as linked to climate change, indicating growing awareness of the interactions between human activities and extreme weather conditions. Similar findings were observed in Tokat province, where farmers reported strong winds, floods, hailstorms, and frost events [10]. Studies, such as the one conducted by [23] in Elazığ province, reveal that 100% of respondents have observed changes such as increased plant diseases, seasonal anomalies and water shortages over the past 20 years, reinforcing the idea that climate change has become a tangible reality for many agricultural communities.

Analysis of the determinants of adaptability to climate change

The multicollinearity assessment was conducted using the tolerance index (TOL) and the variance inflation factor (VIF) to eliminate multicollinear variables (Table 2).

Collinearity between explanatory variables is detected when the TOL is less than 0.1 or the VIF exceeds 10 [6, 41]. Consequently, variables that did not meet these criteria were excluded. Table 2 presents the TOL and VIF results. The findings indicate that all TOL values are greater than 0.1, and all VIF values are below 10, suggesting no collinearity issues.

The results of the logistic regression, detailed in Table 3, reveal that in each model, at least one independent variable significantly influences the producers' decision to implement adaptation measures against the impacts of climate change, with a significance level of 5%.

The R^2 indicator, which ranges from 0 to 1, is used to assess how well the model fits the data. The higher the value, the better the model matches the observed data.

However, in the social sciences, a Nagelkerke R^2 value greater than 0.2 (20%) is considered indicative of a good fit [41].

Table 2. TOL and VIF results

	Variable	TOL	VIF
Economic resources	Income diversification	0.64	1.58
	Use of agricultural credit or financial tools	0.73	1.37
	Use of agricultural subsidies	0.63	1.59
	Monthly earnings	0.80	1.25
Human Resources	Age	0.26	3.78
	Years of experience	0.30	3.36
	Take part in seminars or training courses on climate change	0.86	1.16
	Farm visits by agricultural engineers to provide information	0.68	1.47
	Use of labor other than family labor	0.58	1.71
Resources for production and marketing infrastructure	Use of certified seeds	0.63	1.59
	Receive warnings about climate change	0.56	1.78
Institutions resources	Se rendre à la direction départemental/provinciale de l’agriculture	0.68	1.46
Social capital resources	Be a member of agriculture-related social networks	0.49	2.05
	Membership of agricultural groups	0.62	1.61
	Discuss climate change challenges within cooperatives	0.69	1.50
Natural resources	Farm fertility	0.77	1.3
	Soil analysis	0.70	1.44
	Use of renewable energy sources	0.83	1.20
	Violent winds in the village in the last 10 years	0.53	1.88
	Hurricane in the village in the last 10 years	0.73	1.36
	Flooding in the last 10 years	0.38	2.62

Source: Own calculation based on the survey data.

For the various models presented, the R^2 exceeds this threshold, suggesting a satisfactory fit. For instance, the Y4 model has a Nagelkerke R^2 of 0.64, meaning that the independent variables included in this model explain 64% of the variance in the producers' decisions, indicating a relatively high predictive capability. This underscores the relevance of the identified factors in influencing climate change adaptation practices.

Economic factors

The results of the binary logistic regression (Table 3) indicate that the use of agricultural credit (p=0.02) has a significant negative effect on farmers' decisions to practice crop rotation. This means that an increase in access to agricultural credit would lead to a 2% decrease in the likelihood of adopting this practice. This negative effect could be explained by the obligation to repay the credit, which might reduce producers' flexibility in adopting longer-term practices such as crop rotation. Similar findings were reported by [32], where access to agricultural credit also showed a negative effect on producers' climate change adaptation strategies. However, other previous studies [3, 15, 4] demonstrated that access to agricultural credit significantly and positively influences climate change adaptation measures. These studies highlight that access to financial resources enables farmers to fund the purchase of inputs and agricultural technologies, thereby promoting their adaptation to the effects of climate change. Furthermore, [1] reveal that access to agricultural credit has no notable influence on adaptation measures. This divergence in results underscores the importance of local contextual and economic factors that may differently affect how farmers utilize agricultural credit to adapt to climate change.

The use of agricultural subsidies (p=0.05) has a positive effect on farmers' decisions to increase the application of fertilizers and pesticides (Table 3). Specifically, a one-unit increase in the use of agricultural subsidies raises the probability of increasing the use of these inputs by 5%. This suggests that subsidies encourage farmers to intensify their use of fertilizers and pesticides, likely in an effort to optimize production and maximize yields. This intensification may also be seen as a response to increasingly unpredictable climate conditions, with farmers aiming to enhance the resilience of their crops against disruptions such as droughts, diseases, or pest infestations.

However, this trend of increased chemical input use may raise concerns regarding environmental sustainability, particularly in terms of impacts on soil quality and local ecosystems.

Human factors

The use of non-family labor significantly influences producers' decisions regarding climate change adaptation strategies. It has a positive effect on the decision to increase fertilizer and pesticide application (p = 0.00), with a one-unit increase in the use of non-family labor raising the likelihood of increasing these inputs by 1%. This suggests a connection between access to external labor and the intensification of agricultural practices, likely due to the increased availability of workers to manage more complex and labor-intensive farming tasks. Conversely, the use of non-family labor has a negative effect (p = 0.02) on farmers' decisions to rely on weather information for climate change adaptation. This may imply that while access to external labor supports production intensification, it may also reduce attention to proactive planning and management based on weather forecasts. Producers seem more focused on maximizing immediate yields rather than anticipating climate-related risks.

Production and marketing infrastructure factors

Receiving climate warning messages (e.g., temperature and rainfall alerts) has a significant but negative effect on producers' decisions to increase fertilizer use (p = 0.04) and practice crop rotation (p = 0.02). This outcome may be explained by the fact that upon receiving such warnings, producers might adopt a more cautious or conservative approach, reducing their confidence in increasing inputs like fertilizers or changing agricultural practices such as crop rotation. Rather than taking reactive measures by intensifying input use, they might prefer making more moderate adjustments or waiting for more stable climatic conditions before committing to major changes. These findings align with several previous studies. [1] demonstrated that access to weather information enhances farmers' adaptive capacity to climate change by making them more aware of potential risks and encouraging them to diversify their agricultural practices. Similarly, research by [33, 26, 4], confirms that knowledge of and access to climate information positively influence farmers' adaptation decisions. Farmers who receive early climate warnings are more likely to adjust their practices in a timely manner, whereas those receiving such information later may be forced to react more unpredictably or take riskier actions.

Institutional factors and social capital

Relying on the provincial/district agricultural office (p = 0.01) has a significant and negative impact on farmers' decisions to follow weather information for climate change adaptation. The negative coefficient for this variable may be explained by farmers perceiving the information provided by local authorities as insufficiently relevant or outdated to meet their immediate adaptation needs. This could discourage them from actively following weather information from other sources or relying entirely on such information to guide their agricultural practices. Similarly, [1] suggest that the negative significance of farmers' access to extension services may be linked to the perception that the information provided is often outdated or misaligned with the current realities of climate change. This perceived lack of relevance can lead to mistrust or reduced dependence on these services when making climate adaptation decisions.

However, other studies, such as those by [3, 15, 33, 5, 4], show that farmers who maintain regular contact with extension agents are generally better able to adopt practices that mitigate the effects of climate change. These regular interactions facilitate access to technical information, innovations, and practical advice that can improve farmers' resilience and adaptive capacity.

Natural factors

The regression results reveal that several factors influence producers' decision-making regarding agricultural practices in response to climate change. Conducting a soil analysis (p = 0.02) significantly affects the decision to change wheat varieties. The negative coefficient associated with this variable suggests that after performing a soil analysis, farmers are less likely to switch wheat types. This may be because soil analysis helps them better understand the characteristics of their land, allowing them to optimize the wheat varieties they already use, thereby reducing the need to change.

Table 3. Results of binary logistic regression

	Y1		Y2		Y3		Y4	
	β	P	β	P	β	P	β	P
Economic factors								
Income diversification	-0.30	0.65	-0.23	0.68	0.21	0.79	1.11	0.35
Use of agricultural credit or financial tools	-0.67	0.34	-0.91	0.09	-1.63	**0.02****	3.91	0.07
Use of agricultural subsidies	2.02	0.30	5.04	**0.05****	0.25	0.91	-14.40	1.00
Monthly earnings	0.00	0.88	0.00	0.54	0.00	0.06	0.00	0.11
Human factors								
Age	0.01	0.86	0.04	0.42	-0.06	0.28	-0.03	0.76
Years of experience	-0.01	0.51	-0.03	0.52	0.04	0.37	0.22	0.10
Take part in seminars or training courses on climate change	1.79	0.36	-0.13	0.93	2.14	0.13	-11.73	1.00
Farm visits by agricultural engineers to provide information	-0.85	0.22	0.32	0.58	-0.04	0.95	-0.93	0.38
Use of labor other than family labor	-0.63	0.44	1.99	**0.00*****	-0.74	0.39	-4.68	**0.02****
Factors for production and marketing infrastructure								
Use of certified seeds	-0.85	0.27	-1.13	0.11	0.57	0.50	-2.66	0.13
Receive warnings about climate change	-0.60	0.48	-1.76	**0.04****	-2.31	**0.02****	1.50	0.44
Institutions factors								
Go to the departmental/provincial directorate of agriculture	-0.63	0.63	-2.73	0.20	-20.31	1.00	-13.56	**0.01*****
Social capital factors								
Be a member of agriculture-related social networks	-1.68	0.06	-0.53	0.41	-0.91	0.26	-0.97	0.50
Membership of agricultural groups	1.67	0.10	-0.52	0.43	1.42	0.08	-5.10	0.06
Discuss climate change challenges within cooperatives	0.13	0.87	-0.02	0.98	0.38	0.63	-21.93	1.00
Natural factors								
Farm fertility	-0.42	0.64	1.04	0.23	-0.24	0.79	-0.22	0.90
Soil analysis	-2.62	**0.02****	0.92	0.11	-1.48	0.06	-3.95	0.11
Use of renewable energy sources	-1.68	0.21	0.26	0.78	0.57	0.62	4.30	**0.04****
Violent winds in the village in the last 10 years	1.93	**0.02****	-0.13	0.84	-0.86	0.29	1.88	0.27
Hurricane in the village in the last 10 years	-1.62	0.39	-0.25	0.88	-38.20	1.00	-31.18	1.00
Flooding in the last 10 years	-0.65	0.49	-0.41	0.61	-0.36	0.73	-2.77	0.28
Farm fertility	5.89	0.11	-0.25	0.92	42.27	1	75.59	1
N	116							
Nagelkerke R Square	0.41		0.35		0.53		0.64	

β: Coefficient, P : P-value, Y1 : Change of wheat type, Y2 : Increasing fertilizer and pesticide rates, Y3 : Crop rotation, Y4 : follow weather information, ** 5%, *** 1%

Source: Own calculation based on the survey data.

Experiencing strong winds in the village over the past ten years (p = 0.02) significantly influences the decision to switch wheat varieties. Extreme weather events, such as strong winds, may prompt farmers to adapt their crops by selecting wheat varieties that are more resilient to harsh climate conditions, thereby protecting their yield.

The adoption of renewable energy sources ($p = 0.04$) also significantly impacts producers' decisions to follow weather information to adapt to climate change. Integrating renewable energy sources reflects a heightened awareness of sustainability and resource management, encouraging farmers to stay attentive to weather conditions to better manage their farms in the context of climate change. These findings highlight the importance of climate-related experiences, sustainable agricultural practices, and modern technologies (such as soil analysis and renewable energy) in shaping farmers' adaptation decisions in the face of climate challenges.

CONCLUSIONS

In this study, the factors influencing climate change adaptation among wheat producers were analyzed. Using a binary logistic regression model, variables that could affect farmers' decision-making were examined. The results revealed that the adaptation measures implemented by farmers include changing wheat varieties, adjusting fertilizer and pesticide doses, crop rotation, and monitoring weather information. Factors such as access to agricultural credit, conducting soil analyses, the use of agricultural subsidies, reliance on non-family labor, and receiving climate change warning messages significantly influenced the adoption of various adaptation strategies.

Based on these findings, it is recommended to implement targeted training and awareness programs to enhance farmers' knowledge of climate change adaptation techniques. These initiatives should include practical workshops on sustainable resource management, optimizing agricultural inputs, and the effective use of technological tools such as weather alert systems. Additionally, policymakers must improve access to agricultural credit and subsidies while facilitating the development of agricultural infrastructure suited to the changing climate conditions. Increased institutional support, in collaboration with climatology and agronomy experts, would help promote farmers' resilience. Furthermore, encouraging crop diversification and alternative economic activities could reduce dependency on wheat and mitigate risks associated with climate fluctuations, thus contributing to long-term food security. These recommendations should be integrated into a national agricultural resilience strategy to address the ongoing climate challenges.

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