



Afghan International Journal of Science (AIJS)

Publisher: Afghan International Islamic University

Website: <https://aijs.aiiu.edu.af>

e-ISSN: 3134-5859

Farmers' Perceptions of Climate Change Impacts on Fruit Farming in Paktia Province, Afghanistan

Mohammad Masoom Hussainkhil^{*1}, Abdul Matin Noori²

¹Paktia University, Agricultural Economics and Extension Department, Agriculture Faculty, Paktia, Afghanistan

² Paktia University, Forestry and Natural Resources Department, Agriculture Faculty, Paktia, Afghanistan

Abstract

Agricultural production in Afghanistan faces significant challenges due to climate change, resulting in reduced fruit production. Recently, drought, increasing temperatures, floods, erratic rainfall, and changing rainfall patterns have severely affected fruit production across the country. Farmers' perceptions of climate change impacts are important for policymakers and agricultural planners; however, they are essential but not sufficient for developing effective adaptation policies. This study aimed to investigate farmers' perceptions of climate change effects on fruit farm operations in Paktia Province, Afghanistan. A total of 271 in-person interviews were conducted across four districts of the study area. Data were collected using a structured questionnaire and a random sampling technique. Descriptive statistical analysis Chi-square tests was performed using IBM SPSS Statistics 26. The results revealed that farmers perceived drought and increasing temperatures as the major climate-related factors affecting fruit yield, fruit quality, fruit ripening, and overall fruit production. Furthermore, farmers perceived that climate change had significant pre-harvest impacts, including changes in fruit shape, colour, taste, and increased fruit drop, as well as post-harvest impacts related to fruit losses, storage, marketing, and packaging. Chi-square analysis revealed that most socio-demographic characteristics were not significantly associated with farmers' perceptions of climate change impacts, although education level showed a significant association with perceived fruit size and quality reduction due to increasing temperature. These findings highlight the need for improved climate adaptation strategies, efficient water management, and strengthened agricultural extension services to enhance the resilience of fruit production systems.

Keywords: Climate Change, Farmer, Fruit Farm, Perception, Pre-harvest, Post-harvest

Article History

Published: September 30, 2026

Accepted: August 28, 2026

Revised: August 08, 2026

Received: May 31, 2026

Cite as: Hussainkhil, M. M., & Noori, A. M. (2026). Farmers' Perceptions of Climate Change Impacts on Fruit Farming in Paktia Province, Afghanistan. *Afghan International Journal of Science*, 2(3), 351-363. DOI: <https://doi.org/10.66546/aijs.v2i3.101>

Introduction

Afghanistan is highly vulnerable to climate change (Koshani & Hamdam, 2024; Khan *et al.*, 2024; Safi, 2025). Climate change has substantial impacts on different aspects of human life, including the environment, economy, and social well-being (Khan *et al.*, 2024). The country has increasingly experienced droughts due to changes in temperature and precipitation patterns

*Email: masoomsabarnak@gmail.com (corresponding author)

Link to this article: <https://aijs.aiiu.edu.af/index.php/aijs/article/view/101>

(Khalily, 2022). Rising temperatures and variability in precipitation negatively affect food production and farmers' livelihoods (Samiappan *et al.*, 2025). In recent years, the yields of major crops have steadily decreased, mainly due to persistent drought conditions affecting agriculture (Azimi, 2024). Rising temperatures and prolonged droughts have reduced agricultural productivity (Sarfaraz *et al.*, 2025; Rafiullah, 2018). Declining precipitation levels have caused droughts, floods, unseasonal rainfall, falling groundwater tables, desertification, and biodiversity loss (Khalily, 2022). Furthermore, Afghanistan's water resources have become increasingly threatened by climate change (Nasimi *et al.*, 2021). Fruit production is one of the major agricultural subsectors in Afghanistan and is highly sensitive to climate variability, particularly during flowering, pollination, fruit setting, and harvesting stages (Bhattacharjee *et al.*, 2022; Shinwari *et al.*, 2025). Moreover, fruit crops are highly sensitive to climatic conditions during flowering, pollination, fruit setting, and harvesting stages. Variations in temperature and precipitation can reduce fruit yield and quality, increase pest and disease outbreaks, and damage orchards.

In Paktia Province, where many farmers rely on traditional farming methods and have limited access to modern agricultural technologies, the impacts of climate change are becoming increasingly severe. These environmental changes threaten household income, employment opportunities, and the long-term sustainability of fruit production systems (Safi, 2025). Fruit farming is a key agricultural activity in Paktia Province, providing income and food security for rural households. However, increasing climate variability has disrupted fruit production systems, affecting phenology, yield, and fruit quality (Deori *et al.*, 2024; Samim *et al.*, 2026).

Although previous studies have investigated the impacts of climate change on agriculture in Afghanistan, little empirical evidence is available regarding farmers' perceptions of climate change impacts on fruit farm operations in Paktia Province. To reduce the effects of climate change farmers, need adequate awareness of climate change (Gurbuz *et al.*, 2024). Most existing studies in Afghanistan have focused on general agricultural impacts without adequately addressing local experiences, adaptation practices, and operational challenges faced by fruit growers. Furthermore, farmers in Paktia Province face several constraints in adapting to climate change, including inadequate irrigation systems, limited access to climate information, financial constraints, insufficient agricultural extension services, and weak institutional support. Therefore, understanding farmers' perceptions is essential because local knowledge strongly influences adaptation decisions. Accordingly, this study aimed to investigate fruit farmers' perceptions of climate change impacts on fruit farm operations in Paktia Province, Afghanistan.

Materials and Methods

Study Area

This study was conducted in Paktia Province, located in southeastern Afghanistan. Gardez is the provincial capital, and the province shares borders with Khost, Paktika, Ghazni, Logar, and Nangarhar provinces. Four districts, namely Ahmad Aba, Gardez, Zurmat, and Said Karam, were selected for the study. The study area is located between 68°54' and 69°35' E longitude and 33°09' and 33°54' N latitude. Most local residents are engaged in agriculture and fruit

production, which are the primary sources of their livelihoods. The elevation of the study area ranges from approximately 1,800 to 3,200 m above sea level.

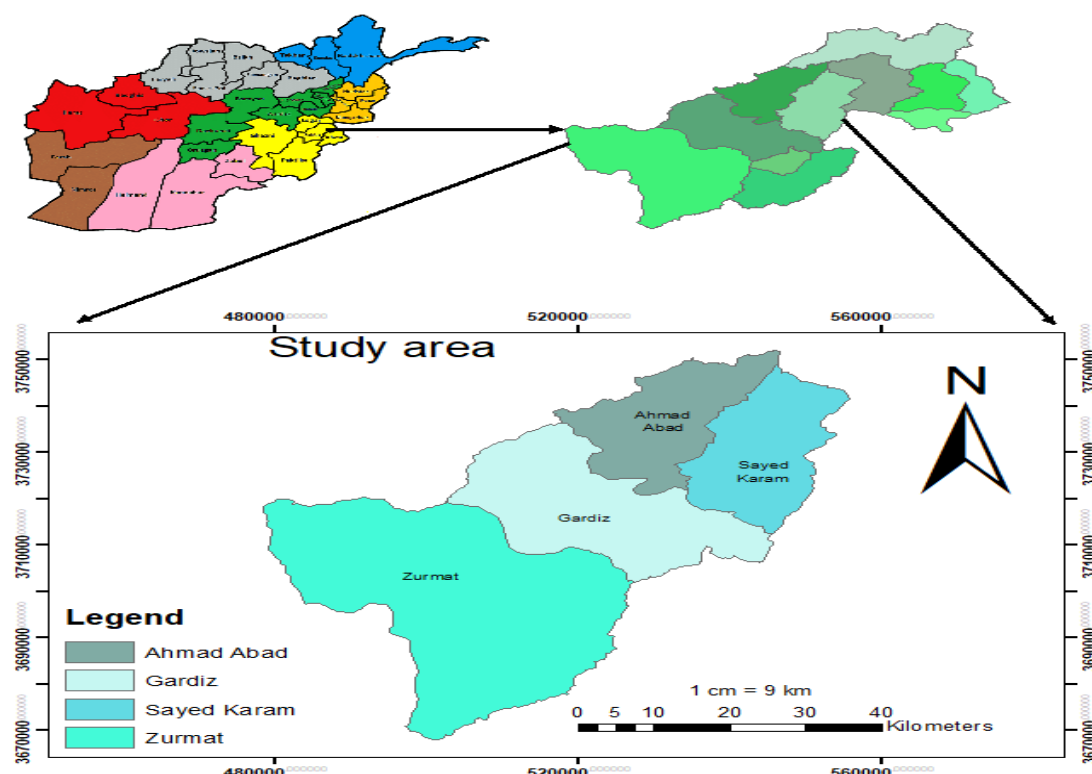


Figure 1. Map of study area

Research Design

This study adopted a descriptive-analytical research design with a quantitative approach to assess farmers' perceptions of the effects of climate change on fruit farm operations. A simple random sampling technique was used to select the study participants. A total of 271 fruit farmers participated in the survey. Primary data were collected in person interviews using a structured questionnaire. The content validity of the questionnaire was evaluated by experts in agriculture and climate change to ensure the relevance, clarity, and appropriateness of the survey items. The internal consistency of the questionnaire was assessed using Cronbach's alpha coefficient ($\alpha = 0.76$), indicating good reliability. The questionnaire comprised two sections. The first section collected respondents' socio-demographic information, whereas the second assessed farmers' perceptions of climate change impacts on fruit farm operations, including the effects of drought and increasing temperature on fruit production and pre-harvest and post-harvest activities. Farmers' perceptions were measured using a five-point Likert scale ranging from 1 (No effect) to 5 (Very high effect). The collected data were coded, entered, and analyzed using IBM SPSS Statistics version 26. Descriptive statistics, including frequencies and percentages, were used to summarize respondents' characteristics and perceptions. In addition, the Chi-square (χ^2) test was performed to examine the associations between selected categorical variables, and statistical significance was determined at $p < 0.05$.

In this study, high temperature refers to farmers' perceived increases in ambient temperature during the fruit-growing season. It represents noticeable warming compared with previous years rather than a specific temperature threshold.

Findings

Frequency distribution analysis was used to describe the demographic characteristics of respondents (Table 1). The results indicated that respondents were distributed across different age groups, with 33.9% aged between 17 and 29 years and 24.7% aged between 30 and 39 years. Approximately 32.1% of respondents were illiterate, followed by respondents with primary education (29.2%) and bachelor's degrees (11.4%).

The farming experience of respondents revealed that approximately 48.7% had between 6 and 15 years of farming experience, indicating that most farmers had considerable agricultural experience in the study area. Results regarding farm size indicated that 46.5% of respondents owned between 2 and 4 jeribs of orchard land, implying that the majority were small-scale farmers.

Regarding irrigation water sources, 42.4% of respondents used deep wells, 36.2% used karezes or springs, and 21.0% used river or canal water for irrigation. These findings suggest that farmers are highly vulnerable to climate change, particularly increasing drought and temperature.

Table 1: Demographic characteristics of respondents.

Characteristics	Categories	Frequency	Percentage (%)
Age of participants (Years)	17_29	92	33.9
	30_39	67	24.7
	40_49	50	18.5
	50_59	29	10.7
	60 and above	33	12.2
Education	Illiterate	87	32.1
	Primary Education	79	29.2
	Secondary Education	54	19.9
	Vocational Education	20	7.4
	Bachelor's degree	31	11.4
Experience (Years)	Less than 6	85	31.4
	6_15	132	48.7
	16_21	34	12.5
	22 and above	20	7.4
Farm size	less than 2	80	29.5
	2_4	126	46.5
	4.1_6	20	7.4
	6.1 and above	45	16.6
Source of water	River or Canal	57	21.0
	Deep Well	115	42.4
	Kariz or Spring	98	36.2
	Otherwise	1	0.4

During the field survey, respondents were asked about climate change impacts (Table 2). The results revealed that the majority of respondents had not received any training related to climate change (63.8%). Nearly four-fifths of respondents perceived drought as the most serious climate-related factor affecting the study area (88.2%). Furthermore, most respondents believed that fruit production had decreased during the past 10 years due to climate change (76.0%).

Regarding irrigation practices, the majority of respondents reported that the number of irrigation events had increased over the last 10 years (80.1%). In addition, 87.1% of respondents reported an increase in pests and diseases during the same period.

Table 2: *Farmers' climate change awareness and perceived climate-related changes*

Characteristics	Categories	Frequency	Percentage (%)
Training on climate change adaptation	Yes	98	36.2
	No	173	63.8
Most effected	Increasing temperature	32	11.8
	Drought	239	88.2
Fruit Production	Production has increased	29	10.7
	Production has decreased	206	76.0
	No change has occurred	25	9.2
	I don't know	11	4.1
	Yes	217	80.1
Change in the number of irrigations	No	25	9.2
	I don't know	29	10.7
Diseases or pests last (10)y	yes	236	87.1
	No	35	12.9

The study also examined the effects of increasing temperature on fruit farming (Table 3). The findings showed that Farmers perceived that increasing temperature reduced fruit yield., with respondents rating the impact as high (43.2%) and very high (32.5%). Respondents also indicated that rising temperatures contributed to early fruit ripening in the study area. Moreover, fruit size and quality were highly affected by increasing temperatures.

The results further indicated that increasing temperature was a major cause of new pests and diseases in the study area. Additionally, respondents reported increased irrigation water demand due to rising temperatures.

Table 3: *Farmer perception effects of increased temperature on fruit farm (frequency%)*

Statements	Very effect	Effect	Low effect	Very low effect	None	Total
Yield	32.5	43.2	14.4	8.1	1.8	100.0
Early ripening	25.8	35.1	18.8	15.1	5.2	100.0
Size or Quality	33.6	42.1	15.9	7.0	1.5	100.0
Pests and diseases	31.7	48.7	13.3	5.5	0.7	100.0
Water demand	30.6	50.9	12.2	4.1	2.2	100.0

The results regarding drought impacts (Table 4) indicated that irrigation demand increased significantly due to drought conditions. These findings imply that drought is a major factor contributing to declining fruit production in the study area. Furthermore, respondents reported that fruit yields were significantly reduced by drought. Soil fertility was also negatively affected

by drought conditions, which consequently increased fruit production costs and reduced fruit quality.

Moreover, respondents reported that pests and diseases increased as drought intensified in the region.

Table 4: Effects of increased drought on fruit farming (frequency%)

Statements	Very High	High	Low	Very low	None	Total
Irrigation requirements	48.0	45.0	6.6	0.0	0.4	100.0
Yield	37.6	48.7	8.1	5.2	0.4	100.0
Soil fertility	36.2	40.2	18.8	3.7	1.1	100.0
Costs	34.3	51.3	9.6	3.3	1.5	100.0
Fruit Size or Quality changes	39.9	49.4	8.1	2.2	0.4	100.0
Pests and diseases	41.0	43.2	12.5	3.3	0.0	100.0

The pre-harvest effects of drought on fruit farms are presented in Table 5. The results revealed that increasing drought had substantial impacts on fruit shape, color, taste, and premature fruit drop. Respondents also indicated that climate change had created additional marketing problems due to reduced fruit quality.

Furthermore, drought contributed to the emergence of new pests and diseases in the study area. Regarding temperature-related pre-harvest impacts, respondents reported that increasing temperatures negatively affected fruit shape and color. In addition, irrigation demand increased due to higher temperatures. Respondents also indicated that increasing temperatures contributed to the spread of pests and diseases in the region.

Table 5: Climate Change (Drought and temperature) pre-harvest impacts on fruit farm (frequency%)

	Statements	Very High	High	Low	Very low	None	Total
Drought	Shape	42.4	41.3	10.3	4.1	1.8	100.0
	Color	32.8	41.7	22.1	2.6	0.7	100.0
	Taste	33.6	41.0	11.1	12.5	1.8	100.0
	Fruits fallen	50.6	35.4	9.6	4.4	0.0	100.0
	Pests and diseases	45.0	45.0	7.7	2.2	0.0	100.0
Temperature	Shape	23.2	48.7	20.7	6.6	0.7	100.0
	Color	20.7	49.4	22.9	5.5	1.5	100.0
	Earlier ripened	34.3	33.6	17.0	12.5	2.6	100.0
	Irrigations	41.0	45.8	11.1	2.2	0.0	100.0
	Pests and diseases	30.3	55.0	8.9	5.2	0.7	100.0

The post-harvest effects of drought and temperature are presented in Table 6.

Table 6: Farmers' perceptions of the effects of drought and increasing temperature on post-harvest fruit farm operations (frequency%)

		Very High	High	low	Very low	None	Total
Drought	Statements						
	Marketing	42.8	49.1	7.4	0.4	0.4	100.0
	Fruit losses	39.1	51.7	7.0	2.2	0.0	100.0
	Grading and packaging	25.1	52.4	19.9	1.8	0.7	100.0
	Price	43.5	48.3	7.0	1.1	0.0	100.0
Temperature	Spoil	28.0	53.9	15.9	2.2	0.0	100.0

Drying and packaging	27.3	35.8	26.2	6.3	4.4	100.0
Harvesting	29.2	46.5	11.1	5.9	7.4	100.0
Fruit losses	31.4	44.6	16.6	2.2	5.2	100.0
Storage	23.2	57.2	7.7	6.3	5.5	100.0
Marketing	26.2	50.9	13.3	3.3	6.3	100.0

Respondents reported that drought affected several fruit quality attributes, including fruit shape (83.7%), color (74.5%), and taste (74.6%). Furthermore, fruit drop (86.0%) and pest and disease incidence (90.0%) were identified as major drought-related problems. Similarly, respondents indicated that rising temperatures affected fruit characteristics and production-related practices, including fruit shape (71.9%), color (70.1%), early ripening (67.9%), irrigation requirements (86.8%), and pest and disease occurrence (85.3%).

The findings presented in this study are based on farmers' perceptions and experiences rather than on direct biophysical measurements of climate variables. Therefore, the reported effects of drought and increasing temperature reflect farmers' subjective assessments, as these climatic factors often occur simultaneously under field conditions.

Table 7 presents the associations between farmers' socio-demographic characteristics and their perceived effects of increased temperature on fruit production. Education level was not significantly associated with perceptions of fruit yield reduction ($\chi^2 = 13.88$, $p = 0.608$). Likewise, no significant associations were observed between age and perceived reduction in fruit size and quality ($\chi^2 = 16.71$, $p = 0.405$) or between farming experience and perceived increases in pest and disease incidence ($\chi^2 = 15.90$, $p = 0.196$).

Table 7: Association between farmers' socio-demographic characteristics and perceived effects of increased temperature on fruit production

Variable	Category	Very high n (%)	High n (%)	Low n (%)	Very low n (%)	No effect n (%)	Total	χ^2	p-value
Education level × Fruit yield reduction	Illiterate	25 (28.7)	44 (50.6)	8 (9.2)	10 (11.5)	0 (0.0)	87	13.88	0.608
	Primary Edu	21 (26.6)	36 (45.6)	12 (15.2)	8 (10.1)	2 (2.5)	79		
	Secondary Edu	21 (38.9)	19 (35.2)	11 (20.4)	2 (3.7)	1 (1.9)	54		
	Vocational Edu	9 (45.0)	7 (35.0)	1 (5.0)	2 (10.0)	1 (5.0)	20		
	Bachelor's degree	12 (38.7)	11 (35.5)	7 (22.6)	0 (0.0)	1 (3.2)	31		
	Total	88 (32.5)	117 (43.2)	39 (14.4)	22 (8.1)	5 (1.8)	271		
Age × Fruit size/quality reduction	17–29	22 (23.9)	45 (48.9)	15 (16.3)	7 (7.6)	3 (3.3)	92	16.71	0.405
	30–39	30 (44.8)	20 (29.9)	12 (17.9)	4 (6.0)	1 (1.5)	67		
	40–49	17 (34.0)	22 (44.0)	6 (12.0)	5 (10.0)	0 (0.0)	50		
	50–59	12 (41.4)	13 (44.8)	4 (13.8)	0 (0.0)	0 (0.0)	29		
	≥60	10 (30.3)	14 (42.4)	6 (18.2)	3 (9.1)	0 (0.0)	33		
	Total	91 (33.6)	114 (42.1)	43 (15.9)	19 (7.0)	4 (1.5)	271		
Education level × Fruit size/quality reduction	Illiterate	26 (29.9)	42 (48.3)	15 (17.2)	2 (2.3)	2 (2.3)	87	26.52	0.047
	Primary Edu	37 (46.8)	24 (30.4)	9 (11.4)	9 (11.4)	0 (0.0)	79		
	Secondary Edu	15 (27.8)	27 (50.0)	8 (14.8)	4 (7.4)	0 (0.0)	54		
	Vocational Edu	2 (10.0)	11 (55.0)	5 (25.0)	1 (5.0)	1 (5.0)	20		
	Bachelor's degree	11 (35.5)	10 (32.3)	6 (19.4)	3 (9.7)	1 (3.2)	31		
	Total	91 (33.6)	114 (42.1)	43 (15.9)	19 (7.0)	4 (1.5)	271		

In contrast, education level was significantly associated with perceived reduction in fruit size and quality due to increased temperature ($\chi^2 = 26.52$, $p = 0.047$). Across all education groups, the majority of respondents rated the effect of increased temperature on fruit size and quality as high or very high, although the distribution of responses differed among education categories. Overall, the findings suggest that age and farming experience were not significantly related to farmers' perceptions of temperature-related effects on fruit production, whereas education level was associated with variations in perceptions of fruit size and quality reduction.

The Chi-square test showed no significant association between irrigation water sources and farmers' perceived drought impacts ($\chi^2 = 8.272$, $df = 6$, $p = 0.219$) (Table 8). Most farmers reported moderate drought impacts across all irrigation water sources, including river/canal (73.7%), deep well (65.2%), and kariz/spring (77.6%) users.

Table 8: Association between irrigation water sources and farmers' perceived drought impacts

Source of irrigation water	High impact n (%)	Moderate impact n (%)	Low impact n (%)	Total	χ^2	p-value
River or Canal	1 (1.8)	42 (73.7)	14 (24.6)	57	8.272	0.219
Deep Well	6 (5.2)	75 (65.2)	34 (29.6)	115		
Kariz or Spring	7 (7.1)	76 (77.6)	15 (15.3)	98		
Total	14 (5.2)	194 (71.6)	63 (23.2)	271		

Discussion

The educational distribution of respondents indicated that a considerable proportion of farmers were young and educated. This suggests that they possess relatively better awareness regarding climate change and the impacts of increasing drought and temperature. These findings are consistent with Roco *et al.* (2015) and Ogunbode *et al.* (2025), who reported a positive relationship between younger, educated farmers and climate change perception. Education plays a crucial role in shaping farmers' perceptions of climate change. The findings related to farming experience revealed that nearly half of the respondents had between 6 and 15 years of farming experience. Farming experience is often associated with improved understanding of climate-related impacts and adaptation strategies (Ricart *et al.*, 2023; Ofuoku, 2011).

Farm size distribution revealed that most farmers owned relatively small orchards in the study area. Small-scale farming systems are generally more vulnerable to climate change impacts. These findings are consistent with previous studies (Sanogo *et al.*, 2017; Mamba, 2016; Habtemariam *et al.*, 2016; Ofuoku, 2011), which reported that age, education level, and farm size significantly influence farmers' perceptions of climate change. Furthermore, the findings regarding irrigation water sources revealed that most farmers relied on deep wells and karezes or springs for irrigation. This further indicates that farmers are highly vulnerable to increasing drought in the region. The study revealed that the majority of respondents had not received any formal training related to climate change. This suggests that farmers may rely mainly on traditional approaches to cope with climate-related impacts and are therefore more vulnerable to climate change. These findings highlight the need to strengthen agricultural extension services and climate-related education programs in the study area. Farmers' perceptions also

indicated that drought is the primary climate-related factor causing water scarcity in the region. Moreover, drought was identified as a major factor contributing to declining fruit production and increased irrigation frequency during the last 10 years. These findings are consistent with Čereković *et al.* (2025). Increasing irrigation frequency raises production costs and places additional pressure on groundwater resources in the study area. These findings are consistent with Samim *et al.* (2026), who reported that climate change increases agricultural production costs. Furthermore, drought has created favourable conditions for the emergence of new pests and diseases in the region, which aligns with the findings of Tamburini *et al.* (2018).

This study focused on two major climate change factors: temperature and drought. The results revealed that Farmers perceived increasing temperature reduced fruit yield. in the study area. These findings are consistent with those reported by Reddy *et al.* (2017), Chawla *et al.* (2011), and Kumari *et al.* (2024), who found that increasing temperature negatively affects fruit yield.

The findings also indicated that rising temperatures contributed to early fruit ripening in the region. Previous studies by Haokip *et al.* (2020), Moretti *et al.* (2011), and Chawla *et al.* (2011) similarly reported negative relationships between increasing temperature and fruit quality. The present study further revealed that farmers perceived increasing temperatures to reduce fruit quality, thereby creating marketing challenges and reducing farmers' income. Respondents also perceived that higher temperature were associated with increased pest and disease incidence, consistent with the findings of Shrestha (2019). Regarding drought impacts, the study revealed that irrigation demand increased significantly under drought conditions. In addition, soil fertility declined as drought intensified. Similar findings were reported by Singh *et al.* (2018), Mondal (2021), and Imran and Ortas (2022), who found strong relationships between climate change and declining soil fertility. These conditions adversely affected fruit quality, increased production costs, and reduced fruit productivity in the study area.

This study also evaluated the pre-harvest and post-harvest impacts of drought and temperature on fruit farming in Paktia Province. The findings indicated that drought had substantial pre-harvest impacts on fruit farms, particularly affecting fruit shape, color, taste, and premature fruit drop. These findings are consistent with Devin *et al.* (2023), who reported that drought reduces fruit quality. According to Thokar *et al.* (2022), pre-harvest factors significantly influence post-harvest quality. Furthermore, drought increased the occurrence of pests and diseases in the study area. Similarly, increasing temperature negatively affected fruit shape and color. In addition, irrigation demand increased due to rising temperatures. Under hot climatic conditions, orchards require greater quantities of irrigation water.

Regarding post-harvest impacts, respondents perceived drought as a major cause of premature fruit ripening. Poor fruit quality also resulted in substantial fruit losses in the study area. Increasing drought negatively affected fruit shape and color, ultimately leading to lower market prices. Moreover, respondents reported that increasing temperatures caused fruit spoilage, drying problems, packaging issues, storage difficulties, and marketing challenges. These findings are consistent with Haokip *et al.* (2020) and Yeshiwas *et al.* (2026), who reported that temperature variations have significant post-harvest impacts on fruit production. Similarly, Stathers *et al.* (2013) reported that climate change has both pre-harvest and post-harvest impacts on agricultural production. Despite providing valuable insights into farmers' perceptions of

climate impacts, this study has some limitations. One limitation is the difficulty of distinguishing the separate effects of drought and rising temperatures based on farmers' perceptions alone. Future studies should integrate long-term climate records and crop yield data to quantify the contributions of individual climate variables.

Conclusion

The study concludes that drought and increasing temperatures were perceived as major climate-related factors affecting fruit production in the study area. Most respondents were small-scale farmers, which may increase their vulnerability to climate variability. The findings showed that socio-demographic characteristics had limited associations with perceptions of temperature-related effects. Specifically, education level was significantly associated with perceptions of fruit size and quality reduction, while no significant associations were observed between education level and fruit yield reduction, age and fruit size/quality reduction, or farming experience and pest and disease incidence. Drought was perceived as a major factor contributing to water scarcity, reduced fruit production, and increased irrigation requirements. Similarly, increasing temperatures were perceived to reduce fruit yield, accelerate fruit ripening, and decrease fruit quality, thereby affecting fruit marketability and farmers' income. Climate-related stresses were also perceived to influence both pre-harvest and post-harvest stages through changes in fruit characteristics, fruit drop, pest and disease occurrence, storage conditions, and packaging challenges. Chi-square analysis indicated that most socio-demographic characteristics were not significantly associated with farmers' perceptions of climate change impacts. However, education level showed a significant association with farmers' perceptions of fruit size and quality reduction caused by increasing temperature. Overall, the study highlights the vulnerability of fruit production systems to drought and rising temperatures and emphasizes the importance of effective water management, climate adaptation strategies, and institutional support to improve farmers' resilience under changing climatic conditions.

Acknowledgements

Authors are thankful to senior students of the department of Agricultural Economics and Extension of Paktia University for their invaluable contribution in the data collection. Also authors sincerely thank the farmers who participated in this study and provided valuable information.

Author Contributions

Mohammad Masoom Hussiankhil. conducted data analysis and contributed to manuscript preparation and writing. Abdul Matin Noori critically reviewed the manuscript and contributed to data interpretation. Both authors read and approved the final version of the manuscript.

References

Azimi, S. (2024). Effect of Climate Change on Agricultural Crops in Afghanistan. *Available at SSRN 5206214*. <http://dx.doi.org/10.2139/ssrn.5206214>

- Čereković, N., Zeljković, M. K., & Daničić, V. (2025). Understanding the response of fruit crops to drought stress and irrigation needs under climate change conditi. *AgroReS*, 14, 55-66. [10.63356/agrores.2025.007](https://doi.org/10.63356/agrores.2025.007)
- Chawla, R., Sheokand, A., Rai, M. R., & Kumar, R. (2011). Impact of climate change on fruit production and various approaches to mitigate these impacts. *Tropical Fruits*, 26.
- Deori, M., Manasa, S., Kakade, P. B., Saikanth, D. R. K., Ranganna, G., Deshmukh, R. N., & Prasad, L. (2024). A comprehensive review on the impact of climate change on fruit yield and quality in modern horticultural practices. *International Journal of Plant & Soil Science*, 36(1), 177-187. <https://doi.org/10.9734/ijpss/2024/v36i14348>.
- Devin, S. R., Prudencio, Á. S., Mahdavi, S. M. E., Rubio, M., Martínez-García, P. J., & Martínez-Gómez, P. (2023). Orchard Management and Incorporation of Biochemical and Molecular Strategies for Improving Drought Tolerance in Fruit Tree Crops. *Plants*, 12(4), 773. <https://doi.org/10.3390/plants12040773>
- Habtemariam, L. T., Gandorfer, M., Kassa, G. A., & Heissenhuber, A. (2016). Factors influencing smallholder farmers' climate change perceptions: a study from farmers in Ethiopia. *Environmental management*, 58(2), 343-358. [10.1007/s00267-016-0708-0](https://doi.org/10.1007/s00267-016-0708-0)
- Haokip, S. W., Shankar, K., & Lalrinnggheta, J. (2020). Climate change and its impact on fruit crops. *Journal of Pharmacognosy and Phytochemistry*, 9(1), 435-438.
- Imran, Amanullah, & Ortas, I. (2022). The declining trend of soil fertility with climate change and its solution. *Climate change and agriculture: Perspectives, sustainability and resilience*, 179-208. <https://doi.org/10.1002/9781119789789.ch8>
- Khalily, F. (2022). Assessment of Global Warming on Food Production in Afghanistan. *Eurasian Journal of Food Science and Technology*, 6(2), 113-119.
- Khalily, R. (2022). Evaluation of climate change on agricultural production in Afghanistan. *Eurasian Journal of Agricultural Research*, 6(2), 91-100.
- Khan, Z., Bawari, N., Wadeer, S., Niazi, M. J., Nazar, N. M., & Aftab, S. U. (2024). Chemical Perspectives on the Impact of Climate Change in Afghanistan: A Comprehensive Review. *Turkish Journal of Computer and Mathematics Education*, 15(2), 104-116. [10.61841/turcomat.v15i2.14650](https://doi.org/10.61841/turcomat.v15i2.14650)
- Koshani, B., & Hamdam, K. H. (2024). Climate Smart Agriculture Opportunities and Challenges in Afghanistan. *Journal of Natural Science Review*, 2(Special. Issue), 451-464. <https://doi.org/10.62810/jnsr.v2iSpecial.Issue.144>
- Kumari, S., Pande, K. K., Movi, S., Kumar, A., Solanki, P., Rajput, R., ... & Das, R. (2024). Climate Change Impact on Fruit Crops and Mitigation through Climate-Smart Production Practices. *Journal of Scientific Research and Reports*, 30(10), 731-738. <https://doi.org/10.9734/jsrr/2024/v30i102499>
- Mamba, S. F. (2016). Factors influencing perception of climate variability and change among smallholder farmers in Swaziland. *Indian Journal of Nutrition*, 3(2), 138-142.

- Mondal, S. (2021). Impact of climate change on soil fertility. *Climate change and the microbiome: sustenance of the ecosphere*, 551-569. [10.1007/978-3-030-76863-8_28](https://doi.org/10.1007/978-3-030-76863-8_28)
- Moretti, C. Á., Mattos, L. M., Calbo, A. G., & Sargent, S. A. (2010). Climate changes and potential impacts on postharvest quality of fruit and vegetable crops: A review. *Food Research International*, 43(7), 1824-1832. <http://dx.doi.org/10.1016/j.foodres.2009.10.013>
- Nasimi, M. N., Sagin, J., & Wijesekera, N. T. S. (2021). *Climate and Water Resources Variation in Afghanistan and the Need for Urgent Adaptation Measures*. July. [10.26855/er.2020.02.009](https://doi.org/10.26855/er.2020.02.009)
- Ofuoku, A. U. (2011). RURAL FARMERS' PERCEPTION OF CLIMATE CHANGE IN CENTRAL AGRICULTURAL ZONE OF DELTA STATE, NIGERIA. *Indonesian Journal of Agricultural Science*, 12(2), 63-69. [10.21082/ijas.v12n2.2011.63-69](https://doi.org/10.21082/ijas.v12n2.2011.63-69)
- Ogunbode, T. O., Esan, V. I., Ayegboyin, M. H., Ogunlaran, O. M., Sangoyomi, E. T., & Akande, J. A. (2025). Analysis of farmers' perceptions on sustainable sweet orange farming in nigeria amid climate change. *Scientific Reports*, 15(1), 5205. <https://doi.org/10.1038/s41598-025-90056-6>
- Rafiullah, N. (2018). Signs of climate change in Afghanistan: drought and its effect on agriculture. *Региональные проблемы*, 21(3-1), 75-81. [10.31433/1605-220X-2018-21-3\(1\)-75-81](https://doi.org/10.31433/1605-220X-2018-21-3(1)-75-81)
- Reddy, A. G. K., Kumar, J. S., Maruthi, V., Venkatasubbaiah, K., & Rao, C. S. (2017). Fruit production under climate changing scenario in India: a review. *Environment and Ecology*, 35(2B), 1010-1017.
- Ricart, S., Gandolfi, C., & Castelletti, A. (2023). Climate change awareness, perceived impacts, and adaptation from farmers' experience and behavior: a triple-loop review. *Regional Environmental Change*, 23(3), 82. <https://doi.org/10.1007/s10113-023-02078-3>
- Roco, L., Engler, A., Bravo-Ureta, B. E., & Jara-Rojas, R. (2015). Farmers' perception of climate change in mediterranean Chile. *Regional environmental change*, 15(5), 867-879. <http://dx.doi.org/10.1007/s10113-014-0669-x>
- Safi, L. (2025). Assessment of the vulnerability of orchard farmers to climate change in the central highlands of Afghanistan. *Theoretical and Applied Climatology*, 156(12), 687. [10.1007/s00704-025-05915-z](https://doi.org/10.1007/s00704-025-05915-z)
- Samiappan, S., Sarwary, M., Venkatachalam, S., Shinwari, E., Sembanan, K., Poornalingam, J., ... & Kathiravan, S. (2025). Determinants of Farmers' Strategies for Adaptation to Climate Change in Agricultural Production in Afghanistan. *World*, 6(2), 59. <https://doi.org/10.3390/world6020059>
- Samim, S. A., Nabizada, A. Q., Khail, M. H., Hu, Z., & Stepien, S. (2026). The Impact of Climatic Variables on Food Production in Afghanistan: The Role of Green Energy. *Climate*, 14(5), 94. <https://doi.org/10.3390/cli14050094>

- Sanogo, K., Binam, J., Bayala, J., Villamor, G. B., Kalinganire, A., & Dodiomon, S. (2017). Farmers' perceptions of climate change impacts on ecosystem services delivery of parklands in southern Mali. *Agroforestry systems*, 91(2), 345-361.
https://doi.org/10.1007/s10457-016-9933-z?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle
- Sarfaraz, M. Y., Hakimi, M. P., & Achak, J. (2025). Global Warming and Its Impact on Rural Livelihood in Afghanistan: Challenges, Opportunities, and Pathways for Sustainable Development. *Journal of Environment, Climate, and Ecology*, 2(1), 20-28.
<https://doi.org/10.69739/jece.v2i1.256>
- Shrestha, S. (2019). Effects of climate change in agricultural insect pest. *Acta Scientific Agriculture*, 3(12), 74-80. <https://doi.org/10.31080/ASAG.2019.03.0727>
- Tamburini, G., van Gils, S., Kos, M., van Der Putten, W., & Marini, L. (2018). Drought and soil fertility modify fertilization effects on aphid performance in wheat. *Basic and Applied Ecology*, 30, 23-31. <https://doi.org/10.1016/j.baae.2018.05.010>
- Thokar, N., Kattel, D., & Subedi, S. (2022). Effect of pre-harvest factors on postharvest quality of horticultural products. *Food Agri Econ. Rev*, 2, 92-95.
<http://doi.org/10.26480/faer.02.2022.92.95>
- Yeshiwas, Y., Tadele, E., Mohammed, A., & Hu, X. (2026). Impacts of climate change on horticultural systems with focus on socio-economic implications, production and postharvest challenges, and adaptive pathways. *Discover Environment*, 4(1), 55.
https://doi.org/10.1007/s44274-026-00539-0?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle