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# Exploring climate change vulnerability and adaptation among smallholder farmers in Nangarhar, Afghanistan: A social-ecological systems perspective

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**Abstract:** Climate change vulnerability and adaptation strategies for smallholder farmers in Afghanistan are critical issues that require urgent attention from national, regional, and global climate-savvy stakeholders. This study investigates the climate change perception and adaptation strategies of smallholder farmers in Nangarhar province, utilizing the social-ecological systems perspective. The study employs a qualitative research design, conducting 11 semi-structured interviews with smallholder farmers to explore their lived experience about climate change, adaptation challenges, and indigenous coping strategies. The study used thematic analysis to examine the collected data. The analysis revealed several key themes that emerged from the data, namely climate change perception, adaptation challenges, indigenous coping strategies, government support and intervention, crop-specific impact, economic impact and livelihood, information sources and communication channels, and concerns about floods. The study highlights the challenges faced by farmers, including difficulties in crop production, limited access to quality inputs, and the adverse effects of drought on agricultural productivity. The findings underscore the importance of developing effective adaptation strategies to mitigate the adverse effects of climate change on the agricultural sector and the livelihoods of smallholder farmers in Afghanistan. The study contributes to the understanding of the vulnerability of smallholder farmers to climate change and the importance of enhancing their adaptive capacity, with a specific focus on conflict-affected agrarian regions like Afghanistan.

**Keywords:** adaptation challenges; climate change perception; indigenous coping strategies; smallholder farmers; social-ecological systems perspective

## 1. Introduction

The agricultural sector plays a crucial role in Afghanistan's economy [1], accounting for around 22% of the Gross Domestic Product (GDP) of the country [2], thereby contributing to the overall welfare of the Afghan population [3]. However, smallholder farmers, who dominate the agriculture sector, have experienced reduced rainfall and prolonged drought, leading to a substantial deterioration in living standards [4]. Smallholder farmers have been defined as small-scale farmers, forest keepers, and fishers who manage areas that are often around one to ten hectares. Smallholders are traditionally characterized by family-focused motives such as favoring the stability of the farm household system, using mainly family labor for production, and using part of the produce for daily family consumption [5,6].

According to Sarwary et al. [7], Afghanistan frequently faces drought and other climate change-related challenges due to rising temperatures and decreased precipitation in many areas of the country. On a similar note, Jawid and Khadjavi [8] have reported that the vulnerability of smallholder farmers to climate change is a significant challenge in Afghanistan. Therefore, the World Bank's Environment, Health, and Safety Guidelines (EHSGs) highlight the need to address climate change adaptation in Afghanistan, particularly in the agriculture sector [4]. According to the study of Aliyar et al. [9], the major challenges of Afghan agriculture include reduction of water availability, mismanagement of water use, and unsustainable food production. Overall, the effects of climate change, such as changes in rainfall variability, increasing number of seasons without enough rainfall, and increased temperatures, lead to extensive droughts and heat stress, lowering crop productivity [10,11]. Despite the growing awareness about the need for enhancing climate resilience among the farm families of developing countries, little is known about the factors that influence their resilience to climate change [12].

Consistent with the Social-Ecological Systems (SES) perspective, adaptation to climate change is context-specific and can be affected by natural, human, and socio-economic factors [13]. Therefore, to investigate the complementary choices of farm families for adaptation, more attention should be paid to the local realities and socio-economic contexts [12]. Moreover, there is a dearth of literature on climate-related hazards and specifically droughts in Afghanistan. Perceptions of farmers about climate change, drought severity, and adaptation strategies have rarely been explored in Afghanistan [9].

The study contributes to enriching the existing knowledge about the vulnerability profiles of smallholder farmers due to climate change using the Intergovernmental Panel on Climate Change (IPCC) framework. Additionally, within the framework of the Sustainable Development Goals (SDGs) set by the United Nations, this study, as an academic initiative, aligns with the objectives of SDG 2 that focuses on *zero hunger* and echoes more prominently with the aspirations of SDG 13, which deals with *climate action* [7]. This study aims to provide insights into the vulnerability of smallholder farmers to climate change, the importance of enhancing their adaptive capacity, and the role of various stakeholders in addressing climate change adaptation in fragile contexts like Afghanistan.

## 2. Literature review

Exploring a broader picture is crucial for understanding a specific region like Nangarhar. Therefore, we review some research studies that have investigated the phenomenon of climate change and the resilience of farmers in similar settings such as Ethiopia, Saudi Arabia, Nepal, Afghanistan, and Pakistan [14–18]. By synthesizing findings from these diverse studies, we aim to establish a comprehensive understanding of climate-related challenges and adaptive strategies. In addition, understanding the perception of climate change among these farmers is crucial for comprehending their real-life experiences and the observed alterations in weather patterns. Smallholder farmers in many least developed and developing countries have been adapting their farming practices in response to climate change, as noted by

Khanal et al. [18], where Afghanistan is not an exception. However, the widespread poverty, particularly among farmers in Afghanistan, hinders the effectiveness of these autonomous adjustments in addressing the current and future consequences of climate change and extreme weather events [19,20].

Worldwide, and notably in agriculturally least developed regions, extensive research has delved into the phenomenon of climate change. For example, investigations in Ethiopia and Saudi Arabia have found that farmers attribute climate change to anthropogenic activities that have potential contributions to drought, insects, crop diseases, and heat stress [14,15]. The lack of information was identified as a significant obstacle to climate change adaptation in these contexts, emphasizing the importance of awareness among farmers [15]. In Afghanistan, a war-affected country, smallholder farmers also experience similar challenges in adapting to climate change, influenced by socio-economic factors and resource access. High vulnerability of crop yields and the livelihoods of farmers is evident due to weather extremities and limited resources for adaptation [8]. Moreover, the lack of knowledge about adaptation practices and inadequate government and financial support further compound these challenges [14]. To sustain agriculture and enhance community resilience amid climate changes, smallholder farmers in Afghanistan employ traditional knowledge and coping mechanisms [7]. Correspondingly, in Afghanistan, changing cropping patterns, drilling new bore wells, farm diversification, reducing irrigations, and adopting water-saving technologies are recognized as crucial coping strategies [7]. However, the necessity of localized adaptation strategies is emphasized, with variations between rainfed and irrigated areas [9].

Regarding adaptive measures for climate change, a study conducted in the KPK region of Pakistan unveiled that farm households implement significant adaptive measures on their farms. These measures included altering crop varieties, diversifying crops, adjusting the crop calendar, and obtaining crop insurance [16]. Additionally, in the agricultural context of Afghanistan, where poverty prevails among farmers, collaborative efforts from various organizations as well as national, regional, and international leaders are essential to fortify adaptive measures and mitigate the adverse impacts of climate change on smallholder farmers. Thus, the extensive review of existing literature and studies across various developing and least developed countries has all emphasized improved indigenous and localized adaptation strategies, enhanced knowledge dissemination, and increased government and financial support to address the diverse challenges posed by climate change in the region. Likewise, the study at hand has devoted a separate section to some practical recommendations targeting various stakeholders to consider context-specific climate change dynamics.

### **3. Theoretical orientation of the study**

The social-ecological systems framework proposed by Ostrom [21] has been used as a theoretical lens for this study. This framework is particularly relevant in studying how smallholder farmers perceive and respond to climate change as it considers the interplay of ecological, economic, and social factors. The SES framework is arguably the most comprehensive framework for diagnosing interactions and outcomes in social-ecological systems [22]. Moreover, this framework assumes that the

interactions between social and ecological systems are complex and dynamic. It recognizes that human activities and institutions are deeply interconnected with the environment and that these interactions shape the capacity of systems to adapt to and cope with environmental changes, such as those associated with climate change. Based on this framework, this study assumes that the resilience and sustainability of social-ecological systems are contingent upon the ability of actors within these systems to manage resources and respond to climate changes in ways that are both practical and effective [21].

### 3.1. Climate change vulnerability profile of Nangarhar

Nangarhar, an eastern province of Afghanistan, is characterized by a subtropical steppe climate (BSh classification), offering a unique environmental backdrop for the exploration of climate change impacts on smallholder farmers (see **Table 1**). Positioned at an elevation of 826.26 m (2710.83 feet) above sea level, Nangarhar experiences an annual average temperature of 21.75 °C (71.15 °F), slightly surpassing Afghanistan's typical averages. The climate is notably arid, with an annual precipitation of 20.43 mm (0.8 inches) distributed over 61.26 rainy days, constituting approximately 16.78% of the year [23].

According to the database of Weather and Climate [23], the warmest month, July, sees temperatures reaching 36.54 °C (97.77 °F), while January stands as the coldest month with temperatures dropping to 3.13 °C (37.63 °F). August claims the title of the wettest month, receiving 40.11 mm (1.58 in) of precipitation, while December holds the distinction of being the driest, with only 6.81 mm (0.27 in). With an insightful look into these climatic data, the susceptibility of the province to extreme weather events, marked by 83.22% of days with no rain, heightens the risk of water scarcity for agriculture. Addressing these climatic challenges is imperative to sustaining agriculture in Nangarhar amid changing climate conditions.

**Table 1.** Quantitative climate and agricultural data for Nangarhar province, Afghanistan.

Attribute	Description	Value
<i>Geographic Location</i>	Latitude	34°26' N
	Longitude	70°28' E
<i>Elevation</i>	Elevation above sea level	599 m
<i>Total Area</i>	Total area of Nangarhar	7916 km <sup>2</sup>
<i>Agricultural Area</i>	Irrigated land	150,000 hectares
	Dry land	34,000 hectares
	Total cultivated area	129,090 hectares
	Primary crop focus area (13 main crops)	124,294 hectares
<i>Climate</i>	Climate classification	Subtropical steppe (BSh)
	Average annual temperature	21.75 °C
	Average summer temperature	45 °C
	Average winter temperature	2 °C
	Total annual precipitation	20.43 mm

**Table 1. (Continued).**

Attribute	Description	Value
<i>Monthly Climate Extremes</i>	Number of rainy days annually	61 days
	Hottest month (July)-Avg. temperature	36.54 °C
	Coldest month (January)-Avg. temperature	3.13 °C
	Wettest month (August)-Avg. precipitation	40.11 mm
<i>Water Scarcity</i>	Driest month (December)-Avg. precipitation	6.81 mm
	Percentage of year with no rain	83.22%

Source: Data from Weather and Climate (2023), and Rasikh, Joolaie, Keramatzadeh, Mirkarimi, (2024).

### 3.2. Socioeconomic factors influencing farmers' adaptation to climate change

Integrating an analysis of socioeconomic factors is essential for understanding the multifaceted challenges farmers face when adapting to climate change. Key elements such as income levels, land ownership, and educational attainment significantly influence both the vulnerability of farmers and their adaptive capacity. Income levels, for instance, determine farmers' access to necessary resources and technologies, impacting their ability to adopt new practices that mitigate climate-related risks. Land ownership also plays a crucial role, as those who own their land may be more inclined to invest in sustainable farming practices than those who lease or lack secure land tenure.

Education further shapes farmers' adaptive capacity by influencing their awareness of climate change and access to information on adaptive techniques. Higher education levels often correlate with an increased ability to understand and implement effective adaptation strategies, such as crop diversification or soil conservation practices. By examining these socioeconomic factors, we can uncover critical insights that enable more targeted interventions, tailored to meet the specific needs and constraints of different farmer groups. Ultimately, this approach can contribute to designing policies and programs that are both equitable and effective in enhancing climate resilience across various agricultural communities.

Although our study does not focus on conducting a detailed analysis of socioeconomic factors such as income levels, land ownership, and education, these elements could critically shape farmers' vulnerability to climate change and adaptive capacity. Future research may benefit from exploring how these socioeconomic dimensions affect farmers' adaptation strategies, which could inform more tailored and effective intervention efforts.

We acknowledge the importance of investigating gender-specific vulnerabilities and adaptation strategies; however, in Afghanistan, especially within the study area of Nangarhar, agricultural work is overwhelmingly performed by men, with very limited involvement from women. This limited female participation in agricultural activities reflects both cultural and religious norms. Additionally, these same cultural factors make it nearly impossible to conduct interviews or collect data from female participants. Consequently, our study does not include gender-based insights into adaptation strategies and vulnerabilities. Future studies in contexts where female

participation in agriculture is more prominent may provide valuable perspectives on this issue.

#### **4. Research design and methods**

This study employs qualitative research design using an interpretive phenomenological approach to investigate smallholder farmers' experiences in Nangarhar province regarding climate change and coping strategies. Phenomenology, a qualitative methodology, centers on the examination of human experiences within specific groups [24,25]. In the context of this study, adopting phenomenology as a qualitative methodology entails exploring the shared meanings of smallholder farmers through their lived experiences regarding climate change. This approach involves capturing the essence of their subjective encounters [24,26] with climatic variations and understanding the ways in which they perceive and adapt to these changes.

A purposive sampling strategy has been used to target actively engaged farmers with at least five years of residence and farming experience with the condition of having small farming land. The study excluded non-farmers and those with limited experience as well as those having large-scale farming land. Eleven semi-structured interviews, guided by inclusion and exclusion criteria, were conducted until data saturation was achieved. Privacy was prioritized in private interview settings, where audio recordings were securely stored and were later transcribed for analysis. This methodological rigor aims to explore the shared meaning of how farmers perceive, adapt to, and cope with climate change impacts on agriculture and livelihoods.

Participants were selected within an age range of 25 to 65 to capture generational differences in adaptive strategies. A minimum of primary education was required to ensure a diverse range of educational backgrounds, allowing an analysis of how education influenced access to adaptation knowledge. The study focused on small-scale farmers with household incomes around \$500 and \$2000 and land sizes under five hectares to understand the unique resource limitations of low-income farmers. Additionally, participants had at least five years of farming experience and continuous residency in the region, ensuring familiarity with local climate variations.

#### **5. Data analysis**

Employing a thematic analysis approach guided by Braun and Clark's six steps [27], Stirling's framework [28], and Creswell's recommendations [24], this study explores interview data to unveil and scrutinize significant themes related to the experience of smallholder farmers with climate change in Nangarhar province. NVivo 12, as data management software for qualitative data, facilitated the analysis, particularly the coding process. This approach organized data and provided clear, brief descriptions of each coding type, connecting them to broader theoretical concepts in qualitative data analysis.

Moreover, the thematic analysis process involves transcribing and systematically examining interview excerpts from participants of the study relevant to the experiences of the challenges and coping strategies associated with climate change. The identified themes encompass perceptions and experiences of climate change, challenges in



and *concerns about floods*. Each of these themes is further elucidated by participant verbatim excerpts to support each theme with the participants’ views.

**Figure 2** provides a visual representation of the main findings from this research, and the proceeding section describes each of the emerging themes of the study. **Tables 2–9** provide a visual summary of the main findings or themes of the study, which are discussed next.



**Figure 2.** Key themes emerged from the data.

**Theme 1: Climate change perception**

Participants across various districts have expressed awareness of climate change to a certain extent in their own way. For instance, according to Participant 6, “*This year, we experienced intense heat and little rainfall, causing significant damage. We usually hear about such changes from the radio, where they announce whether it is a year of drought or abundant rainfall.*” Meanwhile, the statement of Participant 3 reflects a broader acknowledgment of the challenges posed by climate change on a national scale as he stated that “*Afghanistan is facing climate change, causing losses for many farmers.*”

**Table 2.** Climate change perception.

Key Point	Participant Quote
Awareness of changing weather patterns	“This year, we experienced intense heat and little rainfall, causing significant damage...”—Participant 6
National-level climate impact	“Afghanistan is facing climate change, causing losses for many farmers.”—Participant 3

**Theme 2: Adaptation challenges**

Adaptation strategies varied among the participants of the study, where Participant 2 highlighted the limited available options: “*The only method we have is to replant the same crop after rain or storms. However, the yield is not the same as that of the winter crop.*” Economic stability was identified as crucial, as expressed by

Participant 9: *“Economic stability plays a crucial role. If one’s economic situation is sound, the impact of rain and other climate change-related disasters is less harmful.”*

To support the above statement, Participant 3 expressed his feeling about how being financially poor makes it hard for farmers to get the things they need to deal with climate change and make their crops better. He shared that, *“Unfortunately, due to poverty, farmers lack the necessary tools and resources to adapt to climate change and improve their harvests.”* This means that because they do not have much money, it is tough for farmers to do things to protect their crops from changing weather.

**Table 3.** Adaptation challenges.

Key Point	Participant Quote
Limited adaptation strategies	“The only method we have is to replant the same crop...”—Participant 2
Economic barriers to adaptation	“Due to poverty, farmers lack the necessary tools and resources...”—Participant 3
Insufficient support during crop seasons	“The Agriculture Promotion office provides limited support, but the quality is poor.”—Participant 5
Absence of government support	“No, there has been no government support in this area yet.”—Participant 8

Also, Participant 5 and Participant 8 discussed how there is not enough help for farmers. Participant 5 stated, *“During the season of tomatoes, the Agriculture Promotion office provides limited support, but the quality is poor.”* This means that when it is time to grow tomatoes, the office that is supposed to help farmers does not give them enough good help. Participant 8 agrees, saying, *“No, there has been no government support in this area yet.”* This shows that the government has not given the support needed to farmers in their area.

**Theme 3: Indigenous Coping Strategies**

The farmers elucidate a reliance on limited support, particularly during specific crop seasons, such as tomatoes. The farmers shared experiences of purchasing market-bought medicines but expressed dissatisfaction with their effectiveness. The participants further reflect on changes in traditional practices, noting the difficulty in applying home remedies like ashes for soil amendment or pest control.

*“During the season of tomatoes.....we sometimes buy medicines from the market, but they don’t work well. Before, we used home remedies like ashes, “a form of soil amendment or pest control”, but now it is harder because there are different crops and diseases, and they get sick quickly.”* (Participant 5)

Likewise, Participant 10 from Nangarhar Province mentioned the use of medicines with varying effectiveness: *“We use some medicines, but their effectiveness varies.”* He further argued that *“I planted Mung bean (green gram) because it needs less water during the drought. We also grow other crops that require less water, but there is still not enough water overall”* (Participant 10). So, the time-tested generational remedies are how smallholder farmers cope with climate change-related issues.

**Table 4.** Indigenous coping strategies.

Key Point	Participant Quote
Reliance on local remedies	“We used home remedies like ashes, but now it is harder...”—Participant 5
Use of water-efficient crops	“I planted Mung bean...we also grow other crops that require less water...”—Participant 10

**Theme 4: Government Support and Intervention**

While government collaboration was expected, Participant 1 expressed disappointment: “So far, we have not received any support or collaboration from the government concerning our farming activities” (Participant 1). Lack of government aid was reiterated by Participant 8 as well. He stated that:

*“Our only option is to bring medicines, but they are not very effective. We request timely support from the government, especially the Ministry of Agriculture, for seeds and medicines..... Unfortunately, the assistance often arrives late, such as improved seeds reaching us two or three months after the wheat crop season has passed. We hope for timely support to ensure a continuous supply of vegetables to the people”* (Participant 8).

**Table 5.** Government support and intervention.

Key Point	Participant Quote
Lack of government assistance	“We have not received any support from the government...”—Participant 1
Delayed government aid	“Improved seeds often arrive two or three months late...”—Participant 8

**Theme 5: Crop-specific Impacts**

Concerns about crop yield were raised by Participant 2, emphasizing challenges during adverse weather conditions: “when our crops get damaged by hail or storms, we wait for better weather to replant the same crop. However, the yield is not as good as the winter crop”. This highlights the vulnerability of crops to climatic changes (Participant 2). Similarly, another participant has shared his view about water inadequacies as having an impact on their crops, as he stated that “I planted Mung bean (green gram) because it needs less water during the drought. We also grow other crops that require less water, but there is still not enough water overall” (Participant 10).

**Table 6.** Crop-specific impacts.

Key Point	Participant Quote
Impact of adverse weather on crops	“When crops get damaged by hail or storms, the yield is not the same...”—Participant 2
Choosing drought-resistant crops	“I planted Mung bean because it needs less water during drought.”—Participant 10

**Theme 6: Economic Impact and Livelihood**

Across the multiple participants’ views, economic challenges were a recurring theme. Farmers, such as Participant 1, highlighted the minimal economic resources

available for cultivating vegetables. He added that *“Cultivating vegetables requires minimal expenses, and our economic conditions are quite challenging”*. Despite facing climate-related difficulties, like water scarcity, Participant 2 stated that *“No one has shared advice with us..... we haven’t received help in addressing climate change.”* Many participants expressed a lack of government advice and support, exacerbating economic challenges.

**Table 7.** Economic impact and livelihood.

Key Point	Participant Quote
Financial limitations on crop cultivation	<i>“Cultivating vegetables requires minimal expenses, and our economic conditions are challenging.”</i> —Participant 1
Economic burden without support	<i>“No one has shared advice with us...”</i> —Participant 2
High expenses for landless farmers	<i>“Many people here do not own their land and face significant expenses...”</i> —Participant 7

The consequences of climate change can lead to crop loss, as described by Participant 5 as *“We request timely support from the government, especially the Ministry of Agriculture, for seeds and medicines”* highlighting the economic strains on farmers who rely on timely government assistance for seeds and medicines. Participant 7 also acknowledged the economic difficulty of the smallholder farmers as he noted, *“Many people here do not own their land and face significant expenses for fertilizers and seeds.”* Thus, economic instability emerged as a crucial factor in mitigating the adverse effects of climate change, as echoed by Participant 9.

**Theme 7: Information Sources and Communication Channels**

Smallholder farmers in Nangarhar heavily rely on limited information sources to hear about the complexities of weather changes and climate-related challenges. Local FM radio channels emerge as a pivotal medium, providing some updates on climate conditions, seasonal shifts, and potential agricultural threats. Furthermore, farmers value direct interactions with experienced peers who share insights during field visits, enriching their understanding and decision-making in crop cultivation, protection, and adaptation. One of the participants stated that: *“We sometimes listen to the radio, but we do not rely solely on it.....If a knowledgeable farmer visits us, we can gain a lot from their advice”* (Participant 1).

**Table 8.** Information sources and communication channels.

Key Point	Participant Quote
Reliance on local FM radio	<i>“We sometimes listen to the radio, but we do not rely solely on it...”</i> —Participant 1
Peer support in knowledge sharing	<i>“If a knowledgeable farmer visits us, we can gain a lot from their advice.”</i> —Participant 1

**Theme 8: Concerns about Floods**

Floods were identified as a significant threat, impacting both land and communities. Participant 10 highlighted the damage caused by floods, stating, *“Floods cause substantial damage to our land and the harvest.”* Another participant confirmed the view by saying that, *“We grow corn, cauliflower, cabbage..... I*

*cultivate a variety of vegetables. Unfortunately, this time, heavy rain and hail leading to flooding have severely impacted our vegetables.*”

**Table 9.** Concerns about floods.

Key Point	Participant Quote
Flooding as a major threat	“Floods cause substantial damage to our land and the harvest.”—Participant 10
Crop loss due to heavy rain	“Heavy rain and hail leading to flooding have severely impacted our vegetables.”—Anonymous

## 7. Discussion/analysis

The findings of the study offer a holistic understanding of the multifaceted challenges faced by smallholder farmers in Nangarhar from the perspective of the social-ecological systems framework. Considering the SES framework, our study found certain social and ecological drivers that have jointly contributed to the challenges associated with climate change. The first theme illuminates a pervasive awareness of climate change, with participants recognizing the immediate impacts on weather patterns and the broader consequences for farmers. Moreover, the second theme underlines the adaptation strategies employed, revealing the limitations faced by farmers, particularly in terms of economic stability. Indigenous coping strategies, highlighted in the third theme, demonstrate the reliance on limited support and the variable effectiveness of available measures.

Unfortunately, the fourth theme reveals that the government provides little support, highlighting a disconnect between expectations and reality. Crop-specific impacts, as depicted in the fifth theme, underscore the vulnerability of agricultural practices to climatic changes. Economic and financial constraints, a recurrent concern in the sixth theme, reinforce the pivotal role of financial stability in mitigating climate-induced adversities.

Moreover, the seventh theme highlights the pivotal role of information sources, with radio and direct interactions serving as crucial channels for navigating climate complexities. Lastly, the eighth theme emphasizes the significant threat posed by floods, focusing on the tangible and pervasive damages to both land and communities. Collectively, these findings paint a comprehensive picture of the intricate web of challenges faced by smallholder farmers in Nangarhar, calling for targeted interventions, policy reforms, and collaborative efforts among local, national, regional, and global stakeholders to build resilience and sustainable agricultural practices in the face of climate change.

The key themes that emerged from the study are consistent with the existing literature on climate change vulnerability and adaptation strategies for smallholder farmers in similar contexts. The awareness of participants regarding climate change and its impact on agriculture and livelihoods aligns with findings from other studies. For instance, farmers in Yangi Qala District, Takhar, Afghanistan, perceived changes in the climate of their region in terms of warming and/or a decrease in rainfall, which is consistent with the observed changes in weather patterns reported by the participants in Nangarhar [8,17,29,30]. Additionally, the broader impact of climate change on Afghan farmers, causing losses and reduced crop yields, is a shared concern among

smallholder farmers in various regions [7,16,29]. The adaptation challenges faced by smallholder farmers in Nangarhar, such as limited options for replanting and the crucial role of economic stability, are also reflected in the existing literature. Similar studies in Ethiopia, Afghanistan, and Pakistan, as developing countries, have highlighted the limited resources for adaptation and the importance of economic stability in mitigating the adverse effects of climate change on the livelihoods of smallholder farmers [9,15,17].

The reliance on indigenous coping strategies, such as limited support during specific crop seasons, crop variations, and the use of traditional medicines, is consistent with the localized adaptation strategies employed by smallholder farmers in response to climate change in Afghanistan and other similar contexts [7,9,16]. Furthermore, the lack of government support and intervention reported by the participants in Nangarhar is a recurring theme in the literature. In a similar vein, some studies have identified poor government and financial support as major obstacles to climate change adaptation in various agro-climatic zones, emphasizing the need for enhanced government collaboration and support [9,30]. The concerns about floods, economic impact, and livelihood challenges, as well as the long-term commitment to agriculture, are also consistent with the broader literature on climate change vulnerability and adaptation strategies for smallholder farmers in Afghanistan and other similar regions [7,29]. Thus, the shared concerns and challenges faced by smallholder farmers in Nangarhar highlight the need for localized adaptation strategies, improved government support, and enhanced economic stability to address the multifaceted impacts of climate change on smallholder farmers in the region.

## 8. Recommendations for various stakeholders

As shown by empirical studies, depending on the needs of the situation, Afghan leaders can be highly cooperative (since they are socialized with the concept of “guzaara”/getting along) and tend to score high on relationship-orientation [31–34] as well as on task-orientation elements of leadership [35] to bring relevant changes to their nation. It is clear to most individuals in Afghanistan that dealing with and adapting to climate change is a necessity for Afghans, but they need resources, know-how, and guidance from experts, their government, and the international community through innovative leadership practices and interventions [36]. Since much of the Afghan population are agrarians and live in poverty, corruption can easily become endemic throughout the public sector [6]. As such, monitoring and reporting structures should be transparent amid ongoing government and international efforts to help Afghan farmers effectively deal with the ups and downs of climate change. Based on the findings of the study, several recommendations can be proposed targeting various stakeholders:

- **Government and Policy Makers:** Considering the significant role of smallholder farmers in the agricultural landscape of Afghanistan, government and policy makers are urged to enhance collaboration and support mechanisms for smallholder farmers, specifically focusing on climate adaptation. Additionally, policymakers should implement policies that provide financial aid to farmers, particularly during adverse weather conditions. Furthermore, efforts should be

directed towards strengthening climate-smart agricultural practices to ensure the sustainability of agricultural endeavors.

- **Agricultural Extension Services:** Agricultural extension services play a pivotal role in climate change adaptation. It is recommended that these services provide targeted training on diverse climate change adaptation strategies that are presently missing based on the findings of this study. Workshops should be conducted to impart knowledge on indigenous coping strategies and the effective use of medicine for agricultural purposes, thereby enhancing the resilience of farmers facing the impacts of climate change.
- **Non-Governmental Organizations (NGOs):** NGOs are encouraged to actively collaborate on climate resilience projects within local communities. Additionally, advocacy efforts should be intensified to ensure that farmers have equitable access to government aid and resources, fostering a supportive environment for sustainable agricultural practices.
- **Educational Institutions:** Educational institutions are called upon to contribute to climate resilience by developing and offering educational programs focused on climate-resilient farming practices. Furthermore, these institutions should engage in research initiatives to identify innovative solutions and technologies that promote sustainability in agriculture.
- **Community Leaders and Farmer Groups:** Community leaders and farmer groups are vital in fostering community ties for effective knowledge-sharing and mutual support. It is recommended that these leaders and groups advocate for the inclusion of local perspectives in the development of climate change policies to ensure their relevance and effectiveness.
- **International Agencies:** International agencies should prioritize supporting projects that address the specific challenges faced by smallholder farmers in regions such as Nangarhar. Moreover, these agencies should facilitate knowledge exchange initiatives among farmers in similar climatic zones to promote effective strategies for climate change adaptation.

Afghan farmers should continue making good use of traditional best practices. Afghanistan's agriculture relies on deep-rooted indigenous practices and cultural adaptations that offer sustainable, low-cost strategies to tackle climate change and economic challenges [37]. Historically, Afghan farmers have used techniques like the Karez (natural spring water) irrigation system, an ancient underground canal network that conserves water and enhances soil fertility, showing adaptability to arid conditions [38]. Culturally embedded practices also promote biodiversity as farmers grow varied crops such as wheat, barley, and pulses to manage climate and market risks. These traditional crops, often more resistant to local pests, provide a sustainable alternative to commercial seeds [39]. However, farmers still face challenges like limited access to modern inputs and markets. Solutions such as community seed banks and revitalizing traditional irrigation alongside modern techniques can address these barriers, leveraging local resources for resilience [40]. These insights emphasize the importance of culturally embedded practices for developing sustainable agricultural adaptation strategies in Afghanistan.

## 9. Conclusion

The study on climate change perception and adaptation among smallholder farmers in Afghanistan highlights the multifaceted challenges faced by farmers in adapting to the impacts of climate change on their agriculture and livelihoods. The awareness extent of farmers in the region about climate change and its impact on agriculture and livelihoods, the limited options for adaptation, and the reliance on indigenous coping strategies are shared concerns among smallholder farmers.

Due to a lack of educational facilities for the masses in the country, coupled with low literacy levels among farmers, conducting semi-structured interviews was deemed best for this study. However, this is also a limitation as well since each interview takes many hours to plan, schedule, conduct, transcribe, and confirm. Future studies can supplement qualitative interviews with a larger audience through quantitative research methods. Future researchers should focus on identifying effective adaptation strategies that consider the socio-economic factors and resource access of smallholder farmers in places like Afghanistan and other similar contexts. Additionally, research should explore the role of government policies, the international community, and interventions in supporting smallholder farmers' adaptation to climate change and enhancing their resilience to its impact.

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## References

1. Mujtaba BG. The ethics of management and leadership in Afghanistan, 2<sup>nd</sup> ed. Ilead Academy; 2007.
2. Sarwary M, Senthilnathan S, Saravanakumar V, et al. Climate risks, farmers perception and adaptation strategies to climate variability in Afghanistan. *Emirates Journal of Food and Agriculture*. 2021; 33(12): 1038–1048.
3. Kakar K, Xuan TD, Haqani MI, et al. Current situation and sustainable development of rice cultivation and production in Afghanistan. *Agriculture*. 2019; 9(3): 49.
4. FAO—Food and Agriculture Organization of the United Nations. Documents. Available online: <https://www.fao.org/3/cc2104en/cc2104en.pdf> (accessed on 10 October 2024).
5. FAO—Food and Agriculture Organization of the United Nations. Fact sheet, Africa, Asia and the Pacific. Available online: <http://www.fao.org/docrep/018/ar588e/ar588e.pdf> (accessed on 10 October 2024).

6. Mujtaba BG. Ethnic Diversity, Distrust and Corruption in Afghanistan: Reflections on the Creation of an Inclusive Culture. *Equality, Diversity and Inclusion*. 2013; 32(3): 245–261. doi: 10.1108/EDI-12-2012-0113
7. Sarwary M, Samiappan S, Khan GD, Moahid M. Climate Change and Cereal Crops Productivity in Afghanistan: Evidence Based on Panel Regression Model. *Sustainability*. 2023; 15(14): 10963. doi: 10.3390/su151410963
8. Jawid A, Khadjavi M. Adaptation to climate change in Afghanistan: Evidence on the impact of external interventions. *Economic Analysis and Policy*. 2019; 64: 64–82.
9. Aliyar Q, Zulfiqar F, Datta A, et al. Drought perception and field-level adaptation strategies of farming households in drought-prone areas of Afghanistan. *International Journal of Disaster Risk Reduction*. 2022; 72: 102862.
10. Mandleni B, Anim FDK. Climate change awareness and decision on adaptation measures by livestock farmers. *Journal of Agricultural Science*. 2011; 3(3): 258–268.
11. Komba C, Muchapondwa E. Adaptation to Climate Change by Smallholder Farmers in Tanzania. Available online: <https://econrsa.org/wp-content/uploads/2022/06/wp299.pdf> (accessed on 10 October 2024).
12. Keshavarz M, Moqadas RS. Assessing rural households' resilience and adaptation strategies to climate variability and change. *Journal of Arid Environments*. 2021; 184: 104323.
13. Rose DC, Brotherton PN, Owens S, Pryke R. The benefits and limitations of social-ecological systems: A review. *Ecology and Society*. 2019; 24(4): 9.
14. Azeem MI, Alhafi Alotaibi B. Farmers' beliefs and concerns about climate change, and their adaptation behavior to combat climate change in Saudi Arabia. *Plos One*. 2023; 18(1).
15. Tessema YA, Aweke CS, Endris GS. Understanding the process of adaptation to climate change by small-holder farmers: The case of east Hararghe Zone, Ethiopia. *Agricultural and Food Economics*. 2013; 1(1): 1–17.
16. Baloch ZA, Tan Q, Fahad S. Analyzing farm households' perception and choice of adaptation strategies towards climate change impacts: A case study of vulnerable households in an emerging Asian region. *Environmental Science and Pollution Research*. 2022; 29(38): 57306–57316.
17. Omerkhil A, Azizi Z, Azizi N. Climate change vulnerability and adaptation strategies for smallholder farmers in Yangi Qala District, Takhar, Afghanistan. *Environmental Science and Policy*. 2020; 107: 39–47.
18. Khanal U, Wilson C, Hoang VN, Lee B. Farmers' adaptation to climate change, its determinants and impacts on rice yield in Nepal. *Ecological Economics*. 2018; 144: 139–147.
19. Haque TA, Sahibzada H, Shome S, et al. Afghanistan development update. The World Bank; 2018. No. 129163. pp. 1–52.
20. Savage M, Dougherty B, Hamza M, et al. Socio-economic impacts of climate change in Afghanistan. Stockholm Environment Institute; 2009.
21. Ostrom E. A general framework for analyzing sustainability of social-ecological systems. *Science*. 2009; 325(5939): 419–422.
22. Partelow S. A review of the social-ecological systems framework. *Ecology and Society*. 2018; 23(4): 36. doi: 10.5751/ES-10594-230436
23. Weather and Climate. Nangarhar Climate Summary. Available online: <https://weatherandclimate.com/afghanistan/nangarhar> (accessed on 26 December 2023).
24. Creswell JW. *Qualitative inquiry & research design: Choosing among five approaches*, 3rd ed. Sage Publications; 2013.
25. Moustakas C. *Phenomenological research methods*. Sage Publications; 1994.
26. Wilding C, Whiteford G. *Phenomenological research: An exploration of conceptual, theoretical, and practical issues*. OTJR: Occupation, Participation and Health. 2005; 25(3): 98–104.
27. Clarke V, Braun V. Thematic analysis. *Journal of Positive Psychology*. 2017; 12(3): 297–298.
28. Attride-Stirling J. Thematic networks: An analytic tool for qualitative research. *Qualitative Research*. 2001; 1(3): 385–405.
29. Baizayee B, Doosti AA, Sedigi N. Building adaptive capacity and resilience to climate change in Afghanistan (LDCF): Baseline assessment report. UNEP Afghanistan; 2014.
30. Estrada F, Tol RS, Botzen WJ. VU Research Portal. *Environmental Modelling and Software*. 2019; 121: 104504.
31. Mujtaba BG. Leadership and Management Philosophy of “Guzaara” or cooperating to “Get Along” in South Asia's Afghanistan. *Business Ethics and Leadership*. 2019; 3(1): 44–57. [http://doi.org/10.21272/bel.3\(1\).44-57.2019](http://doi.org/10.21272/bel.3(1).44-57.2019)
32. Kaifi BA, Mujtaba BG, Mujtaba MG, Younos F. Assessing the Leadership Orientation of Afghan American Registered Nurses based on Acculturation Factors. *Journal of Cultural Leadership Studies*. 2023; 4(4): 95–118.

33. Mujtaba BG, Kaifi BA. An Inquiry into Eastern Leadership Orientation of Working Adults in Afghanistan. *Journal of Leadership Studies*. 2010; 4(1): 36–46. doi: 10.1002/jls.20153
34. Mujtaba BG, Senathip T, Sungkhawan J. Task and Relationship Orientation of Professionals in Afghanistan and Thailand. *Business Ethics and Leadership*. 2021; 5(2): 6–20. doi: 10.21272/bel.5(2).6-20.2021
35. Kaifi BA, Mujtaba BG. The Emergence of a New Era of Management: The Leadership Traits and Skills of Eastern Indian and Afghan Women. *Tecnia Journal of Management Studies*. 2012; 6(2): 1–9.
36. Subramaniam SAP, Salamzadeh Y, Mujtaba BG. The Mediating Role of Dynamic Capability on the Relationship between E-Leadership Qualities and Innovation Management: Insights from Malaysia’s Medical Device Industry. *Sustainability*. 2023; 15(24): 16778. doi: 10.3390/su152416778
37. Sarhadi WA, Fahim SA, Tangutan K. Sustainable agricultural development in Afghanistan. *Journal of Developments in Sustainable Agriculture*. 2014; 9(1): 41–46.
38. Yar FGM, Zazia JG. Obstacles and challenges of rural development in Afghanistan: Examining problems and solutions. *Jurnal Locus Penelitian dan Pengabdian*. 2024; 3(9): 787–796.
39. Leao I, Ahmed M, Kar A. Jobs from agriculture in Afghanistan. *International Development in Focus*. World Bank; 2018.
40. Solidarités International. Afghanistan: Towards a sustainable agriculture. Available online: <https://www.solidarites.org/en/countries/afghanistan/afghanistan-towards-sustainable-agriculture/> (accessed on 10 October 2024).