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Climate Change Impacts on Agricultural Development in Bamyan Province, Afghanistan

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Assessing the Impacts of Climate Change On Agricultural Production in Bamyan of Afghanistan

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Abstract

Climate change is one of the main challenges facing agriculture in Afghanistan, particularly in Bamyan Province, which is severely affected due to its cold mountainous climate and limited water resources. This research aims to investigate the impacts of climate change on agricultural activities and the livelihoods of rural communities in Bamyan. A mixed-method approach was used and data were collected through questionnaires, focus groups, and interviews. The target population included farmers, experts, and educated locals. The findings indicate that reduced rainfall, frequent droughts, rising temperatures, and changes in seasonal rainfall patterns have had severe negative impacts on agriculture and livestock in the region. The production of staple crops such as potatoes, wheat, and beans has decreased, and production costs have increased. Additionally, water shortages, soil erosion, and crop pests have reduced productivity, forcing many farmers to abandon their profession. Livestock farmers are also under pressure due to the reduced availability of grazing lands, livestock diseases, and inadequate veterinary services. The results suggest that the lack of modern irrigation infrastructure, the unavailability of improved seeds, and limited access to markets are factors exacerbating these crises. These conditions not only threaten the livelihoods of farmers and livestock breeders but also pose a risk to the region's food security. This research emphasizes the need for supportive policies and the implementation of development projects to mitigate the effects of climate change and improve the livelihoods of farmers.

Keywords: climate change, agricultural communities, agricultural production, Bamyan

Évaluation des impacts du changement climatique sur la production agricole à Bamyan, en Afghanistan

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Résumé

Les changements climatiques constituent l'un des principaux défis auxquels est confrontée l'agriculture en Afghanistan, en particulier dans la province de Bamyan, qui est très touchée par son climat montagneux froid et ses ressources en eau limitées. Cette recherche vise à étudier les impacts du changement climatique sur les activités agricoles et les moyens de subsistance des communautés rurales de Bamyan. Une approche mixte a été utilisée, combinant questionnaires, groupes de discussion et entretiens. La population cible comprenait des agriculteurs, des experts et des habitants instruits. Les résultats indiquent que la diminution des précipitations, la fréquence accrue des sécheresses, la hausse des températures et les modifications des régimes pluviométriques saisonniers ont eu de graves répercussions négatives sur l'agriculture et l'élevage dans la région. La production de cultures vivrières comme les pommes de terre, le blé et les haricots a diminué, tandis que les coûts de production ont augmenté. De plus, les pénuries d'eau, l'érosion du sol et les ravageurs des cultures ont réduit la productivité, forçant de nombreux agriculteurs à abandonner leur activité. Les éleveurs sont également sous pression en raison de la réduction des pâturages disponibles, des maladies animales et de l'insuffisance des services vétérinaires. Les résultats suggèrent que le manque d'infrastructures d'irrigation modernes, l'indisponibilité de semences améliorées et l'accès limité aux marchés sont des facteurs aggravants. Ces conditions menacent non seulement les moyens de subsistance des agriculteurs et des éleveurs, mais aussi la sécurité alimentaire de la région. Cette recherche souligne la nécessité de politiques de soutien et de mise en œuvre de projets de développement pour atténuer les effets du changement climatique et améliorer les conditions de vie des agriculteurs.

Mots-clés : changements climatiques, communautés agricoles, production agricole, Bamyan

1.0 Introduction

Climate change, a significant global challenge in recent decades, has impacted agriculture and agricultural development worldwide, especially in developing countries, drawing attention from researchers and policymakers. This phenomenon, marked by long-term changes in temperature, rainfall, and climatic conditions, affects both natural and human systems. Climate change, mainly due to global warming, influences agricultural productivity and food production globally (Vijai et al., 2023). The phenomenon of climate change not only leads to an increase in the frequency and intensity of heat waves but can also alter weather patterns in such a way that abnormal cold conditions occur in some regions. Although the overall global trend is toward warming, this warming can weaken or alter the path of atmospheric currents such as the jet stream. This disruption in atmospheric systems can push polar cold air masses to lower latitudes than usual, resulting in periods of severe cold and winter storms in some areas (Cohen et al., 2021). Thus, climate change affects both extreme heat events and extreme cold events. Climate change is defined by the IPCC as long-term shifts in climate patterns from both natural causes and human activities, a description echoed by the United Nations Framework Convention on Climate Change with a specific emphasis on alterations attributable to human action that disrupt the natural composition of the atmosphere (Sarwary et al., 2023).

Climate change has widespread effects on agriculture, food security, and human livelihoods, with extreme weather conditions like droughts and floods significantly impacting farmers' lives (Naik et al., 2024). Furthermore, climate change disrupts agricultural sectors and related industries, negatively affecting crop growth—including physiological processes such as photosynthesis—evaporation rates, moisture levels, and overall productivity.

Developing countries, particularly those dependent on agriculture, are especially vulnerable to climate change. In Afghanistan, where a significant portion of the population relies on agriculture, climate change threatens food security, farmers' livelihoods, and economic development. Bamyan Province, a mountainous area with a diverse climate, faces serious risks from climate change, including reduced rainfall, rising temperatures, and altered precipitation patterns. These changes impact the region's cropping patterns, crop growth, and water resources. Significant challenges for farmers in Bamyan include water scarcity, reduced crop diversity, and the emergence of new pests and diseases (Vijai et al., 2023). Furthermore, climate change could alter agricultural production and consumption patterns, trigger social and economic crises, and ultimately jeopardize sustainability in this province.

On a global and regional scale, extensive research has been conducted, indicating that climate change has affected agricultural products.

Chanchal et al. (2025) show in their research that climate change, with increasing temperatures and rainfall fluctuations, poses a serious threat to global agricultural production and food security and leads to a decrease in the yield of crops such as wheat, corn, rice, and legumes. Studies have reported significant reductions in the yield of lentils, chickpeas, and other legumes in countries such as Canada, Ethiopia, Australia, and India. This situation has increased the vulnerability of smallholder farmers and endangered food security, especially in monsoon-dependent regions like India (Chanchal et al., 2025).

A study in 2025 indicated that climate change has become a primary and determining factor in agricultural production worldwide, particularly in developing countries. Through rising temperatures, weather fluctuations, and extreme weather events, this phenomenon leads not only to reduced crop yields

but also to decreased household income, increased vulnerability of smallholder farmers, and exacerbated social inequalities (Faradiba, 2025).

Climate change has had devastating impacts on agriculture and food security in Sub-Saharan Africa, leading to reduced production of staple crops, increased natural disasters, and heightened vulnerability of poor groups. Sensitive regions such as the Sahel and the Horn of Africa experience the most severe impacts. To address these challenges, developing climate-resilient farming practices, strengthening supportive policies, and implementing urgent measures such as investing in infrastructure, technology, and empowering vulnerable groups are essential (Omokpariola, 2025).

A study in Pakistan, "Climate Change Impact on Sustainable Agricultural Growth: Insights from Rural Areas," highlights how rising seasonal temperatures threaten agricultural growth by shortening growing seasons, reducing crop yields, and affecting food security (Khan et al., 2023). A broader Asian study, "Impact of Climate Change on Agricultural Production; Issues, Challenges, and Opportunities in Asia," underlines the harmful effects of rising temperatures on productivity and the importance of crop growth models for adaptation strategies (Habib-Ur-Rahman et al., 2022).

Research in arid regions of Iran, titled "The Impacts of Climate Change on Water Resources and Crop Production in an Arid Region," predicts that increased temperatures and declining rainfall could reduce water availability by 13–15%, significantly impacting crop yields (Shayanmehr et al., 2022). Additionally, a study in Nepal, "Climate Change Impacts in Agriculture: A Case of Makrahar Village, Rupandehi, Nepal," shows how changes in rainfall patterns negatively affect traditional practices, including crop selection and pest management (Katuwal & Rijal, 2015).

At the national level, research conducted in Afghanistan also indicates climate change and rising temperatures in various regions, which has disrupted agricultural development.

A recent study utilizing a regression model found that rising temperatures negatively impact agricultural yields in Afghanistan. Specifically, a 1°C increase in temperature results in a decrease of 271 kg per hectare in wheat yield and 221 kg per hectare in barley yield. Additionally, rainfall has a notable adverse effect on rice yield; each 1 mm increase in rainfall correlates with a decline of 11.77 kg per hectare in rice yield (Sarwary et al., 2023).

Afghanistan faces significant vulnerability to climate change; particularly the country's agricultural sector, which is affected by rising temperatures, high evapotranspiration, and low rainfall. The current reality includes a 1.8°C increase in annual temperature and a 22% decrease in surface water, highlighting the need for urgent action for adaptation and mitigating impacts (Sayedi et al., 2024).

According to a study by Safi and Safi (2024), which analyzed 63 years of climate data from Afghanistan, the country is one of the world's most vulnerable regions to climate change. During this period, temperatures—especially in winter—increased significantly, and average rainfall decreased. Projections under a severe scenario (SSP5-8.5)[1] indicate a potential temperature increase of up to 5.9°C and a decrease in rainfall of up to 17.3 mm. The results show that higher

[1] Shared Socioeconomic Pathways (SSPs) are climate change scenarios of projected socioeconomic global changes up to 2100, as defined in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report on climate change in 2021.

temperatures have a negative effect on wheat yield, while lower temperatures and higher rainfall have a positive effect (Safi & Safi, 2024).

Also, Ghulami (2017) studied the Kabul basin, reporting that rising temperatures and decreasing rainfall are disrupting agriculture. These trends reflect Afghanistan's overall climate vulnerability, marked by severe droughts, floods, and water shortages that adversely affect agriculture, the environment, and biodiversity (Mehrad, 2020).

Another study indicates that climate change has widespread and interconnected effects on rural areas of Afghanistan, including water scarcity, decreased agricultural productivity, increased vulnerability to natural disasters, and ultimately, the exacerbation of poverty and food insecurity. The results emphasize the necessity for comprehensive and cross-sectoral measures, such as sustainable land management, improved water conservation and management, and the promotion of climate-resilient agricultural techniques (Khan et al., 2024).

At the provincial level, the limited research that has been conducted also points to the impacts of climate change on rural development. Research conducted by Mushwani and his colleagues shows that drought is a serious threat to social and economic stability in Afghanistan, particularly in Bamyan Province, leading to problems such as (a) poverty, (b) water scarcity, (c) water conflicts, (d) migration, (e) reduced crop yields, and (f) increased food prices (Mushwani et al., 2025).

A localized study by Hasani and Shrestha (2024) in the Baba Mountain valleys found that decreasing snowfall and rainfall have resulted in severe water shortages, intensifying household land use conflicts. These shortages and disputes and reduced agricultural potential have heightened social tensions (Hasani & Shrestha, 2024).

Research by Aliyar et al. (2024) examined the perceptions of agro-pastoral communities in the Afghan central highlands, revealing mixed views on climate change. Farmers and herders foresee shorter cold seasons and improved grazing opportunities but also anticipate reduced snowfall, depleted water sources, and diminished agricultural yields. A study by Aliyar et al. (2022) confirmed significant crop productivity declines due to drought in rain-fed and irrigated areas. Sarwary et al. (2022) identified the central agricultural region as particularly vulnerable, with respondents citing water depletion, crop failure, and food inflation as key climate change impacts.

These studies highlight the need for timely adaptation strategies and the development of climate-resilient agricultural technologies to address these challenges. However, previous research has primarily focused on the farming perspective, often neglecting its social dimensions. This study adopts a sociological approach to highlight the socio-economic aspects of climate change. It specifically examines the impact of climate change on agricultural development at the provincial level in Bamyan. Unlike earlier studies, which tended to be narrowly scoped or conducted in regions with vastly different social and economic contexts, this research fills a significant gap. Notably, there has been no prior sociological investigation at the provincial level in Bamyan. As an original effort in this field, the findings of this study can be generalized to the provincial context, potentially influencing policymaking and strategy development by government institutions and relevant organizations at both local and national levels.

2.0 Context

Afghanistan relies heavily on agriculture, which makes up 22% of the country's GDP and employs 70% of the rural workforce. Afghan farmers are particularly vulnerable to climate change and face limited resources for adaptation. The country is located in a dry continental and semi-arid zone at a latitude of 37° north, and recent analyses show a decline in rainfall. From 1960–2008, Afghanistan experienced an average annual temperature increase of 0.13°C and a 2% decrease in rainfall per decade. Prolonged droughts have become more frequent, affecting vast areas with insufficient rainfall (Sarwary et al., 2023).

Bamyan Province is a key agricultural region historically recognized for its fertile land and groundwater access, making agriculture a primary source of income and employment for locals (Ahmadi, 2025). However, climate change has increasingly impacted economic and living conditions. Rapid shifts in temperature, rainfall, wind patterns, and growing seasons have negatively affected agriculture, resulting in reduced growth periods, soil degradation, and more frequent droughts (Khan et al,. 2024). The vulnerability of women and low-income farmers has led to decreased crop production, limited access to water, and rising agricultural costs. Climate change has also introduced new pests and diseases, leaving farmers unprepared to address these challenges, increasing economic costs and reducing household income. With more frequent droughts and water shortages, there is a growing need for climate-adaptive technologies in Bamyan. Yet, many farmers lack the income, access to technology, and financial resources to adopt modern farming methods, exacerbating the impacts of climate change.

A major challenge for agriculture in Bamyan is the scarcity of water resources caused by altered rainfall patterns and increased evaporation. This has made farmers increasingly reliant on groundwater, risking the depletion of underground reserves. The absence of cohesive support programs and effective policies at local and national levels hampers farmers' ability to manage climate change effects. This threat to food security also undermines the region's social and economic structure, contributing to forced migration and displacement of rural households.

Thus, the key research questions for this study are: What impacts has climate change had on agricultural activities in Bamyan Province? To what extent has climate change affected the livelihoods and incomes of farmers in Bamyan, and what economic implications does it have for rural families? Additionally, by identifying the existing challenges, what strategies and policies can effectively reduce the negative effects of climate change on agricultural production in Bamyan?

3.0 Research Methodology

This research is applied in terms of its objective and has utilized a mixed-methods approach. Currently, the mixed-methods approach is considered one of the most effective research methods in the social sciences, as it increases the validity of the results. This method has gained attention from sociologists due to its ability to overcome the inherent limitations of quantitative and qualitative methods and to enhance the validity and accuracy of findings. This approach was specifically chosen because it allows for the simultaneous collection of quantitative data to examine the scope of the phenomenon and qualitative data to understand its context and causes. This study collected both quantitative and qualitative data; quantitative data were obtained through a structured

questionnaire, and qualitative data were obtained through semi-structured interviews and focus groups.

The target population of this research is Bamyan Province, which consists of eight districts. Samples were selected through cluster random sampling. Initially, each district was considered a cluster. Subsequently, villages were selected from within each district as clusters, and from the selected villages, samples were chosen from among farmers based on a systematic simple random sampling method.

According to the Economic State of Bamyan Province (2019) report, the population of this province is 572,874 people. The sample size was calculated using Cochran's formula for the Bamyan population, considering a 95% confidence level and a 5% margin of error, resulting in a sample size of 383 people. However, for greater accuracy and to cover potential non-response rates, this number was increased to 400, and 400 questionnaires were distributed to farmers. In the qualitative part, 10 in-depth interviews and two focus group discussions, each consisting of five participants, were conducted. The interviews and focus groups were carried out with (a) officials and staff of government institutions related to agriculture and water resource management, (b) local representatives and village councils, (c) staff of national and international development organizations, (d) academic specialists, (e) agricultural cooperatives and the private sector, (f) traders, as well as (g) socially vulnerable groups dependent on agriculture. Participants were selected based on the provincial census list from each relevant organization, with two representatives per organization in Bamyan Province, in order to examine the various dimensions of the impacts of climate change on agricultural products from different perspectives.

The questionnaire was designed based on a review of the relevant literature and preliminary studies. Its content validity was confirmed by receiving feedback from specialists and professors in the relevant field. Furthermore, to assess reliability, a pilot study was conducted by distributing 30 questionnaires, and the calculated Cronbach's alpha coefficient (above 0.7) indicated the acceptable reliability of the research instrument. The interview questions and focus group guide were similarly designed and reviewed based on the research objectives. This research was conducted in July and August 2024 in the eight districts of Bamyan Province.

Quantitative data were analyzed using SPSS software, through descriptive statistical methods (such as mean, percentage, and frequency) and inferential statistics (including regression analysis) to examine the relationship and influence of variables and to identify and measure the factors affecting the challenges perceived by farmers. Alongside this, qualitative data were coded using MAXQDA software and analyzed using thematic analysis. Finally, the results of both the quantitative and qualitative parts were integrated and used complementarily to provide a comprehensive response to the research questions.

4.0 Findings

4.1 Socio-Economic Profile of Respondents

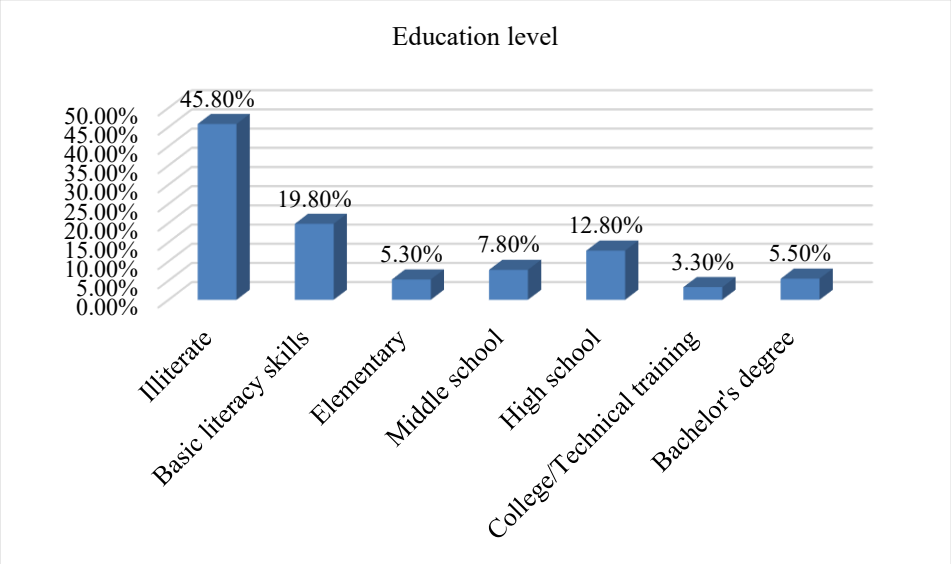
Most respondents to the questionnaires were male (99%), as agriculture is primarily recognized as a male responsibility in rural Afghanistan. However, gender balance was well maintained in the focus groups and interviews. The participants' ages ranged from 18 to 93 years, with an average age of 45.2

years, and most of them (77%) were married. Additionally, 77% of the farmers owned their land, while the remaining participants worked on land owned by others.

The education system in Afghanistan has been severely affected over the past forty years due to ongoing war and instability. Overall, the literacy rate in Afghan society is low, especially in rural areas. Figure 1 shows that 65% of surveyed participants are either illiterate or possess only basic literacy skills. Only the participants in focus groups and interviews had higher education.

For farmers who cannot read or write, we need to find simple and practical ways to deal with climate change. By holding training workshops in villages that use images and visual tools, we can teach them sustainable farming methods and how to preserve natural resources. Additionally, establishing local farmer groups to facilitate the exchange of experiences and introducing low-cost technologies tailored to local climatic conditions can have a significant impact. Ensuring access to drought-resistant seeds and promoting modern irrigation methods, such as drip irrigation, are also crucial for improving agricultural productivity and addressing the challenges posed by climate change.

Figure 1: Education level of study participants.



In rural Afghan communities, the extended family structure is a norm, with the average number of family members being 8.5. The livelihoods of these families largely depend on agriculture. Most families are poor, with 57% having annual incomes of less than $1,000 (see Table 1). The average income of the surveyed families was $1,472, which results in a per capita annual income of $172, given the family size. In 2023, the country's per capita GDP was $415 (ALFRED, 2024). The per capita income of Bamyan farming families is half the national average.

Bamyan is one of the poorest provinces in Afghanistan, with the majority of its people living in absolute poverty and according to international reports, if the political and economic conditions do not improve, the overwhelming majority of the population is at risk of falling below the poverty line (Ahmadi, 2024). In 2022, it was estimated that nearly half of Afghanistan's population—over 18 million people—would require substantial aid (Ahmadi, 2024). More than one million children are at risk of malnutrition and hunger. Situations in which families sell their children due to poverty are among the most alarming indicators of this ongoing crisis (Ahmadi, 2024).

Table 1. *Annual Income of Farmers in Bamyan Province*

Annual Family income	**Frequency**	**Percent**
Less than $500	68	17%
From $501 up to $1,000	159	40%
From $1,001 up to $2,000	104	26%
From $2,001 up to $3,000	42	10%
From $3,001 up to $5,000	13	3%
From $5,001 up to $10,000	8	2%
More than $10,000	6	2%
Total	400	100%

According to Hasell and Arriagada's report (2022), the poverty line was set at $2.15 per day in 2022, meaning that each person needs to consume $2.15 daily to meet basic needs. Individuals who cannot afford this daily amount are considered to be living in absolute poverty. Based on this poverty line, an analysis of the annual income of participating families indicates that approximately 90% of the residents of rural areas in Bamyan province live below the poverty line and cannot afford to spend $2.15 per day per capita (Hasell & Arriagada, 2022).

4.2 Profile of Agriculture in Bamyan Province

In Afghanistan, the majority of people are engaged in farming, which is central to their quality of life. In Bamyan, most respondents report that quality of life has recently deteriorated (see Table 2). The worsening conditions are particularly concerning given the already low starting point.

Table 2. *Quality of Life of Farmers in Bamyan Province*

Overall, has your quality of life improved, remained the same, or deteriorated in recent years?		
	Frequency	**Percent**
Much better	13	3.3
Better	27	6.8
Remained the same	137	34.3
Worse	201	50.3
Much worse	22	5.5
Total	400	100.0

The qualitative data, including focus group discussions and interviews, highlight the factors responsible for declining quality of life. These factors include the economic recession, the cessation of development projects, disruptions in produce markets, and a decline in domestic investment in agriculture, which led to a drop in incomes and increased unemployment. Additionally, drought contributed to decreased yields and a drop in agricultural incomes, putting many families in precarious positions.

The survey indicated that 41% of farmers experienced decreased incomes, while 46% reported no change (see Table 3). The challenges stemming from sudden political changes contribute to the significant environmental factors that have led to reduced agricultural production. However, as highlighted by discussion and interview participants, government support—particularly through a long-term agrarian development program—is essential for helping farmers address the impacts of climate change and adopt new agricultural practices that could set them on a path to growth.

Table 3. *Agricultural Income in Recent Years*

Overall, has your agricultural income increased, decreased, or remained the same compared to previous years?

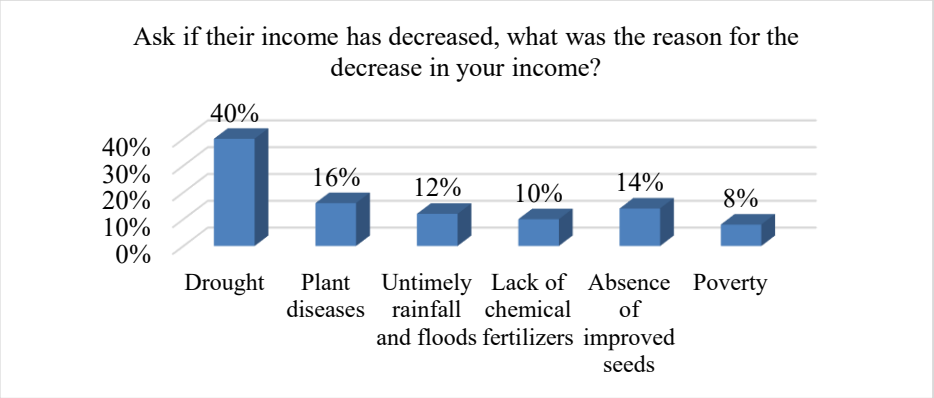
	Frequency	**Percent**
Increased significantly	10	2.5
Increased	40	10.0
Remained the same	185	46.3
Decreased	152	38.0
Decreased significantly	13	3.3
Total	400	100.0

4.3 Impacts of Climate Change on Agriculture

Drought is one of the primary factors contributing to the decline in agricultural income in Bamyan province, with widespread impacts on crop production and farmers' livelihoods. Qualitative data indicate that water shortages, caused by reduced rainfall, limited water resources, and inadequate irrigation infrastructure, have severely diminished farm productivity, rendering many lands uncultivable. This situation has resulted in decreased production of crops such as potatoes, wheat, and beans, which are key sources of income for farmers in the region. Additionally, drought raises production costs as farmers are compelled to use alternative water sources, such as deep and semi-deep wells, or to purchase expensive irrigation equipment. Furthermore, decreased crop yields have led to lower incomes for farming households, exacerbating their economic crises.

Forty percent of respondents identified drought as the primary factor contributing to the decrease in their incomes. The same percentage attributed the decline to plant diseases, a lack of chemical fertilizers, and insufficient access to appropriate seeds—issues that could potentially be addressed through agricultural improvement measures (see Figure 2).

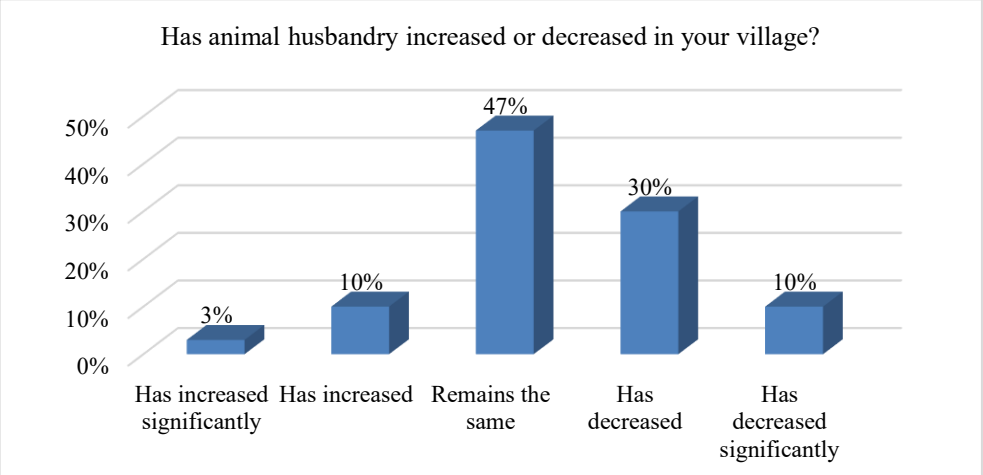
Figure : Factors reducing agricultural income in Bamyan Province.



Climate change has significantly impacted livestock development in Bamyan Province. Successive droughts and the reduction of water resources have limited natural grazing areas and made it difficult to provide adequate fodder for livestock. Severe cold weather during winter, along with reduced snowfall and rainfall, has negatively affected both the quality and quantity of livestock production. These conditions have led to increased costs for maintaining livestock, reduced dairy and meat production, and greater vulnerability for livestock farmers. Additionally, livestock diseases exacerbated by climate change and the lack of veterinary services pose major challenges.

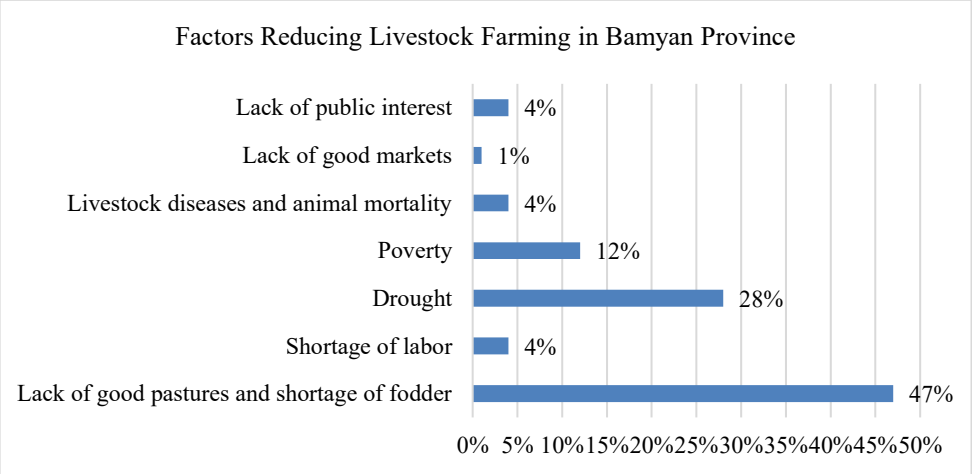
These conditions are reflected in respondents' answers regarding livestock farming in the province, with 40% reporting a decrease in their stock, while 47% reported no changes (see Figure 3).

Figure 3: The status of livestock development in Bamyan Province.



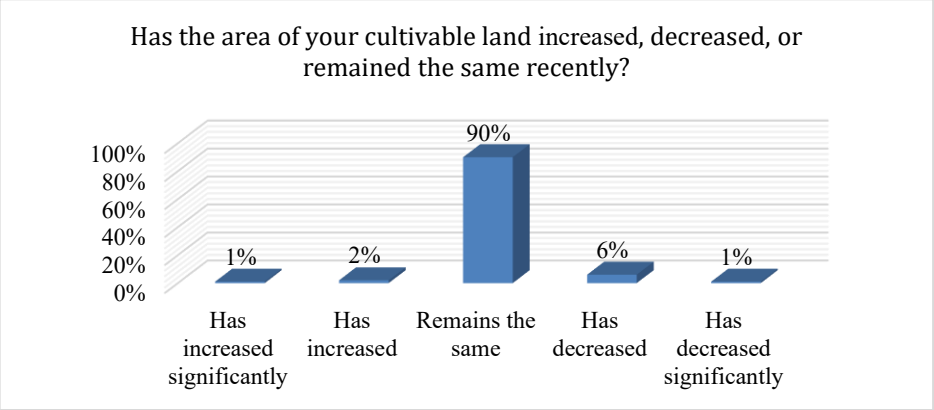
The factors causing the reduction in livestock are primarily related to a lack of good pastures and fodder, as well as drought, which are associated with climatic and land management issues. Additionally, poverty limits the ability to purchase fodder and improve herds (see Figure 4).

Figure 4: Factors reducing livestock farming in Bamyan Province.



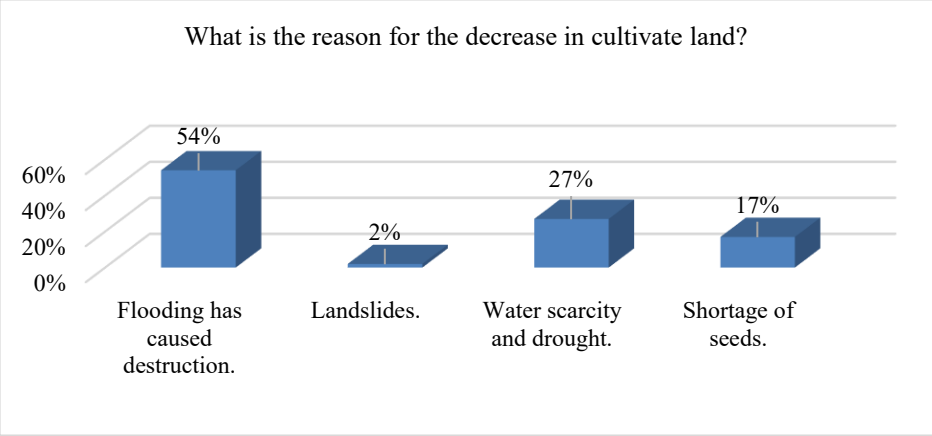
Successive droughts, reduced rainfall, and changes in the seasonal distribution of precipitation have decreased soil fertility and limited water resources. Seven percent of respondents express reduction in arable land, 90% of respondents argue it remains the same, and 3% of respondents express that cultivable land increased (see Figure 5). Additionally, rising temperatures have caused natural water sources to dry up, reduced groundwater levels, and created difficulties in irrigating agricultural land. These changes, particularly in high-altitude areas and remote villages, have made agricultural lands less usable, forcing farmers to alter land use or reduce the area under cultivation. Furthermore, soil erosion and phenomena such as dust storms have negatively impacted the quality of agricultural lands, leading to a decline in agricultural production in the region.

Figure 5: Analysis of the increase and decrease in the area of arable land.



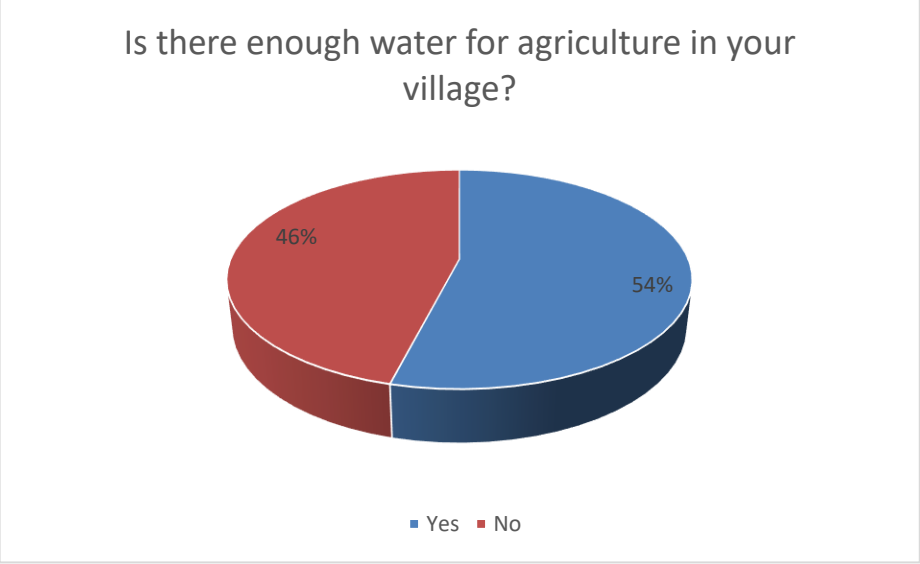
Among respondents who reported a decrease in arable land, seasonal flooding and drought are the main factors indicating water management issues. The shortage of seeds was identified as the third most important cause (see Figure 6).

Figure 6: Factors contributing to the decrease in arable land area in Bamyan Province.



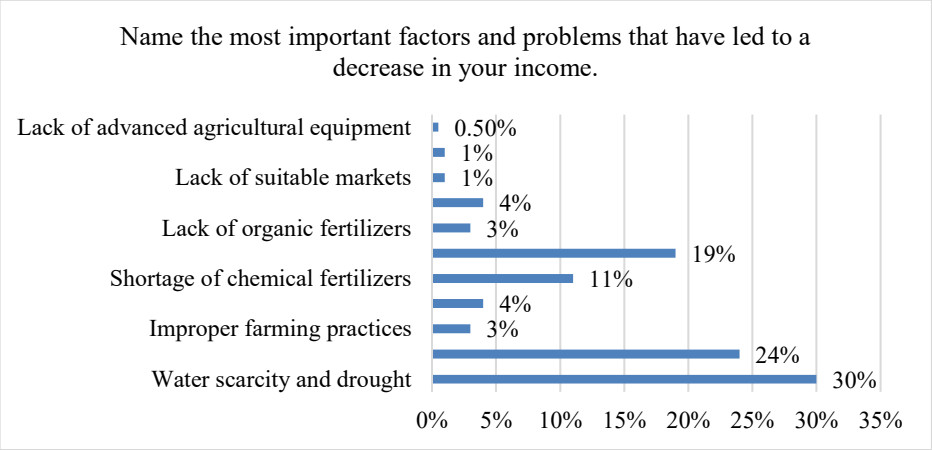
With its cold mountainous climate, Bamyan Province suffers from limited water resources and irregular rainfall, which have significantly impacted the region's agriculture. Frequent droughts in recent years have led to a severe reduction in water resources, the drying up of springs, and a decrease in groundwater levels. This situation, especially in the fields of agriculture and animal husbandry, has created significant challenges for farmers, reducing agricultural and livestock production. The lack of modern irrigation systems and water storage infrastructure, such as dams and proper canals, has exacerbated the problem and forced farmers to use the remaining water resources inefficiently. Drought has also placed additional economic pressure on farming households and increased migration to other areas. The survey showed that 54% of farmers have access to sufficient water for agriculture, while 46% do not have adequate water for farming.

Figure 7: Sufficient water availability for agriculture.



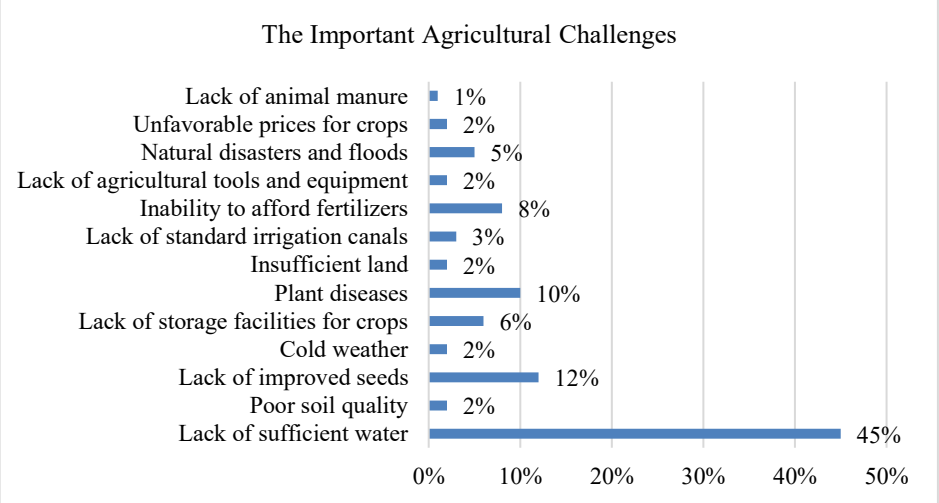
The survey results provided a more detailed look at the various factors that have a direct impact on farmers' income. Water scarcity and drought ranked first in importance, followed by agricultural pests— which have increased due to climate change—in second place, and the shortage of fertilizers in third place (see Figure 7).

Figure 7: Major factors affecting farmers' income.



The survey question that asked respondents to identify the most important challenges provides insight into long-term issues that need to be addressed. The order of importance is slightly different from that shown in the previous question regarding factors impacting farmers' incomes. Forty-five percent of respondents listed water scarcity as the main challenge, while plant diseases and improved seeds received 12% and 10%, respectively (see Figure 8). Additionally, in response to a separate question about the seriousness of drought as a challenge, two-thirds identified it as critical.

Figure 8: The most important agricultural challenges in Bamyan Province.



Assessments derived from focus group discussions and interviews align with the views of the farmer survey and further elaborate on several key issues. Farmers in Bamyan province face significant challenges, including water shortages, recurring droughts, a harsh climate, and inadequate crop storage facilities. This water shortage has reduced crop production, increased reliance on limited groundwater resources, and reduced soil quality due to salinity and erosion. Additionally, restricted access to improved seeds, dependence on traditional farming methods, the prevalence of pests and plant diseases, and a shortage of chemical fertilizers have exacerbated these problems. Difficulties in accessing local markets and a lack of governmental support for facilities and technical training are also major obstacles to improving agricultural conditions

in the region. Nevertheless, the most pressing issues remain water scarcity and drought, which are critical barriers to agricultural development in the province.

4.4 Regression Analysis: Factors Affecting the Decrease in Farmers' Income

To identify and measure the impact of various factors on the decrease in farmers' income, a logistic regression analysis was performed. This method is the most appropriate technique due to the nature of the dependent variable (decreased income versus unchanged/increased income) (see Table 4).

Table 4. *Results of the Logistic Regression Analysis for Predicting Decreased Agricultural Income*

Independent Variable	**Coefficient (B)**	**Standard Error**	**Sig.**	**Odds Ratio**
(Constant)	-1.23	0.45	0.01	0.29
Water Scarcity and Drought	1.85	0.32	0.000	6.36
Pests and Plant Diseases	1.21	0.29	0.000	3.35
Shortage of Chemical Fertilizers	0.94	0.31	0.002	2.56
Shortage of Suitable Seeds	0.58	0.33	0.078	1.79
Reduction of Arable Land	0.42	0.28	0.134	1.52
Reduction in Livestock Numbers	0.61	0.30	0.042	1.84

4.5 Interpretation of Results

4.5.1. The main determining factor: Water scarcity and drought. The variable 'Water Scarcity and Drought' is the strongest predictor of decreased income, with a very high significance level (0.000) and the highest coefficient (1.85). The odds ratio for this variable is 6.36, meaning that the probability of decreased income for farmers who reported drought as a major challenge is more than six times higher compared to others. This finding clearly confirms the devastating impact of climate change on farmers' livelihoods.

4.5.2. Important secondary factors: Pests and fertilizer shortage. 'Pests and Plant Diseases', with an odds ratio of 3.35, is the second most powerful factor. Farmers facing this problem are more than three times more likely to experience a decrease in income. This is likely directly linked to climate change, which creates more favorable conditions for the spread of pests.

'Shortage of Chemical Fertilizers' is also a significant risk factor, with an odds ratio of 2.56. The lack of fertilizer directly affects soil fertility and crop yield, thereby reducing income.

4.5.3. Factors with lesser impact. The variables 'Shortage of Suitable Seeds' and 'Reduction of Arable Land' were not statistically significant at the 95% confidence level (Sig. > 0.05). This may indicate that these problems are more widespread, but their direct and immediate impact on income is less compared to drought and pests.

Although 'Reduction in Livestock Numbers' is significant (0.042), its odds ratio (1.84) indicates that its impact on overall income is relatively moderate compared to agricultural factors.

This analysis clearly shows that the water crisis and drought, directly linked to climate change, constitute the primary and most immediate threat to farmers' livelihoods in Bamyan. While other factors such as pests and fertilizer shortages are also very important, this finding quantitatively confirms and highlights the farmers' statements in the focus groups that prioritized drought.

5.0 Discussion

This study, through a sociological lens, reveals that agricultural systems in Bamyan are under severe stress from climate change and socio-economic factors. The key finding is the critical role of water scarcity and drought, which logistic regression analysis identified as the primary driver of decreased farmer income (with an odds ratio of over six). This finding is consistent with national studies showing rising temperatures and declining surface water (Safi & Safi, 2024; Sayedi et al., 2024) and with local research on disrupted snowfall patterns (Aliyar et al., 2024; Hasani & Shrestha, 2024).

Climate-induced challenges manifest in a cascading and systemic manner. The emergence of pests and plant diseases (the second most important factor with an odds ratio of 3.35) and the shortage of chemical fertilizers, all direct or indirect consequences of climate change, compound the crisis. The reduction in livestock numbers due to fodder shortages, aligning with the findings of Aliyar et al. (2024), further erodes a vital safety net and income source for rural households.

These environmental impacts are amplified by the vulnerable socio-economic conditions of the residents, including severe poverty (90% of the sample living below the poverty line) and a high illiteracy rate (65%). This context severely limits farmers' adaptive capacity and has led to a perceived decline in quality of life and income. This finding supports global studies emphasizing the disproportionate vulnerability of smallholder farmers (Faradiba, 2025; Omokpariola, 2025) and national studies linking temperature increases to reduced crop yields (Safi & Safi, 2024; Sarwary et al., 2023).

In conclusion, this study demonstrates that climate change is a present and compound threat to Bamyan. Urgent actions must focus on water resource management (e.g., small-scale check dams, drip irrigation), promoting climate-resilient agriculture (drought-resistant seeds, integrated pest management), and livelihood diversification. As also called for by Khan et al. (2024), a comprehensive, cross-sectoral approach informed by the lived experiences of farmers is essential to break the cycle of declining production and deepening poverty.

Bamyan's challenges extend beyond technical limitations, as high poverty levels and low literacy rates hinder knowledge transfer and the adoption of new practices. Employing visual education tools and enhancing farmer participation

in decision-making can improve the effectiveness of these initiatives. Using practical educational tools and culturally compatible methods can strengthen awareness and adoption. In addition to technical measures, increasing public awareness about the impacts of climate change and its socio-economic implications is essential. Community-based programs can play a vital role in building resilience against climate shocks. For example, establishing local water management systems or agricultural cooperatives may create alternative income sources and enhance farmers' capacity to cope with climate change effects.

Financial support and long-term investments are crucial for the success of these programs. Leveraging international aid and microfinance initiatives can provide the necessary resources for implementing climate-resilient technologies and infrastructure. However, this support must be coupled with educational (teaching new ırrigation methods, promoting drought-resistant crops and raising awareness about climate change) and social programs (strengthening local ınstitutions and developing community-based organizations) to ensure long-term sustainability.

Addressing climate change impacts in Bamyan ultimately requires coordinated efforts among environmental actions, targeted education, and socio-economic policies. Empowering farmers with access to resources, knowledge, and financial support is key to establishing a sustainable and climate-resilient agricultural system, paving the way for a more stable future for Bamyan's farming communities.

6.0 Conclusion

Agriculture is a primary economic resource in Afghanistan, with most residents engaged in this occupation. In recent years, farmers in Bamyan have faced deteriorating living conditions due to various factors, including reduced income, halted development projects, drought, and a lack of suitable markets. Climate change and water scarcity have hindered the production of staple crops like potatoes, wheat, and beans, increasing production costs. The spread of plant diseases and inadequate access to improved seeds have further negatively affected productivity, resulting in significant pressure on families and leading some to abandon farming altogether. Additionally, government support and domestic investment have declined, disrupting agricultural growth.

The negative impacts of climate change extend to livestock farming in Bamyan. Consecutive droughts and limited grazing areas have made providing fodder increasingly difficult, decreasing dairy and meat production. Harsh winters, reduced precipitation, livestock diseases, and insufficient veterinary services have compounded these challenges. Statistical data indicate that the decline in livestock farming correlates directly with these climatic changes.

The combination of reduced rainfall, persistent droughts, and changes in seasonal rainfall patterns has led to diminished soil fertility, water scarcity, and decreased arable land in Bamyan. Rising temperatures have further exacerbated these issues, causing water resources to dry and groundwater levels to drop. Soil erosion and dust storms have degraded land quality, negatively impacting agricultural production. Key factors contributing to reducing arable land include floods, landslides, droughts, water scarcity, and lack of seed availability.

Bamyan's cold climate and limited water resources pose severe agricultural challenges due to irregular rainfall and recurring droughts. The lack of modern irrigation and storage infrastructure, water scarcity, and reduced groundwater reserves have led to decreased agricultural and livestock production. Climate change, agricultural pests, and plant diseases add to farmers' difficulties. The

reliance on traditional methods, the lack of improved seeds and fertilizers, and limited access to local and international markets constitute significant barriers to agricultural development in the region. Additionally, reduced rainfall and the early melting of glaciers have diminished water resources, further impacting agricultural productivity. These conditions pose a threat to food security in the area and place farmers' livelihoods in jeopardy.

This study offers significant innovation through its sociological approach and focus on the under-researched region of Bamyan, addressing a critical gap in existing literature. By employing a mixed-methods design and advanced statistical analysis (logistic regression), it not only quantitatively identifies key drivers of income decline, such as water scarcity, but also generates profound and reliable findings by providing a detailed picture of the vulnerable socio-economic context of farmers. This establishes a solid foundation for designing practical policies and interventions at both local and national levels. Also, this study has several limitations, including gender imbalance in the quantitative sample that may underrepresent female farmers' perspectives, and a geographical focus on Bamyan province that limits the generalizability of findings to other regions of Afghanistan. Furthermore, limited access to reliable secondary data due to the country's political and security situation, combined with a narrow focus on agriculture and livestock without considering other livelihood sources, constrains the comprehensiveness of the findings. These advantages and limitations can assist future researchers in designing their studies in this field with greater precision and in addressing the existing gaps.

The impacts of climate change pose serious threats to agriculture and food security in Afghanistan, including droughts, the increase in pests and diseases, and reduced crop production. To address these challenges, educating farmers about climate change and adaptation methods can improve livelihoods and increase productivity. Furthermore, focusing on modern technologies such as climate-smart agriculture, biotechnology, and nanotechnology, as well as adopting practices like water resource management, adjusting planting dates, and cultivating drought-resistant crops, is of great importance. These actions align with Sustainable Development Goals (SDGs), specifically SDG 2 (Zero Hunger) and SDG 13 (Climate Action).

The role of policymakers in creating overarching strategies to tackle climate change is vital. Government and international support, enhancing agricultural infrastructure, improving irrigation systems, and facilitating access to financial resources for farmers are among the measures that can increase the resilience of the agricultural sector. These efforts, in addition to reducing the negative effects of climate change, provide opportunities for sustainable agricultural development in vulnerable areas like Bamyan. Research institutions should also pay more attention to the social issues of climate change, focusing on the role of climate change in local conflicts and social struggles related to agricultural resources. At the national level, attention should be given to climate change policies and actions that are community-centered.

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