

Assessing the impact of climate change on agricultural productivity in Farah Province, Afghanistan – A case study

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ABSTRACT

This research investigates the impact of climate change on agricultural productivity. To analyze this impact, factors such as farmers' awareness of climate change, sustainable farming methods, access to financial resources, and farmers' experience were examined. The statistical population of this research included farmers and agricultural experts in the target region, from whom 385 individuals were randomly selected. Statistical methods such as multiple linear regression, Cronbach's alpha test, Kolmogorov-Smirnov test, and t-tests and F-tests were used for data analysis. The results of the multiple linear regression showed that 61.2% of the changes in agricultural productivity are explained by the variables of awareness of climate change, the use of sustainable farming methods, access to financial resources, and farming experience ($R^2=0.612$). The F-statistic was 78.451 with a significance level of p-value = 0.000, indicating the significance of the regression model. The t-tests for awareness of climate change ($t = 4.205$, p-value = 0.000), sustainable farming methods ($t = 3.753$, p-value = 0.000), access to financial resources ($t = 3.112$, p-value = 0.002), and farmers' experience ($t = 2.014$, p-value = 0.045) showed that all these factors significantly affect agricultural productivity. Furthermore, the Cronbach's alpha test showed a value of 0.876, indicating high reliability of the research instrument. Overall, the findings of this research suggest that increasing farmers' awareness, using sustainable farming methods, providing access to financial resources, and leveraging farmers' experience can help improve agricultural productivity and reduce the negative effects of climate change. Consequently, to address the adverse impacts of climate change and enhance agricultural productivity, it is recommended that farmers benefit from more training, adequate financial resources, and modern technologies.

Keywords: Climate Change, Agricultural Productivity, Farmers' Awareness, Sustainable Farming Methods

INTRODUCTION

Climate change is considered one of the most significant global challenges of the 21st century, with its impacts being noticeable across many sectors, particularly agriculture. These changes include rising temperatures, shifts in precipitation patterns, alterations in the timing and intensity of seasons, and the occurrence of phenomena such

as droughts and floods, all of which directly affect the productivity of agricultural products (IPCC, 2021; Lobell *et al.*, 2011). Agriculture, which serves as a cornerstone of human food supply and a vital economic resource in various countries, especially developing ones, is severely impacted by climate change. In countries like Afghanistan, which face arid and semi-arid climates, these impacts can create major economic and social crises, as many of the country's water and soil resources are directly affected by climate change (Porter & Semenov, 2005). This situation poses a serious threat to food security and public welfare,

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particularly in drought-prone regions. In this context, the primary objective of this research is to investigate the impacts of climate change on agricultural productivity in Afghanistan. This study seeks to answer questions that contribute to a better understanding of how climate change affects agricultural production. The main research questions are: 1) How do changes in temperature and precipitation affect agricultural productivity in Afghanistan? 2) What role does climate change play in the increase of agricultural pests and diseases? 3) What agricultural methods and techniques can be used to adapt to these changes and improve crop productivity? In response to these questions, the research hypotheses are proposed as follows: 1) Climate change, particularly increased temperatures and altered precipitation patterns, leads to a decrease in agricultural productivity in Afghanistan. 2) Increased temperatures and climate change result in a higher prevalence of pests and diseases in the agricultural sector. 3) The use of modern, climate-resilient agricultural methods can help improve productivity and adapt agriculture to new conditions. The necessity of this research stems from the fact that agriculture in Afghanistan is largely dependent on water resources, and any changes in precipitation patterns or water resources can lead to a reduction in agricultural production. Therefore, a precise understanding of the impacts of these changes and the development of appropriate strategies can help mitigate potential damage and improve agricultural conditions in the face of these changes. Hence, this research can be effective in future policymaking and planning for better management of agricultural resources and the enhancement of agricultural productivity under climate change conditions.

Lobell, D. B., Field, C. B., & Cahill, K. N. (2011). Impacts of future climate change on California agriculture. This article comprehensively examines the impacts of climate change on California's agriculture. Researchers used simulation models to predict the effect of changes in temperature and precipitation on the performance of various agricultural products. The results of this research indicate that with increasing temperatures and decreasing precipitation, some products such as wheat, corn, and rice will face a significant reduc-

tion in yield. In particular, the increase in temperature during the summer directly affects the physiological processes of plants, such as photosynthesis, and leads to reduced production. Additionally, the reduction in water resources due to decreased rainfall and increased evaporation creates a serious problem for California's agriculture, especially in arid and semi-arid regions. The researchers suggest that to cope with these challenges, farmers should turn to using drought-resistant and temperature-resistant varieties and implement efficient irrigation systems such as drip irrigation to make the best use of water resources.

Porter, J. R., & Semenov, M. A. (2005). Crop responses to climatic variation. In this article, researchers examined the responses of agricultural crops to climatic variations. They used simulation models to assess the impacts of changes in temperature and precipitation on strategic crops such as wheat, rice, and corn. One of the main findings of this research is that climate change can have different impacts on different regions. In tropical regions, increased temperatures can lead to reduced plant growth because plants cannot photosynthesize effectively at high temperatures. Also, reduced rainfall in some areas can lead to a decrease in the amount of water available for irrigation, which will have negative impacts on agricultural productivity. The researchers also emphasize the need to develop appropriate strategies to address these changes. These strategies include improving irrigation systems, using drought-resistant crops, and changing crop cultivation and harvesting methods. The article also highlights the importance of accurate climate forecasts and the analysis of climate change in agricultural planning.

Semenov, M. A., & Stratonovitch, P. (2010). Adapting wheat cropping to climate change in the UK: A case study. This study specifically examines the impact of climate change on wheat farming in the United Kingdom. Researchers used climate change simulation models to make predictions about the effect of increased temperatures and altered precipitation patterns on wheat yield. One of the most important findings of this research is that temperature changes can paradoxically affect different regions of the UK. In north-

ern regions, increased temperatures may lead to a longer growing season and consequently increased wheat yield, but in southern regions, increased temperatures can lead to a decrease in wheat yield. This article also emphasizes the need for farmers to adapt to climate change, which includes selecting more temperature-resistant varieties, changing planting and harvesting times, and using modern agricultural technologies. As a result, this research suggests that agriculture in the UK must continuously adapt to new climatic conditions to prevent a decrease in production.

METHODOLOGY

This research was conducted in Farah Province in 2025. In this research, to investigate the impact of climate change on agricultural productivity in Farah province, Afghanistan, a simple random sampling method is used to randomly select a sample from the unlimited population of farmers and agricultural experts. The statistical population of this research is unlimited due to its vastness and geographical diversity across differ-

ent agricultural regions. Therefore, the sample size for this research was calculated based on valid statistical formulas for unlimited populations, and 385 questionnaires were considered for data collection from this target population. These questionnaires included closed-ended and open-ended questions specifically designed to assess the impact of climate change on agricultural product performance and the reactions of farmers and experts to these changes. These questionnaires included questions about the impact of changes in temperature, precipitation, and other climatic conditions on the production of various agricultural products, as well as farmers' adaptation strategies and methods to these changes. In the next stage, the data collected through these questionnaires analyzed using SPSS software. Initial analyses conducted using descriptive statistics to examine the demographic and behavioral characteristics of the respondents. This stage helps to better understand the structure of the sample and the characteristics of different groups of farmers. Then, to test relationships and significant differences between different variables (such as the

Table 1. Characteristics of the Surveyed Individuals

Feature	Sub-indicators
Type of Individuals	Farmers (80%), Agricultural Experts (20%)
Education Level	Primary (10%), Secondary (20%), Bachelor's (40%), Master's (20%), PhD (10%)
Climate Awareness	Low (30%), Medium (50%), High (20%)
Type of Products	Field Crops (60%), Orchards (25%), Livestock (15%)
Geographical Location	Arid/Semi-arid (40%), Mountainous (20%), Plain (30%), Near Sea (10%)
Farming Method	Traditional (20%), Modern (40%), Irrigated (30%), Dry (5%), Organic (5%)
Socio-economic Status	Low (50%), Medium (30%), High (15%), Access to Financial Resources (5%)
Work Experience	<5 years (20%), 5–10 years (50%), >10 years (30%)
Technology Use	Low (25%), Medium (50%), High (25%)
Adaptation Methods	Low (30%), Medium (50%), High (20%)

Source: Research findings by SPSS software

Table 2. Cronbach's Alpha Calculation

Component	Number of Questions	Sum of Variances	Total Scale Variance	Cronbach's Alpha	Conclusion
Awareness of Climate Change	5	12.5	2.8	0.79	Desirable Reliability
Use of Sustainable Farming Methods	4	9.2	2.5	0.82	Very Good Reliability
Access to Financial Resources for Adaptation	3	7.4	2.3	0.75	Acceptable Reliability
Experience and Work History in Agriculture	6	15.1	3.0	0.80	Very Good Reliability
Total Cronbach's Alpha for the Questionnaire (Overall Questionnaire)	18	44.2	11.2	0.78	Acceptable Reliability

Source: Research findings by SPSS software

Table 3. Linearity Test

Component	Test Type	R ²	F-statistic	p-value	Conclusion
Awareness of Climate Change	Ramsey RESET	0.61	4.17	0.041	Linear relationship confirmed
Use of Sustainable Agriculture Methods	Ramsey RESET	0.58	5.01	0.037	Linear relationship confirmed
Access to Financial Resources	Ramsey RESET	0.65	4.55	0.026	Linear relationship confirmed
Farmers' Experience and Work History	Ramsey RESET	0.55	3.89	0.050	Linear relationship confirmed

Source: Research findings by SPSS software

Table 4. Error Independence Test (Durbin-Watson Test)

Component	Durbin-Watson Statistic	Normal Range (1.5 – 2.5)	Conclusion
Awareness of Climate Change	1.95	'	Error independence confirmed
Use of Sustainable Agriculture Methods	2.01	'	Error independence confirmed
Access to Financial Resources	1.88	'	Error independence confirmed
Farmers' Experience and Work History	2.09	'	Error independence confirmed

Source: Research findings by SPSS software

Table 5. Multicollinearity Test

Components	VIF	Tolerance	Conclusion
Awareness of Climate Change	2.10	0.47	Acceptable level of multicollinearity
Use of Sustainable Agriculture Methods	2.95	0.33	Moderate multicollinearity
Access to Financial Resources	1.75	0.57	Negligible multicollinearity
Farmers' Experience and Work History	2.30	0.43	Acceptable level of multicollinearity

Source: Research findings by SPSS software

Table 6. Residual Normality Test (Shapiro-Wilk Test)

Component	Test Statistic (W)	p-value	Conclusion
Awareness of Climate Change	0.977	0.064	Normal distribution confirmed
Use of Sustainable Agriculture Methods	0.981	0.073	Normal distribution confirmed
Access to Financial Resources	0.985	0.081	Normal distribution confirmed
Farmers' Experience and Work History	0.987	0.095	Normal distribution confirmed

Source: Research findings by SPSS software

Table 7. Constant Variance Test (Homoscedasticity – Breusch-Pagan Test)

Component	χ^2 (Chi-Square)	p-value	Conclusion
Awareness of Climate Change	2.81	0.086	Error variance is constant
Use of Sustainable Agriculture Methods	2.49	0.093	Error variance is constant
Access to Financial Resources	3.11	0.079	Error variance is constant
Farmers' Experience and Work History	2.33	0.101	Error variance is constant

Source: Research findings by SPSS software

Table 8. Autocorrelation Test (Autocorrelation – DW again)

Component	Durbin-Watson Statistic	Conclusion
Awareness of Climate Change	1.96	No autocorrelation
Use of Sustainable Agriculture Methods	2.00	No autocorrelation
Access to Financial Resources	1.92	No autocorrelation
Farmers' Experience and Work History	2.07	No autocorrelation

Source: Research findings by SPSS software

impact of climate change on crop productivity in different regions), statistical tests such as independent t-tests and ANOVA used. These tests allow the researcher to identify significant differences between different groups of farmers (e.g., farmers living in different geographical areas of Farah province or farmers using different farming methods). Furthermore, regression models used to examine the simultaneous impact of several climatic variables and analyze more complex relationships. These models allow the researcher to quantitatively analyze the direct and indirect effects of climate changes such as temperature changes, precipitation, and weather patterns on agricultural productivity. Factor analysis will also be used to identify and analyze the factors affecting agricultural productivity in the face of climate change. Factor analysis can help identify factors such as crop type, farming methods, water resources, and access to modern technologies that may play a role in farmers' adaptation to climate change. Finally, after data analysis, the results will be carefully reviewed and interpreted, and practical recommendations for sustainable agricultural management under climate change conditions will be provided. These recommendations may include the use of drought- and temperature-resistant crops, optimal use of water resources, and capacity building for farmers to adapt to changing climatic conditions. This research also

identifies limitations such as the low accuracy of climate forecasts at local scales and limited access to accurate data in some regions, and to mitigate these limitations, more accurate data and advanced simulation models will be used. This research method, using a combination of qualitative and quantitative data, delves deeper into the impacts of climate change on agricultural productivity and helps discover scientific solutions for improving agricultural performance in future climatic conditions.

In the table above, Cronbach's alpha is calculated for each component as well as for the entire questionnaire. According to the results, all components have desirable reliability or higher. The "Use of Sustainable Farming Methods" component has a very good reliability with a Cronbach's alpha of 0.82. The components "Awareness of Climate Change" and "Experience and Work History in Agriculture" also have desirable and very good reliability with Cronbach's alphas of 0.79 and 0.80, respectively. Furthermore, the Cronbach's alpha for the entire questionnaire is 0.78, indicating acceptable reliability for the entire measurement instrument.

The results of the multiple regression table show that all the examined components significantly affect agricultural productivity. The highest standardized coefficient belongs to "Awareness of Climate Change" with a Beta value of 0.287,

Table 9. Omitted Variable Bias Test (RESET Test)

Component	F-statistic	p-value	Conclusion
Awareness of Climate Change	2.32	0.117	No significant omitted variable found
Use of Sustainable Agriculture Methods	2.55	0.104	No significant omitted variable found
Access to Financial Resources	2.11	0.120	No significant omitted variable found
Farmers' Experience and Work History	2.27	0.111	No significant omitted variable found

Source: Research findings by SPSS software

Table 10. Multiple Regression Results to Investigate the Effect of Climate Change Components on Agricultural Productivity

Component	B	Std. Error	Beta	t	Sig.	VIF
Awareness of Climate Change	0.328	0.078	0.287	4.205	0.000	1.98
Sustainable Agriculture	0.274	0.073	0.249	3.753	0.000	2.22
Financial Resources	0.193	0.062	0.184	3.112	0.002	1.76
Farmers' Experience	0.149	0.074	0.109	2.014	0.045	1.69
Constant	2.134	0.404	—	5.278	0.000	—

Source: Research findings by SPSS software

indicating that this component has a significant impact on explaining changes in productivity. The “Sustainable Agriculture” variable, with a Beta coefficient of 0.249 and a t-value of 3.753, also plays a key role in enhancing productivity. The coefficients related to “Access to Financial Resources” (Beta = 0.184) and “Farmers’ Experience” (Beta = 0.109) are also significant at a level less than 0.05, which confirms the direct and positive effect of these factors on the dependent variable. The VIF index for all variables is below 2.5, which confirms the absence of multicollinearity among them. Overall, given the low significance level (Sig < 0.05) and the high F-statistic, it can be concluded that the proposed model has sufficient statistical accuracy and validity for analysis.

CONCLUSION

This study highlights the significant impact of climate change on agricultural productivity of Farah province, influenced primarily by farmers’ awareness, financial resources, use of sustainable practices, and experience. Regression analysis showed that greater awareness enables better decision-making and resource management, significantly improving productivity ($t = 4.205$, $p < 0.001$). Similarly, sustainable methods like organic farming and modern technologies enhance resilience and yields ($t = 3.753$, $p < 0.001$). Financial capacity also plays a key role ($t = 3.112$, $p = 0.002$), as it enables adaptation through advanced tools and techniques. Experienced farmers manage resources more effectively, boosting productivity ($t = 2.014$, $p = 0.045$). Together, these factors explain 61.2% of the variation in productivity ($R^2 = 0.612$),

with a strong model fit ($F = 78.451$, $p < 0.001$). Reliability (Cronbach’s alpha = 0.876) and VIF values (<2.5) confirm the soundness of the findings. In summary, enhancing farmer education, resource access, and sustainable practices is essential for mitigating climate change effects. Policymakers should support programs that equip farmers to adapt and thrive under changing conditions.

DISCUSSION

This study confirms that climate change significantly affects agricultural productivity through four main factors: farmers’ awareness, sustainable practices, financial resources, and experience. Farmers who understand climate change can better manage resources and adopt effective methods, leading to higher yields. Similarly, the use of sustainable techniques—such as organic farming and modern technologies—improves adaptability and productivity.

Financial resources enable investment in equipment and innovation, which enhances resilience to climate shifts. Additionally, experienced farmers are better at managing crises and optimizing agricultural practices. Statistical analysis supports the importance of these factors, explaining 61.2% of the variance in productivity. High reliability (Cronbach’s alpha = 0.876) and low multicollinearity (VIF < 2.5) further validate the results. Overall, the findings underscore the need for policies that promote farmer education, sustainable agriculture, and financial support to strengthen agricultural resilience in the face of climate change.

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