

A HAWK'S EYE VIEW: THE IMPACT OF CLIMATE CHANGE ON FOOD SECURITY IN PAKISTAN

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ABSTRACT

The focus of this research is to comprehend the impact of climate change on food production and accessibility specifically for vulnerable populations in Pakistan. The study explores different strategies for adaptation and mitigation, such as climate-resistant farming methods, water management, and policy reforms to ensure food security in the backdrop of climate change. Pakistan, a country with a rapidly expanding population and limited cultivable land, faces significant food security challenges exacerbated by the growing threats of climate change. As one of the countries most vulnerable to global warming, Pakistan is at high risk from temperature variations, changing precipitation patterns, and extreme weather events. These factors directly affect agricultural output, water resources, livestock, and overall health and well-being. Consequently, this qualitative research, which utilized secondary data and adopted a positivist approach, emphasizes the need for integrated and comprehensive strategies to tackle climate change and its implications for food security in the country. Current evidence underscores the critical importance of substantial investment in mitigation strategies to build a climate-resilient food system and address food security challenges.

Keywords: Climate Change, Food Security, Adaptation & Mitigation, Policy Reforms, Pakistan.

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INTRODUCTION

The term "food security" refers to the availability of sufficient food that meets nutritional energy requirements [1]. Food security is achieved when everyone has both economic and physical access to fresh and nutritious food that meets their dietary preferences for a healthy and active life [2]. The definition includes five key elements:

availability, access, stability, dietary quality, and food preferences. These elements are influenced by economic, physical, and political factors within societies and households, and can also be disrupted by events such as natural hazard-induced disasters and conflicts. Climate refers to the long-term weather patterns of a region,

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including factors such as wind, temperature, velocity, and rainfall [3]. Climate change refers to long-term shifts in temperature and weather patterns. While these changes can occur naturally due to factors like changes in solar activity or major volcanic eruptions, human activities have been the primary cause of climate change since the 1800s. The main contributors are the burning of fossil fuels such as coal, oil, and gas. These are the biggest drivers of global climate change, responsible for more than 75% of worldwide greenhouse gas emissions and nearly 90% of all carbon dioxide emissions. Climate shifts and the growing frequency of extreme weather events are key factors driving the global surge in hunger and malnutrition. Fisheries, crops, and livestock may suffer damage or reduced productivity. As oceans become more acidic, marine resources that sustain billions of people are endangered. In many Arctic areas, alterations in snow and ice cover have disrupted food sources derived from herding, hunting, and fishing. Additionally, heat stress can reduce water availability and degrade grasslands, leading to lower crop yields and negatively impacting livestock [4, 5].

Climate change is adversely affecting the livelihoods and food security of rural communities, who account for approximately 80% of the global population. The impact of climate change on ecosystems are already worse and widespread, causing a ripple effect on agricultural systems and people's livelihoods [6]. Agroecosystems are directly affected by climate change, which in turn affects agricultural productivity. This has economic and social consequences that impact people's livelihoods [7]. In simpler terms, climate change affects the environment, which then affects productivity, ultimately leading to economic and social problems [8]. Therefore, assuring food security in the face of climate change is one

of the greatest challenges humanity faces today. Immediate action is necessary to reduce vulnerability and build resilience in food systems in order to assure food security and improve nutrition for everyone.

Climate change has the potential to disrupt progress towards achieving global food security. There is clear evidence, based on various indicators related to nutrition, that climate change is affecting crop production and therefore the availability of food on a global scale. The resilience of entire food systems is at risk due to inconsistent short-term supplies. At the local level, the impact may not be immediately noticeable, but it is widely predicted that climate unpredictability and change will worsen food insecurity in regions that are already prone to hunger and/or malnutrition [9]. Therefore, existing evidence highlights the need for significant investments in mitigation measures to create a climate-smart food system that is better equipped to withstand the impact of climate change on food security.

The objectives of this research include (1) Investigating the impacts of climate change on food production and accessibility (2) Analysing the significance of climate change on food security, and (3) Exploring possible adaptation and controlling strategies to ensure food security in the face of climate change in Pakistan.

MATERIAL AND METHODS

Guided by the researchers' ontological stance of "subjectivism" and epistemological "positivism," the study adopted an exploratory research design. Evidence suggests that a narrative qualitative research approach, rooted in inductive reasoning, is well-suited for studies aiming to understand the complexities of different issues, which allowed the researchers of this study to comprehend the impact of climate change on food security. To gather secondary data aligned with the research objectives, various

articles, publications, newspaper, and international reports based on grounded theory analyses were consulted.

Impact of Agriculture and Livestock on GDP

Pakistan is primarily an agrarian country, accounting for 20% of the total GDP and experiencing an annual growth rate of 2.7%. The agricultural sector also employs 43% of the workforce, and 62% of the rural population is dependent on it for their livelihood. The importance of agriculture to Pakistan's economy can be understood from three perspectives: 1) providing food for the nation and raw materials for domestic industries, 2) earning foreign exchange, and 3) supplying goods and services to both domestic industries and international markets. However, climate change poses a serious threat to the agricultural growth in Pakistan, especially to food crops such as wheat, rice, maize, and cash crops like sugarcane. If significant measures are not taken to address this issue, it is estimated that Pakistan could suffer a loss of approximately US\$20 billion by the middle of this century due to climate change-induced decline in rice and wheat crop production. Despite some changes over time, agriculture and related activities remain central to the livelihoods of over two-thirds of Pakistan's population, particularly those living in rural areas. The contribution of agro-based products continues to play a vital role in overall economic development and growth [11, 12]. Similarly, livestock plays a crucial role in the rural economy of Pakistan, contributing approximately 58.3% to agricultural value and 11.4% to the gross GDP. Livestock serves as a element of cash income, often the sole source of income for rural and marginalized individuals. In fact, more than eight million families in Pakistan are engaged in raising livestock and receive about 35% of their income from livestock production on

average. As of 2017-18, the number of cattle increased to 46.1 million, buffalo increased to 38.8 million, and goats/sheep increased to 104.6 million [13].

Climate Trend in Pakistan

In the Global Climate Risk Index 2024, Pakistan is ranked 30th overall and considered a medium performer. Pakistan's climate policy performs poorly in terms of renewable energy and ranks very low in greenhouse gas emissions, but receives a high rating for energy use. It is important to note that Pakistan is among the countries facing a severe climate crisis, as demonstrated by the devastating floods in 2022. Climate change has the potential to hinder progress towards achieving zero hunger worldwide. The impact on crop production and global food availability is evident from related nutrition indicators. Although the impact may be less visible at the local level, climate variability and change are predicted to worsen food insecurity in areas which are prone to be affected by hunger and malnutrition.

Agricultural productivity is influenced by various climate-related parameters, including temperature, solar radiation, carbon dioxide (CO₂), and precipitation, among soil moisture, wind speed, direction, and water vapors. The understanding the functions and interactions of these parameters enables us to manipulate plants and management practices to meet human needs for food, fiber, and shelter. Additionally, these parameters help us comprehend the impacts of climate change on productivity and develop strategies for adaptation and mitigation to counteract negative effects. When analyzing annual precipitation trends, arid regions show a significant increase of 0.828 mm per year, while maximum temperature trends show a significant increase per year in both extremely arid and humid regions, with 0.014 °C per year and 0.018 °C per year respectively. Bhatti's findings indicate that all



Figure 1: The specific dynamics of food security.

precipitation extreme indices in Pakistan exhibited an increasing trend from 1980 to 2016 [14-19].

Impact of Climate on Production

Due to global warming, the average global temperature has been increasing over the past few decades and is predicted to continue rising. This temperature rise directly affects wheat productivity due to the resulting extreme weather and temperature conditions. Higher temperatures generally speed up the growth cycle of wheat, leading to a shorter period for growth. Studies conducted in fields and controlled environments have demonstrated that well-watered wheat crops yield less grain in response to rising temperatures during the growing season [20]. Moreover, minimum temperatures also impact the efficiency of wheat production.

In Pakistan, it is expected that the average maximum temperature for wheat will range between 23-27 °C, while the minimum temperature will be between 3-8 °C. A temperature increase of 0.3 °C would result in a 0.4 percent increase in production. Regarding rainfall changes, a 5 mm increase in rainfall could raise total wheat production by 0.06 percent, while a 5 mm decrease would decrease production by the same

percentage. However, both minimum temperature, mean temperature, and rainfall have a negative and significant impact on wheat production. Statistical data indicates that an increase in rainfall variability could potentially increase wheat productivity by 4.66 percent [21-23]. Pakistan has been experiencing water shortages and drought for the past few decades, making it vital to use available irrigation water wisely.

Food Security in Pakistan

Pakistan is currently facing challenges in maintaining food security due to the impact of climate change on food and livestock production. The Green Revolution in the 1960s initially played a crucial role in increasing agricultural production and ensuring food security. However, over time, its effectiveness has diminished due to the depletion of natural resources and the adverse effects of climate change. The impact of climate change on food security is particularly significant and quantifiable in Punjab. Fluctuations in temperature and rainfall greatly affect food production at different stages of development in this region [24, 25]. The situation is especially concerning in urban areas of Pakistan, where 21 million people are currently experiencing

food insecurity in terms of calorie consumption. The province of Baluchistan is particularly affected, with 20 districts having extremely food-insecure urban populations. Additionally, there are six districts in the province of Sindh and five in Khyber Pakhtunkhwa facing similar issues. However, when compared to other provinces, Punjab appears to be relatively better off [26, 27].

Specific Dynamics

Climate change poses significant challenges to food security in Pakistan [28]. The country faces multiple dynamics in terms of food security due to climate change. Such as illustrated in Figure 1, unpredictable weather, rising temperatures, melting glaciers, outbreaks of pests and diseases, water shortages, decline in livestock and agricultural products, and land degradation. These factors contribute to food shortages and higher prices for consumers.

Rainfall patterns vary across different regions, with a magnification in monsoon rainfall in sub-humid and humid areas, and a reduction in winter and summer rain. Research on wheat crops has shown that higher temperatures can accelerate growth but shorten the grain filling phase. Additionally, increased mean minimum temperatures during crop maturity significantly improve crop yields. Adequate and consistent rainfall is critical for a successful wheat harvest. The melting of glaciers is another consequence of climate change, and Pakistan is particularly concerned about the melting of its large glaciers, including the Siachen Glacier, the second-largest glacier on Earth outside of the Polar regions [29]. This melting poses the risk of floods, landslides, and water shortages [30]. The melting of the Himalayan Glaciers in the Indus River System also presents a significant threat of natural hazard-induced disasters such as floods and droughts [31]. These extreme weather changes, characterized by fluctuating temperatures and

low precipitation, pose major obstacles to agricultural production and contribute to food insecurity. Moreover, rising temperatures create more favorable conditions for pests and diseases that can damage crops, leading to decreased production and food scarcity. Pakistan also faces a shortage of freshwater, with the Indus River and its tributaries being the primary water sources for the majority of the population. Increasing temperatures affect the country's water supply as high temperatures intensify evaporation and water pressure, resulting in inadequate water for agriculture. This, in turn, affects crop irrigation and reduces crop production, further impacting food security. Additionally, rising temperatures have a negative impact on livestock production, subjecting animals to heat stress, decreasing feed quality, and disrupting breeding cycles. Ultimately, this affects the availability of meat, milk, and eggs [32]. Finally, climate change worsens land degradation through processes such as erosion, salinization, and nutrient depletion, making it challenging to maintain fertile land for farming. Among the various climate change threats that Pakistan faces, land degradation appears to have the most severe impact on food security.

Resilience Plans

To ensure food security in the face of climate change, Pakistan may implement a series of strategic and resilient plans (Figure 2). These include:

1. Raising awareness about climate change
2. Improving disaster management
3. Implementing pest eradication measures
4. Preserving livestock
5. Managing water resources
6. Encouraging diversity in crops and livestock
7. Investing in research and development
8. Promoting skills acquisition
9. Implementing policy reforms

To sustain agricultural production and support the growth of farm households, a



Figure 2: The strategic and resilient plans for food security.

comprehensive understanding of the effects of climate change and potential adaptation plans is crucial [33]. In Pakistan, prioritizing climate change adaptation and mitigation measures in flood management strategies is essential to minimize the impacts of rising temperatures and ensure a sustainable environment for future generations. The country frequently experiences natural hazard-induced disasters such as earthquakes, floods, droughts, and landslides, which often occur simultaneously and exacerbate their impact on people and the economy [34]. Other important plans include conservation agriculture, livestock management, and integrated pest control methods. Developing efficient and sustainable irrigation systems can effectively manage water resources, ensuring that agricultural production is not hindered by water shortages. Diversifying crops and livestock is emphasized to mitigate the threats posed by climate change, as different species have varying abilities to adapt to changing environments. Additionally, supporting research and development efforts can lead to the discovery of new crop varieties and technologies that are well-suited

for climate change resilience. Lastly, providing training and skills to understand the effects of climate change and controlling strategic policies for effective adaptation is crucial in facing these challenges.

CONCLUSION

Pakistan faces significant challenges related to climate change, which directly threaten food security, agricultural productivity, and overall sustainability. Despite being ranked as a medium performer in the Global Climate Risk Index, Pakistan is highly vulnerable to climate impacts, as evidenced by extreme weather events like the 2022 floods. Climate change has adverse effects on agricultural production, particularly on crops like wheat, and contributes to food insecurity, especially in urban and rural regions prone to hunger and malnutrition. The changing climate, characterized by rising temperatures, fluctuating rainfall, and melting glaciers, affects key factors like water availability, soil health, and livestock productivity. These changes lead to reduced crop yields, higher food prices, and increased vulnerability to natural hazard-induced disasters, all of which worsen food insecurity. Specific regions, such as Baluchistan, Sindh, and Khyber

Pakhtunkhwa, are most severely affected. To combat these challenges, Pakistan needs to adopt a multi-faceted approach that includes climate change adaptation, improved disaster management, water conservation, crop diversification, and investment in research and development. Strategic plans that focus on sustainable agricultural practices, integrated pest management, and better irrigation systems are crucial for ensuring food security in the face of these climate

REFERENCES

1. Pinstup, A.P. (2009). Food security: definition and measurement. *Food security*, 1(1), 5-7.
2. Kotir, J. H. (2011). Climate change and variability in Sub-Saharan Africa: a review of current and future trends and impacts on agriculture and food security. *Environment, Development and Sustainability*, 13(1), 587-605.
3. Muluneh, M. G. (2021). Impact of climate change on biodiversity and food security: a global perspective—a review article. *Agriculture & Food Security*, 10(1), 1-25.
4. Harnisch, J., Frische, M., Borchers, R., Eisenhauer, A., & Jordan, A. (2000). Natural fluorinated organics in fluorite and rocks. *Geophysical Research Letters*, 27(13), 1883-1886.
5. Houghton, R. A., Davidson, E. A., & Woodwell, G. M. (1998). Missing sinks, feedbacks, and understanding the role of terrestrial ecosystems in the global carbon balance. *Global Biogeochemical Cycles*, 12(1), 25-34.
6. Baldos, U. L. C., & Hertel, T. W. (2014). Global food security in 2050: The role of agricultural productivity and climate change. *Australian Journal of Agricultural and Resource Economics*, 58(1), 1-18.
7. Dawson, T. P., Perryman, A. H., & Osborne, T. M. (2016). Modelling impacts of climate change on global food security. *Climatic Change*, 134(1), 429-440.
8. Ericksen, P. J. (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change*, 18(1), 234-245.
9. Wheeler, T., & Von Braun, J. (2013). Climate change impacts on global food security. *Science*, 341(6145), 508-513.
10. Neuman, W. (2011). *Social Research Methods: Quantitative and Qualitative Approaches*. Pearson.
11. Azam A, Shafique M. Agriculture in Pakistan and

challenges.

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- its Impact on Economy. A Review. *Inter. J. Adv. Sci. Technol.* 2017;103:47-60.
12. Ali A. Impact of climate-change risk-coping strategies on livestock productivity and household welfare: empirical evidence from Pakistan. *Heliyon*. 2018 Oct 1;4(10).
13. Government of Pakistan. Board of Investment, Prime Minister's Office, Government of Pakistan. 2018
<http://boi.gov.pk/Sector/SectorDetail.aspx?sid=1>.
14. Abbas, S., Kousar, S. & Khan, M.S. The role of climate change in food security; empirical evidence over Punjab regions, Pakistan. *Environ Sci Pollut Res* 29, 53718–53736 (2022).
15. Abbas S, Mayo ZA (2021) Impact of temperature and rainfall on rice production in Punjab, Pakistan. *Environ Dev Sustain* 23(2):1706–1728.
16. Akhter Ali, Olaf Erenstein, Assessing farmer use of climate change adaptation practices and impacts on food security and poverty in Pakistan. *Climate Risk Management*, 16, 2017, 183-194.
17. Abid M, Scheffran J, Schneider UA, Ashfaq MJ. Farmers' perceptions of and adaptation strategies to climate change and their determinants: the case of Punjab province, Pakistan. *Earth System Dynamics*. 2015 May 11;6(1):225-43.
18. Ahmad M, Iqbal M, Khan MA. Climate change, agriculture and food security in Pakistan: adaptation options and strategies. *Pakistan Institute of Development Economics, Islamabad. (Climate Change Brief)*. 2013.
19. Bhatti AS, Wang G, Ullah W, Ullah S, Fifi Tawia Hagan D, Kwesi Noonu I, Lou D, Ullah I. Trend in extreme precipitation indices based on long term in situ precipitation records over Pakistan. *Water*. 2020 Mar 12;12(3):797.
20. Asseng, S., Ewert, F., Martre, P. Rising temperatures reduce global wheat production. *Nature Clim Change* 5, 143–147 (2015).
21. Ottman, M. J., Kimball, B. A., White, J. W. &

- Wall, G. W. Wheat growth response to increased temperature from varied planting dates and supplemental infrared heating. *Agron. J.* 104, 7–16 (2012).
22. Khan F, Ali S, Mayer C, Ullah H, Muhammad S (2022) Climate change and spatio-temporal trend analysis of climate extremes in the homogeneous climatic zones of Pakistan during 1962-2019. *PLoS ONE* 17(7): e0271626.
 23. Adnan S, Ullah K, Gao S, Khosa AH, Wang Z. Shifting of agro-climatic zones, their drought vulnerability, and precipitation and temperature trends in Pakistan. *International Journal of Climatology*. 2017 Aug;37:529-43.
 24. Ahmad, M., & Farooq, U. (2010). The state of food security in Pakistan: Future challenges and coping strategies. *The Pakistan Development Review*, 49(4), 903-923.
 25. Abrar, M. A., & Maryiam, M. (2023). Climate change impact on food security in Pakistan. *Pakistan Journal of Multidisciplinary Research*, 4(1), 131-146.
 26. Arshad, S., & Shafqat, A. (2012). Food security indicators, distribution and techniques for agriculture sustainability in Pakistan. *International Journal of Applied Science and Technology*, 2(5), 137-147.
 27. Khattak, S. G., Habib, K., & Khan, F. S. (2008). Women and Human Security in South Asia: The Cases of Bangladesh and Pakistan. University Press.
 28. Munir, H., & Ejaz, Q. (2010). Global water crisis and future food security in an era of climate change. *Food Policy*, 35(5), 365-377.
 29. Xu, J., Grumbine, R. E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y. U. N., Wilkes, A. (2009). The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. *Conservation Biology*, 23(3), 520-530.
 30. Aslam, B., Gul, S., & Asghar, M. F. (2021). Evaluation of environmental degradation as an unprecedented threat to human security in Pakistan. *Liberal Arts and Social Sciences International Journal (LASSIJ)*, 5(1), 197-211.
 31. Abdela, N., & Jilo, K. (2016). Impact of climate change on livestock health: A review. *Global Veterinaria*, 16(5), 419-424.
 32. Garnaut, R. (2008). *The Garnaut climate change review* (Vol. 13). Cambridge University Press.
 33. Hussain, Z., Mujahid, F., & Anwar, U. (2022). Climate Change in Pakistan: Impacts, Strategies, and the Way Forward. *Pakistan Languages and Humanities Review*, 6(1), 181-192.
 34. Shahzad, M. F., Abdulai, A., & Issahaku, G. (2021). Adaptation implications of climate smart agriculture in rural Pakistan. *Sustainability*, 13(21), 11702.