SOCIAL SCIENCE REVIEW ARCHIVES
ISSN Online: 3006-4708
ISSN Print: 3006-4694
https://policyjournalofms.com

The Impact of Climate Change on Food Security in KPK, Pakistan an Analysis

Sher Akbar[1]

[1] M.Phil Scholar, Pakistan Studies, Qurtuba University of Science and Technology Peshawar, Pakistan, sherakbar2008b@gmail.com

DOI: https://doi.org/10.70670/sra.v3i1.518

Abstract

This research investigates the effects of climate changes on food production and accessibility, particularly for the country's most vulnerable populations. Additionally, the study explores potential adaptation and mitigation strategies, such as implementing climate-resistant agricultural methods, water management, and policy reforms, to ensure food security to deal with climate change. Pakistan, a country with a fast-growing population and inadequate arable land, is experiencing many challenges in preserving food security due to the mounting threats of climate change. As a country extremely susceptible to the effects of global warming, it faces significant threats due to fluctuations in temperature, precipitation patterns, and extreme weather events. These factors directly impact agricultural productivity, the availability of water, and livestock health. The research is qualitative in nature because it helps to explain comprehensively and supports interpretive goals. Qualitative research methods are applied for data collection since the nature of the research is qualitative. The data source is secondary in nature. The findings emphasize the need for immediate action for inclusive and cohesive approaches to address the complex problem of climate change and its implications for Pakistan's food security. To face the challenges of climate change adaptation of sustainable land management, decentralized renewable systems of energy and Insurance System for crop are recommended.

Keywords: Challenges, Climate Change, Food Security, Mitigation Strategies.

Introduction

Climate change could possibly disturb development toward a world zero hunger. An obvious and from other related indicators of nutrition, such clear global designs is visible of the effects of climate change on production of crop that could have effect availability of food internationally. The strength of entire food systems of may be at danger because of short-term inconsistency in supply. But the potential effect is less visible at local level however it is predictable that climate unpredictability and change will worsen food insecurity in areas currently susceptible to hunger and Malnutrition (Wheeler & Von, 2013, p.511). The existing evidence highlights the requirement for extensive investments in mitigation actions for a towards a climate-smart system of food, that is more effective to effects of climate change on food security.

Literature Review

In the studies of Wheeler & Von, (2013) & Hasibullah, (2009) explains over the last few decades, climate change has received world attention. Both developed and developing countries are facing adverse socio-economic effects of environmental deterioration and Global Warming. But the poor nations face much more than the rich ones. According to Berrang & Paterson (2011), & Dietz, et al.

(2020) because of economic limitations and technological restraints, majority of the developing countries is Incapable to take solid policy-decisions for speedy action regarding environment and climate - related problems. The major challenges faced by poor countries, which comprise energy deficiencies, discontent with multilateral initiatives, weak global collaboration, and absence of no clear plans for future actions.

Taylor, et al. (2013) & Nelson, et al. (2009) & Garnaut (2008) describes in spite of these problems, possibilities exist, for example nuclear power should be replaced with carbon-emitting energy sources to address climate-related issues. Moreover, renewable energy technologies can effectively play role in dropping carbon dioxide emissions, though they still need more technological progresses and market acceptance.

According to the Ahmad, & Farooq, (2010) & Abrar, & Maryiam (2023) Pakistan is facing challenges in upholding food security because of climate change and its effects on agricultural production. At first The Green Revolution in the 1960s, was effective in increasing agricultural production and food security. But its effect has lessened with the passage of time because of reduced natural resources and climate change. The impact of climate change on food security are both important and quantifiable, predominantly in the province of Punjab, where climate change considerably disturbs production of food at different phases of its development, in which temperature and rainfall are critical factors.

Material and Methods

The epistemology of research is posting positivist and the nature of research is qualitative. The research is centered on the following objectives. To investigates the effects of climate change on food production and accessibility. To analyze the impact of climate change on food security. The study explores potential adaptation and mitigation strategies to ensure food security in the face of climate change. Based on the objectives of the study, the following questions are posed. What do climate change effects food production and accessibility? How climate change pose threat to food security? Why adaptation of adaptation and mitigation strategies are inevitable to ensure the food security? For present research secondary type of data is used. Electronic and print sources are used. Print material comprised books, research articles published reports and newspapers. While electronic sources contained Google Scholar and JSTOR. The current study has analytically handled for analysis the process of integrative review is applied (Neuman, 2011,p.104). Approximately 90 studies comprised books, research articles, published and reports gathered from websites, libraries, Google scholar, and JSTOR, were studied for the reason that for the analytical procedure literature review is essential. This research is only limited to impact of climate change on Food Security in Pakistan and its conclusion may be limited to the climate's change effects on food security in perspective of challenges and mitigation strategies. So, there is no assurance of the application of the findings of this research to another dimension of climate change.

Results and Discussion

Food security

The term "food security" denotes the access to satisfactory quantity of food for acquiring nutritional energy requirements that indicates for various as self-sufficiency as creating needs food locally (Pinstrup ,2009,p.6).According to World Food Summit (1996) 'food security occurs when all individuals, at all times , have economic and physical and reach to adequate healthy food to fulfil

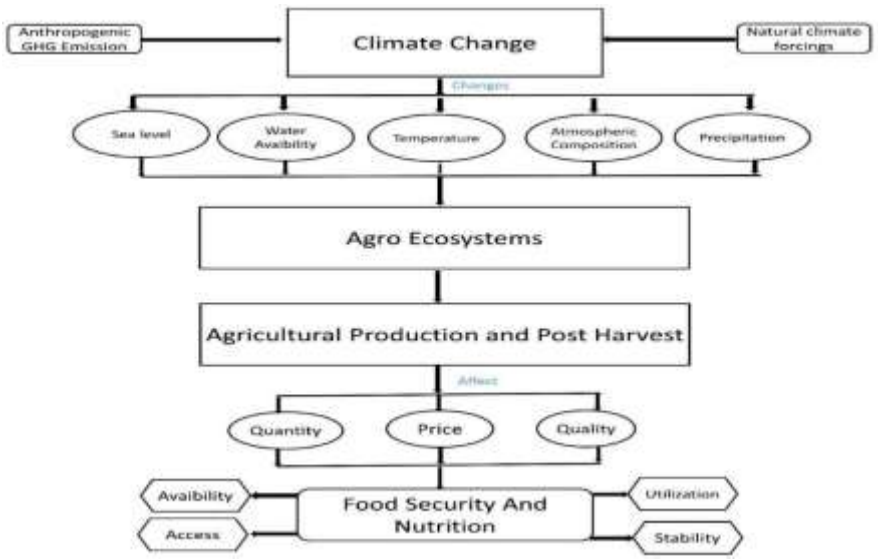
their nutritional requirements and food choice for a healthy and energetic life'(Kotir, 2011,p.597). This definition covers five important features: obtainability, access, permanency, dietetic rank and preferences of food. All of these elements are effected by economic, physical, political and other situations in societies and even inside households, and are frequently damaged by tremors such as natural adversities and wars.

Food security and Climate change

Climate is defend as the average situation of the weather at a region generally over a course of years as displayed by wind, temperature, velocity, and rainfall(Muluneh, 2021,p.14).Whereas climate change is defined as the variation in the climate of an region as a consequences of anthropogenic and natural upheaval(Khan, 2019,p.62) for example the weakening of greenhouse and the ozone layer impacts(Kotir,2011,p.597). Climate change may consequence of several factors, comprising changes in natural processes, solar radiation, long-term variations in the orbit of Earth and human-generated effects on the planet (Harnisch, et al., 2000, p. 1885). Whereas future forecasts usually consider only the effect of human actions, for example amplified greenhouse gases and other anthropogenic elements (Houghton et al.,2001, p.33). The 20th century experienced the most substantial warming tendency of the last century, with average temperatures increasing by about 0.6°C. Though, future temperature increases are estimated to surpass this pace, with predictable rises ranging from 0.1 to 2°C per decade.

Figure1

Impact of Climate Change



Source: Rahman et al., (2022).

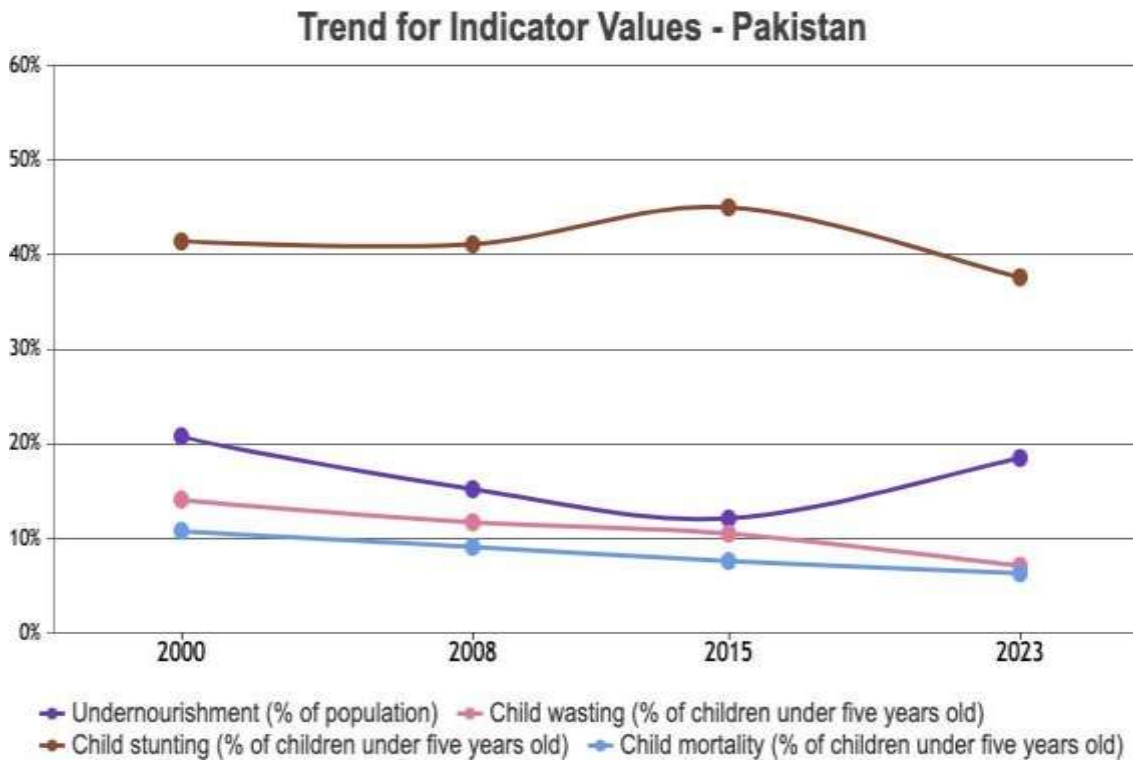
End hunger, attain food security and improve the quality of nutrition are at the core of the sustainable development goals (Bouis, & Hunt, 1999, p.185). The World has dedicated to eliminate absolute poverty and hunger by 2030. But climate change is declining the livelihoods and food security of the rural poor, who comprises approximately 80% of the world's poor. The impacts of climate change on ecosystems are already extreme and extensive. Climate change carries a cascade of effects from

agroecosystems to livelihoods (Baldos, 2014, p.14). Climate change influences directly agroecosystems, which consecutively has a potential effect on agricultural productivity, which initiatives economic and social effects, which influence livelihoods (Dawson, et al.,2016, 436).. In other words, effects transform from climate to the environment, to the productive scope, to economic and social scopes (Ericksen, 2008, p.238). So, guaranteeing food security in the face of climate change is among the most overwhelming challenges facing humanity. Action is immediately required now to lessen vulnerability and intensify resilience of food systems to guarantee food security and better nutrition for all.

Food security in Pakistan

According to Global Hunger Index 2023, Pakistan ranks 102nd out of the 125 countries. With a score of 26.6, Pakistan has a serious level of hunger.

Figure 2



The condition in Pakistan is not hopeful as 21 million population in urban areas are facing food insecurity in terms of (calorie consumption). This problem is worst in province of Baluchistan, where 20 districts have extremely food-insecure urban populations. In Province of Sindh six and five in Khyber Pakhtunkhwa are also facing food insecurity, though Punjab seems comparatively better to other provinces (Arshad, & Shafqat, 2012, p. 141.). In rural regions, 80 districts are facing issue of food in security, in which mostly backward 38 districts also included. Across many regions, 28 districts of KPK, 22 of Baluchistan, 11 in Sindh, 10 in Punjab, and 5 districts of Northern Areas face food insecurity (Khattak et al., 2003, p.132).

Climate Change and Food security in Pakistan

The Germanwatch Global Climate Risk Index calculates data on four indicators: Deaths in the consequences of climate change, the number of deaths per 100,000 people, losses per unit of gross domestic product and the aggregate of losses in US$ in buying power parity. Every country's index score is calculated from a country's average position on all four indicators. According to Global Climate Risk Index 2020, more than 526,000 deaths reported all over the world, and from 1998 to 2018 losses of $3.3 trillion were experienced attributed to 11,500 climate change-related factors. Pakistan is the 5th most vulnerable country in the world to climate change. Pakistan grieved 500 climate change- related demises and $3.8 billion economic losses because of more than 152 extreme weather happenings from 1999 to 2018.

Table 1

Climate Change -Key Indicators

Indicators	Rank	Weighting	Rating
GHG Emission	18	40%	High
GHG per capita- Current level (Including LULUCF)	4	10%	very High
(excluding LULUCF)	59	GHG per capita Current trend 10%	very Low
GHG per capita— Compared toa well – below- two- degree bench mark	4	10%	very High
GHG 2030 Target - two- degree bench mark	15	- Compared to a well –below 10%	High

Global Climate Risk Index 2024, ranks Pakistan 30th overall and classifies it as a medium performer. In climate policy, Pakistan scores low in Renewable Energy and ranks very low in greenhouse gas emissions and Energy use has a high rating. It is significant to note that Pakistan is one of the countries experiencing a severe climate crisis. For example, the disastrous floods in 2022 accentuate this vulnerability.

Challenges

Climate change has an important effect on food security in Pakistan and carrying many challenges. Regrettably, "Pakistan has confronted about 150 weather-related occurrences as a direct consequence of climate change" Some of the main challenges that Pakistan experiencing because of climate change regarding food security (Munir, & Ejaz, 2010, p.370) comprise:

Unpredictability of weather

Severe weather unpredictability causes floods, heat waves and droughts have become more recurrent

and extreme become the reasons of crop failures, decrease quantity of crops, and damage of livestock. This can consequence in food scarcities and higher prices for buyers. Variations in rainfall are not uniform for example in sub-humid and humid areas there will be rise in monsoon rainfall, while in the coastal and hyper- arid regions there will be decline in winter and summer rainfalls. Study on wheat crop has revealed that a rise in extreme temperatures can accelerate the growth procedure and curtail the grain filling phase. Moreover, an escalation in mean minimum temperature throughout the adulthood phase has been establish to significantly boost crops. Rainfall is another vital climate aspect, as a greater and more constant quantity of rainfall has been related to a considerable flow in wheat crop.

Rise of Temperature

One of the most noteworthy effects of climate change is the increase in global temperatures, known as global warming. This can have a wide range of consequences, comprising the melting of glaciers, recurrent and severe heatwaves, rising sea levels, changes in rainfall patterns, and changes in ecosystems and wildlife natural environments. The rise of temperature can change the timing of sowing and reaping seasons and possibly decrease total production (Ashfaq et al., 2011, p. 112). This can disturb the chain of food supply and intensify food insecurity. Climate change disturbs the crop of rice when it is in the flowering and milking phase (Ahmed, & Javed,2016, p.15). Maize crop has an undesirable relationship with temperature; higher temperature inclines to low maize crop. Temperature also harmfully affects arid region crop production. (Shakoor et al., 2011, p. 329). Decline in production of crop because of increasing temperatures is probably to reason shortfall: in production of wheat approximately 6-8%, and in rice by approximately 15-20%, near the end of this century.

Melting of Glaciers

Many large glaciers exist in Pakistan, containing the second-largest glacier on Earth in non-Polar regions is the Siachen Glacier (Lodhi et al., 2024, p.148). Pakistan is very worried about the melting of these glaciers because it might cause floods, land sliding, and a shortage of water (Xu, et al.,2009, p.529). Melting of the Himalayan Glaciers in the Indus River System gives carries great possibility of natural tragedies like floods and droughts(Aslam et al.,2021,p.204).. Such radical variations in temperature and low precipitation increase hurdles in the agriculture production and strengthen food insecurity. Research displays that about 67% of glaciers in the Himalayas are reducing because of extreme climate conditions Pakistan is predominantly vulnerable as its glaciers are disappearing at a faster rate than glaciers somewhere else in the world(Muhammed et al., 2004). WGHG (Working Group on Himalayan Glaciology) warned in 1999 that if shrinking of continues unimpeded, by 2035 Pakistan could lose its glaciers (Rees & Collins, 2006, p.2162). This constant glacial shrink consequences in floods and landslides in lower areas, producing destruction in regions like Sindh and Punjab and almost every year.

Eruptions of Pest and disease

Mounting temperatures can generate more satisfactory circumstances for pests and diseases that can harm crops. This can decrease crop production and cause food scarcity.

Freshwater shortage

Pakistan undergoes a freshwater shortage, and the Indus River and its tributaries Fulfill the requirements of water for the majority of the population. Increasing temperatures have an impact on the water supplies of the country due to high temperatures can intensify the evaporation and water pressure, leading to water lack for agriculture (Ahmed,2015, et al, p.94). This can affect crop irrigation and decrease the production of crops, impacting food security.

Impact on livestock

A temperature rise can also affect the production of livestock by raising heat stress on animals, decreasing feed quality, and upsetting breeding cycles that can affect the availability of meat, milk, and eggs (Abdela, 2016, p.420).

Land degradation

Climate change aggravates land degradation through processes like erosion, salinization, and nutrient reduction, making it problematic to keep fertile land for farming. Pakistan is fronting many climate change threats that are affecting its food security, amongst them land degradation appears to be the worst warning. In Pakistan, land degradation largely includes and desertification, deforestation, soil erosion, sodicity, salinity and, water logging, reduction fertility of soil and adverse nutrient balances.

Table2

Land degradation in Pakistan

Category	Description	Causes	Consequences	Impact
Soil Erosion	Loss of topsoil due to water and wind erosion	Deforestation, intensive agriculture, overgrazing, mining	Reduced soil fertility, loss of agricultural land, increased sedimentation in water bodies	15% of Pakistan's land area is affected
Salinization	Soil degradation due to excessive salt buildup	Irrigation with salty water, poor drainage, and inadequate crop management	Reduced soil fertility, increased crop failure, and decreased agricultural productivity	20% of Pakistan's agricultural land is affected
Waterlogging	Excess ater accumulation in the soil due to poor drainage and irrigation	Inadequate drainage systems, inefficient irrigation practices, and over-irrigation	Reduced soil aeration, increased soil salinity, and decreased crop growth	25% of Pakistan's agricultural land is affected

	practices			
Deforestation	Loss of forest cover due to logging, urbanization, and agricultural expansion	Over-logging, urbanization, agricultural expansion, and illegal logging	Loss of biodiversity, reduced carbon sequestration, and increased soil erosion	1.4 million hectares of forest have been lost since 1990
Overgrazing	Over-use of grazing land by livestock leading to soil degradation and loss of vegetation cover	Over-population of livestock, inadequate grazing management, and poverty	Reduced vegetation cover, soil erosion, and decreased biodiversity	20% of Pakistan's rangeland is affected
Land Fragmentation	Division of large landholdings into smaller plots leading to inefficient use of land and resources	Inheritance patterns, fragmentation due to sale or partition of landholdings, and lack of consolidation policies	Reduced agricultural productivity, increased costs for farmers, and decreased food security	30% of Pakistan's agricultural land is fragmented
Urbanization	Rapid expansion of urban areas leading to conversion of agricultura	Population growth, economic growth, and lack of urban planning policies	Loss of agricultural land, increased food prices, and decreased urban sustainability	25% of Pakistan's agricultural land is being converted to urban use

	l land to residential and commercial use	

Overall, the climate change poses a serious risk to global food security, demanding adaptation and mitigation strategies to guarantee the availability and accessibility to satisfactory, safe, and healthy food for all.

Mitigation strategies

Crop cultivars that are more resilient to temperature and drought possibly be produced or used. Water-saving systems and modern irrigation substructure may also be used. Cohesive watershed management, replanting of catchment regions, extra water storage structure, variation of energy sources, comprising investment in renewable and minor hydropower plans, better weather predicting system, and serious infrastructure rebuilding may also be used (Hussain, et al., 2022, p. 190).To alleviate these challenges and guarantee food security in the appearance of climate change, Pakistan can implement following strategies:

Awareness on climate Change

For sustainable production of agriculture and farm household growth, awareness on climate change (Garnaut, 2008, p.24) effects and possible adaptation plans should be extensively identified to update environmentalists, decision-makers and farm households.

Institutional measures

Addressing climate change and dropping of releases of greenhouse gas are significant to minimizing the effects of increasing temperatures and conserving a better and sustainable environment for future generations. Variations in temperature, rainfall trends, and the melting of glaciers in the Himalayas, the source of the majority of the rivers of the Pakistan are earlier being sensed in the country. Due to these strategies of flood management in Pakistan must focus the climate change adaptation and mitigation measures. Many kinds of natural disasters, for example earthquakes, floods, droughts and landslides are common in Pakistan. These disasters repeatedly occur concurrently, worsening the effects on the people and the economy (Hussain, 2022, et al., p.189). A cohesive method to disaster threat decrease is essential to lessen the hazard of floods and other natural adversities in Pakistan. General, the increase in temperature because climate change is a noteworthy risk to global food security, necessitating adaptation and mitigation strategies to guarantee the obtainability and access to adequate, safe, and healthy food for all.

Climate-smart agriculture

Executing climate-smart agricultural plan that intensify productivity, increase flexibility, and decrease greenhouse gas emissions can support agriculturalists adjust to changing climate situations. This comprises methods like preservation agriculture, agroforestry, and incorporated pest management (Shahzad et al., 2021, p.11702).

Developed irrigation systems

Developing effective and sustainable irrigation systems can support manage water resources more efficiently, guaranteeing that agricultural production is not stalled by water shortage.

Variation in crops and livestock

Encouraging agriculturalists to cultivate a diversity of crops and rear diverse livestock can support decrease the threats connected with climate change, as diverse species have variable acceptances to changing environments (Jamil et al., 2023, p. 1162).

Investment in research and development

Supporting research and development struggles can help to the finding of new crop diversities and technologies that are well suitable to handle with climate change.

Capacity building and responsiveness

Giving training and awareness on climate change effects and adaptation strategies to agriculturalists, decision-makers, and other stakeholders can support acquire the essential skills and knowledge to face these challenges efficiently.

Institutional and policy and reforms

Evolving and applying plans that backing climate-adaptable agriculture and food security, alongside supporting the institutional framework to implement these strategies, is vital for a effective reaction to climate change (Ahmad, 2010, p. 920). By addressing these challenges and executing suitable mitigation strategies, Pakistan can work to guaranteeing food security in the face of climate change.

Conclusion

Pakistan is vulnerable to climate change due to its geographical position, yearly mean temperature in Pakistan has risen. Furthermore, the unpredictability of weather and emissions of greenhouses has posed a serious challenge to the food security of Pakistan. To address the complex problem of climate change for food security Pak should adopt potential adaptation and mitigation strategies, such as implementing climate-resistant agricultural methods, water management, and policy reforms, to ensure food security in the face of climate change.

References

Abdela, N., & Jilo, K. (2016). Impact of climate change on livestock health: A review. Global Veterinaria, 16(5), 419-424.

Abrar, M. A., & Maryiam, M. (2023). Climate change impact on food security in Pakistan. Pakistan Journal of Multidisciplinary Research, 4(1), 131-146.

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.

Ahmed, K., Shahbaz, M., Qasim, A., & Long, W. (2015). The linkages between deforestation, energy and growth for environmental degradation in Pakistan. Ecological Indicators, 49(1), 95-103.

Ahmed, V., & Javed, A. (2016). Climate Change and Agriculture. In National study on agriculture investment in Pakistan (pp. 11-16). Sustainable Development Policy Institute. http://www.jstor.org/stable/resrep02851.5

Anjum, S. A., Wang, L. C., Xue, L., Saleem, M. F., Wang, G. X., & Zou, C. M. (2010). Desertification in Pakistan: Causes, impacts and management. J. Food Agric. Environ, 8(1), 1203-1208.

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.

Ashfaq, M., Zulfiqar, F., Sarwar, I., Quddus, M. A., & Baig, I. A. (2011). Impact of climate change on wheat productivity in mixed cropping system of Punjab. Soil & Environment, 30(2). 110-114.

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.

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.

Berrang-Ford, L., Ford, J. D., & Paterson, J. (2011). Are we adapting to climate change? Global environmental change, 21(1), 25-33.

Bouis, H., & Hunt, J. (1999). Linking food and nutrition security: past lessons and future opportunities. Asian Development Review, 17(1), 168-213.

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.

Dietz, T., Shwom, R. L., & Whitley, C. T. (2020). Climate change and society. Annual Review of Sociology, 46(1), 135-158.

Ericksen, P. J. (2008). Conceptualizing food systems for global environmental change research. Global Environmental Change, 18(1), 234-245.

Garnaut, R. (2008). The Garnaut climate change review (Vol. 13). Cambridge University Press.

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.

Hasibullah. (2009). (Environmental Challenges and Opportunities for the Developing Countries. Science Vision, 15(1), 1-14.

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.

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.

Khan, I., Lei, H., Shah, A. A., Khan, I., & Muhammad, I. (2021). Climate change impact assessment, flood management, and mitigation strategies in Pakistan for sustainable future. Environmental Science and Pollution Research, 28(4), 29720-29731.

Khan, S. (2019). Climate classification of Pakistan. International Journal of Economic and Environmental Geology, 10(2), 60-71.

Khattak, S. G., Habib, K., & Khan, F. S. (2008). Women and Human Security in South Asia: The Cases of Bangladesh and Pakistan. University Press.

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.https://doi.org/10.1007/s10668-010- 9278-0

Lodhi, S., Ayyubi, M. S., Hayat, S., & Iqbal, Z. (2024). Unravelling the Effects of Climate Change on Agriculture of Pakistan: An Exploratory Analysis. Qlantic Journal of Social Sciences, 5(2), 142-158.

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. https://doi.org/10.1186/s40066-021-00318

Munir, H., & Ejaz, Q. (2010). Global water crisis and future food security in an era of climate change. Food Policy, 35(5), 365-377.

Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson, R., Sulser, T., Zhu, T., &Lee, D. (2009). Climate change: Impact on agriculture and costs of adaptation. International Food Policy Research Institute.

Neuman, W. (2011). Social Research Methods: Quantitative and Qualitative Approaches.Pearson.

Pinstrup,A.P.(2009). Food security: definition and measurement. Food security, 1(1), 5-7. https://doi.org/10.1007/s12571-008-0002-y

Rahman, M. M., Akter, R., Abdul Bari, J. B., Hasan, M. A., Rahman, M. S., Abu Shoaib, S., Rahman, S. M. (2022). Analysis of Climate Change Impacts on the Food System Security of Saudi Arabia. Sustainability, 14(21), 14482.

Rees, W. G., & Collins, D. N. (2006). Regional differences in response of flow in glacier- fed Himalayan rivers to climatic warming Hydrological Processes, 20(10), 2157-2169.

Salam, A. (1980). Structure of farm holdings, land tenure and fragmentation in Pakistan. Pakistan Economic .and Social Review, 18(3/4), 112-126.

Shahzad, M. F., Abdulai, A., & Issahaku, G. (2021). Adaptation implications of climate- smart agriculture in rural Pakistan. Sustainability, 13(21), 11702.

Shakoor, U., Saboor, A., Ali, I., & Mohsin, A. Q. (2011). Impact of climate change on agriculture: empirical evidence from arid region. Pak. J. Agri. Sci, 48(4), 327-333.

Syed, A., Sarwar, G., Shah, S. H., & Muhammad, S. (2021). Soil salinity research in 21st century in Pakistan: its impact on availability of plant nutrients, growth and yield of crops. Communications in Soil Science and Plant Analysis, 52(3), 183-200.

Taylor, R. G., Scanlon, B., Döll, P., Rodell, M., Van Beek, R., Wada, Y., Treidel, H. (2013). Ground water and climate change. Nature climate change, 3(4), 322-329.

Wheeler, T., & Von Braun, J. (2013). Climate change impacts on global food security. Science, 341(6145), 508-513.

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.

Yang, X., Yang, Q., Zhu, H., Wang, L., Wang, C., Pang, G., & Hussain, S. (2023). Quantitative evaluation of soil water and wind erosion rates in Pakistan. Remote Sensing, 15(9), 2404.