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

Climate change: A growing challenge for food security in Pakistan

Dr. Afshan Aziz[1]

[1,] Assistant Professor Department of Political Science Lahore College for Women University Lahore Email: afsha.lcwu@gmail.com

DOI: https://doi.org/10.70670/sra.v3i1.442

Abstract

Pakistan, with a mushrooming population and insufficient cultivable area, is facing multiple challenges in ensuring climate change-induced food security for its people. As a country highly liable to the drastic effects of global warming, it confronts major risks including temperature changes, variations in precipitation, and natural disasters. These factors have a significant impact on agricultural output, water availability, and livestock health. So, the current article aims to look into the adverse effects of climate change on food security. In addition, the article investigates various mitigation and adaptation options, like introducing climate-smart agricultural technologies, water management, and legislative reforms, to maintain food security and counter climate change hazards. The study has adopted a qualitative research methodology which provides a full explanation and supports interpretive objectives. Data is collected using qualitative research methodologies since the nature of the inquiry is qualitative. The data source is of secondary nature. The study findings underline the urgent requirement for comprehensive and diverse methods to address the intricate issue of global warming and its consequences for Pakistan's food security.

Keywords: Climate Change, Food Security, Policies

Introduction

Pakistan is believed to be extremely vulnerable to the drastic effects of climate change. Ironically, the country ranks 16th in regard to climate change sensitivity despite being 135th in regard to GHG emissions per capita. All facets of sustainable development are seriously threatened by climate change, which also has a significant impact on a wide range of ecosystems and areas, including food, energy, and water; ecological diversity; the coastal and marine environment; and the frequency and severity of climate-related disasters like drought and floods (Khan et al., 2016). The vision of transitioning to a future with 'no hunger' might be hampered by climate change. It is evident from various nutrition indicators that global warming has a direct impact on agricultural output, which may affect the availability of food globally. Short-term supply fluctuations might jeopardize the sustainability of the overall food supply systems. Although the possible impact is less obvious at the local level, it is certain that climate change and volatility would exacerbate food insecurity in regions that are already at risk for malnutrition and famine (Wheeler & Von, 2013). Struggling economies in South Asia and Africa rely on subsistence agriculture due to limited financial and technical means to address the negative effects of climate change. This negatively affects the overall development of these countries. Research indicates that changes in temperature and precipitation patterns have a significant impact on global and regional food production (Janjua et al., 2010; Mahmood et al., 2012). The analysis predicts that wheat output, a staple in many South Asian countries, will decline by over 50% by 2050. A number of studies suggested that if climate change continues, South Asian countries may experience over 40% agricultural losses due to global warming (Arnell et al., 2004). The existing body of research shows that significant investments in mitigation measures are necessary to move towards a climate-smart food system that is more resilient to the adverse

impacts of climate change on food security. Since, underdeveloped countries lack the resources for adaptation measures the intensity of climate change-driven consequences is more severe (Naz, Iqbal, & Begum, 2024). The impact of climate change on agricultural productivity is making it difficult for Pakistan to maintain food security (Ahmad & Farooq, 2010; Abrar & Maryiam, 2023). Initially, the 1960s Green Revolution was successful in raising food security and agricultural output. However, over the years, its impact has diminished due to climate change and the depletion of natural resources (Naz, Iqbal, & Begum, 2024). Thus, climate change has a significant and measurable influence on food security, especially in an agrarian country like Pakistan, where it significantly disrupts food production at various stages. Hence, exploring the topic is crucial to help understand the depth of the issue as well as to propose potential solutions.

1. Research Objectives and Questions

The study is based on the following objectives.

To examine how food security is affected by climate change in Pakistan.
To establish a link between climate change and all dimensions of food security.
To underline the policies adopted by Pakistan and propose recommendations for the future.
The following inquiries are made in light of the study's objectives.
How is food security threatened by climate change?
What implications does climate change have on the various dimensions of food security?
What policy measures can be adopted to guarantee food security in Pakistan?

Research Methodology

The current article adopts a qualitative approach and has a post-positivist epistemology. Secondary data is employed which is collected using numerous print and electronic media sources. Research papers, books, published reports, and newspapers were all sources for the print media. On the other hand, JSTOR and Google Scholar were electronic sources. The integrative review procedure has been used to analyze the current work analytically. Because a literature review is crucial to the analytical process, a number of studies—which included books, research papers, published reports, and materials obtained from libraries, websites, Google Scholar, and JSTOR—were examined. However, this study solely looks at how global warming affects food security in Pakistan, and its findings could only cover the implications of climate change on this sector. Therefore, there is no promise that the results of this article will be applied to several other sectors that are affected by climate change.

Discussion/Analysis

Climate Change and Pakistan

Parameters like preassure, humidity, temperature, and precipitation all change in the worldwide environmental scenario. One term used for these alterations in the global environment is "climate change" (Lipczynska-Kochany, 2018). The primary cause of the environmental changes is human activity. Carbon dioxide gas, which is mostly released by human activity, is the cause of global warming. This gas that traps heat remains in the atmosphere for a long time. Therefore, the next generation will still be impacted by global warming even if we stop generating heat-trapping gases today (Balaban & Gedikli, 2018). Moreover, the global economic system is eventually impacted by the significant disruptions to the natural ecosystem brought about by climate change (Kohler & Maselli, 2009). It affects different regions of the world in varying degrees of severity. According to Ali and Erenstein (2017), certain regions are affected more than others. Pakistan is among the countries expected to be most severely affected by climate change. Pakistan was ranked 12th in 2012 and 8th in 2015 on the list of countries most affected (Kreft et al., 2014). Floods, droughts, storms, and cyclones have all seriously damaged Pakistan in recent years (Zhu et al., 2015). Due to several factors, such as its dependence on the agricultural sector, water scarcity, geographic location, and lack of assets to adjust to the shifting climate, it is poised to become the country most severely affected by climate change (Balkhair et al., 2018). The high rate of Himalayan glacier melting is just one of

the many factors contributing to Pakistan's extreme climate change effects (Abid et al., 2016). Other factors include flooding, fluctuating rainfall patterns, droughts, a shortage of water supplies, land sliding, storms, extreme heat waves, pest and disease attacks, changes in the length of the seasons, and health problems (Hussain et al., 2016). These natural disasters become more frequent and resulted in significant losses (Qasim et al., 2015). Because of Pakistan's climate, many rural residents suffered greatly during the 2010 and 2014 floods (Fahad & Wang, 2020; Tabasam, Rasheed, & Fatima, 2022). The flood that occurred in 2022 is the most severe and catastrophic, having a significant impact on the economy. The "Office for the Coordination of Humanitarian Affairs" (OCHA) study states that Pakistan's flood situation is at its worst point ever. Approximately eight million individuals are thought to have been displaced. There are 7.8 million homes that have been totally destroyed. There were 1739 fatalities altogether. Moreover, in Pakistan, the agriculture sector was severely impacted by the 2015 flood, which destroyed standing crops on about millions of acres (Tabasam, Rasheed, & Fatima, 2022). Over the course of the 20th century, the country's average annual temperature rose by 0.57 0C, or 0.06 oC every decade. Pakistan's average yearly temperature showed an upward trend (FAO, 2020). Because of climate change, the country's precipitation ratio also fluctuated over time. In Pakistan, the precipitation ratio rose by 25% over the previous century. Crop productivity and output are affected by changes in temperature and precipitation levels. Additionally, it has an impact on the fertility of the soil (Schmidhuber & Tubiello, 2007).

Food Security and Pakistan

The largest issue facing the expanding population is food security. Food security, as per the "World Food Summit", is the steady supply of staple foods to sustain growing food demand and offset shifts in production and cost (Nations, 1975 as cited in Tabasam, Rasheed, & Fatima, 2022). In 1983, food and agricultural organisations updated their concept of food security to guarantee that everyone always has physical and financial access to the staple foods they require (FAO, 1983). In 1986, the World Bank expanded the definition of food security to include everybody always having access to sufficient food for a healthy and active life. Every country, including Pakistan, has the fundamental and significant goal of ensuring that people have access to food. According to FAO estimations, climate factors are responsible for eighty percent of the major disasters that could endanger the country's food security (FAO, 2018). The most often used approach for food security measures is a daily dietary energy intake of 2700 kcal (Molden et al., 2007). One liter of water is required to produce one kcal for an average diet (Patt et al., 2009). Global warming might cause 9 billion individuals to be food insecure by 2050. According to Von Grebmer et al. (2017), increasing agricultural output is necessary for reducing poverty and ensuring food security. According to the FAO (2014), food insecurity affects 65% of the world's population, including Congo, China, India, Ethiopia, Pakistan, Bangladesh, and Indonesia. Food insecurity is a global issue that can lead to increased restlessness. Food availability decreases when output diminishes (Tabasam, Rasheed, & Fatima, 2022). Pakistan has a population of about 212 million, out of which fifty-eight percent are suffering from malnutrition and twenty percent are experiencing food insecurity. Pakistan ranks 102 out of 125 countries based on the Global Hunger Index 2023, indicating acute food insecurity. Climate change drastically threatens Pakistani livelihoods (Naz, Iqbal, & Begum, 2024). Pakistan cannot adequately mitigate the impact of disasters. The impact of climate change on vital food crops like wheat and rice could cost Pakistan $20 billion by the middle of the century (Shahzad & Amjad, 2022). According to the International Institute for Applied System Analysis in Austria, production of all the major crops and grains will decline, with wheat production reaching its peak by 2080 (Chaudhry, 2017). The United Nations Development Agency and the Pakistani government both estimate that 40% of Pakistanis are food insecure. According to calculations made in 2003, only 46 of Pakistan's 120 districts have food security; the remaining districts were classified as food insecure (Tariq et al., 2014). Given Pakistan's reliance on hydroelectric power, the country's energy and water supplies will run out in the upcoming years. It will eventually result in food insecurity and low productivity. The nation is making every effort to raise the degree of food security while taking these difficulties into account. According

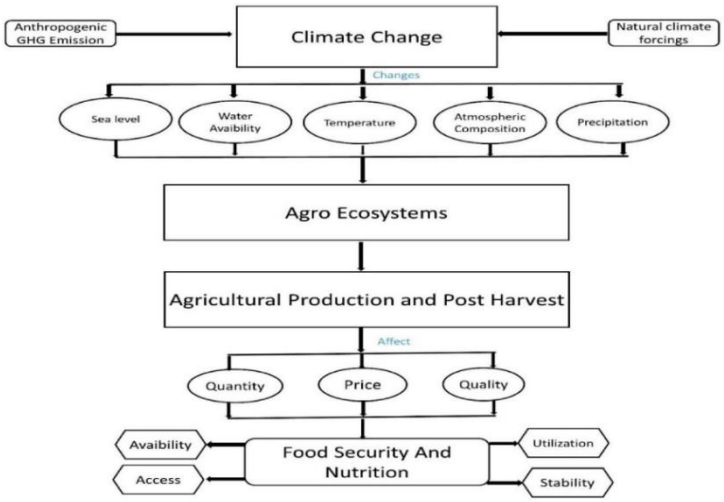
to the SDGs, Pakistan wants to eradicate hunger by 2030 (Von Grebmer et al., 2017) which seems impossible given the situation of climate change. Rahman (2021) compares Pakistan to other nations in the region like the SAARC members, and also to the average food security grade among developing countries. According to the report, Pakistan is food insecure when compared to SAARC and other emerging economies in Africa and Asia. According to the research, Pakistan performs poorly in two of the most essential pillars of the food security model: availability of food and utilization, as well as supply stability. The findings highlight malnutrition, contaminated water, and sanitary facilities are significant barriers to reaching the best utilization profile.

4.3. Impact of Climate Change on various dimensions of Food Security

Climate change has a devastating impact on Pakistan's food security by affecting all four essential dimensions: availability, access, utilization, and stability.

Figure 1

Impact of Climate Change



Source: Rahman et al., 2022

Pakistan, a primarily agrarian economy with a high sensitivity to climate change, presents innumerable issues that are worsened by its socioeconomic status, geographical location, and dependence on natural resources. The following section covers a detailed discussion that specifically links each component of food security to Pakistan.

Food Availability

Food availability is defined as the production and supply of enough food that satisfy the population's demands (Farooq et al., 2022). In other words, it refers to whether every individual has enough food to suit his/her nutritional needs. It also takes into consideration the supply side of the food chain. Its measuring factors include food production, available technology, stocks, supply chain efficiency, and trade regulations at national as well as international levels. It is a well-known fact that the countries with a higher hunger index are expected to be more seriously impacted by climate change in terms of agricultural productivity and livestock loss. It has been determined that there is a strong pattern of global warming consequences for agricultural output, and it is anticipated that inconsistent climate change will have a negative impact on areas where malnutrition and food scarcity are already prevalent. Climate change is expected to reduce agriculture and livestock productivity across South Asia and Africa by 2050, according to a systematic analysis (Knox et al., 2012; Sultan, 2012). A study by Knox and colleagues (2016) also underlined that crop productivity declines are expected for maize, wheat, and sorghum, although estimates for rice and sugarcane remain ambiguous. Climate change impairs Pakistan's ability to guarantee food security in numerous ways.

Impact on Crop Yields

Policymakers in Pakistan prioritize wheat production as a staple food source. Wheat growing covers around 22.45 million hectares, with 12.52 million hectares watered by tube wells and 6.34 million hectares irrigated with canal water. The remaining 3.59 million hectares are rain-fed (GOP, 2017 as cited in). Between 2013-2014 and 2014-2015, wheat production decreased by approximately 1.9%. If temperatures rose by 30 degrees Celsius by 2050, the amount of wheat available per capita would decrease from 198 kg annually in 2012 to 84 kg annually. The wheat crop is at risk during the growth and flowering stages due to the increasing precipitation level (Zhou et al., 2019). Another study anticipated a 15–18% drop in basmati rice yield and a 6% drop in wheat yield (Chaudhry, 2017). The wheat crop provides 48% of Pakistan's population's calories. Three primary causes of the low wheat production are weed invasion, climate change, and tillage. Wheat yield can be increased by about 50–80% with new and efficient weed control techniques (Abbasi et al., 2022).

Natural Disasters

Flooding and catastrophic natural hazards are common in Pakistan, despite the fact that local flood types vary (Tariq et al., 2020). The floods that struck Pakistan in 2010, 2013, 2015, and 2022 caused enormous destruction. Businesses and homes closer to the river suffered damage as a result of the floods. Delays in the continuing political and development processes are caused by floods, along with damage to infrastructure, and the loss of crops, cattle, and animals. Thus, floods have a major effect on food security, especially in developing and emerging countries like Pakistan (Tabasam, Rasheed, & Fatima, 2022).

Water Scarcity

While the water levels in Pakistan are dropping, the country's population is growing quickly. Food output eventually declines as water availability declines. By 2030, it is predicted that crop production will require more water, especially for food crops like wheat. An estimate states that until 2030, the demand for water will grow by every 10 degrees Celsius. It comes to the conclusion that the agriculture industry needs more water due to the rising temperatures (FAO, 2008).

Land Degradation

Rising temperatures and inefficient farming methods exacerbate soil erosion and desertification, particularly in arid locations such as Tharparkar. This shrinks agricultural land, limiting Pakistan's capacity to produce enough food (Tabasam, Rasheed, & Fatima, 2022).

Food Access

Food access refers to people's ability to afford and obtain food (Farooq et al., 2022). According to Ludi (2009) and Masipa (2017), food accessibility refers to a household's ability to obtain adequate quality food to fulfill dietary needs. Adequate money is necessary for households to purchase healthy food to preserve satisfactory nutritional levels (Gartaula et al., 2017; Gupta et al., 2019). In Pakistan, global warming worsens economic and physical obstacles to food access.

Economic Constraints

The effects of climate change on agriculture diminish the supply of critical foods, raising prices. Pakistan's already elevated inflation trends make food more costlier for low-income families, exacerbating the issue of hunger and poverty. Moreover, poor nations like Pakistan, find it challenging to implement climate change-related technology and practices (Abid et al., 2015; Kandlikar & Risbey, 2000).

Impact on Rural Livelihoods

Agriculture employs a significant portion of Pakistan's workforce. Climate shocks such as drought or flooding affect farming activities, resulting in decreased earnings and joblessness in rural populations. The economy as a whole suffered from climate change, but small farmers

were particularly hard hit since floods destroyed their lives and damaged their whole output (Ahmed & Schmitz, 2011).

Market Disruptions

Floods destroy bridges, roads, and transportation systems, interrupting food supply chains. Following disasters, isolated regions like Gilgit-Baltistan and southern Sindh frequently experience protracted periods of food scarcity due to restricted access to markets (Idris, 2021). Areas and population groups in Pakistan are most exposed to the combined effects of climate change, food insecurity, and COVID-19.

Food Utilization

Food utilization is the efficient biological use of food, which is accompanied by adequate nourishment, water, and health care. Any moderate change in climate has a significant impact on the consumption of food to meet nutritional and dietary requirements, as do other secondary elements such as water availability and sanitary conditions (Farooq et al., 2022). There are very few studies that take a comprehensive look at how climate change affects this component and driver of food security. Climate change influences food usage in Pakistan in a variety of ways:

Declining Nutritional Quality

Climate stressors, such as rising CO2, have an impact on crop nutritional value. According to research, staple commodities such as wheat and rice cultivated in shifting climatic circumstances may have reduced protein, zinc, and iron content, worsening malnutrition in Pakistan.

Health Impacts

As per Duran-Encalada and colleagues (2017), global warming also impacts the food supply chain by affecting drinking water. Undeveloped communities are frequently bereft of adequate sanitation facilities, causing hygiene difficulties during severe natural calamities like droughts or floods (Hashizume et al., 2008; Seneviratne et al., 2012). Inadequate hygiene systems can lead to stomach disorders that impair nutrient intake and are linked to temperature fluctuations (Lloyd et al., 2011). Global warming raises the risk of diseases such as diarrhea, cholera, and malaria, particularly during flooding. These disorders affect people's ability to absorb nutrients, increasing malnutrition rates, especially in regions susceptible to disasters like Sindh and Khyber Pakhtunkhwa (Farooq et al., 2022).

Food Stability

Food stability is the consistent availability and access to food across time (Farooq et al., 2022). Climate change has a significant impact on food price patterns, affecting both long-term and short-term variability (Myers et al., 2017; Farooq et al., 2022). Since the last decade, minor disruptions in the food chain, whether on the demand or supply side, have had an impact on prices, frequently raising them. Food instability is more widespread in underdeveloped cultures because impoverished people must spend the majority of their money on expensive staple foods (Gilbert & Morgan, 2010). Haile and Wossen (2016) highlight that global warming raises food volatility by interfering with the supply as well as the demand side. Global warming damages Pakistan's food stability through:

Seasonal Variability

Climate change alters traditional farming calendars, causing shifting seasons and unexpected monsoons. This makes it harder for farmers to schedule their cultivation and harvesting cycles, resulting in a lower year-round food supply.

Reduction in Livestock and land degradation

Livestock is also vital to Pakistan's food security. Global warming has a negative effect on cattle grass, water, and feed, causing communicable and fatal infections. As a result, milk as well as meat production has reduced significantly. Livestock productivity is heavily influenced by

factors such as feed quality, disease vectors, biodiversity, and animal diseases (Aftab & Hickey 2010). The changing climate exacerbates soil degradation through processes like salinization, erosion, and nutrient loss, making it difficult to maintain fertile ground for agriculture. Pakistan is facing numerous climate change dangers that are hurting its food security, with land degradation appearing to be the most serious warning. Deforestation, desertification, sodicity, soil erosion, salinity, waterlogging, reduced soil fertility, and negative nutrient balances are all examples of land degradation in Pakistan.

Climate Change Policies Adopted by Pakistan

Owing to the high vulnerability to detrimental consequences, the first ever "National Climate Change Policy" (NCPP) in Pakistan was designed in 2012. This policy framework aimed to motivate all parties involved to modify and push for mitigation. The policy highlighted that several sectors (agriculture, water, coastal belts, forestry, livestock, biodiversity, and ecosystems) are particularly sensitive to the consequences of climate change. Adaption strategies were also thoroughly examined (Shahzad & Amjad, 2022). However, the effective implementation of the NCPP-2012 was delayed due to various factors. Some primary factors among others were the lack of political commitment and prioritizing (Aslam et al., 2021). Moreover, inadequate professional assets and inter-ministerial cooperation also hindered effective policy execution. Thus, the delay in implementation demonstrates the Pakistani government's inadequate political will.In 2014, Pakistan established the Framework for Coordination of "Climate Change Programmed" (FICCP) in response to the NCCP. The FICCP developed a thorough roadmap to combat global warming, including mitigation, adaptation, research, capacity building, and raising knowledge. The "Framework for Implementation of Climate Change Policy" (FICCP) (2014-2030) aimed to integrate climate change into national planning and foster climate-friendly development. Despite having a blueprint to guide policy implementation, the process has been long and challenging (Afzal & Akhtar, 2021). Moreover, the efficiency of climate policy also depends on how provincial governments respond to vulnerable sectors. So the NCCP has emphasized the need for provinces to put together climate change policies, and policy frameworks (Afzal & Akhtar, 2021). Thus, the provincial governments worked towards achieving this goal. Pakistan's government established the "National Climate Change Policy" (NCCP) 2017-2030 in 2017. The approach aimed to strengthen institutional frameworks, promote global collaboration and integrate climate change considerations into development planning. The report identified key industries such as agriculture, water, forestry, and energy, and proposed strategies to improve resilience and reduce emissions (Waheed, Bernward Fischer, & Khan, 2021). Moving forward, NCPP-2021 was proposed which can be regarded as the revised version of the previous policies. The NCCP 2021 represents a considerable upgrade, providing a broader, action-oriented, and internationally harmonized framework (Khan, 2023). It effectively addresses Pakistan's developing climate issues and lays out an improved roadmap for implementation and monitoring. While the NCCP-2012 was proposed before the Paris Agreement, NCCP 2021 took into consideration the Paris Accord and the Sustainable Development Goals (SDGs). Additionally, Pakistan came up with numerous sectoral policies to counter the devastating impacts of global warming. Among these is the "National Food Security Policy" which was given in 2018. The policy was formulated to address the issues of food security, the agricultural sector, and national sustainability. The guidelines lay emphasis on all four dimensions of food security (Ahmad & Saboor, 2022). However, an initial review of the pertinent policies on food security, agricultural extension, and governing structures reveals that the majority of these regulations were drafted without taking into account the views and aspirations of different stakeholders, such as farmers, organizations, and support groups like the World Food Program (WFP), Food and Agriculture Organization (FAO), and others. Furthermore, no intrinsic links have been formed to support the formulation and execution of initiatives and plans through the separate institutional structures. According to numerous documents on the matter, policy evaluations are hardly ever carried out by the appropriate stakeholders, particularly at levels that call for particular focus in regard to geographical location, socioeconomic factors, poverty,

accessibility of the necessary assets, political will, and agricultural procedures. For instance, parts of KPK and Baluchistan are frequently omitted in evaluation exercises, leading to policies with limited universality and appeal (Fahad et al., 2024).

Recommendations

Pakistan in particular is in a very vulnerable position to climate change and face major threats of food insecurity due to most likely decline in agriculture productivity, water shortage, and frequent floods and droughts. Keeping in mind the policies put in place by Pakistan and the gaps in existing policies, this study has proposed the following comprehensive guide on how to avoid climate change effects and ensure sustainable food security.

Promoting Climate-Smart Agriculture

- Executing climate-smart agricultural plans that boost production, and flexibility, and reduce greenhouse gas emissions can help farmers adapt to changing climate conditions. This includes strategies such as preservation agriculture, agroforestry, and integrated pest management (Shahzad et al., 2021).
- Owing to the challenges posed by climate change, one policy that Pakistan should consider is switching to climate Resilient Crops. It should promote and disseminate heat, drought, and flood-resistant crops through Research and Development (R&D). Popularize the growth of local seeds so that they are tolerant to prevailing climatic factors in a given region.
- Besides, to increase the resilience of food production systems, crop diversification should also be embraced. Policymakers should encourage agriculturalists to grow diverse crops and rear various kinds of livestock. This can help reduce the hazards associated with climate change, as diverse species have varying tolerances for changing conditions (Jamil et al., 2023). Encourage the production of many cereal crops, pulses, and oil crops in order to avoid consecutive cultivation of water-intensive species such as wheat and rice.
- Pakistan ought to include agroforestry programs. Plant trees and shrubs next to crop plants so as to replenish the soil nutrients, also to reduce the effect of heat on the crops, and act as an additional source of income through timber and nontimber forest produce. Emerging technology solutions like remote sensing and GPS, IoT to help track/manage crop health, water, fertilizer, and all other resources used substantially.

Strengthening Disaster Risk Management

- Pakistan is prone to a variety of natural calamities, including droughts floods, earthquakes, as well as landslides. These calamities occur concurrently, exacerbating the effects on individuals as well as the economy (Khan & Hussain, 2023). A coordinated approach to disaster threat reduction is required to reduce the risk of floods and other natural disasters in the country.
- It is necessary to establish and implement the Early Warning Systems. For this reason, related departments should set up effective meteorological systems in the course of observing weather conditions. Innovate mobile applications to issue weather forecasts and disasters to the farmers.
- Implementation of Risk Transfer Mechanisms should be done. Embrace climate-based insurance policies that will help protect farmers from huge financial losses resulting from crop failure.
- Another area of concern is Infrastructure Resilience. Build flood barriers to embankments and Standard Levees Drainage in affected locations. Ensure that important structures such as food storage facilities and transport can be protected from the aggressiveness of some types of weather conditions.

Improving Water Management

- Water-saving devices and advanced irrigation infrastructure may also be utilized. Designing efficient and environmentally friendly sprinkler systems can help manage water resources efficiently while making sure that agricultural productivity is not hampered by water scarcity.

- Cohesive watershed management, catchment region replanting, energy source diversification, including investment in renewable and minor hydropower programs, additional water storage structure, a stronger weather forecasting system, and significant infrastructure reconstruction should be adopted by policymakers in Pakistan (Khan & Hussain, 2023).
- Pakistan should attempt to utilize effective Irrigation Systems. Use water-efficient irrigation technologies such as the drip and sprinkle irrigation systems. Subsidize and assist farmers who switch to new technology in irrigation.
- Constructing rainwater reservoirs and ponds is also recommended for water storage during dry periods to enhance irrigation. Besides, encourage the use of roof water harvesting systems in rural homes.
- Water Recycling and Reuse is also strongly recommended. Measures for the stages of wastewater treatment and its further use in irrigation of agricultural lands should be designed.
- Groundwater Management can also act as another step. Authorities should control excessive groundwater extraction by licensing and monitoring. Artificial recharging of the aquifers along with watershed management should be used.

Reducing Greenhouse Gas Emissions

- Sustainable farming practices should be adopted. These comprise the promotion of no-till farming as well as crop rotation in order to combat greenhouse gases. However, it is important that organic fertilizer should be preferred to chemical fertilizers.
- Renewable Energy Integration should be efficiently implemented. For this, install solar panels and wind turbines on farms in order to minimize the use of fossil fuels.

Engaging Stakeholders

- Providing agriculturalists, decision-makers, and other stakeholders with training and information on climate change consequences and adaptation techniques will help them gain the necessary abilities and expertise to address these issues effectively.
- Food security can never be achieved without educating and training the farmers. For this, conduct workshops and training sessions on Climate Resilient Agriculture, for instance water conservation agriculture and pest control agriculture.
- Another area that remains vital is Public-Private Partnerships. Government organizations should start partnerships with private sector stakeholders to finance sustainable inputs in agriculture production systems and physical capital.
- Incorporate the involvement of local communities in planning and decision-making so that thorough solutions are implemented.
- To address climate change concerns, it's necessary to provide training and skills for understanding its implications and implementing appropriate adaptation strategies.

Institutional policy and reforms

- Developing and implementing plans to enhance climate-adaptable agriculture and food security, as well as strengthening the institutional structure needed for carrying out these strategies, is critical for an effective response to climate change. By addressing these issues and implementing appropriate mitigation techniques, Pakistan may seek to ensure food security while dealing with the effects of climate change.

Conclusion

Despite adding minimally to global warming, Pakistan is one of the most highly liable nations to climate change. Countering the hazards of global warming is no longer a choice for Pakistan since it has become an inevitable challenge. The adverse impacts of climate change are already being displayed in the country in the form of disastrous floods as well as droughts. Climate change's potential implications, as identified in this study, are wide-ranging and expected to touch all elements of sustainable development, spanning numerous industries and ecosystems. Climate change will have far-reaching economic consequences, affecting not only food security, energy security, and water security, but also forests, agriculture, cattle, and fisheries, all of which are critical to Pakistan's already struggling economy. In regards to the societal aspect,

global warming will have drastic consequences for public health, induce displacement, and result in economic loss owing to increased catastrophic natural disasters like droughts and floods or sea level rise. Most importantly, as the article underlines, climate change poses significant concerns to food production and availability in underdeveloped countries like Pakistan. This is attributed to the fact that developed countries are capable of implementing adaptation methods. It might threaten hundreds of employment opportunities, cause an increase in food prices, and raise the number of people facing food insecurity and famine. It could also lead to relocation, migration, civil upheaval, and conflict. Climate change is also expected to have a significant impact on biophysical conditions, such as changes in ecology and ecosystems; the amount and quality of land, soil, water, and biotic resources; and rising sea levels, ocean temperature, and salinity. It may also increase the occurrence of weeds and pests, exacerbating adverse environmental changes. All of these aspects are directly linked to the agricultural industry thus adding to food insecurity. Individuals, groups, and societies' ability to respond successfully to such changes in the country will be determined by a variety of ecological, financial, social, and physical elements. Coastal towns and small farmers, for instance, will be particularly vulnerable. Rural buildings built with mud and improvised materials will be more vulnerable than better-quality houses in cities. The poor will also face difficulties as a result of rising living costs caused by decreasing food security, increased healthcare costs, and rising energy prices. It is therefore highly crucial for policymakers to consider these variables when developing a climate change strategy or adaptation strategies. The government is now formulating an action strategy to mitigate the effects of climate change on food security. While developing this plan, it is vital to make it multifaceted, covering not only an array of key businesses but also a complex set of economic and political considerations. The plan should incorporate feasible adaptation and mitigation options, as well as a cost estimate for achieving climate-sensitive growth nationwide. In addition, it should be formed under the wider scheme of the global policy framework, which comprises of climate change convention and the Kyoto Protocol, nevertheless meeting national environmental standards.

References

Abbasi, Z. A. K., & Nawaz, A. (2020). Impact of climate change awareness on climate change adaptions and climate change adaptation issues. Pakistan Journal of Agricultural Research, 33(3), 619.

Abid, M., Scheffran, J., Schneider, U. A., & Ashfaq, M. J. E. S. D. (2015). Farmers' perceptions of and adaptation strategies to climate change and their determinants: the case of Punjab province, Pakistan. Earth System Dynamics, 6(1), 225-243.

Abid, M., Schneider, U. A., & Scheffran, J. (2016). Adaptation to climate change and its impacts on food productivity and crop income: Perspectives of farmers in rural Pakistan. Journal of Rural Studies, 47, 254-266.

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

Aftab, E., & Hickey, G. M. (2010). Forest administration challenges in Pakistan: the case of the Patriata reserved forest and the new Murree development. International Forestry Review, 12(1), 97-105.

Afzal, S., & Akhtar, S. (2021). Mainstreaming climate change in policy processes of Pakistan. ISSRA Papers, 13, 75-100.

Ahmad, M., & Farooq, U. (2010). The state of food security in Pakistan: Future challenges and coping strategies. The Pakistan Development Review, 903-923.

Ahmad, T., & Saboor, A. (2022). Food Security in Pakistan and Need for Public Policy Adjustments. Policy Perspectives, 19(2), 89-122.

Ahmed, M., & Schmitz, M. (2011). Economic assessment of the impact of climate change on the agriculture of Pakistan. Business and Economic Horizons, 4(1), 1-12.

Ali, A., & Erenstein, O. (2017). Assessing farmer use of climate change adaptation practices and impacts on food security and poverty in Pakistan. Climate Risk Management, 16, 183-194.

Arnell, N. W., Livermore, M. J., Kovats, S., Levy, P. E., Nicholls, R., Parry, M. L., & Gaffin, S. R. (2004). Climate and socio-economic scenarios for global-scale climate change impacts assessments: characterising the SRES storylines. Global Environmental Change, 14(1), 3-20.

Balaban, O., & Gedikli, B. (2018). Sustainability of Climate Policy at Local Level: The Case of Gaziantep City. Smart Resilient and Transition Cities Emerging Approaches and Tools for a Climate-Sensitive Urban Development Amsterdam: Elsevier.

Balkhair, K. S., Masood, A., Almazroui, M., Rahman, K. U., Bamaga, O. A., Kamis, A. S., ... & Hesham, K. (2018). Groundwater share quantification through flood hydrographs simulation using two temporal rainfall distributions. Desalin. Water Treat, 114, 109-119.

Chaudhry, Q. U. Z. (2017). Climate change profile of Pakistan. Asian development bank.

Chaudhury, A. S., Thornton, T. F., Helfgott, A., & Sova, C. (2017). Applying the robust adaptation planning (RAP) framework to Ghana's agricultural climate change adaptation regime. Sustainability science, 12, 657-676.

Duran-Encalada, J. A., Paucar-Caceres, A., Bandala, E. R., & Wright, G. H. (2017). The impact of global climate change on water quantity and quality: A system dynamics approach to the US–Mexican transborder region. European Journal of Operational Research, 256(2), 567-581.

Fahad, S., Basit, A., Iqbal, N., Akram, N., & Orakzai, J. K. (2024). Evaluation of implementation strategies of food security in Pakistan.

FAO. (1983). World food security: a reappraisal of the concepts and approaches. Director General's Report.

FAO. (2014).State of Food Insecurity in the World 2013: The Multiple Dimensions of Food Security.

FAO. (2018).The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition, Rome.

FAO. (2020). Framework programme on climate change adaptation. Food and Agriculture Organization of the United Nation, Rome.

Farooq, M. S., Uzair, M., Raza, A., Habib, M., Xu, Y., Yousuf, M., ... & Ramzan Khan, M. (2022). Uncovering the research gaps to alleviate the negative impacts of climate change on food security: a review. Frontiers in plant science, 13, 927535.

Fischer, E., & Qaim, M. (2012). Gender, agricultural commercialization, and collective action in Kenya. Food security, 4, 441-453.

Fisher, M. C., Henk, D. A., Briggs, C. J., Brownstein, J. S., Madoff, L. C., McCraw, S. L., & Gurr, S. J. (2012). Emerging fungal threats to animal, plant and ecosystem health. Nature, 484(7393), 186-194.

Gartaula, H., Patel, K., Johnson, D., Devkota, R., Khadka, K., & Chaudhary, P. (2017). From food security to food wellbeing: examining food security through the lens of food wellbeing in Nepal's rapidly changing agrarian landscape. Agriculture and human values, 34, 573-589.

Gilbert, C. L., & Morgan, C. W. (2010). Food price volatility, Philos. T. Roy. Soc. B, 365, 3023–3034.

Gupta, S., Pingali, P., & Pinstrup-Andersen, P. (2019). Women's empowerment and nutrition status: The case of iron deficiency in India. Food Policy, 88, 101763.

Haile, M. G., & Wossen, T. (2016). Impacts of climate and price changes on global food production.

Hashizume, M., Armstrong, B., Hajat, S., Wagatsuma, Y., Faruque, A. S., Hayashi, T., & Sack, D. A. (2008). The effect of rainfall on the incidence of cholera in Bangladesh. Epidemiology, 19(1), 103-110.

Hussain, A., Agrawal, N. K., & Leikanger, I. (2016). Action for Adaptation: Bringing climate change science to policy makers-a synthesis report of a conference held in Islamabad on 23–25 July 2015. Food Security, 8, 285-289.

Idris, I. (2021). Areas and population groups in Pakistan most exposed to combined effects of climate change, food insecurity and COVID-19.

Jamil, M. J., Muhammad Mansoor, M. M., Fawad Anwar, F. A., Sher Muhammad, S. M., & Awan, A. A. (2023). A review on rangeland management in Pakistan, bottlenecks and recommendations.

Janjua, P. Z., Samad, G., Khan, N. U., & Nasir, M. (2010). Impact of climate change on wheat production: A case study of Pakistan [with comments]. The Pakistan Development Review, 799-822.

Kandlikar, M., & Risbey, J. (2000). Agricultural impacts of climate change: if adaptation is the answer, what is the question?. Climatic change, 45(3-4), 529-539.

Khan, M. A., Khan, J. A., Ali, Z., Ahmad, I., & Ahmad, M. N. (2016). The challenge of climate change and policy response in Pakistan. Environmental Earth Sciences, 75, 1-16.

Khan, Q., & Hussain, K. (2023). Gone with the Flood: Natural Disasters and Children's Schooling in Pakistan. The BE Journal of Economic Analysis & Policy, 23(1), 271-283.

Khan, Z. (2023). Gender Disparities in Climate Change Policies and Actions: A Case Study of Pakistan.

Knox, J., Daccache, A., Hess, T., & Haro, D. (2016). Meta-analysis of climate impacts and uncertainty on crop yields in Europe. Environmental Research Letters, 11(11), 113004.

Knox, J., Hess, T., Daccache, A., & Wheeler, T. (2012). Climate change impacts on crop productivity in Africa and South Asia. Environmental research letters, 7(3), 034032.

Kohler, T., & Maselli, D. (2009). Mountains and climate change. From understanding to action. Geographica Bernensia.

Kreft, S., Eckstein, D., Junghans, L., Kerestan, C., & Hagen, U. (2014). Global climate risk index 2015: who suffers most From extreme weather events? weather-related loss events in 2013 and 1994 to 2013.

Lipczynska-Kochany, E. (2018). Effect of climate change on humic substances and associated impacts on the quality of surface water and groundwater: A review. Science of the total environment, 640, 1548-1565.

Lloyd, S. J., Kovats, R. S., & Chalabi, Z. (2011). Climate change, crop yields, and undernutrition: development of a model to quantify the impact of climate scenarios on child undernutrition. Environmental health perspectives, 119(12), 1817-1823.

Ludi, E. (2009). Climate change, water and food security-ODI Background Notes.

Mahmood, N., Ahmad, B., Hassan, S., & Bakhsh, K. (2012). Impact of temperature ADN precipitation on rice productivity in rice-wheat cropping system of Punjab province. J. Anim. Plant Sci, 22, 993-997.

Masipa, T. (2017). The impact of climate change on food security in South Africa: Current realities and challenges ahead. Jàmbá: Journal of Disaster Risk Studies, 9(1), 1-7.

Molden, D., Oweis, T. Y., Pasquale, S., Kijne, J. W., Hanjra, M. A., Bindraban, P. S., ... & Zwart, S. (2007). Pathways for increasing agricultural water productivity.

Myers, S. S., Smith, M. R., Guth, S., Golden, C. D., Vaitla, B., Mueller, N. D., ... & Huybers, P. (2017). Climate change and global food systems: potential impacts on food security and undernutrition. Annual review of public health, 38(1), 259-277.

Naz, S., Iqbal, Z., & Begum, S. (2024). Climate Change's Impact on Food Security in Pakistan: Challenges and Mitigation Strategies. Pakistan Social Sciences Review, 8(2), 426-438.

Patt, A., Peterson, N., Carter, M., Velez, M., Hess, U., & Suarez, P. (2009). Making index insurance attractive to farmers. Mitigation and Adaptation Strategies for Global Change, 14, 737-753.

Rahman, I. U., Khattak, S. W., Israr, M., & Hashim, S. (2021). A multi-dimensional analysis of food security situation in Pakistan: the way forward.

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.

Rezvi, H. U. A., Tahjib-Ul-Arif, M., Azim, M. A., Tumpa, T. A., Tipu, M. M. H., Najnine, F., ... & Brestič, M. (2023). Rice and food security: Climate change implications and the future prospects for nutritional security. Food and Energy Security, 12(1), e430.

Schmidhuber, J., & Tubiello, F. N. (2007). Global food security under climate change. Proceedings of the national academy of sciences, 104(50), 19703-19708.

Schmidhuber, J., & Tubiello, F. N. (2007). Global food security under climate change. Proceedings of the national academy of sciences, 104(50), 19703-19708.

Shahzad, N., & Amjad, M. (2022). Climate change and food security in Pakistan. In Sustainable agriculture and food security (pp. 579-594). Cham: Springer International Publishing.

Shahzad, N., & Amjad, M. (2022). Climate change and food security in Pakistan. In Sustainable agriculture and food security (pp. 579-594). Cham: Springer International Publishing.

Shahzad, U. (2015). Global warming: Causes, effects and solutions. Durreesamin Journal, 1(4), 1-7.

Sultan, B. (2012). Global warming threatens agricultural productivity in Africa and South Asia. Environmental Research Letters, 7(4), 041001.

Tabasam, N., Rasheed, S., & Fatima, A. (2022). Food Security in Context of Climate Change in Pakistan: A Review. Research Journal of Social Sciences and Economics Review, 3(4), 141-148.

Tariq, A., Shu, H., Kuriqi, A., Siddiqui, S., Gagnon, A. S., Lu, L., ... & Pham, Q. B. (2021). Characterization of the 2014 Indus river flood using hydraulic simulations and satellite images. Remote Sensing, 13(11), 2053.

Tariq, A., Tabasam, N., Bakhsh, K., Ashfaq, M., & Hassan, S. (2014). Food security in the context of climate change in Pakistan. Pakistan Journal of Commerce and Social Sciences (PJCSS), 8(2), 540-550.

Von Grebmer, K., Bernstein, J., Hossain, N., Brown, T., Prasai, N., Yohannes, Y., ... & Foley, C. (2017). 2017 Global Hunger Index: the inequalities of hunger. Intl Food Policy Res Inst.

Waheed, A., Bernward Fischer, T., & Khan, M. I. (2021). Climate change policy coherence across policies, plans, and strategies in Pakistan—implications for the China–Pakistan economic corridor plan. Environmental Management, 67(5), 793-810.

Wassmann, R., Jagadish, S. V. K., Sumfleth, K., Pathak, H., Howell, G., Ismail, A., ... & Heuer, S. (2009). Regional vulnerability of climate change impacts on Asian rice production and scope for adaptation. Advances in agronomy, 102, 91-133.

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

Zhou, D., Shah, T., Ali, S., Ahmad, W., Din, I. U., & Ilyas, A. (2019). Factors affecting household food security in rural northern hinterland of Pakistan. Journal of the Saudi Society of Agricultural Sciences, 18(2), 201-210.

Zhu, T., Xie, H., Waqas, A., Ringler, C., Iqbal, M. M., Goheer, M. A., & Sulser, T. B. (2014). Climate change and extreme events: impacts on Pakistan's agriculture.