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CLIMATE IMPACT AND RESILIENCE STRATEGIES FOR PAKISTAN'S FOOD SYSTEM

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Abstract

Pakistan's food system faces formidable challenges in the context of climate change. This paper provides a comprehensive overview of the potential impacts of climate hazards on Pakistan's food security and resilience. It also proposes practical strategies for adaptation and resilience-building. The integrated planning and implementation strategies outlined here span various sectors. They aim to enhance climate resilience, improve access to nutritious diets, and foster resilient food systems. In the short term, the focus is on timely responses during shocks. Meanwhile, long-term planning emphasizes structural transformation and affordability improvements. Key areas for investment include sustainable agriculture, water management, and diversified livelihoods. However, further research and collaborative efforts are essential to refine these strategies and ensure their effective implementation. By addressing these challenges head-on, Pakistan can strengthen its food system and mitigate the impact of climate change.

Keywords: climate, food system, climate impact, resilience strategies, climate hazards

Introduction

Climate change poses significant threats to global food systems (Myers et al., 2017; Oriekhoe et al., 2024; Tchoukouang et al., 2024), with Pakistan being no exception. Pakistan, a country with a fast-growing population is extremely susceptible to the effects of global warming and is facing increasingly significant threats due to the increasing frequency and intensity in temperature variations, precipitation patterns, and extreme weather events (Naz et al., 2024). In Pakistan, where agriculture is vital for livelihoods, the impact of climate variability is particularly severe (Aitzaz et al., 2024). Daily climate variability hazards create significant challenges for achieving food security, poverty reduction, and rural development (Shawad et al., 2021; Ahmed et al., 2024). These climate hazards disrupt production, resulting in low yields, and quality at all levels of the food chain, leading to reduced monetary and nutritional value (Hussain et al., 2020; Khurshid & Abid 2024; Mirzabaev et al., 2023). This disruption creates a vicious cycle of food insecurity by impacting yield, quality, income, and the overall well-being of all actors involved in food production, post-harvest management, processing, and distribution (Richards 2021; Buhaug & Von 2021; Gupta et al., 2023).

Yield variability and disrupted supply chains due to weather hazards further affect the sustainable supply and price stability, impacting availability and affordability at the consumer level. In a country like Pakistan, which is highly dependent on agriculture, climate-induced hazards can have severe impacts on food production, distribution, and consumption. The small farm economy, coupled with underdeveloped value chains, low processing capabilities, and minimal modern storage capacity, results in low adaptive capacity, hindering successful adaptation efforts (Gujar and Bedcke,

2024; Mbuli et al., 2021). Climate change is recognized and proven to be a major global challenge, with research indicating it will impact agricultural output, incomes, prices, food access, food quality, and food safety (Tchoukouang et al., 2024).

This paper explores how different pillars of the food system in Pakistan would be affected by climate hazards and outlines possible coping and adaptation strategies across the food system chain.

Components of the Food System in Pakistan

The food system in Pakistan can be divided into four main components: production, processing and storage, distribution and marketing, and consumption. Each component is interconnected and any disruption in one can cascade through the others.

1. Production

Impact of Climate Hazards:

- **Temperature Extremes:** Both cold and heat stress have detrimental impacts on agricultural production (Bhandari et al., 2017). Furthermore, increasing climate variability will put crop production at risk as any variation above or below threshold limits even for shorter time periods have detrimental impact on crop yield as well as quality (Shah et al., 2021). Higher intensity resulting from overtime increase in temperature and higher frequency of climate stresses due to increasing variability are resulting in compound impacts over the same production cycle wherein there are limited coping strategies (Shah et al. 2021, Shah et al., 2020). The monocrop cultivation on larger scale like wheat and rice, staples in Pakistan (Ijaz et al., 2019; Nawaz et al., 2019; Sendhi 2022), are particularly vulnerable and may affect food security due to seasonal uncertainty leading to variation in crop production (Ahmed et al., 2023).
- **Water Scarcity:** Erratic rainfall patterns and reduced water availability from glaciers impact irrigation, critical for agricultural production in Pakistan. Fluctuation in temperature, and variation in precipitation are the main causes of climatic variability (van der Wiel and Bintanja 2021; Hussain et al., 2022). Pakistan is one of the most vulnerable regions exposed to variations in climate, and farming sector is one of the mostly affected sectors of the country (Fahad and Wang 2020).
- **Pests and Diseases:** Climate change will alter the prevalence and distribution of pests and diseases, further threatening crop yields. Since temperature is the most important environmental factor affecting insect population dynamics, it is expected that global climate warming could trigger an expansion of their geographic range, increased overwintering survival, increased number of generations, increased risk of invasive insect species and insect-transmitted plant diseases, as well as changes in their interaction with host plants and natural enemies (Skendrić et al., 2021). Climate change further increases outbreak risks by altering pathogen evolution and host—pathogen interactions and facilitating the emergence of new pathogenic strains. Pathogen range can shift, increasing the spread of plant diseases in new areas (Singh et al., 2023).
- **Soil Degradation:** Extreme weather events can lead to soil erosion and loss of fertility, impacting long-term agricultural productivity (Khan et al., 2020; Rupesh et al., 2020; Anwar-ul-Haq et al., 2023).

Coping and Adaptation Strategies:

- Drought-Resistant Crops: Development and adoption of drought-resistant and heat-tolerant crop varieties.
- Efficient Irrigation Techniques: Implementing water-saving technologies such as drip irrigation and rainwater harvesting.
- Integrated Pest Management (IPM): Adopting IPM practices to manage pests and diseases sustainably.
- Soil Conservation Practices: Techniques such as contour plowing, terracing, and agroforestry to prevent soil erosion and maintain fertility.

2. Processing and Storage

Impact of Climate Hazards:

- Infrastructure Damage: Extreme weather events such as floods and storms can damage agribusiness infrastructure, processing facilities, storage and road infrastructure causing losses, damage to commodities and delay in supply affecting availability and price hikes affecting affordability leading to food insecurity (Ahmad and Afral 2021; Syed et al., 2022).
- Post-Harvest Losses: Higher temperatures and humidity can increase the rate of spoilage and pest infestation in stored food (Misiou and Koutsoumanis, 2022). High cost of refrigeration during storage and transportation affects return on investment, as well as increase in prices (Zanoni and Marchi 2021 ; Amjad 2023).

Coping and Adaptation Strategies:

- Climate-Resilient Infrastructure: Building and retrofitting processing and storage facilities to withstand extreme weather.
- Improved Storage Techniques: Using hermetic storage, refrigeration, and controlled atmosphere storage to reduce spoilage.
- Diversification of Processing Locations: Establishing multiple processing centers to reduce the risk of localized climate events disrupting the entire supply chain.

3. Distribution and Marketing

Impact of Climate Hazards:

- Transport Disruptions: The primary role of food systems is to supply food. Ensuring stability during disruptions and volatility, along with adaptability, is crucial for both supply chain actors and societies. (Stone and Rahimifard 2018). National Disaster Management Authority (NDMA), Pakistan reports frequently highlight the impact of natural disasters, including floods and landslides, glacial lake outburst floods, on infrastructure and food distribution in Pakistan. The 2022 flooding highlighted several underlying issues, including poor urban planning, inadequate water resource management, lack of infrastructure maintenance, complex governance, structural inequalities, and limited disaster risk reduction capacity (GOP 2022).
- Market Volatility: Climate-induced supply shocks lead to price volatility, impacting both producers and consumers (Chaudhry et al., 2021). Climate change threatens food security by reducing crop yields and damaging infrastructure through severe weather events, leading to decreased food supply, price shocks, and reduced food access (Wheeler and Braun, 2013).

In Pakistan, limited economic access for the poorest and food chain disruptions, exacerbated by climate change, contribute significantly to growing food insecurity (Jalil et al., 2023).

Coping and Adaptation Strategies:

- **Robust Transport Networks:** Investing in resilient transport infrastructure and maintaining contingency routes.
- **Market Information Systems:** Establishing systems to provide real-time information on market conditions and prices to help stakeholders make informed decisions.
- **Local Markets:** Promoting local markets to reduce dependence on long-distance transport and increase food system resilience.

4. Consumption

Impact of Climate Hazards:

- **Food Security:** Reduced agricultural productivity can lead to food shortages, affecting the availability and affordability of food (Ahmed et al., 2023). In Pakistan, climate change is not only negatively impacting crop productivity but also severely affecting animal productivity. With livestock being the primary source of protein, heat stress, ecosystem changes, and deficiencies in Crude Protein and Total Digestible Nutrients (TDN) for large and small ruminants are likely to significantly impact food availability (Hashmi et al., 2021). Climate change is driving many current economic issues, including rising food sector inflation, particularly through the inflation phenomenon. This situation necessitates a national food security policy that incorporates environmental, agricultural, and monetary factors to stabilize food prices (Erdogan et al. 2024).
- **Nutritional Quality:** Climate change can impact the nutritional content of crops, reducing the quality of food available. Climate hazards impact not only the quantity but also the quality of crop yields, often rendering them unmarketable (Shah et al., 2021). Temperature variability affects photosynthesis and enzyme activity (Porter and Gawilh, 1999), diminishing crop quality (Yipathi et al., 2016). For instance, high temperatures during rice grain-filling reduce quality (Shi et al., 2017), and heat stress during maize kernel growth lowers protein and starch content (Mayer et al., 2016). Additionally, heavy rains can cause potato tubers to rot, and humid weather can lead to mycotoxin formation in winter wheat (Schaap et al., 2011).

Coping and Adaptation Strategies:

- **Diversified Diets:** Encouraging dietary diversity to reduce reliance on a few staple crops.
- **Food Assistance Programs:** Strengthening social safety nets and food assistance programs to support vulnerable populations during times of food scarcity.
- **Nutrition Education:** Promoting awareness about the importance of a balanced diet and nutrition.

Conclusion

Climate hazards pose significant threats to the food system in Pakistan, impacting all stages from production to consumption. To build a resilient food system, it is essential to adopt a multifaceted approach encompassing technological innovation, infrastructure development, policy support, and community engagement. By implementing effective coping and adaptation strategies,

Pakistan can mitigate the adverse impacts of climate change and ensure food security for its population.

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