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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 challcngcs in thc context of climalc change. 'Ihis paper provides a comprchensive overview of the potential impacts of climatc harards on Pakistan's food security and rcsilicnce. It also proposes practical stratcgics for adaptation and rcsilicncc-building. The intcgralcd planning and implementation stratcgics outlined herc span various sectors. They aim to cnhancc climate rcsilicnce, improvc access to nutritious diets, and foster rcsilicnt food systems. In thc short tcrm, thc focus is on timely rcsponscs during shocks. Mcanwh:ilc, long-term planning cmphasizcs structural transformation and affordability improvements. Key areas for invcstmcnt includc sustainablc agriculture, watcr management, and diversificd livclihoods. However, further research and collaborative efforts arc csscnlial to rcfinc these stratcgics and ensurc lhcir cffectivc implcmcntalion. By addressing these challcngcs head-on, Pakistan can strengthcn its food systcm and mitigatc thc impact of climatc change.

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

## Introduction

Climate change poses significant frcats to global food syslcms (Myers et al, 2017; Oriekhoe et al., 2024; Tchonkouang et al., 2024), with Pakistan being no cxccption. Pakistan, a country with a fast-growing population is cxtrcmcly susceptible to the cffccls of global warming and is facing increasingly significant threats due 10 the incrcasing frcqucncy and intensity in temperature variations, precipitation patterns, and cxtrcmc wcalher cvcnts (Naz el al 2024). In Pakistan, whcrc agriculture is vital for livelihoods, the impact of climatc variability is particularly scvcre (Aitzaz et al 2024). I)aily climate variability hazards creatc significant challcngcs for achicving food security, poverty reduction, and rural dcvclopment (Shawad ct al., 2021; Ahmed et al., 2024). These climate hazards disrupt production, rcsulting in low yields, and quality at all levels of the food chain, leading to reduced monetary and nutritional valuc (Hussain ct al., 2020; Khurshid & Abid 2024; Mirzabaev et al., 2023). This disruption creates a vicious cyclc of food insecurity by impacting yield, quality, income, and thc overall well-being of all actors involved in food production, post-harvcst managcment, processing, and distribution (Richards 2021; Buhaug & Von 2021; Gupta et al., 2023).

Yield variability and disruptcd supply chains due to wcathcr hazards further afTccL thc sustainablc supply and price stability, impacting availability and affordability at the consumer level. In a country likc Pakistan, which is highly dcpcndcnl on agriculturc, climate-induccd hazards can havc scvcrc impacts on food production, distribution, and

consumption. 'lhc small farm cconomy, coupled with underdeveloped valuc chains, low processing capabilitics, and minirnal modem storage capacity, results in low adaptivc capacity, hindcring successftlk adaptation efforts (Guja and Bedckc, 2024; Mbuli et al., 2021). Climatc change is rccognizcd and proven Lo bc a major global challcngc, with rescarch indicating il will impact agricultural output, incomes, priccs, food access, food quality, and food safety (Tchonkouang et al., 2024).

This paper explores how diffcrcnl pillars of the food system in Pakistan would be affcctcd by climatc hazards and outlines possible coping and adaptation stratcgics across thc food system chain.

Components of the Food System in Pakistan

The food system in Pakistan can bc dividcd into four main components: production, proccssing and storagc, distribution and marketing, and consumption. Each component is intcrconncctcd and any disruption in onc can cascade through the olhcrs.

## 1. Production

Impact of Climate Hazards:

- Temperature Extremes: Both cold and heat strcss 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 lirnits even for shorter time period 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 el al., 2019; Nawaz ct al., 2019; Sendhi 2022), arc particularly vulnerablc and may affcct food security duc to scasonal uncertainty Icading to variation in crop production (Ahmed et al., 2023).
- Water Scarcity: Erratic rainfall patterns and reduced water availability from glacicrs impact irrigation, critical for agricultural production in Pakistan. Fluctuation in temperature, and variation in precipitation arc the main causes of climatic variability (van der Wiel and Bintanja 2021; Hussain et al., 2022). Pakistan is onc of thc rnosl. vulncrablc regions cxposcd to variations in climate, and farming sector is onc of the mostly affected sectors orthc country (Fahad and Wang 2020).
- Pests and Diseases: Climate changc will alter the prevalcncc and distribution of pests and discascs, furthcr Ihrcatcning crop yields. Since temperature is the most important environmental factor affecting insect population dynamics, it is cxpectcd that global climalc warming could trigger an expansion of their geographic rangc, increased overwintcring survival, increased number of gcncrations, incrcascd risk of invasive insect spccics and inscct-transmittcd plant diseases, as well as changes in their interaction with host plants and natural cncmics (Skcndiié ct al., 2021). Climatc changc further increases outbreak risks by allcring pathogen evolution and host—pathogen interactions and facilitating the cmcrgcncc of new pathogenic strains. Pathogen rangc can shift, increasing the spread of plant discascs in new areas (Singh ct al., 2023).

- Soil Degradation: Extrcmc wcathcr cvcnts can lead to soil crosion and loss of fertility, impacting long-term agricultural productivity (Khan ct al., 2020; Rupesh et al., 2020; Anwar-ul-Haq et al., 2023).

Coping and Adaptation Strategies:

- rought-Rcsistant Crops: l)cvckopmcnt and adoption of drought-resistant and heattolcrant crop varieties.
- Efficient Irrigation Techniques: Implcmcnting water-saving tcchnologics such as drip irrigation and rainwater harvesting.
- Integrated Pest Management (IPM): Adopting IPM practices to managc pests and discascs sustainably.
- Soil Conservation Practices: 'f'cchniqucs such as contour plowing, terracing, and agroforcstry to prevent soil erosion and maintain fertility.

## 2. Processing and Storagc

Impact of Climate Hazards:

- Infrastructurc Damage: F,xlrcmc wcalhcr cvcnts such as floods and storms can damagc agribusiness infrastructure, processing facililics, storagc and road infrastructurc casing losscs, damagc to commodities and delay in supply affecting availability and pricc hikcs affecting affordability leading to food insccurity (Ahmad and Afral 2021; Sycd ct al., 2022).
- Post-Ilarvcst Losses: Higher temperatures and humidity can increase the ratc of spoilage and pcst infestation in stored food (Misiou and Koutsoumanis, 2022). [ligh cost of refrigeration during storagc and transportation affccts return on invcstmcnl. as well as increasc in prices (Zanoni and Marchi 2021 ; Amjad 2023).

Coping and Adaptation Strategies:

- Climate-Resilient Infrastructure: Building and retrofitting processing and storagc facilities to withstand cxtrcmc weather.
- Improved Storage Techniques: Using hermetic storagc, refrigeration, and controllcd almosphcrc storagc 10 rcducc spoilage.
- Diversification of Processing Locations: Establishing multiplc processing centers to reducc the risk of localized climatc events disrupting thc cntirc supply chain.

## 3. Distribution and Marketing

Impact of Climate Ilazards:

- Transport Disruptions: 'lhc primary rolc of food systems is to supply Iöod. Ensuring stability during disruptions and volatility, along with adaptability, is crucial for both supply chain actors and socictics. (Stonc and Rahimifard 2018). National l)isastcr Management Authority (NI)MA), Pakistan reports frcqucntly highlight lhc impact of natural disaslcrs, including floods and landslides, glacial lakc outburst floods, on infrastructure and food distribution in Pakistan. 'lhc 2022 flooding highlighted several underlying iss ucs, including poor urban planning, inadcquatc watcr rcsourcc managcmcnt, lack of infrastructurc maintcnancc, complex

govcrnancc, structural incqualitics, and limitcd disaster risk reduction capacity (GOP 2022).

- Market Volatility: Climate-induced supply shocks Icad to pricc volatility, impacting both produccrs and consumers (Chaudhry et al., 2021). Climate changc threatens food security by reducing crop yields and damaging infrastructure through scvcrc wc.alhcr cvcnts, leading to dccrcascd food supply, price shocks, and rcduccd food access (Whcclcr and Braun, 2013). In Pakistan, limited economic acccss for the poorest and food chain disruptions, cxaccrbatcd by climatc change, contribute significantly to growing food i_nsecuriLy (Jalccl el al., 2023).

Coping and Adaptation Strategies:

- Robust Transport Networks: Investing in resilient transport infrastruclurc and maintaining contingency routes.
- Market Information Systems: Establishing systcms to providc real-lime information on market conditions and prices to help stakeholders makc informed dccisions. ▪ Local Markets: Promoting local markets to rcducc dcpcndcncc on long-distancc transport and incrcasc l'ood system rcsilicncc.

## 4. Consumption

Impact of Climate Hazards:

- Food Sccurity: Rcduccd agricultural productivity can lead 10 food shortagcs, affecting the availability and affordability of food (Ahmed ct al., 2023). In Pakistan, climate change is not only ncgalivcly impacting crop productivity but also scvcrcly affccl.ing animal productivity. With livestock being the primary sourcc of protcin, heal stress, ecosystem changcs, and deficiencies in Crude Protein and 'lbtal l)igcstible Nutricnts ('I'DN) for large and small ruminants arc likely to significantly impact food availability (Hashmi et Ia., 2021). Climalc changc is driving many currcnt economic issucs, including rising food sector inflation, particularly through the healflation phenomenon. 'l'his situation ncccssitatcs a national food security policy that incorporates environmental, agricultural, and monclary factors to stabilizc food prices (Erdogan et al. 2024).
- Nutritional Quality: Climate change can impact the nutritional content of crops, reducing lhc quality of food available. Climaic huards impact not only the quantity but also the quality of crop yicld‍s, often rendcring lhcm unmarkelablc (Shah cl al., 2()2 1 'l'empcraturc variability affccts photosynthesis and cnzymc activity (Portcr and Gawilh, 1999), diminishing crop quality ('IYipathi ct al., 2016) . For instance, high tcmpcralurcs during rice grain-filling rcducc quality (Shi ct al., 2017), and heat stress during maize kernel growth lowers protein and starch content (Maycr ct al., 2016). Additionally, heavy rains can cause potato tubers to rot, and humid wcathcr can Icad to mycotoxin formation in winter wheat (Schaap al., 2011).

Coping and Adaptation Strategies:

- Diversified I)iets: Encouraging dictary diversity to reduce rcliancc on a few staplc crops. ▪ Food Assistance Programs: Strengthening social safety nels and food assistance programs to support vulncrablc populations during times of food scarcity.
- Nutrition Education: Promoting awareness about the importance of a balanced dict and nutrition.

## Conclusion

Climatc hazards pose significant thrcats to the food system in Pakistan, impacting all stages from production to consumption. •ro build a resilient food system, it is csscntial 10 adopt a multifaceted approach cncompassing technological innovation, infrastructure development, policy support, and community cngagcmcnl. By implementing cfTcctive coping and adaptation stratcgics, Pakistan can mitigate the advcrsc impacts of climate changc and cnsurc food security for its population.

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