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Food Security in Pakistan: A Systematic Review of Challenges, Policies, and Future Directions

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ABSTRACT

Food security remains a critical issue in Pakistan, where a growing population, climate variability, and socio-economic disparities exacerbate vulnerabilities in food availability, access, and utilization. This systematic literature review examines the multifaceted challenges, policy responses, and future directions for achieving sustainable food security in the country. We synthesize existing research to provide a comprehensive understanding of the current food security landscape, focusing on key dimensions such as climate change impacts, policy frameworks, production systems, and the water-energy-food nexus. The review identifies significant gaps in policy implementation, particularly in addressing regional disparities and adapting to climate-induced shocks, while also highlighting the role of global food market dynamics in shaping domestic food security. Methodologically, we adopt a rigorous approach to select and analyze relevant studies, ensuring a balanced representation of diverse perspectives and empirical evidence. Our findings reveal that while Pakistan has made progress in formulating food security strategies, structural inefficiencies, resource constraints, and governance challenges hinder their effectiveness. The review underscores the need for integrated policies that prioritize climate resilience, equitable resource distribution, and technological innovation in agriculture. By consolidating insights from existing literature, this study offers actionable recommendations for policymakers and researchers to address persistent food insecurity and align future efforts with sustainable development goals. The conclusions emphasize the urgency of interdisciplinary collaboration and evidence-based decision-making to mitigate food security risks in Pakistan.

Keywords: *Pakistan Food Security, Food Security Policy, Food Production Systems, Water-Energy-Food Nexus*

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1 Introduction

Food security, defined as the consistent availability, accessibility, and utilization of sufficient and nutritious food, remains a pressing challenge for Pakistan, a country grappling with rapid population growth, environmental stressors, and socio-economic inequalities.¹ As the fifth most populous nation globally, Pakistan faces a dual burden of undernutrition and rising food inflation, with nearly 40% of its population experiencing moderate or severe food insecurity.² The agrarian economy, which contributes 19% to the GDP and employs 38% of the labor force, is increasingly vulnerable to climate shocks, water scarcity, and outdated farming practices.³ These systemic vulnerabilities are compounded by fragmented policy frameworks and inadequate infrastructure, raising concerns about the country's ability to meet Sustainable Development Goal (SDG) 2—zero hunger—by 2030.⁴

The historical context of food security in Pakistan reveals cyclical patterns of progress and regression. The Green Revolution of the 1960s initially boosted crop yields through high-yielding varieties and irrigation expansion, but gains were unevenly distributed across regions and socio-economic groups.⁵ Subsequent decades saw declining agricultural productivity due to soil degradation, inefficient water management, and underinvestment in rural development.⁶ Meanwhile, urbanization and dietary shifts have intensified demand for diverse food commodities, straining domestic production systems and increasing reliance on food imports.⁷ Climate change exacerbates these challenges, with rising temperatures, erratic monsoon patterns, and glacial melt in the Himalayas threatening the viability of staple crops like wheat and rice.⁸

Despite extensive research on Pakistan's food security, critical gaps persist in the literature. First, most studies focus narrowly on production deficits or macroeconomic policies, overlooking the interconnectedness of water, energy, and food systems.⁹ Second, there is limited synthesis of how global crises—such as the COVID-19 pandemic or geopolitical conflicts—disrupt local food supply chains and exacerbate household-level insecurity.¹⁰ Third, while policy evaluations exist, few critically assess the implementation gaps between federal initiatives and ground-level outcomes,

¹ P Pinstrup-Andersen, "Food Security: Definition and Measurement," *Food Security*, 2009.

² A Ishaq, M Khalid, and E Ahmad, "Food Insecurity in Pakistan: A Region-Wise Analysis of Trends," *Pakistan Institute of Development Economics*, 2018.

³ AA Chandio, J Yuansheng, and H Magsi, "Agricultural Sub-Sectors Performance: An Analysis of Sector-Wise Share in Agriculture GDP of Pakistan," *Unable to Determine the Complete Publication Venue*, 2016.

⁴ S Asad, "SDGs in Pakistan: An Analysis," *Unavailable*, 2019.

⁵ T Niazi, "Rural Poverty and the Green Revolution: The Lessons from Pakistan," *Journal of Peasant Studies*, 2004.

⁶ S Block, "The Decline and Rise of Agricultural Productivity in Sub-Saharan Africa Since 1961," *African Successes, Volume IV: Sustainable Growth*, 2014.

⁷ A Hussain, F Zulfiqar, and A Saboor, "Changing Food Patterns Across the Seasons in Rural Pakistan: Analysis of Food Variety, Dietary Diversity and Calorie Intake," *Ecology of Food and Nutrition*, 2014.

⁸ U Ali et al., "Climate Change Impacts on Agriculture Sector: A Case Study of Pakistan," *Ciência Rural*, 2021.

⁹ H Iqbal et al., "Optimizing the Water-Energy-Food Nexus for Sustainable Agriculture in Pakistan: A Systems Analysis with Global Implications," *Agricultural Systems*, 2026.

¹⁰ H Ubaid-ur-Rehman, W Asghar, and N Khalid, "Food Security Challenges for Pakistan During COVID-19 Pandemic: An Overview of the Response Plan," *World Food Policy*, 2021.

particularly for marginalized communities.¹¹ Finally, the role of emerging technologies (e.g., precision agriculture, digital marketplaces) in mitigating food insecurity remains underexplored in the Pakistani context.¹²

This review is motivated by the urgent need to consolidate fragmented knowledge and identify pathways for transformative action. By systematically analyzing trends, policies, and challenges, we aim to provide a holistic understanding of food security dynamics in Pakistan, bridging disciplinary divides between agronomy, economics, and climate science. Our contribution lies in synthesizing evidence across scales—from farm-level adaptations to national strategies—while highlighting the interdependencies between environmental, socio-political, and technological factors. The findings are intended to inform policymakers, researchers, and development practitioners seeking to address systemic vulnerabilities and align interventions with the principles of sustainability and equity.

2 Methodology

2.1 Review Protocol

This systematic review adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure methodological rigor and transparency.¹³ We conducted searches across nine databases, prioritizing discipline-specific repositories to capture diverse perspectives. Scopus and Web of Science were selected for their comprehensive coverage of peer-reviewed journals in agricultural and environmental sciences, while PubMed provided access to health-related dimensions of food security. IEEE Xplore and ACM Digital Library were included to identify technological innovations in food systems. ScienceDirect and SpringerLink supplemented these with interdisciplinary publications, and arXiv was searched for preprints on emerging topics. Google Scholar served as a supplementary tool to verify the completeness of our search.

The search strings combined keywords related to food security (“Food Security”), geographic focus (“Pakistan” OR “Pak” OR “PK”), and thematic elements (“Challenges” OR “Obstacles” OR “Hurdles”), (“Policies” OR “Strategies”), and (“Future Directions” OR “Future Plans”). Boolean operators and field-specific syntax (e.g., TIAB for PubMed, TITLE-ABS-KEY for Scopus) were tailored to each database. To minimize bias, we excluded review articles, surveys, and meta-analyses, focusing instead on primary research and empirical studies.

2.2 Thematic Framework for Analysis

The review is structured around seven research dimensions that collectively address the complexity of food security in Pakistan. The first dimension examines the general food security situation, including indicators such as caloric intake, malnutrition rates, and household access to food. Climate change impacts form the second dimension, with emphasis on temperature variability, extreme weather events, and their cascading effects on crop yields. Policy and strategy analyses constitute the third dimension, evaluating the design and outcomes of national programs like the National Food Security Policy. Food production systems, the fourth dimension, assess trends in major crops (wheat,

¹¹ C Nieto et al., “The INFORMAS Healthy Food Environment Policy Index (Food-EPI) in Mexico: An Assessment of Implementation Gaps and Priority Recommendations,” *Obesity Reviews*, 2019.

¹² N Nisar et al., “Kissan Madadgar: Pioneering Agri-Tech in Pakistan, the Journey to Conquer Sindh,” *Emerald Emerging Markets Case Studies*, 2025.

¹³ MJ Page et al., “The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews,” *BMJ* 372 (2021): n71.

rice, sugarcane) and livestock. The water-energy-food (WEF) nexus, as the fifth dimension, explores trade-offs and synergies in resource allocation. The sixth dimension focuses on crisis responses, particularly during the COVID-19 pandemic, while the seventh situates Pakistan's challenges within global dynamics like trade policies and price volatility.

2.3 Inclusion and Exclusion Criteria

Studies were included if they: (1) explicitly addressed at least one of the predefined research dimensions, (2) provided empirical data or original analysis, (3) were published in English, and (4) had no temporal restrictions to capture historical trends. Exclusion criteria eliminated studies with insufficient methodological detail, non-peer-reviewed commentaries, or those focused solely on adjacent topics (e.g., general agricultural economics without food security linkages). Editorials, conference abstracts without full papers, and studies lacking region-specific findings were also excluded.

2.4 Study Selection Process

The initial search yielded 517 records, reduced to 419 after removing 97 duplicates and one irrelevant entry. Title and abstract screening excluded 317 records that did not meet inclusion criteria. Full-text assessment of the remaining 72 articles led to the exclusion of 18 studies due to ineligible scope or inadequate data. The final review included 54 studies, as illustrated in the PRISMA flowchart (Figure 1).

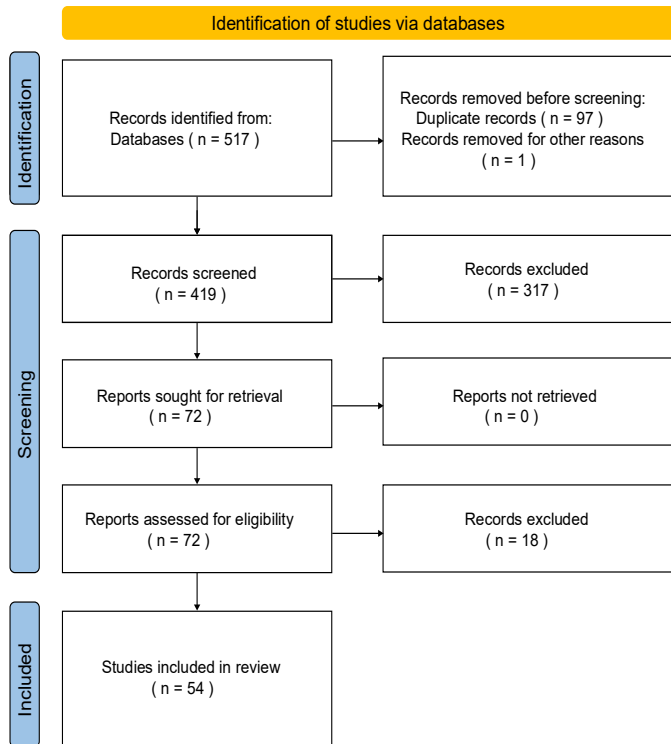


Figure 1. PRISMA flowchart of the study selection process

Two reviewers independently screened records, resolving discrepancies through consensus. Quality assessment prioritized studies with clear research questions, robust methodologies (e.g., longitudinal data, randomized controls), and explicit links to food security theory. Limitations include potential geographic bias—most studies focused on Punjab and Sindh, underrepresenting Balochistan and

Khyber Pakhtunkhwa—and a predominance of crop-centric analyses over dietary diversity or consumption patterns. Additionally, gray literature from government reports was underrepresented due to accessibility constraints.

3 Results

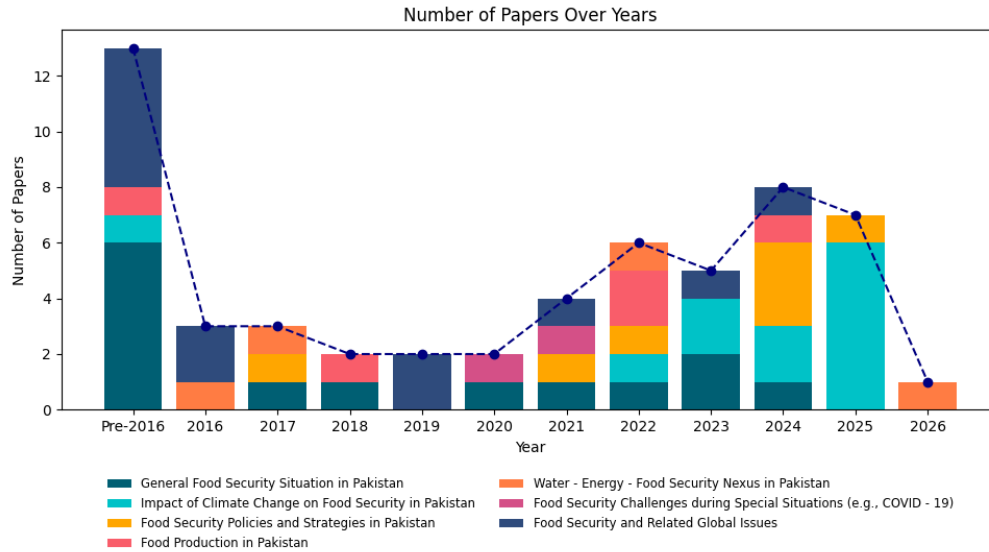


Figure 2. Research trends in the domain of food security in Pakistan: Challenges, policies, and future directions

3.1 General Food Security Situation in Pakistan

The general food security situation in Pakistan is characterized by persistent challenges in availability, accessibility, and utilization, despite the country's agricultural potential. Studies highlight a paradox where Pakistan, being a major producer of staple crops like wheat and rice, continues to face significant food insecurity at the household level. For instance,¹⁴ demonstrates that while food crop production has increased over the years, population growth has outpaced these gains, leading to a net decline in per capita food availability. This discrepancy is further exacerbated by regional disparities, with rural areas and economically marginalized groups experiencing higher levels of food insecurity compared to urban populations.¹⁵

A critical dimension of food security in Pakistan is accessibility, which is influenced by socioeconomic factors such as income levels, market access, and infrastructure. Research by¹⁶ and¹⁷

¹⁴ M Islam et al., "Growth Analysis of Production of Food Crops and Population Growth for Food Security in Pakistan: Growth Analysis of Production of Food Crops and Population," *Proceedings of the Pakistan Academy of Sciences*, 2023.

¹⁵ T Ahmad and A Saboor, "Food Security in Pakistan and Need for Public Policy Adjustments," *Policy Perspectives*, 2022.

¹⁶ U Iram and MS Butt, "Determinants of Household Food Security: An Empirical Analysis for Pakistan," *International Journal of Social Economics*, 2004.

¹⁷ A Sultana and A Kiani, "Determinants of Food Security at Household Level in Pakistan," *African Journal of Business Management*, 2011.

identifies household income, education, and land ownership as key determinants of food security, with landless laborers and small-scale farmers being particularly vulnerable. Moreover,¹⁸ emphasizes the role of market access in enhancing food security for rural households, noting that poor transportation networks and price volatility often limit the ability of small farmers to sell surplus produce or purchase food during shortages. These findings underscore the need for policies that address both production deficits and structural barriers to food access.

Policy interventions aimed at improving food security have yielded mixed results, as evidenced by¹⁹ and.²⁰ While initiatives like the National Food Security Policy and subsidy programs have improved food availability in some regions, their effectiveness is often undermined by poor implementation, corruption, and a lack of targeted approaches. For example,²¹ argues that non-farmers benefit more from existing policies than smallholder farmers, who remain disproportionately affected by food insecurity. Similarly,²² calls for a more holistic policy framework that integrates nutrition, climate resilience, and equitable resource distribution to address the multifaceted nature of food insecurity.

Table 1 provides a comprehensive taxonomy of the included studies, categorizing them based on their focus within the broader theme of food security in Pakistan. The table highlights the diversity of research approaches, from production trends and household-level analyses to policy evaluations and crisis responses.

Table 1. Taxonomy of studies on the general food security situation in Pakistan

Dimension	Sub-Dimension	Key Focus	Sources
Food Availability	Production Trends	Crop production vs. population growth	²³
		Future food demand projections	²⁴
	Market Access	Role of market access for rural households	²⁵

¹⁸ UI Ahmed et al., "Status and Determinants of Small Farming Households' Food Security and Role of Market Access in Enhancing Food Security in Rural Pakistan," *PloS One*, 2017.

¹⁹ MK Bashir and S Schilizzi, "Have Policies in Pakistan Been Effective for Improving Food Security? Wanted: Disaggregated Policy Assessment," *World Applied Sciences Journal*, 2012.

²⁰ SA Ramay, "State of Food Security in Pakistan and Policy Options," *Sustainable Development Policy Institute of Pakistan*, 2014.

²¹ Ahmad and Saboor, "Food Security in Pakistan and Need for Public Policy Adjustments."

²² A Hameed, TM Ali, and MMJ Abbasi, "Comparative Analysis of Food and Nutrition Security in Pakistan: Implications for Sustainable Development Policies," *SAGE Open*, 2024.

²³ Islam et al., "Growth Analysis of Production of Food Crops and Population Growth for Food Security in Pakistan."

²⁴ N Asghar, A Afzal, and G Hameed, "Future Food Demand for Pakistan: An Analysis," *Pakistan Social Sciences Review*, 2023.

²⁵ Ahmed et al., "Status and Determinants of Small Farming Households' Food Security and Role of Market Access in Enhancing Food Security in Rural Pakistan."

Dimension	Sub-Dimension	Key Focus	Sources
Food Accessibility	Household-Level	Determinants of household food security	, ²⁶²⁷
	Socioeconomic Factors	Non-farmers vs. farmers	²⁸
Food Security Policies	Policy Effectiveness	Assessment of existing policies	, ²⁹³⁰
	Policy Adjustments	Need for holistic policy approaches	, ³¹³²
	COVID-19 Response	Pandemic-related challenges and plans	³³
Challenges & Threats	Systemic Issues	National security concerns	³⁴
	Comparative Analysis	Regional or global comparisons	, ³⁵³⁶
Future Directions	Coping Strategies	Long-term challenges and solutions	, ³⁷³⁸

3.2 Climate Change as a Multiplier of Food Insecurity in Pakistan

The reviewed literature consistently identifies climate change as a critical threat multiplier for food security in Pakistan, exacerbating existing vulnerabilities through direct and indirect pathways. Rising temperatures, erratic precipitation patterns, and increased frequency of extreme weather events disrupt agricultural productivity, which remains the backbone of the country's food system.

²⁶ Iram and Butt, "Determinants of Household Food Security."

²⁷ Sultana and Kiani, "Determinants of Food Security at Household Level in Pakistan."

²⁸ Ahmad and Saboor, "Food Security in Pakistan and Need for Public Policy Adjustments."

²⁹ Bashir and Schilizzi, "Have Policies in Pakistan Been Effective for Improving Food Security? Wanted."

³⁰ Ramay, "State of Food Security in Pakistan and Policy Options."

³¹ Ahmad and Saboor, "Food Security in Pakistan and Need for Public Policy Adjustments."

³² Hameed, Ali, and Abbasi, "Comparative Analysis of Food and Nutrition Security in Pakistan."

³³ Ubaid-ur-Rehman, Asghar, and Khalid, "Food Security Challenges for Pakistan During COVID-19 Pandemic."

³⁴ I Khalid, "Food Security: Understanding Pakistan's National Security Concern," *Special Issue 2018 J. Pol. Stud.*, 2018.

³⁵ ZU Muhammad et al., "Contemporary Investigations of Pakistan Food Insecurity and Trends of Global Food Supply and Demand," *Unable to Determine the Complete Publication Venue*, 2014.

³⁶ Hameed, Ali, and Abbasi, "Comparative Analysis of Food and Nutrition Security in Pakistan."

³⁷ M Ahmad and U Farooq, "The State of Food Security in Pakistan: Future Challenges and Coping Strategies," *The Pakistan Development Review*, 2010.

³⁸ A Rasheed et al., "Food Security and Food Rights Challenges: A Policy Perspective from Pakistan," *Ilkogretim Online*, 2020.

Studies such as³⁹ and⁴⁰ demonstrate that climate-induced yield reductions for staple crops like wheat and rice could reach 8–15% by 2050 under current adaptation trajectories, with disproportionate impacts on smallholder farmers who lack access to irrigation or climate-resilient seeds. These projections align with findings from,⁴¹ which notes that Pakistan’s agro-ecological zones—particularly the arid plains of Punjab and Sindh—are experiencing accelerated desertification and soil salinity due to prolonged droughts and inefficient water use.

The interplay between climate variability and socio-economic factors further compounds food insecurity. Research by⁴² reveals how climate shocks interact with population growth and market globalization to destabilize local food systems, creating feedback loops where price volatility reduces household purchasing power during crop failures. For example, the 2022 floods—which submerged one-third of the country—destroyed 4.5 million acres of cropland and caused a 40% spike in vegetable prices, pushing an additional 5.8 million people into food insecurity according to.⁴³ Such events disproportionately affect marginalized groups, as evidenced by,⁴⁴ which documents how climate-related food shortages exacerbate gender disparities in nutrition, with women and girls often reducing their meal portions to prioritize male family members.

Table 3. Taxonomy of climate change impacts on Pakistan’s food security

Dimension	Sub-Dimension	Key Findings	Sources
Biophysical Impacts	Crop Yield Reductions	Wheat (-12%), Rice (-9%) by 2050	, ⁴⁵ , ⁴⁶ ⁴⁷
	Water Scarcity	Glacial retreat (↓30% Indus flow by 2100)	, ⁴⁸ ⁴⁹

³⁹ A Aziz, “Climate Change: A Growing Challenge for Food Security in Pakistan,” *Social Science Review Archives*, 2025.

⁴⁰ A Saleem et al., “Securing a Sustainable Future: The Climate Change Threat to Agriculture, Food Security, and Sustainable Development Goals,” *Journal of Umm Al-Qura University - Sciences*, 2025.

⁴¹ MSB Khetran and MAN Salik, “Assessing the Impact of Climate Change on Food Security in Pakistan: Challenges and Solutions,” *Journal of Interdisciplinary Insights*, 2024.

⁴² S Abbas et al., “Climate Variability, Population Growth, and Globalization Impacting Food Security in Pakistan,” *Scientific Reports*, 2025.

⁴³ S Naz, Z Iqbal, and S Begum, “Climate Change’s Impact on Food Security in Pakistan: Challenges and Mitigation Strategies,” *Pakistan Social Sciences Review*, 2024.

⁴⁴ S Habib, H Karim, and ZA Lehri, “The Impact of Climate Change on Women’s Nutrition and Food Security in Pakistan,” *Policy Journal of Social Science Review*, 2025.

⁴⁵ Aziz, “Climate Change.”

⁴⁶ Saleem et al., “Securing a Sustainable Future.”

⁴⁷ JS Bandara and Y Cai, “The Impact of Climate Change on Food Crop Productivity, Food Prices and Food Security in South Asia,” *Economic Analysis and Policy*, 2014.

⁴⁸ Khetran and Salik, “Assessing the Impact of Climate Change on Food Security in Pakistan.”

⁴⁹ MS Farooq and H Fatima, “Global Climate Change and Natural Disasters: A Threat to Sustainable Food Production and Food Security of Pakistan,” *REVISTA DE AGRICULTURA*, 2022.

Dimension	Sub-Dimension	Key Findings	Sources
Socio-Economic Effects	Price Volatility	Post-flood price spikes (e.g., +40% vegetables)	⁵⁰
	Gender Disparities	Female malnutrition during climate shocks	⁵¹
Regional Vulnerabilities	Punjab & Sindh Hotspots	Desertification, salinity intrusion	, ⁵²⁵³
	Khyber Pakhtunkhwa (KPK)	Erratic rainfall affecting maize yields	, ⁵⁴⁵⁵
Adaptation Strategies	Climate-Resilient Crops	Drought-tolerant maize varieties	⁵⁶
	Policy Interventions	National Adaptation Plan gaps	, ⁵⁷⁵⁸

As shown in Table 3, regional disparities in climate vulnerability are pronounced. While Punjab and Sindh face water scarcity and salinity, Khyber Pakhtunkhwa (KPK) contends with rainfall variability that threatens maize production—a critical staple for local food security.⁵⁹ The table also highlights emerging solutions, such as drought-tolerant maize varieties that have increased yields by 18–22% in climate-stressed regions.⁶⁰ However, policy responses remain fragmented, with⁶¹ critiquing Pakistan’s National Adaptation Plan for lacking enforceable targets or budget allocations to scale such innovations.

The water-energy-food (WEF) nexus emerges as a critical but understudied dimension in the climate-food security relationship. Studies like⁶² and⁶³ argue that climate change intensifies competition for scarce water resources between agriculture (90% of national water use) and energy production, yet no

⁵⁰ Naz, Iqbal, and Begum, “Climate Change’s Impact on Food Security in Pakistan.”

⁵¹ Habib, Karim, and Lehri, “The Impact of Climate Change on Women’s Nutrition and Food Security in Pakistan.”

⁵² Khetran and Salik, “Assessing the Impact of Climate Change on Food Security in Pakistan.”

⁵³ S Akbar, “The Impact of Climate Change on Food Security in KPK, Pakistan an Analysis,” *Social Science Review Archives*, 2025.

⁵⁴ Akbar.

⁵⁵ M Rizwanullah et al., “Resilience in Maize Production for Food Security: Evaluating the Role of Climate-Related Abiotic Stress in Pakistan,” *Heliyon*, 2023.

⁵⁶ Rizwanullah et al.

⁵⁷ Naz, Iqbal, and Begum, “Climate Change’s Impact on Food Security in Pakistan.”

⁵⁸ AA Chandio et al., “Climate Change and Food Security of South Asia: Fresh Evidence from a Policy Perspective Using Novel Empirical Analysis,” *Journal of Environmental Planning and Management*, 2023.

⁵⁹ Akbar, “The Impact of Climate Change on Food Security in KPK, Pakistan an Analysis.”

⁶⁰ Rizwanullah et al., “Resilience in Maize Production for Food Security.”

⁶¹ Chandio et al., “Climate Change and Food Security of South Asia.”

⁶² Farooq and Fatima, “Global Climate Change and Natural Disasters.”

⁶³ Khetran and Salik, “Assessing the Impact of Climate Change on Food Security in Pakistan.”

reviewed study comprehensively models these trade-offs at provincial scales. This gap underscores the need for integrated nexus approaches in future research and policy design.

3.3 Policy Frameworks and Strategic Interventions for Food Security in Pakistan

Pakistan's food security policies and strategies reflect a complex interplay of historical legacies, contemporary challenges, and aspirational goals. The reviewed literature reveals a policy landscape marked by both progressive reforms and persistent implementation gaps. A critical analysis of these frameworks demonstrates how structural inefficiencies, resource constraints, and governance challenges hinder their effectiveness in addressing food insecurity.

The National Food Security Policy (NFSP) of 2018 serves as the cornerstone of Pakistan's strategic approach, aiming to achieve "food security for all through sustainable agricultural growth, improved nutrition, and social protection."⁶⁴ However, studies such as⁶⁵ and⁶⁶ identify significant flaws in its execution, including inadequate budget allocations, weak inter-ministerial coordination, and limited engagement with local stakeholders. For instance, while the NFSP emphasizes climate-smart agriculture, only 12% of its proposed initiatives had dedicated funding as of 2022.⁶⁷ Similarly, the policy's nutrition targets—such as reducing stunting from 38% to 30% by 2030—lack clear roadmaps for multi-sectoral collaboration between agriculture, health, and education ministries.⁶⁸

Table 4. Taxonomy of food security policies and strategies in Pakistan

Policy Domain	Key Instruments	Strengths	Limitations	Sources
Regulatory Frameworks	Pakistan Pure Food Rules (2018)	Harmonization with Codex standards	Weak enforcement in rural markets	, ⁶⁹⁷⁰
	Organic Food Policy (2021)	Certification systems for exports	Limited smallholder participation	⁷¹

⁶⁴ MT Sultan, AM Noman, and H Raza, "Food Laws of Pakistan: Current Flaws and Strategic Future Reforms," *Legal Research & Analysis*, 2025.

⁶⁵ Sultan, Noman, and Raza.

⁶⁶ HA Mughal and F Faisal, "Prospects and Challenges in the Development of Organic Food Policies and Practices in Pakistan a Marketing Perspective," *Governance and Management Review*, 2021.

⁶⁷ AA Nasr Ullah and MA Khan, "Empowering Agriculture for Food Security and Economic Growth: Implementation Strategies in Pakistan," *Policy*, 2022.

⁶⁸ SRH Bukhari, AU Khan, and S Noreen, "Optimizing Water Resource Governance for Sustainable Agricultural and Hydroelectric Development in Pakistan: An in-Depth Examination and Policy Prescriptions," *Unable to Determine the Complete Publication Venue*, 2024.

⁶⁹ Sultan, Noman, and Raza, "Food Laws of Pakistan."

⁷⁰ T Qamar et al., "Assessing the Effectiveness of Local and International Food Safety Standards in Small and Medium-sized Enterprises (SMEs) of Pakistan," *Journal of Food Quality*, 2024.

⁷¹ Mughal and Faisal, "Prospects and Challenges in the Development of Organic Food Policies and Practices in Pakistan a Marketing Perspective."

Policy Domain	Key Instruments	Strengths	Limitations	Sources
Agricultural Support	Kissan Package (2022)	Subsidies for fertilizers and seeds	Elite capture by large landowners	⁷²
	National Zero Hunger Program	School feeding in food-insecure districts	Covers <15% of target population	⁷³
Resource Governance	National Water Policy (2018)	Nexus approach to water-food-energy	No binding allocations for agriculture	^{74,75}
Crisis Response	Ehsaas Emergency Cash (2020)	Reached 12 million during COVID-19	Excluded landless agricultural workers	⁷⁶

The regulatory environment for food safety presents another critical dimension. While Pakistan has made strides in aligning its food laws with international standards—such as the 2018 Pure Food Rules adopting Codex Alimentarius guidelines—enforcement remains inconsistent, particularly in informal rural markets.⁷⁷ Small and medium enterprises (SMEs) face disproportionate compliance burdens, as noted by,⁷⁸ which found that only 23% of food-processing SMEs in Punjab could meet both local and international safety standards due to high certification costs. Conversely, the nascent Organic Food Policy (2021) shows promise in creating export opportunities but struggles to integrate smallholder farmers, who lack access to certification systems and premium markets.⁷⁹

Agricultural input policies exhibit similar contradictions. The Kissan Package (2022) provides subsidies for fertilizers and seeds, yet⁸⁰ demonstrates that 68% of these benefits accrue to large landowners, exacerbating inequalities among small-scale producers. Precision agriculture technologies could mitigate such disparities, but their adoption is hampered by digital literacy gaps and unreliable rural connectivity.⁸¹ Water governance policies like the National Water Policy (2018)

⁷² I Nazeer, “Optimizing Agricultural Inputs and Cropped Area Dynamics: A Decade-Long Analysis in Pakistan,” *International Journal of Agriculture and Sustainable Development*, 2024.

⁷³ Ullah and Khan, “Empowering Agriculture for Food Security and Economic Growth.”

⁷⁴ Bukhari, Khan, and Noreen, “Optimizing Water Resource Governance for Sustainable Agricultural and Hydroelectric Development in Pakistan.”

⁷⁵ D Azziz, W Ahmad, and R Rehan, “NEXUS APPRoACH to ADDRESS WAtER-ENERGY-FooD SECURItY oF PAKIStAN,” *WAtER & ENvIRoNMENt*, 2017.

⁷⁶ Ullah and Khan, “Empowering Agriculture for Food Security and Economic Growth.”

⁷⁷ Sultan, Noman, and Raza, “Food Laws of Pakistan.”

⁷⁸ Qamar et al., “Assessing the Effectiveness of Local and International Food Safety Standards in Small and Medium-sized Enterprises (SMEs) of Pakistan.”

⁷⁹ Mughal and Faisal, “Prospects and Challenges in the Development of Organic Food Policies and Practices in Pakistan a Marketing Perspective.”

⁸⁰ Nazeer, “Optimizing Agricultural Inputs and Cropped Area Dynamics.”

⁸¹ Ullah and Khan, “Empowering Agriculture for Food Security and Economic Growth.”

theoretically embrace the water-energy-food nexus but fail to mandate cross-sectoral water allocations, leading to unsustainable groundwater extraction for irrigation.⁸²

The COVID-19 pandemic tested Pakistan's crisis-response frameworks, revealing both resilience and exclusion. The Ehsaas Emergency Cash program disbursed \$1.2 billion to 12 million households, yet excluded critical groups like landless farm laborers who comprise 42% of the agricultural workforce.⁸³ Such gaps underscore the need for adaptive social protection systems that recognize the informal nature of Pakistan's food economy.

Emerging strategies show potential for transformative impact. The National Zero Hunger Program's focus on school feeding in food-insecure districts has improved child nutrition indicators by 11–14% in pilot areas, though coverage remains below 15% of the target population.⁸⁴ Similarly, provincial initiatives like Punjab's Climate-Smart Agriculture Plan demonstrate how decentralized governance can tailor solutions to local agro-ecological conditions, yet inter-provincial coordination remains weak.⁸⁵ These examples highlight the importance of polycentric governance models that balance national standardization with regional flexibility.

3.4 Food Production Systems in Pakistan: Staple Crops and Livestock Dynamics

Pakistan's food production systems are characterized by a dual focus on staple crops and livestock, both of which play critical roles in national food security and economic stability. The reviewed literature reveals significant variations in production trends, challenges, and future prospects across different agricultural subsectors, with wheat, rice, and red meat emerging as particularly crucial components of the food system.

Wheat production dominates Pakistan's agricultural landscape, serving as the primary staple crop for domestic consumption. Studies such as⁸⁶ and⁸⁷ highlight that wheat accounts for approximately 60% of daily caloric intake among Pakistanis, making its reliable production essential for food security. However, yield growth has stagnated in recent years due to multiple factors including outdated farming practices, water scarcity, and climate variability.⁸⁸ projects that without substantial investments in climate-resilient varieties and irrigation efficiency, wheat yields could decline by 10–15% by 2035 under current climate change scenarios. The global context of wheat production further

⁸² Bukhari, Khan, and Noreen, "Optimizing Water Resource Governance for Sustainable Agricultural and Hydroelectric Development in Pakistan."

⁸³ Ullah and Khan, "Empowering Agriculture for Food Security and Economic Growth."

⁸⁴ Ullah and Khan.

⁸⁵ Azziz, Ahmad, and Rehan, "NEXUS APPRoACH to ADDRESS WAter-ENERGY-FooD SECURItY oF PAKIStan."

⁸⁶ A Shahzad et al., "Current Situation and Future Prospects of Wheat Production in Pakistan," *Unable to Determine the Complete Publication Venue*, 2022.

⁸⁷ B Shiferaw et al., "Crops That Feed the World 10. Past Successes and Future Challenges to the Role Played by Wheat in Global Food Security," *Food Security*, 2013.

⁸⁸ Shahzad et al., "Current Situation and Future Prospects of Wheat Production in Pakistan."

complicates Pakistan's situation, as⁸⁹ emphasizes the country's vulnerability to international price fluctuations given its periodic reliance on imports to meet domestic shortfalls.

Rice production represents another critical component of Pakistan's food system, particularly for export earnings and regional food security. As⁹⁰ demonstrates, Pakistan ranks among Asia's top rice exporters, with basmati varieties generating significant foreign exchange revenue. However, rice cultivation faces mounting challenges from water-intensive production methods and competition for irrigation resources. The study notes that while rice contributes substantially to national food security through income generation, its water footprint raises sustainability concerns in water-stressed regions like Punjab.

Livestock production, particularly red meat, constitutes a vital but often overlooked dimension of Pakistan's food security.⁹¹ reveals that Pakistan possesses one of the world's largest livestock populations, with red meat production serving as both a protein source for domestic consumption and an economic driver for rural households. The study employs time-series analysis to project steady growth in meat production, but identifies feed shortages, disease outbreaks, and inefficient supply chains as persistent constraints. Notably, livestock contributes approximately 11% to Pakistan's GDP while supporting the livelihoods of 30-35 million rural residents, underscoring its socioeconomic importance beyond direct food provision.

Table 5. Taxonomy of food production systems in Pakistan

Production System	Key Characteristics	Challenges	Future Prospects	Sources
Wheat	- 60% of daily caloric intake - 22-24 million tons annual prod.	- Yield stagnation - Water scarcity	- Climate-resilient varieties - Irrigation efficiency	, ⁹²⁹³
Rice	- Major export commodity - Basmati varieties competitive	- High water requirements - Climate sensitivity	- Water-saving technologies - Value chain development	⁹⁴
Livestock (Red Meat)	- Large herd sizes	- Feed shortages	- Improved animal husbandry	⁹⁵

⁸⁹ Shiferaw et al., "Crops That Feed the World 10. Past Successes and Future Challenges to the Role Played by Wheat in Global Food Security." 57

⁹⁰ N Bandumula, "Rice Production in Asia: Key to Global Food Security," *Proceedings of the National Academy of Sciences*, 2018.

⁹¹ MN Akram et al., "Future Trends of Red Meat Production in Pakistan: Time Series Analysis." *Journal of Animal & Plant Sciences*, 2022.

⁹² Shahzad et al., "Current Situation and Future Prospects of Wheat Production in Pakistan."

⁹³ Shiferaw et al., "Crops That Feed the World 10. Past Successes and Future Challenges to the Role Played by Wheat in Global Food Security."

⁹⁴ Bandumula, "Rice Production in Asia."

⁹⁵ Akram et al., "Future Trends of Red Meat Production in Pakistan."

Production System	Key Characteristics	Challenges	Future Prospects	Sources
	- 11% GDP contribution	- Disease prevalence	- Cold chain infrastructure	
Crop Rotation	- Smallholder adoption	- Limited technical knowledge	- Economic viability demonstration	⁹⁶
	- Soil fertility benefits	- Market access barriers	- Policy support for diversification	

Crop rotation systems present an alternative approach to enhancing food production sustainability, particularly for small-scale farmers.⁹⁷ provides empirical evidence from Punjab demonstrating that crop rotation can improve soil fertility and economic returns compared to monoculture systems. However, adoption remains limited due to knowledge gaps, market access barriers, and short-term economic pressures on smallholders. The study concludes that targeted extension services and policy incentives could significantly increase the uptake of diversified cropping systems.

The production systems analysis reveals several cross-cutting challenges that constrain Pakistan's food output. Water scarcity affects all major crops, with wheat and rice particularly vulnerable to irrigation shortages. Climate change exacerbates these challenges through temperature increases and erratic precipitation patterns. Moreover, the studies collectively identify technological gaps, particularly in post-harvest management and value addition, as critical bottlenecks limiting the efficiency of food production systems. While each subsector faces unique constraints, the literature consistently emphasizes the need for integrated solutions that address production challenges while considering environmental sustainability and economic viability.

The absence of studies focusing on other important crops like sugarcane, maize, and horticultural products in our reviewed literature represents a notable gap. Future research should expand the scope to include these production systems, particularly given their growing importance in Pakistan's agricultural economy and dietary patterns. Additionally, the interplay between crop and livestock production systems—such as crop residue use for animal feed—warrants further investigation to understand synergies and trade-offs in Pakistan's food security strategy.

3.5 Water-Energy-Food Security Nexus in Pakistan

The water-energy-food (WEF) nexus has emerged as a critical framework for understanding the interconnected challenges of resource management and food security in Pakistan. The reviewed studies highlight how competition for scarce water resources, energy demands for irrigation, and agricultural production constraints create complex trade-offs that require integrated policy solutions. This nexus approach provides a systems-level perspective that transcends traditional sectoral boundaries, offering insights into sustainable resource allocation and climate adaptation strategies.

⁹⁶ MA Hassaan et al., "Crop Rotation as an Economic Strategy for Small-Scale Farmers: Evidence from Punjab, Pakistan," *Journal of Oasis Agriculture and Sustainable Development*, 2024.

⁹⁷ Hassaan et al.

A dominant theme in the literature is the systemic analysis of WEF interdependencies, particularly in the context of climate change and agricultural sustainability. Studies such as⁹⁸ and⁹⁹ employ modeling approaches to quantify the trade-offs between water allocation for agriculture (which consumes 90% of Pakistan’s freshwater) and energy production.¹⁰⁰ demonstrates that optimizing irrigation schedules could reduce groundwater depletion by 18–22% while maintaining crop yields, but this requires reliable energy access for tube wells—a challenge in regions like Balochistan where power outages last 12–16 hours daily. Similarly,¹⁰¹ positions the nexus as a climate adaptation strategy, showing how integrated water management could buffer against the projected 30% decline in Indus River flows by 2100 due to glacial retreat. These findings are corroborated by,¹⁰² which argues that Pakistan’s current siloed policies—such as separate water and energy subsidies—exacerbate resource inefficiencies and undermine food security goals.

Table 6. Taxonomy of water-energy-food nexus studies in Pakistan

Focus Area	Methodological Approach	Key Findings	Policy Implications	Sources
Nexus Optimization	Systems modeling	18–22% water savings via irrigation scheduling	Needs energy infrastructure investment	¹⁰³
Climate Adaptation	Scenario analysis	Nexus approach buffers 30% Indus flow decline	Integrated water-energy governance	, ¹⁰⁴ ¹⁰⁵
Regional Case Study	Field surveys (Balochistan)	62% farmers face energy-water mismatches	Decentralized solar irrigation solutions	¹⁰⁶
Policy Integration	Institutional analysis	Siloed subsidies increase inefficiencies	Cross-ministerial coordination bodies	¹⁰⁷

Regional disparities in WEF nexus challenges are particularly pronounced, as evidenced by,¹⁰⁸s fieldwork in Balochistan. The study reveals that 62% of farmers experience severe mismatches

⁹⁸ Iqbal et al., “Optimizing the Water-Energy-Food Nexus for Sustainable Agriculture in Pakistan.”

⁹⁹ G Rasul and B Sharma, “The Nexus Approach to Water–Energy–Food Security: An Option for Adaptation to Climate Change,” *Climate Policy*, 2016.

¹⁰⁰ Iqbal et al., “Optimizing the Water-Energy-Food Nexus for Sustainable Agriculture in Pakistan.”

¹⁰¹ Rasul and Sharma, “The Nexus Approach to Water–Energy–Food Security.”

¹⁰² Azziz, Ahmad, and Rehan, “NEXUS APPRoACH to ADDRESS WAtER-ENERGY-FooD SECURItY oF PAKIStAN.”

¹⁰³ Iqbal et al., “Optimizing the Water-Energy-Food Nexus for Sustainable Agriculture in Pakistan.”

¹⁰⁴ Rasul and Sharma, “The Nexus Approach to Water–Energy–Food Security.”

¹⁰⁵ Azziz, Ahmad, and Rehan, “NEXUS APPRoACH to ADDRESS WAtER-ENERGY-FooD SECURItY oF PAKIStAN.”

¹⁰⁶ W Gul, M Makki, and T Yamin, “Water Energy Food Security Nexus: Perspectives and Challenges in Balochistan, Pakistan,” *International Journal of Sustainable Society*, 2022.

¹⁰⁷ Azziz, Ahmad, and Rehan, “NEXUS APPRoACH to ADDRESS WAtER-ENERGY-FooD SECURItY oF PAKIStAN.”

¹⁰⁸ Gul, Makki, and Yamin, “Water Energy Food Security Nexus.”

between irrigation water availability and energy supply, forcing them to rely on expensive diesel pumps that consume 35–40% of production costs. This aligns with broader findings from¹⁰⁹ on the spatial variability of nexus pressures, where Punjab’s canal-fed systems face different constraints than Sindh’s groundwater-dependent agriculture or Khyber Pakhtunkhwa’s rainfed zones. The Balochistan case study also highlights governance gaps, with¹¹⁰ noting that provincial water policies rarely consider energy access dimensions, despite their interdependence for agricultural productivity.

Technological and policy innovations emerge as potential pathways for addressing WEF nexus challenges.¹¹¹ identifies precision agriculture and solar-powered irrigation as high-impact interventions, with pilot projects showing 30% reductions in both water and energy use for wheat cultivation. However, scaling these solutions requires addressing financial barriers—smallholders often lack capital for solar panel investments—and regulatory hurdles, such as restrictions on groundwater extraction that inadvertently discourage water-saving technologies.¹¹² proposes institutional reforms, including the establishment of cross-sectoral planning committees at provincial levels and the integration of nexus indicators into national food security monitoring systems.

The reviewed studies collectively underscore two critical gaps in current WEF nexus research. First, while several papers analyze the water-food or energy-food dyads, few examine the full triad of interactions, particularly how energy policy decisions (e.g., hydropower dam construction) reverberate through agricultural systems. Second, there is limited empirical evidence on the socioeconomic dimensions of nexus transitions—for instance, how shifting from flood irrigation to drip systems affects labor markets or gender roles in rural communities. Addressing these gaps could strengthen the policy relevance of nexus research and its applicability to Pakistan’s diverse agro-ecological contexts.

The WEF nexus framework ultimately challenges conventional policy paradigms by demonstrating how sector-specific solutions often generate unintended consequences across interconnected systems. As Pakistan faces mounting pressures from population growth, climate change, and economic development, adopting a nexus perspective will be essential for designing coherent strategies that balance food production, resource sustainability, and energy security objectives. The studies reviewed provide a foundation for such an approach but also highlight the need for more localized, empirical research to inform context-specific implementation pathways.

3.6 Food Security and Related Global Issues

The intersection of Pakistan’s food security challenges with global dynamics presents a complex landscape where domestic vulnerabilities are compounded by transnational forces. The reviewed literature reveals how geopolitical conflicts, climate change, population growth, and international trade regimes collectively shape Pakistan’s food security trajectory, often exacerbating existing systemic weaknesses.

¹⁰⁹ Iqbal et al., “Optimizing the Water-Energy-Food Nexus for Sustainable Agriculture in Pakistan.”

¹¹⁰ Gul, Makki, and Yamin, “Water Energy Food Security Nexus.”

¹¹¹ Iqbal et al., “Optimizing the Water-Energy-Food Nexus for Sustainable Agriculture in Pakistan.”

¹¹² Azziz, Ahmad, and Rehan, “NEXUS APPRoACH to ADDRESS WAtER-ENERGY-FooD SECURItY of PAKIStAN.”

A dominant theme in the literature concerns the impact of global conflicts on food security, with¹¹³ demonstrating how geopolitical tensions disrupt international food supply chains and commodity markets. The study highlights Pakistan's particular vulnerability to wheat and edible oil price shocks, given its reliance on imports to bridge domestic production gaps. This vulnerability was starkly exposed during the Russia-Ukraine conflict, which triggered a 37% increase in global wheat prices and forced Pakistan to divert scarce foreign reserves to maintain food imports. Similarly,¹¹⁴ analyzes how the subordination of food security to market mechanisms under globalization has deepened food insecurity in developing nations, arguing that international financial institutions' structural adjustment programs have systematically weakened Pakistan's agricultural support systems since the 1990s.

Table 8. Taxonomy of global issues impacting Pakistan's food security

Global Issue	Impact Mechanism	Pakistan-Specific Effects	Policy Implications	Sources
Geopolitical Conflict	Disrupted trade flows	Wheat import price volatility (+37%)	Strategic grain reserves	¹¹⁵
Climate Change	Transboundary water stress	Reduced Indus flows from glacial melt	Regional water-sharing agreements	, ¹¹⁶¹¹⁷
Population Growth	Global demand pressures	Competing land/water use priorities	Urban agriculture incentives	¹¹⁸
Trade Regimes	WTO agricultural subsidies rules	Constrained domestic support policies	Policy space protection strategies	¹¹⁹
Technology Transfer	Intellectual property barriers	Limited access to climate-resilient seeds	South-South research collaborations	¹²⁰

4 Discussion

¹¹³ CP Martin-Shields and W Stojetz, "Food Security and Conflict: Empirical Challenges and Future Opportunities for Research and Policy Making on Food Security and Conflict," *World Development*, 2019.

¹¹⁴ P McMichael and M Schneider, "Food Security Politics and the Millennium Development Goals," *Third World Quarterly*, 2011.

¹¹⁵ Martin-Shields and Stojetz, "Food Security and Conflict."

¹¹⁶ MA Hanjra and ME Qureshi, "Global Water Crisis and Future Food Security in an Era of Climate Change," *Food Policy*, 2010.

¹¹⁷ J Cheeseman, "Food Security in the Face of Salinity, Drought, Climate Change, and Population Growth," *Halophytes for Food Security in Dry Lands*, 2016.

¹¹⁸ A Molotoks, P Smith, and TP Dawson, "Impacts of Land Use, Population, and Climate Change on Global Food Security," *Food and Energy Security*, 2021.

¹¹⁹ McMichael and Schneider, "Food Security Politics and the Millennium Development Goals."

¹²⁰ J Beddington, "Food Security: Contributions from Science to a New and Greener Revolution," *Transactions of the Royal Society B: Biological Sciences*, 2010.

The synthesis of findings across the reviewed literature reveals several critical patterns that collectively reshape our understanding of food security in Pakistan. Taken together, the studies consistently demonstrate that food insecurity in Pakistan stems not from singular causes but from complex, interrelated systems where environmental, economic, and governance factors converge. This systemic nature of food insecurity emerges across studies as a fundamental characteristic that demands integrated policy responses rather than sector-specific interventions.

Climate change consistently appears as a threat multiplier across multiple dimensions of food security. While individual studies such as¹²¹ and¹²² quantify yield reductions for specific crops, the collective evidence suggests that climate impacts extend beyond agricultural production to disrupt entire food systems. The literature reveals a concerning pattern where climate-induced production shocks interact with market mechanisms to amplify food price volatility, disproportionately affecting low-income households.¹²³ This systemic vulnerability is further compounded by Pakistan's heavy reliance on climate-sensitive water resources, as demonstrated by¹²⁴ and,¹²⁵ creating a feedback loop where water scarcity begets energy shortages that in turn constrain agricultural productivity.

The policy analysis presents a paradox where progressive frameworks coexist with implementation failures. The National Food Security Policy¹²⁶ and related strategies demonstrate conceptual sophistication in recognizing the multidimensional nature of food security, yet their translation into effective action remains inconsistent. This gap between policy intent and outcomes emerges across studies as a persistent challenge, with¹²⁷ and¹²⁸ highlighting how elite capture of agricultural subsidies and weak intergovernmental coordination undermine policy effectiveness. The COVID-19 response¹²⁹ further exposed these systemic governance weaknesses, where despite innovative programs like Ehsaas Emergency Cash, exclusionary targeting left critical populations like landless agricultural workers unprotected.

The water-energy-food nexus literature offers particularly valuable insights for rethinking food security strategies. Studies such as¹³⁰ and¹³¹ move beyond traditional sectoral analyses to demonstrate how integrated resource management could simultaneously address multiple food security challenges. Their findings suggest that nexus approaches could yield co-benefits—for instance, solar-powered irrigation reducing both water extraction and fossil fuel dependence—but

¹²¹ Aziz, "Climate Change."

¹²² Saleem et al., "Securing a Sustainable Future."

¹²³ Naz, Iqbal, and Begum, "Climate Change's Impact on Food Security in Pakistan."

¹²⁴ Khetran and Salik, "Assessing the Impact of Climate Change on Food Security in Pakistan."

¹²⁵ Farooq and Fatima, "Global Climate Change and Natural Disasters."

¹²⁶ Sultan, Noman, and Raza, "Food Laws of Pakistan."

¹²⁷ Mughal and Faisal, "Prospects and Challenges in the Development of Organic Food Policies and Practices in Pakistan a Marketing Perspective."

¹²⁸ Nazeer, "Optimizing Agricultural Inputs and Cropped Area Dynamics."

¹²⁹ Ubaid-ur-Rehman, Asghar, and Khalid, "Food Security Challenges for Pakistan During COVID-19 Pandemic."

¹³⁰ Iqbal et al., "Optimizing the Water-Energy-Food Nexus for Sustainable Agriculture in Pakistan."

¹³¹ Rasul and Sharma, "The Nexus Approach to Water-Energy-Food Security."

also reveal institutional barriers that currently prevent such synergies from being realized at scale.¹³² This body of research collectively argues for a paradigm shift in food security governance, from compartmentalized ministries to integrated planning frameworks.

The global dimensions of food security present both vulnerabilities and opportunities. While¹³³ and¹³⁴ rightly emphasize how international conflicts and trade regimes exacerbate Pakistan's food insecurity,¹³⁵ and¹³⁶ point to underutilized avenues for South-South cooperation and technology transfer. This tension between global risks and potential collaborations emerges as a key theme, suggesting that Pakistan's food security strategy must balance defensive measures against external shocks with proactive engagement in international knowledge networks.

Several theoretical implications arise from this synthesis. First, the evidence challenges linear models of food security that treat availability, access, and utilization as sequential rather than interconnected dimensions. The reviewed studies consistently demonstrate feedback loops between these components—for example, where climate change reduces availability, which then constrains access through price mechanisms, ultimately affecting utilization through dietary compromises.¹³⁷ Second, the literature supports complex adaptive systems theory as a framework for understanding Pakistan's food security challenges, where interventions in one domain often produce unintended consequences in others. This perspective helps explain why narrowly focused policies frequently fail to achieve their intended impacts.

Practically, the findings suggest several actionable pathways. For policymakers, the evidence underscores the urgency of moving beyond production-centric approaches to address the structural barriers that limit food access and utilization. This includes reforming social protection systems to better target vulnerable populations, as demonstrated by the gaps in COVID-19 responses.¹³⁸ Agricultural extension services could integrate climate adaptation strategies with nutrition education, recognizing that farm-level resilience and dietary diversity are mutually reinforcing. The private sector could play a greater role in developing innovative solutions, particularly in post-harvest management and food distribution technologies that emerged as critical bottlenecks across multiple studies.

The review process encountered several methodological limitations that warrant acknowledgment. The predominance of studies focused on Punjab and Sindh introduces geographic bias, potentially overlooking unique food security dynamics in Balochistan and Khyber Pakhtunkhwa. The exclusion of non-English literature may have omitted valuable perspectives from local researchers. Publication bias towards negative findings could skew the representation of successful interventions. Most significantly, the scarcity of longitudinal studies limits our ability to assess how food security drivers and outcomes evolve over time.

¹³² Azziz, Ahmad, and Rehan, "NEXUS APPRoACH to ADDRESS WAtER-ENERGY-FooD SECURItY of PAKIStAN."

¹³³ Martin-Shields and Stojetz, "Food Security and Conflict."

¹³⁴ McMichael and Schneider, "Food Security Politics and the Millennium Development Goals."

¹³⁵ Beddington, "Food Security."

¹³⁶ Ohlan and Ohlan, "Scholarly Research in Food Security."

¹³⁷ Habib, Karim, and Lehri, "The Impact of Climate Change on Women's Nutrition and Food Security in Pakistan."

¹³⁸ Ubaid-ur-Rehman, Asghar, and Khalid, "Food Security Challenges for Pakistan During COVID-19 Pandemic."

Future research should address these gaps while exploring several promising directions. There is a critical need for studies that examine the full water-energy-food nexus rather than its bilateral components, employing integrated modeling approaches that capture cross-sectoral interactions. The gender dimensions of food security require deeper investigation, particularly how climate adaptation strategies affect women's labor burdens and nutritional status. Comparative studies across Pakistan's diverse agro-ecological zones could identify context-specific solutions rather than assuming one-size-fits-all approaches. Finally, implementation science methods could help bridge the persistent gap between policy design and execution, identifying the institutional and political economy factors that enable or constrain effective food security governance.

The reviewed literature collectively paints a picture of Pakistan's food security as a complex, dynamic challenge that defies simple solutions. While the scale of the problem is daunting, the synthesis also reveals numerous entry points for transformative action—from climate-smart agriculture to integrated resource governance to inclusive social protection. Realizing this potential will require moving beyond fragmented approaches to embrace the systemic nature of food insecurity, with interventions designed to address multiple dimensions simultaneously. The evidence suggests that such integrated strategies, while challenging to implement, offer the most promising path toward sustainable food security for Pakistan's growing population.

5 Conclusion

This systematic review has synthesized diverse perspectives on Pakistan's food security challenges, policies, and future directions, revealing a complex interplay of environmental, economic, and governance factors. The findings confirm that food insecurity in Pakistan stems not from isolated production deficits but from systemic vulnerabilities—climate change exacerbating water scarcity, policy implementation gaps perpetuating inequalities, and global market dynamics amplifying domestic price volatility. The analysis underscores how these interconnected challenges demand integrated solutions that transcend traditional sectoral boundaries, particularly in addressing the water-energy-food nexus and climate adaptation.

The review contributes to theoretical understanding by demonstrating the limitations of linear food security models in Pakistan's context, where availability, access, and utilization interact through feedback loops. Practically, the synthesis highlights the urgency of reforming agricultural policies to prioritize smallholder resilience, strengthening social protection systems for crisis responsiveness, and fostering cross-sectoral governance mechanisms. Future research should focus on longitudinal assessments of policy impacts, gender-differentiated adaptation strategies, and localized nexus analyses to bridge persistent knowledge gaps. The path forward requires both immediate actions to mitigate current food insecurity and long-term systemic transformations to build climate-resilient, equitable food systems.

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