

CHAPTER 03

Linking Food Systems to Nutrition and Public Health: Pathways, Challenges, and Policy Directions

Ayesha Rouf^{1,*}, Zaki Rauf^{2*}, Tahira Sadaf¹, Michael Lahr³, Muhammad Khalid Bashir^{1,4}

¹Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, Pakistan.

²National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

³The Edward J. Bloustein School of Planning & Public Policy, Rutgers, The State University of New Jersey, New Brunswick, NJ, USA

⁴Policy, Advocacy, and Outreach, Pak-Korea Nutrition Center, University of Agriculture, Faisalabad, Pakistan

*Corresponding authors' email: 2013ag3509@uaf.edu.pk | zakirau88@gmail.com

Abstract

Food systems have a significant effect on eating patterns, nutritional quality, and population health. This chapter examines the channels through which food systems influence nutrition, identifying production, distribution, market accessibility, and consumption as the key factors that define diet quality. It examines the impact of structural changes, including the commercialization of agriculture, climate instability, and urbanization, on the availability, affordability, and adequacy of food, which in turn contribute to both undernutrition and overnutrition, echoing the food-security constraints identified for Pakistan's agricultural system in Chapter 2. The chapter gives priority to expanding equitable access to wholesome, safe foods; addressing gender inequalities in food distribution; and reducing food loss and waste across the value chain. It further clarifies the policy gaps between trade, health, and agriculture sectors that hinder the effectiveness of nutrition-sensitive interventions. Evidence-based recommendations are discussed, including avenues for stimulating the growth of nutrient-fortified foods, strengthening social safety nets, and shaping food environments that support healthy eating behaviors, complementing the household-level food-security pathways explored later through dairy farming in Chapter 5. The chapter concludes that maintaining population health and nutrition requires integrating agricultural and health policies within a multisectoral framework to achieve a sustainable, inclusive food system.

<https://doi.org/10.66529/book.9786277945053.2026.ch03>

Received: 15-November 2025 Revised: 30-July 2026 Accepted: 30-August 2026

Keywords: Food systems, Nutrition, Public health, Dietary diversity, Policy interventions

3.1 Introduction

Various studies have explored how dietary patterns, food systems and community health are interconnected, showing that what people eat is shaped by broader agricultural, trade and policy structures and, in turn, drives major health outcomes (Tilman & Clark, 2014; Popkin, 2017; Willett et al., 2019; Swinburn et al., 2019; Fanzo et al., 2021). As the global population grows and environmental pressures intensify, research highlights rising concern about ensuring access to healthy, affordable and environmentally sustainable diets rather than calories alone (Tilman & Clark, 2014; Willett et al., 2019). This work points to the need for a hybrid strategy that links food production and trade with public health and social policy, so that agricultural, market and nutrition agendas are aligned rather than working in isolation (Gustafson et al., 2016; Swinburn et al., 2019; Hawkes, 2012).

In this chapter, food systems are understood as the full set of activities and actors involved in the production, processing, distribution, marketing, consumption and disposal of food, and the wider economic, political and environmental context in which these occur. Food security refers to the ability of individuals and households to access sufficient, safe and nutritious food that meets their dietary needs and preferences. Nutrition refers to the quality of diets and their biological effects on growth, health and disease. Public health captures population-level outcomes that arise from the interaction between food

systems, nutrition and broader social determinants of health. Treating these concepts as distinct but interconnected helps avoid conceptual overlap and supports a more structured analysis.

3.2 Conceptual foundations of food systems

Food systems shape eating habits, nutritional quality and public-health outcomes. They connect agriculture, markets, environments and social structures. A solid conceptual foundation is essential for understanding how these systems affect communities.

The **One Health** approach highlights that food systems must be considered in relation to human health, environmental change and societal dynamics at the same time (Angelos et al., 2017). The Network for Evaluation of One Health (NEOH) shows how integrated evaluations can be used to guide better food and health policy (Rüegg et al., 2018). Sustainable food systems are those that protect diet quality, environmental integrity and nutrition security simultaneously (Fanzo et al., 2021). Climate change directly affects agricultural production, food availability and nutritional outcomes, particularly in low- and middle-income countries (Owino et al., 2022).

3.2.1 Global frameworks

Several global frameworks guide current thinking on food systems. The HLPE (High Level Panel of Experts on Food Security and Nutrition) global food system framework proposes that food systems be analyzed across production, markets, environment, diets, socioeconomic drivers and governance (Battersby et al., 2024). The FAO food-systems approach stresses the interconnectedness between agriculture, trade, nutrition, climate resilience and livelihoods (Miles et al., 2025). The nutrition-transition literature, especially Popkin (2017), explains how rising income, urbanization and market exposure shift diets from traditional, plant-based patterns to energy-dense, ultra-processed foods, with major implications for obesity and non-communicable diseases. Political-economy perspectives further underline how power imbalances, global value chains and trade agreements shape food access and dietary outcomes (Clapp, 2021; Thow et al., 2023). Together, these frameworks show that food systems are not just technical or agricultural structures; they are embedded in economic incentives, governance arrangements and consumer food environments.

3.2.2 Problem statement

Despite a large body of research on agriculture and nutrition, Pakistan still faces persistent problems of poor dietary diversity, micronutrient deficiencies, gender-based nutritional gaps and weak coordination between food, health and trade policies. Existing food systems are not designed to address these multi-dimensional challenges and continue to generate high levels of malnutrition, food insecurity and preventable disease. What remains unclear is how food systems can be structured to support equitable nutrition and long-term health resilience, particularly under conditions of climate stress and rapid urban change.

3.2.3 Scope and objectives

This chapter focuses on the links between food systems, nutrition and public health, with a particular emphasis on Pakistan as an illustrative case. It aims to:

- Identify structural and social factors that affect nutrition outcomes.
- Analyze gender and climate as key stressors within food systems.
- Show how food accessibility and dietary patterns are linked to public-health outcomes.
- Provide policy recommendations for nutrition-sensitive and gender-responsive food systems.

The main objective is to bridge conceptual understanding with real-world evidence and demonstrate how food systems can be redesigned to support equitable nutrition, reduce health disparities and improve population well-being.

3.3 Methodological approach

A structured narrative review was used to synthesize literature for this chapter. Figure 3.1 (PRISMA-style flow diagram) summarizes the process. Peer-reviewed studies were identified through major databases such as Scopus, Web of Science, PubMed and ScienceDirect. After removing duplicates, preprints, student theses and non-peer-reviewed material, global, regional (LMIC) and Pakistan-specific studies were screened using predefined inclusion criteria related to food systems, nutrition, gender, climate and public health. Only methodologically sound and conceptually relevant research was retained, ensuring a transparent and academically rigorous evidence base.

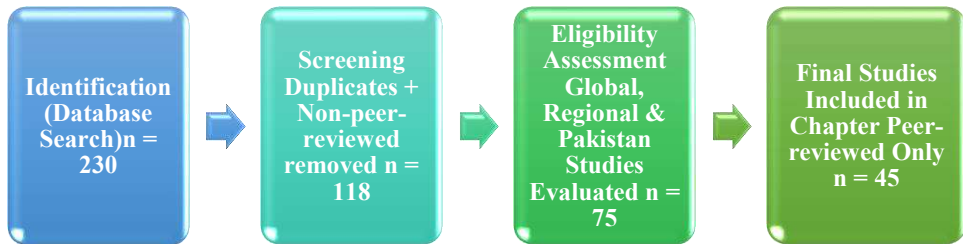


Figure 3.1. PRISMA-style flow diagram for literature selection and screening process

Local case studies from different regions of Pakistan (for example, Sindh, Balochistan, Bajaur, Faisalabad and Kurram) were used as illustrative examples rather than as statistically representative evidence of the national food system. This aligns with qualitative norms where local evidence serves as a lens to understand structural barriers rather than as nationally generalizable estimates.

3.4 Contextual challenges affecting food systems

3.4.1 Climate change and environmental stressors

Climate change increasingly disrupts food availability, market supply and diet quality (Syed et al., 2022). Evidence from Pakistan shows that extreme weather events and climate variability contribute to food insecurity among women and children, leading to poorer maternal and infant health outcomes (Ullah, 2023). Environmental degradation, including soil depletion and water scarcity, reduces the micronutrient content of crops and heightens public-health risks (Ringler & Dias, 2020).

3.4.2 Gender inequality in nutrition

Gender norms strongly influence food access and nutritional outcomes. In Pakistan, women often face socio-cultural restrictions, mobility limits and heavy care responsibilities that reduce their capacity to participate in paid work, agricultural production and decision-making around food (Rouf et al., 2025). At the same time, maternal employment has been associated with improved child nutrition when supported by adequate childcare and social protection (Rouf et al., 2023). Gender-sensitive agricultural and nutrition policies are therefore essential for improving household health.

3.4.3 Trade policies and food access

Trade policies and certification systems also shape food environments. Agreements such as the Trans-Pacific Partnership and similar trade arrangements can influence national food environments, altering the availability and price of both healthy and unhealthy foods (Thow et al., 2023). Weak or confusing certification schemes complicate consumers' ability to identify healthy, sustainable products (Smith & Glauber, 2020). Aligning trade, health and agriculture policies is crucial for building equitable food systems.

3.4.4 Essential dimensions of modern food systems

Contemporary food systems operate within complex global and political structures. Four additional dimensions are particularly important:

- **Market concentration and corporate power**
A small number of multinational firms increasingly control seed production, processing, retail, advertising and supply chains. High concentration can limit farmer autonomy, constrain dietary diversity and marginalize small producers (Clapp, 2021).
- **Food environments**
Food environments include the physical, economic and socio-cultural surroundings in which people make food choices: availability, price, marketing, labelling and spatial access. Poor food environments often drive consumption of ultra-processed, nutrient-poor foods even when more nutritious options exist (Swinburn et al., 2019).
- **Global value chains (GVCs)**
- Food production, processing and retail are increasingly organized across borders. Participation in GVCs can generate income but also exposes countries to external price shocks, currency fluctuations and trade disruptions, with implications for affordability and diet quality (Li et al., 2022).
- **Political economy of food trade**
Tariff regimes, subsidies and trade rules determine who benefits from food production and who bears the risks. In Pakistan, reliance on wheat subsidies and the taxation of fruit and vegetable imports creates structural bias toward calorie-rich but nutrient-poor diets (Thow et al., 2023).

These dimensions underline that food systems are deeply political and economic, not merely technical.

3.4.5 Empirical evidence: case studies from Pakistan

Pakistan-based case studies

Pakistan demonstrates complex interconnections between food systems, nutrition, and social factors. Across Sindh and Balochistan, poor dietary diversity and heavy reliance on starch-based foods continue to contribute to poverty-related health problems. Evidence shows that maternal labor and community-level Lady Health Worker programs can improve child nutrition, although their impact is constrained by limited coverage and underfunding. Localized nutrition initiatives, including locally produced supplementary-food interventions, have shown potential to reduce stunting among young children (Fazid et al., 2024). These challenges are intensified by climate-related shocks, particularly droughts, that heighten household vulnerability to food insecurity and malnutrition. Educational and school-based nutrition programs have also demonstrated positive behavioral changes among adolescents, suggesting that knowledge and awareness interventions remain valuable (Perveen et al., 2025). Taken together, these findings highlight the need for context-specific and regionally tailored nutrition strategies that address both environmental stresses and structural inequities in access to nutritious food.

Limitations of case-based generalization

The Pakistan-based case studies included in this chapter (such as those from Bajaur, Faisalabad, Kurram and Sindh) provide important local insights but do not represent the full diversity of the national food system. These findings should therefore be interpreted as context-specific illustrations rather than evidence of universal patterns across Pakistan or global food systems. Each region has distinct socio-cultural, agro-ecological and economic characteristics that shape dietary practices and food access differently. Recognizing this limitation, the chapter does not attempt to generalize local outcomes to national or international contexts. Instead, these cases are used to show how broader global challenges such as climate stress, gender inequalities and food-environment constraints manifest in specific local

forms. This approach aligns with qualitative research norms, where local evidence serves as a lens to understand structural barriers rather than as a statistical representation of national trends. Future research should incorporate comparative regional data, nationally representative surveys and cross-country evidence to deepen generalizability and improve policy relevance.

3.5 Analysis: linking food systems to nutrition and health

Food systems shape diets through several interconnected pathways. Production practices influence the micronutrient content and safety of food reaching consumers. Market access and food prices determine what households can realistically purchase. Within households, gender norms and bargaining power guide food distribution, affecting who eats first, who gets more and who is most exposed to deficiencies.

Broader forces such as climate stress and trade dynamics alter supply chains, influencing both availability and affordability. Urbanization, income inequality and changing work patterns are reshaping food preferences and consumption habits, often pushing diets toward processed, energy-dense products (Kenney et al., 2024). Urban food environments in cities such as Lahore, Karachi, Faisalabad and Islamabad characterized by supermarket expansion, fast-food outlets, street food and delivery apps play a central role in this nutrition transition (Ashraf et al., 2024; Rouf et al., 2023; Popkin, 2017; Swinburn et al., 2019; Reardon et al., 2021; Miles et al., 2025; Samoggia et al., 2021).

Institutional programs, particularly school-based interventions and community health services, can counter some of these trends when supported by reliable supply chains and coherent policy coordination (Liguori et al., 2024; Choudhury et al., 2025). Food systems therefore need to be evaluated not only in terms of economic output, but also their impact on dietary diversity, equity and health resilience.

3.5.1 Economic analysis

Food choices are heavily shaped by economic constraints. Poor households often prioritize cheap, calorie-dense staples over nutrient-rich foods. Evidence from Pakistan indicates that the income elasticity of demand for fruits, vegetables and animal-source foods is higher than for wheat and rice, effectively making healthier options “luxury goods” for low-income families (Haider & Zaidi, 2017).

Affordability indicators, such as the cost of a “healthy plate” relative to income, show that many households struggle to maintain a balanced diet. Recent evidence from Faisalabad further illustrates the connection between food insecurity, dietary behavior, and nutritional outcomes, showing that food access and institutional food environments can jointly shape nutritional status among university students (Saddique et al., 2026). Price volatility, especially in fresh produce connected to global value chains, pushes consumers toward ultra-processed alternatives when prices spike.

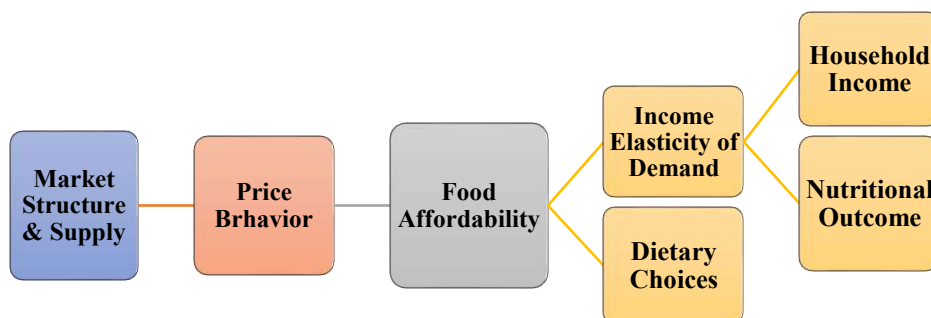


Figure 3.2. Economic drivers influencing dietary choices and nutritional outcomes

Figure 3.2 (Economic drivers influencing dietary choices and nutritional outcomes) summarizes these relationships: household income interacts with food prices, market structure and income elasticity to determine what people can buy. When economic constraints tighten, diets tend to shift away from fresh,

nutrient-dense food towards cheaper processed items, with predictable effects on nutritional status. This underlines the need for nutrition-sensitive pricing policies, targeted subsidies and social protection that explicitly account for diet quality.

3.5.2 Literature synthesis

Recent literature converges on the idea that food systems must be studied through multiple lenses nutrition, markets, environment, gender and governance. The EAT-Lancet framework links food systems to sustainable diets and public health (Willett et al., 2019), while (Fanzo et al., 2021; Fanzo, 2023) show how environmental degradation undermines nutrition. Swinburn et al. (2019) describe the global “syndemic” of obesity, undernutrition and climate change rooted in dysfunctional food systems.

Nutrition-sensitive agriculture has improved diet quality in several low- and middle-income settings (Liguori et al., 2024; Khandoker et al., 2022). Women’s participation in agriculture and decision-making improves household dietary diversity (Rouf et al., 2025), but is constrained by time poverty, mobility limits and restricted access to resources. Pakistani evidence from LHW programs and school feeding schemes shows that community-based and institutional interventions can shift behaviors when they are adequately supported (Shahid et al., 2022; Rouf et al., 2023).

These insights reinforce the argument that nutrition-sensitive and gender-responsive food systems are essential for long-term public-health improvement.

3.5.3 Economic growth, dietary transition and NCDs

Figure 3.3 (Conceptual flow of this perspective) illustrates how economic growth can inadvertently increase nutrition-related disease. Rising incomes and market integration lead to a dietary transition away from traditional, largely plant-based diets towards processed foods, sugary drinks and fast food. While undernutrition may decline, intake of salt, sugar and unhealthy fats increases, raising NCD (Noncommunicable Disease) risk. This dynamic underpins the argument for comprehensive food-system reform: once the nutrition transition is underway, isolated interventions are insufficient without broader changes in agriculture, retail, trade and health policy.

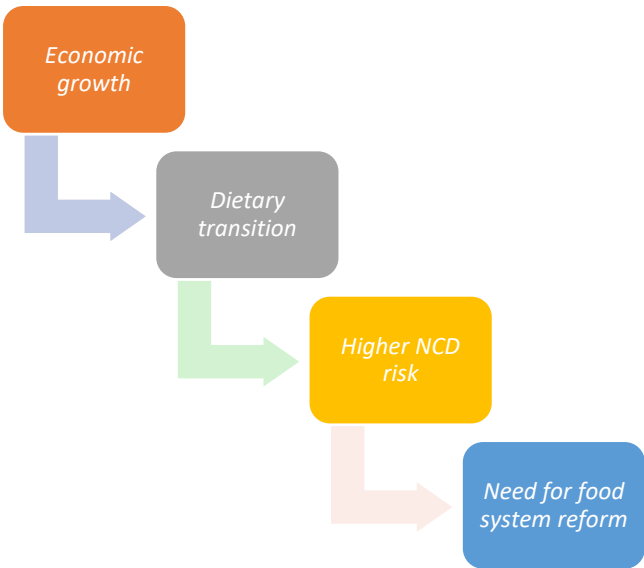


Figure 3.3: Conceptual flow of this perspective

3.6 Conclusion

The chapter makes it clear that food systems are far more than channels for producing and selling food. They are dense webs of interaction linking agriculture, health, the environment, gender relations, trade regimes, and policy and regulatory choices. Evidence from global research shows that these systems must be redesigned within the perspectives of One Health, climate resilience, and sustainable diets. Climate change reshapes what can be grown and with what nutritional quality, trade rules shape which foods are affordable and available, gender norms influence who eats what within households, and consumer behavior responds to and reinforces these structures. Because of these connections, food systems need to be treated as a central public health concern, not only as a question of yields or economic output.

In Pakistan, these global pressures are often intensified by deep income inequalities, weak coordination across institutions, and the limited reach of nutrition-sensitive policies. The case examples from Sindh, Faisalabad, and rural Punjab highlight chronic dietary gaps, widespread food insecurity, gendered barriers to resources and decision-making, overstretched health services, and agricultural practices that cannot be sustained in the long run. At the same time, the experience with school feeding programs, the Lady Health Worker network, biofortified crops, maternal nutrition initiatives, and community-based schemes shows that progress is possible when interventions are rooted in local realities and backed by sound evidence.

Taken together, the chapter points to a central lesson: future improvements in nutrition depend on bringing food, health, gender, trade, and climate agendas into a single, coordinated policy vision. Building stronger food systems will require:

- Expanding nutrition-sensitive agriculture and the use of biofortified crops
- Designing and enforcing gender-responsive policies that enhance women's economic and decision-making power
- Investing in education and behavior change to support healthier food choices
- Framing national dietary goals within One Health and sustainability principles
- Ensuring policy coherence across agriculture, trade, social protection, and public health

In conclusion, insights from international frameworks and Pakistan-specific evidence converge on the same message: meaningful nutritional progress is impossible without structural change in food systems. Only a coordinated, regionally adapted, and equity-focused approach can create food systems that are resilient to shocks, inclusive in access, and supportive of public health and wellbeing over the long term.

3.7 Policy directions and recommendations

To move toward healthier and more resilient food systems, the chapter proposes the following priority areas.

3.7.1 Nutrition-sensitive agriculture

Place human nutrition, not just yield, at the center of farming systems. This includes promoting biofortified crops such as zinc-enriched wheat and iron-rich lentils; encouraging diversified production of pulses, fruits, vegetables and small livestock; and adopting practices that protect soil health and ecosystem functions (mixed cropping, organic inputs, reduced chemical dependence). Such strategies expand the availability of nutrient-dense foods in local markets and support rural livelihoods.

3.7.2 Strengthen food access and supply chains

Invest in transport, cold chains and storage so that perishable foods reach markets with minimal loss. Support local processing industries to reduce post-harvest waste and add value near production areas. Design targeted subsidies or vouchers for fruits, vegetables and other nutrient-rich foods, focusing on poor households and urban low-income areas, so that healthy options become competitive with cheap ultra-processed foods.

3.7.3 Gender-sensitive approaches

Ensure women's secure access to land, credit and agricultural training and recognize their central role in food provisioning. Policies should reduce women's time poverty through childcare, improved water and energy infrastructure and social protection. Nutrition education initiatives aimed at mothers and adolescents can reinforce positive food choices, child-feeding practices and awareness of ultra-processed food risks.

3.7.4 Education and community nutrition

Scale up school-based nutrition and hygiene programs that build knowledge and provide healthy meals or snacks. Strengthen the role of Lady Health Workers in delivering nutrition counselling, growth monitoring and referral services at household level. Use community platforms for awareness campaigns and maternal nutrition counselling, aligning messages with local beliefs and food availability.

3.7.5 Climate-resilient nutrition policies

Integrate nutrition objectives into disaster-risk management and climate-adaptation plans. Relief and recovery programs should protect access to diverse, safe foods, not just staple calories. Invest in water management (small-scale irrigation, rainwater harvesting, safe drinking water) and climate-smart agriculture, combined with livelihood diversification and social protection, so that households can maintain adequate diets under climatic and economic shocks.

3.7.6 Policy trade-offs and institutional constraints

Well-intentioned policies can have unintended consequences. Calorie-oriented subsidies may crowd out fruit, vegetables and pulse consumption; cash transfers can increase purchases of processed foods if not paired with nutrition education and healthy local options. At the same time, weak coordination across ministries, limited local capacity, unstable funding and low female representation in decision-making undermine implementation.

Effective policy therefore depends not only on technical solutions but also on governance, budgeting, accountability and gender-responsive planning. Recommendations must be realistic, linked to existing institutions and instruments, and sensitive to political and administrative constraints.

Recommendations

Each recommendation is explicitly grounded in empirical findings and linked to a specific policy instrument. Subsidies are no longer framed as a generic call to "promote fruits and vegetables," but as targeted measures aimed at closing affordability gaps for low-income and urban households. Nutrition education is positioned within existing delivery platforms such as Lady Health Worker programs, school curricula and mobile-health initiatives, rather than as a stand-alone slogan. Likewise, organic farming is recommended only where farmer training, market incentives and procurement mechanisms can support its economic viability. Food-safety improvements are anchored in institutional mechanisms, including street-vendor certification, urban zoning for food outlets and routine inspection systems. Together, these changes make the recommendations more realistic, actionable and useful for decision-makers.

Thus, instead of presenting general advice, the revised recommendations focus on actionable strategies with practical entry points for policy implementation. This includes policy alignment across ministries, nutrition-sensitive public procurement, evidence-based subsidy reform, and gender-responsive planning. By linking suggestions to institutional capacity, budget requirements and political feasibility, the chapter now provides guidance that is both context-aware and useful for decision-makers.

3.7.7 Linking Evidence to Recommendations

One limitation of the earlier draft was that the recommendations were not clearly connected to the evidence presented in the literature review. In the revised version, each policy direction is now explicitly informed by the findings discussed throughout the chapter. For instance, the evidence on poor dietary diversity, urban nutrition transition, and gender-based constraints supports the need for nutrition-sensitive

public procurement and school-based programs. Similarly, Pakistan-specific case studies on Lady Health Workers and maternal labor participation provide justification for integrating nutrition education into existing community structures rather than creating new standalone programs. The discussion on income elasticity and affordability informs the need for targeted fiscal instruments rather than broad subsidies. Likewise, the review of food environments particularly supermarket expansion, fast-food retail, and food delivery apps supports the recommendation to regulate marketing practices and zoning around schools and hospitals. In this way, the revised recommendations are directly tied to empirical and conceptual evidence, ensuring policy relevance and academic coherence.

References

- Angelos, J. A., Arens, A. L., Johnson, H. A., Cadriel, J. L., & Osburn, B. I. (2017). One Health in food safety and security education: Subject matter outline for a curricular framework. *One Health*, 3, 56-65. <https://doi.org/10.1016/j.onehlt.2017.04.001>.
- Ashraf, K., Huda, T. M., Ikram, J., Ariff, S., Sajid, M., Khan, G. N., & Soofi, S. B. (2024). The Effectiveness of Nutritional Interventions Implemented through Lady Health Workers on the Reduction of Stunting in Children under 5 in Pakistan: The Difference-in-Difference Analysis. *Nutrients*, 16(13), 2149. <https://doi.org/10.3390/nu16132149>
- Battersby, J., Hatab, A. A., Ambikapathi, R., Chicoma, J. L., Shulang, F., Kimani-Murage, E., Resnick, D., Tschirley, D., & Vink, N. (2024). Strengthening urban and peri-urban food systems to achieve food security and nutrition, in the context of urbanization and rural transformation. HLPE Report No. 19. High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security.
- Choudhury, S., Bi, A. Z., Medina-Lara, A., Morrish, N., & Veettil, P. C. (2025). The rural food environment and its association with diet, nutrition status, and health outcomes in low-income and middle-income countries (LMICs): a systematic review. *BMC public health*, 25(1), 1-18. <https://doi.org/10.1186/s12889-025-22098-4>.
- Clapp, J. (2021). The problem with growing corporate concentration and power in the global food system. *Nature food*, 2(6), 404-408. <https://www.nature.com/articles/s43016-021-00297-7>.
- Fanzo, J. (2023). Achieving food security through a food systems lens. In *Resilience and food security in a food systems context* (pp. 31-52). Cham: Springer International Publishing.
- Fanzo, J., Bellows, A. L., Spiker, M. L., Thorne-Lyman, A. L., & Bloem, M. W. (2021). The importance of food systems and the environment for nutrition. *The American Journal of Clinical Nutrition*, 113(1), 7-16. <https://doi.org/10.1093/ajcn/nqaa313>.
- Fazid, S., Haq, Z. U., Gillani, B. H., Khan, A. J., Khan, M. N., Khan, A., & Heald, A. H. (2024). Effectiveness of locally produced ready-to-use supplementary foods on the prevention of stunting in children aged 6–23 months: a community-based trial from Pakistan. *British Journal of Nutrition*, 131(7), 1189-1195. <https://doi.org/10.1017/S0007114523002702>
- Gustafson, D., Gutman, A., Leet, W., Drewnowski, A., Fanzo, J., & Ingram, J. (2016). Seven food system metrics of sustainable nutrition security. *Sustainability*, 8(3), 196. <https://doi.org/10.3390/su8030196>
- Haider, A., & Zaidi, M. (2017). Food consumption patterns and nutrition disparity in Pakistan. <https://mpr.ub.uni-muenchen.de/83522/>
- Hawkes, C. (2012). Food policies for healthy populations and healthy economies. *Bmj*, 344. <https://doi.org/10.1136/bmj.e2801>.
- Kenney, E., Rampalli, K. K., Samin, S., Frongillo, E. A., Reyes, L. I., Bhandari, S., & Blake, C. E. (2024). How livelihood change affects food choice behaviors in low-and middle-income countries: A scoping review. *Advances in Nutrition*, 15(5), 100203. <https://doi.org/10.1016/j.advnut.2024.100203>
- Khandoker, S., Singh, A., & Srivastava, S. K. (2022). Leveraging farm production diversity for dietary diversity: evidence from national level panel data. *Agricultural and Food Economics*, 10(1), 15. <https://doi.org/10.1186/s40100-022-00221-y>
- Li, M., Jia, N., Lenzen, M., Malik, A., Wei, L., Jin, Y., & Raubenheimer, D. (2022). Global food-miles account for nearly 20% of total food-systems emissions. *Nature food*, 3(6), 445-453. <https://doi.org/10.1038/s43016-022-00531-w>
- Liguori, J., Amevinya, G. S., Holdsworth, M., Savy, M., & Laar, A. (2024). Nutritional quality and diversity in Ghana's school feeding program: a mixed-methods exploration through caterer interviews in the Greater Accra Region. *BMC nutrition*, 10(1), 127. <https://doi.org/10.1186/s40795-024-00936-9>
- Miles, A. F., Phipps, B. E., & Berry, E. (2025). Food system transformation and the realization of the UN Sustainable Development Goals. *Frontiers in Sustainable Food Systems*, 9, 1691198. <https://doi.org/10.3389/fsufs.2025.1691198>

- Owino, V., Kumwenda, C., Ekesa, B., Parker, M. E., Ewoldt, L., Roos, N., & Tome, D. (2022). The impact of climate change on food systems, diet quality, nutrition, and health outcomes: A narrative review. *Frontiers in Climate*, 4, 941842. <https://doi.org/10.3389/fclim.2022.941842>
- Perveen, S., Karmaliani, R., Mistry, R. F., & Barolia, R. (2025). Improving nutritional status and health outcomes in school-going adolescents: a randomized controlled trial of nutrition and WASH education interventions in Gojra, Pakistan. *Frontiers in Public Health*, 13, 1440634. <https://doi.org/10.3389/fpubh.2025.1440634>.
- Popkin, B. M. (2017). Relationship between shifts in food system dynamics and acceleration of the global nutrition transition. *Nutrition reviews*, 75(2), 73–82. [10.1093/nutrit/nuw064](https://doi.org/10.1093/nutrit/nuw064)
- Reardon, T., Liverpool-Tasie, L. S. O., & Minten, B. (2021). Quiet Revolution by SMEs in the midstream of value chains in developing regions: wholesale markets, wholesalers, logistics, and processing. *Food Security*, 13(6), 1577–1594. [10.1007/s12571-021-01224-1](https://doi.org/10.1007/s12571-021-01224-1).
- Ringler, C., & Dias, P. (2020). Water and nutrition: Harmonizing actions for the United Nations decade of action on nutrition and the United Nations water action decade. <https://www.unscn.org/uploads/web/news/document/Water-Paper-EN-WEB-12feb.pdf>
- Rouf, A., Sadaf, T., Iqbal, M. A., Rauf, Z., & Tabasam, N. (2023). Effect of Maternal Employment on Nutritional Status of Children in Faisalabad City. *Journal of Education and Social Studies*, 4(2), 271–282. <https://doi.org/10.52223/jess.20234205>.
- Rouf, A., Sadaf, T., Lahr, M. L., Bashir, M. K., & Kousar, R. (2025). Barriers to Female Labor Participation in Mixed Farming Systems: Evidence and Policy Insights from Rural Pakistan. *Research Journal for Social Affairs*, 3(3), 151–167. <https://doi.org/10.71317/RJSA.003.03.0208>.
- Rüegg, S. R., Nielsen, L. R., Buttigieg, S. C., Santa, M., Aragrande, M., Canali, M., Ehlinger, T., Chantziaras, I., Boriani, E., Radeski, M., Bruce, M., Queenan, K., & Häslar, B. (2018). A systems approach to evaluate One Health initiatives. *Frontiers in Veterinary Science*, 5, 23. <https://doi.org/10.3389/fvets.2018.00023>
- Saddique, B., Bashir, M. K., Haq, I. U., & Nasir, J. (2026). Food insecurity, oral health, and nutritional status among university students in Faisalabad, Pakistan. *Journal of Agricultural Policy and Transformation*, 2(2), 62–78. <https://doi.org/10.66529/agripat.2026.2.2.66>
- Samoggia, A., Monticone, F., & Bertazzoli, A. (2021). Innovative digital technologies for purchasing and consumption in urban and regional agro-food systems: A systematic review. *Foods*, 10(2), 208. <https://doi.org/10.3390/foods10020208>.
- Shahid, M., Ameer, W., Malik, N. I., Alam, M. B., Ahmed, F., Qureshi, M. G., & Zia, S. (2022). Distance to healthcare facility and lady health workers' visits reduce malnutrition in under five children: A case study of a disadvantaged rural district in Pakistan. *International Journal of Environmental Research and Public Health*, 19(13), 8200. <https://doi.org/10.3390/ijerph19138200>.
- Smith, V. H., & Glauber, J. W. (2020). Trade, policy, and food security. *Agricultural Economics*, 51(1), 159–171. [doi: 10.1111/agec.12547](https://doi.org/10.1111/agec.12547).
- Swinburn, B. A., Kraak, V. I., Allender, S., Atkins, V. J., Baker, P. I., Bogard, J. R., Brinsden, H., Calvillo, A., De Schutter, O., Devarajan, R., Ezzati, M., Friel, S., Goenka, S., Hammond, R. A., Hastings, G., Hawkes, C., Herrero, M., Hovmand, P. S., Howden, M., ... Dietz, W. H. (2019). The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. *The Lancet*, 393(10173), 791–846. [https://doi.org/10.1016/S0140-6736\(18\)32822-8](https://doi.org/10.1016/S0140-6736(18)32822-8)
- Syed, A., Raza, T., Bhatti, T. T., & Eash, N. S. (2022). Climate Impacts on the agricultural sector of Pakistan: Risks and solutions. *Environmental Challenges*, 6, 100433. <https://doi.org/10.1016/j.envc.2021.100433>.
- Thow, A. M., Alschner, W., & Aljunied, F. (2023). Public health clauses in international investment agreements: Sword or shield. *Global Policy*, 14(2), 260–269. [DOI: 10.1111/1758-5899.13199](https://doi.org/10.1111/1758-5899.13199).
- Tilman, D., & Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature*, 515(7528), 518–522. [doi:10.1038/nature13959](https://doi.org/10.1038/nature13959).
- Ullah, I. (2023). Experiences of indigenous women with maternal nutrition in climate change (Cold weather) in rural Bajaur, Khyber Pakhtunkhwa, Pakistan: Implications for maternal-infant health. https://ecommons.aku.edu/etd_pk_sonam_mscn/163/.
- Willett, W., Rockstrom, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., & Murray, C. J. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, 393(10170), 447–492. [10.1016/S0140-6736\(18\)31788-4](https://doi.org/10.1016/S0140-6736(18)31788-4).

Declaration: AI-assisted tools (LLMs) were used to prepare figures/illustrations and to improve the language and grammar of this chapter. The authors reviewed and approved all content and assume full responsibility for its accuracy.