

CHAPTER 02

Food Security and Sustainable Agriculture: Pathways to Harvesting — A Global and Pakistan Perspective

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Abstract

This chapter explores the interlinkages between food security and sustainable agriculture in the context of global challenges and Pakistan's development landscape. It argues that achieving food security requires a transformation of agrifood systems that goes beyond increasing production to include environmental sustainability, economic access, nutritional outcomes, and social inclusion. Drawing on global literature, the chapter examines key drivers of food insecurity, including climate change, ecological degradation, market instability, and inequality, and highlights sustainable agriculture approaches such as climate-smart agriculture, agroecology, and sustainable intensification. It provides a detailed analysis of Pakistan's agricultural system, emphasizing structural constraints such as water scarcity, low productivity, land fragmentation, and institutional weaknesses, and connects these constraints to the land-use, dairy-economics, biodiversity, and green-finance themes examined respectively in later chapters of this volume. It also addresses nutrition, food affordability, and climate vulnerability, particularly following recent environmental shocks. By integrating global insights with country-specific analysis, the chapter identifies strategic pathways for strengthening food systems, including water governance reform, diversification, post-harvest improvement, institutional coordination, and social protection. The chapter concludes that sustainable agriculture is essential for resilient, equitable, and long-term food security in Pakistan and comparable developing economies, setting the empirical agenda that subsequent chapters pursue in greater depth.

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2.1 Introduction

Food security and sustainable agriculture are one of the most pressing development issues of the twenty-first century. They are not only essential to human life, but they are also critical for economic viability, environmental conservation, public health and social justice. Food security is generally always defined as access to enough, safe and nutritious food for an active and healthy life by all people, both on their own and as members of a family (Food and Agriculture Organization of the United Nations [FAO], 2008). Sustainable agriculture refers to methods of farming that operate over time, maintaining productivity and natural resource status and supporting livelihoods and ecological balance. Both are closely related. Food security won't be achieved in the long run when food production systems destroy the land, exhaust water, exacerbate inequality and increase the vulnerability to climatic events. Hence, if agriculture does not contribute to food security and/or leaves behind vulnerable groups in the process of development, it must not be called sustainable.

The current food system is a disturbing paradox in the world. There is enough food in total to feed the world, but hunger, undernutrition, micronutrient deficiencies and the cost of a healthy diet is common. The Food and Agriculture Organization (FAO), the International Fund for Agricultural Development

(IFAD), the United Nations Children's Fund (UNICEF), the World Food Programme (WFP), and the World Health Organization (WHO) (2023) estimate that hundreds of millions are still hungry and billions are unable to afford a healthy diet. Meanwhile, agriculture and food systems are significant sources of climate change, land degradation, freshwater stress and biodiversity loss. This implies that existing food systems are victims and contributors to ecological crisis. Climate change is increasing uncertainty, including through impacts on crops, livestock productivity, pest occurrences, rainfall patterns, droughts and floods (Intergovernmental Panel on Climate Change [IPCC], 2022).

The challenges are particularly great in countries where agriculture still plays a pivotal role in the employment and income of people. One such case is Pakistan. An agricultural country that has a large irrigation network, agroecological diversity and dependence on crops and livestock in relation to rural livelihoods and economic activities. However, the menace of food insecurity, malnutrition, water scarcity, climate vulnerability, low farm productivity, post-harvest losses and inequitable access to resources persist in Pakistan. Wheat, rice, sugarcane, maize and livestock product production is substantial but food availability at the national level does not necessarily translate into food access, food dietary diversity and nutritional well-being at the household level. The fact that child stunting is still present in the country food stress is caused by inflation, and repeated climate disasters indicate that food security needs to be seen as a larger systems problem and not a mere output problem. There is a large body of literature on food security and sustainable agriculture, from various angles and focusing on the complexity of contemporary agri food systems. There are a number of conceptual frameworks developed by the Food and Agriculture Organization (FAO, 2008) that have been used to conceptualize and measure food security, including availability, access, utilization and stability; other food security assessments in recent years have identified the importance of affordability and nutrition as a key aspect of food outcomes (FAO et al., 2023). Meanwhile, studies on sustainable agriculture highlight the importance of balancing productivity with conservation of the environment, efficient use of resources and social inclusion (FAO, 2013; FAO, 2019). The ongoing climate crisis has also focused research on the new challenges facing agricultural systems (IPCC, 2022), and on the ecological pillars of food production (IPBES, 2019). These studies collectively demonstrate that food security is not a production problem alone, but a systemic problem related to environmental, economic and institutional factors.

Although all of these above-mentioned contributions have been valuable, there are still some gaps in the literature. Most of the current literature focuses on food security, agricultural sustainability and climate resilience as distinct and separately analyzed fields, with little connectivity in a coherent approach that captures the whole agri food system. Secondly, the concepts are not analyzed in detail in the context of the country or the local situation, as they are in developing countries, which are subject to structural constraints, institutional fragmentation and climate vulnerability from their environment in complex ways. Existing studies in the case of Pakistan tend to focus on single aspects like productivity, water management or food access, and there is limited attention given to a systems-based approach that connects the dots. This chapter is a valuable addition to the literature, as it integrates the fields of food security and sustainable agriculture, while also providing a detailed understanding of the agricultural landscape, ecological challenges and policy options for the more resilient and inclusive food system in Pakistan, taking a global perspective.

The chapter reviews the food security and sustainable agriculture at global and national level (Pakistan). It begins with the conceptual underpinning of food security and sustainable agriculture and goes on to examine the dominant global forces that contribute to a state of food insecurity, such as climate change, environmental degradation, poverty and food market volatility. It then explores sustainable agriculture as a transformative response, focusing on sustainable resilience, efficiency, diversification and inclusiveness. The next section focuses on Pakistan, its agricultural potentials, structural issues, ecological threats, and policy challenges. Lastly, it identifies important avenues through which the world and Pakistan can shift towards more resilient, equitable and sustainable food systems. The main premise is that the future of harvesting is not just about increasing food production, but also about changing the way food is produced, distributed, accessed and sustained across generations.

2.2 Food Security and Sustainable Agriculture: Core Concepts

The four cornerstones of food security are defined as food availability, access, utilization and stability (FAO, 2008). Availability is the actual supply of adequate quantities of food in the household, storage, distribution and imports. Access is issues of whether households and individuals have the income, assets, entitlements, or social support to acquire that food. Utilization refers to the quality and safety of food and the absorption of nutrients in the body, which is dependent on the health care system, sanitation, clean water and feeding practices. Stability would imply that they have to last and that they should not be jeopardized by an economic crisis, conflict, climate event or seasonal scarcity. The concept has been extended in recent policy debates to include sustainability and agency. Sustainability questions the viability of food systems to ensure secure food access with non-destruction to the ecological foundations of future production. Agency understands that access to food, diets, and food production systems should be meaningful and under control of the people.

All of these dimensions are related to sustainable agriculture. It's not just a technical approach; it's not a single model of agriculture. Instead, it is a general strategy for agriculture that aims to achieve sustainability in all aspects: production, profitability, environmental health and social equity. The goal of a sustainable agricultural system is to preserve and enhance soil fertility, ensure the efficient use of water, reduce negative externalities, preserve biodiversity, and promote viable livelihoods. It prioritizes resilience over extraction, a short-term phenomenon. On the operational level, sustainable agriculture might mean crop rotation, integrated pest management, agroforestry and/or conservation tillage, smart water usage, improved seed systems, climate resilient varieties, better livestock integration, and improved post-harvest systems. It also relies on institutions, such as land rights, credit access, extension services, research systems, infrastructure and fair markets.

An important takeaway is that food security and food sustainability do not necessarily go hand-in-hand in the short term. Various policies can increase output very quickly but can negatively impact the natural resource base over time. For instance, a substantial subsidy, whether for irrigation water, cheap energy for tube wells or abundant fertilizers, may be a stimulant to initial production increases, but can lead to fiscal inefficiencies or to the depletion of aquifers, ruin of soils, or damage of soils in the long term. Similarly, deforestation or degradation of valuable ecosystems for land use can provide food supply temporarily, but harm security in the long term. The problem is not only to maximize yields, but to enhance the resilience, inclusiveness and nutritional levels of food systems, while preserving ecosystems. It is for this reason that the policy dialogue today has begun to shift to the terminology of 'agrifood systems', referring to food production, processing, storage, transport, trade, retail, consumption and waste management as a single system.

The Sustainable Development Goals are in keeping with this broader perspective, particularly SDG 2: Zero Hunger, food security, improved nutrition, and sustainable agriculture. But the journey to achieving this is complicated. The interplay of ecology, economy, governance and inequality are demonstrated to have an impact on food security in response to global crises. Growing productivity is not sufficient if people cannot afford nutritious food; if climate shocks kill off crops regularly; or if rural producers cannot make adaptation. Sustainable agriculture is therefore not just an environmental concern, but also a development measure to help stabilize food systems in the face of uncertainty.

2.3 Global Dimensions of Food Insecurity

The world food system is under pressure from several simultaneous forces. Population growth continues to increase demand for food, especially in regions where fertility rates remain high. Urbanization is changing consumption patterns, increasing the demand for processed food, animal products, fats, and sugar. Rising incomes in some countries have altered diets and expanded demand for land-, water-, and energy-intensive food products. At the same time, many low-income populations still struggle to secure enough calories, protein, and micronutrients. The result is a complex nutritional landscape in which hunger, undernutrition, obesity, and diet-related non-communicable diseases coexist. This phenomenon, often described as the triple burden of malnutrition, reveals that food security is no longer just about

supply volume; it is increasingly about the affordability and accessibility of healthy diets (FAO et al., 2023).

Climate change is one of the strongest drivers of current and future food insecurity. Agricultural production depends heavily on predictable weather, manageable temperature ranges, water availability, healthy soils, and functioning ecosystems. Climate change disrupts all of these factors. Heat stress reduces yields of staple crops, accelerates evapotranspiration, and harms livestock. Changes in rainfall patterns create uncertainty in planting calendars and increase the risk of drought or waterlogging. Floods destroy crops, wash away topsoil, damage roads and storage facilities, and isolate farming communities from markets. Sea-level rise and salinity intrusion affect delta regions and coastal farming systems. According to the IPCC (2022), climate-related risks to food systems are already being observed globally and are expected to intensify further, especially in vulnerable regions with limited adaptive capacity.

Environmental degradation further weakens food systems. Soil erosion, nutrient depletion, salinization, acidification, and compaction reduce long-term productivity. The Food and Agriculture Organization and the Intergovernmental Technical Panel on Soils (FAO & ITPS, 2015) have emphasized that soils are under severe pressure worldwide, with major implications for food production. Water scarcity is another critical issue. Agriculture accounts for the majority of global freshwater withdrawals, and competition for water from cities, industries, and ecosystems is increasing. In many countries, groundwater extraction exceeds recharge rates, creating unsustainable dependence on hidden reserves. Biodiversity loss also undermines food security by weakening pollination, reducing genetic diversity, destabilizing pest control mechanisms, and eroding ecosystem resilience. The global assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services highlighted that biodiversity loss threatens the ecological services essential for food production (IPBES, 2019).

Economic and political instability also shape food insecurity. Conflict disrupts agriculture through displacement, destruction of infrastructure, loss of labor, interrupted trade, and rising food prices. Economic crises reduce purchasing power and can make food unaffordable even when it remains physically available in markets. The COVID-19 pandemic revealed how vulnerable food systems are to supply chain disruptions, labor shortages, transport bottlenecks, and household income losses. More recent global shocks in energy, fertilizer, and grain markets have demonstrated how quickly international events can affect food prices and national food security. Countries that are highly dependent on imports or on a narrow basket of staple crops are particularly vulnerable to such shocks.

Inequality remains one of the most persistent barriers to food security. National food sufficiency does not guarantee that poor households can access enough food, or that the food they can access is safe or nutritious. Rural landless workers, urban informal laborers, migrants, women, and conflict-affected communities often face the greatest food insecurity. Gender inequality is especially important because women play major roles in agriculture, household nutrition, and caregiving, yet often lack equal access to land, credit, training, technology, and decision-making power. Therefore, addressing food insecurity requires more than increasing production. It requires tackling poverty, exclusion, weak safety nets, and unequal access to productive assets.

Table 2.1. Global Food Security Challenges

Issue	Effect	Response
Climate change	Yield loss	Resilient farming
Soil decline	Low fertility	Soil recovery
Water stress	Less irrigation	Efficient use
Biodiversity loss	Weak resilience	Crop diversity
Poverty	Low access	Social support
Food loss	Less supply	Better storage
Price shocks	High costs	Stable systems

Source: FAO (2013, 2019, 2021); FAO et al. (2023); IPCC (2022); World Bank (2022, 2023).

2.4 Sustainable Agriculture as a Transformative Response

Sustainable agriculture has emerged as one of the most important frameworks for responding to the crisis of food insecurity. It seeks to increase productivity while preserving the natural resource base and strengthening the resilience of farming systems. Sustainable agriculture does not reject innovation or modernization. Rather, it promotes forms of innovation that are resource-efficient, climate-resilient, socially inclusive, and environmentally responsible. In this sense, it is better understood as a direction of transformation than as a rigid model. “The integrated nature of sustainable agriculture and food systems can be conceptually illustrated as shown in Figure 2.1.”

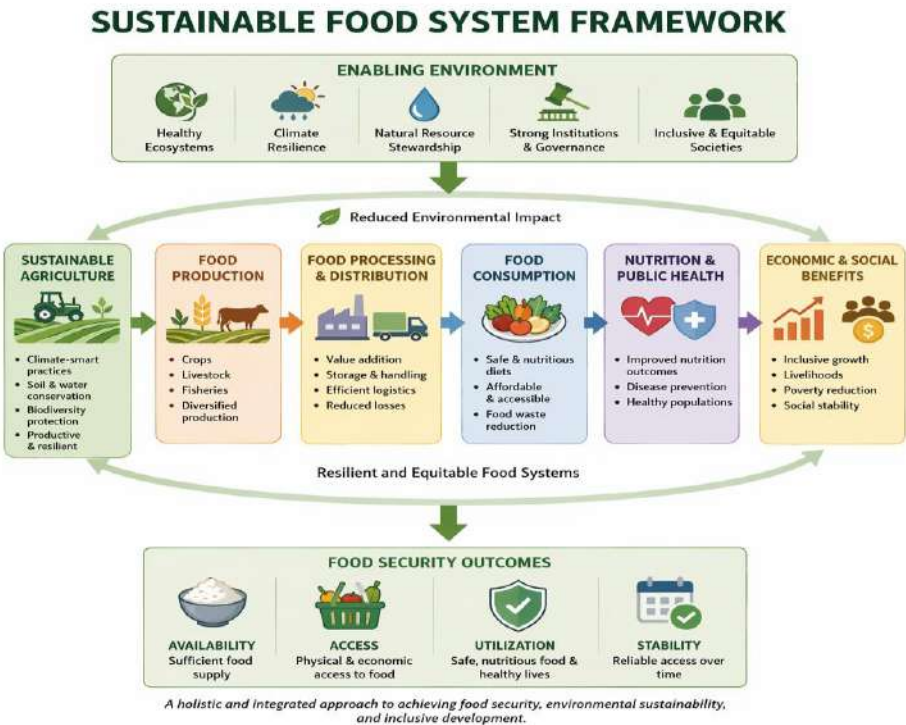


Figure 2.1. Sustainable food system framework linking agriculture, food supply chains, nutrition, and food security outcomes

Source: Author’s illustration based on FAO (2008, 2013, 2019), FAO et al. (2023), and IPCC (2022)

One important approach is sustainable intensification. This concept aims to increase agricultural output from existing farmland while reducing environmental harm. It includes more efficient use of water, fertilizers, seeds, labor, and energy, along with improved agronomic practices, better extension services, and context-sensitive mechanization. Sustainable intensification recognizes that in many regions, especially where population pressure is high and land expansion is environmentally costly, yield improvement remains necessary. However, it insists that productivity gains must not come at the expense of ecosystem collapse.

Another influential approach is agroecology. Agroecology emphasizes ecological relationships within farming systems and promotes biodiversity, local knowledge, biological pest control, soil organic matter, nutrient cycling, and mixed production systems. Practices such as intercropping, agroforestry, crop

rotation, integrated crop-livestock systems, and reduced chemical dependency can improve resilience and reduce external input costs. Agroecological approaches are often especially relevant for smallholders operating in risk-prone environments, though they require local adaptation and supportive institutions.

Climate-smart agriculture has also gained prominence as a policy framework. FAO (2013) describes climate-smart agriculture as an approach that seeks to increase productivity, improve resilience to climate change, and where possible reduce greenhouse gas emissions. Its practices include drought-tolerant and heat-tolerant crop varieties, improved water management, weather advisory systems, climate-informed planting schedules, risk insurance, and better livestock management. Climate-smart agriculture is particularly relevant because climate change is no longer a distant threat; it is already shaping planting decisions, food prices, and rural survival.

Sustainable agriculture must also be linked to nutrition. For many decades, agricultural policy in many countries focused heavily on increasing staple grain production, especially cereals. While this helped address calorie shortages in many contexts, it did not necessarily solve protein and micronutrient deficiencies. Nutrition-sensitive agriculture promotes diversification into pulses, fruits, vegetables, livestock products, and other nutrient-rich foods. It also seeks to strengthen the links between agriculture, health, sanitation, and women's empowerment. In this way, it moves food policy beyond tonnage and toward human well-being.

Reducing food loss and waste is another critical dimension of sustainable agriculture. Large volumes of food are lost between harvest and consumption due to poor harvesting techniques, inadequate storage, lack of refrigeration, weak transport networks, inefficient processing, retail waste, and consumer behavior. In many low- and middle-income countries, losses are especially high in post-harvest stages because of inadequate infrastructure and market coordination. FAO (2019) argues that reducing food loss and waste can improve food availability, conserve resources, lower emissions, and increase farmer incomes. It is one of the few food security strategies that can produce gains without requiring additional land or water.

However, sustainable agriculture cannot succeed through farm-level practices alone. It depends on governance. Public policy shapes water pricing, land use, research investment, seed regulation, rural infrastructure, food safety standards, agricultural extension, and market incentives. If governments subsidize inefficient irrigation, reward monocultures, neglect smallholders, or fail to invest in research and logistics, sustainable agriculture will remain difficult to scale. Conversely, when institutions support farmer training, access to finance, climate adaptation, gender equality, and transparent markets, the transition becomes far more achievable. In this sense, sustainable agriculture is as much an institutional challenge as a technical one.

2.5 Pakistan's Agricultural Landscape and Food Security Context

Pakistan presents a significant and complex case in the study of food security and sustainable agriculture. Agriculture remains a key sector of the national economy and a major source of employment and rural livelihood. The country possesses diverse agroecological zones, ranging from irrigated plains to arid and semi-arid areas, and its farming systems support the production of wheat, rice, maize, sugarcane, cotton, fruits, vegetables, and livestock. The Indus Basin irrigation system provides the backbone of crop production and is one of the largest irrigation networks in the world. These features give Pakistan considerable agricultural potential. Yet this potential has not fully translated into broad-based food security, nutritional improvement, or sustainability.

One major reason is that food security in Pakistan is shaped not only by production, but also by inequality, inflation, weak service delivery, and environmental stress. A country may produce sufficient staple crops in aggregate while millions of households remain unable to afford diverse and nutritious diets. Food inflation in Pakistan has repeatedly reduced household purchasing power, especially among the poor, who spend a large share of their income on food. Low-income urban households, landless rural laborers, and

climate-affected communities are particularly vulnerable. Thus, food security in Pakistan must be analyzed at the household level rather than only at the national production level.

Pakistan also faces a persistent nutrition challenge. Many households consume diets dominated by cereals and lack adequate intake of pulses, fruits, vegetables, and high-quality protein. This contributes to child stunting, micronutrient deficiencies, and broader public health concerns. Food utilization is therefore a major issue. Nutritional outcomes are shaped not only by the availability of food, but also by maternal health, sanitation, access to clean water, infant feeding practices, education, and health services. A narrow focus on wheat production cannot resolve these deeper structural determinants of malnutrition.

Farm productivity in Pakistan remains below potential in many crops. Yield gaps persist because of poor seed quality, untimely input use, weak extension services, pest pressure, inadequate mechanization for smallholders, land fragmentation, and uneven access to technology. While some commercial farms benefit from better inputs and market links, many smallholders operate with limited capital and face significant risk. Research institutions and universities have produced useful innovations, but adoption remains uneven. The problem is not only the existence of technology, but also whether it reaches farmers in ways that are affordable, trusted, and suited to local conditions.

Land and tenancy structures also shape agricultural outcomes. Unequal land distribution and fragmented holdings complicate productivity growth and equitable rural development. Small farmers often face barriers in accessing formal credit, crop insurance, storage, transport, and profitable markets. Tenants and informal cultivators may have little incentive to invest in soil health or water efficiency if they lack secure tenure or stable returns. These structural issues make sustainability harder to achieve because they reduce the ability of producers to adopt longer-term strategies.

Livestock is another essential component of Pakistan's food system. It contributes significantly to agricultural value added and plays a central role in rural livelihoods, household income, and nutritional support. Women are often heavily involved in livestock care, milk handling, fodder collection, and household-level food management. Yet livestock development policy has often received less systematic attention than major crops. Improving animal health, feed quality, breeding systems, milk safety, and value addition could support both food security and rural income generation.

2.5.1 Water, Climate, and Ecological Stress in Pakistan

Among all the challenges facing Pakistan's food system, water stress is perhaps the most serious. The country's agriculture depends heavily on irrigation, but water use is often inefficient. Losses occur through seepage in canals and watercourses, over-irrigation in fields, outdated flood irrigation methods, poor drainage, and weak maintenance of infrastructure. Groundwater extraction has expanded in many regions as farmers seek to compensate for unreliable canal water, but this has created new problems, including aquifer depletion and declining water quality. Qureshi (2011) noted that the Indus Basin faces serious water management challenges that require institutional as well as technical reform.

Salinity and waterlogging have long affected agricultural productivity in parts of Pakistan. These problems reduce soil health, limit crop options, and lower long-term yields. At the same time, cropping patterns often remain poorly aligned with ecological realities. Water-intensive crops continue to occupy large areas even in settings where water scarcity is becoming more severe. Sustainable agriculture in Pakistan therefore requires not only better irrigation technology, but also more rational crop planning, improved drainage, and stronger governance of surface water and groundwater.

Climate change is intensifying these pressures. Pakistan is highly exposed to floods, droughts, heatwaves, glacial melt variability, and erratic rainfall. The floods of 2022 caused devastating damage to crops, livestock, homes, roads, and irrigation systems, illustrating how climate disasters can instantly reverse development gains and deepen food insecurity. Climate shocks affect both availability and access. They reduce production, kill animals, damage infrastructure, and disrupt transport, but they also undermine incomes, increase debt, raise prices, and force households to reduce diet quality. The World Bank Group

(2022) has emphasized that climate risks threaten Pakistan’s development trajectory and require urgent adaptation measures across sectors, especially agriculture.

Heat stress is becoming increasingly important. High temperatures can reduce wheat grain formation, increase water demand, lower milk yields, and reduce labor productivity during harvest and field operations. Changing pest and disease patterns also create new production risks. These trends demand stronger agricultural research, localized advisories, and adaptive management. Climate adaptation in agriculture cannot be limited to emergency response; it must be integrated into seed systems, extension services, farm planning, water management, and rural finance.

Ecological degradation is closely connected to these issues. Soil fertility decline, imbalanced fertilizer use, loss of organic matter, and excessive residue burning in some areas reduce the resilience of farming systems. Biodiversity in agricultural landscapes is under pressure from monoculture, habitat change, and chemical misuse. Sustainable agriculture in Pakistan must therefore include soil restoration, improved nutrient management, crop rotation, agroforestry where feasible, and integrated pest management. These are not abstract environmental concerns. They are practical measures that determine whether farms remain productive under increasingly volatile conditions.

Table 2.2. Pakistan Food Security Challenges

Area	Problem	Solution
Crops	Low yields	Better seeds
Water	High losses	Water reform
Climate	Floods, heat	Adaptation
Nutrition	Poor diets	Diverse farming
Markets	Food loss	Storage links
Equity	Weak support	Inclusive policy

Source: Government of Pakistan, Finance Division (2023); World Bank Group (2022); FAO et al. (2023); Qureshi (2011).

2.5.2 Institutions, Markets, and Social Inclusion in Pakistan

Policy and institutions are central to the future of food security in Pakistan. For many years, agricultural policy has focused strongly on major crops, especially wheat, through procurement systems, price support, public stockholding, and input subsidies. These measures have contributed to staple grain availability, but they have also created distortions. They can reduce incentives for crop diversification, encourage inefficient resource allocation, and privilege certain regions or farm categories over others. A food-secure future requires moving from a narrow staple-focused policy model toward a broader food systems approach that values nutrition, sustainability, and resilience.

Institutional fragmentation remains a major challenge. Agriculture, irrigation, climate adaptation, nutrition, social protection, and disaster management are often governed through separate systems with limited coordination. After devolution, provincial governments assumed greater responsibility for agriculture, creating both opportunities and coordination difficulties. While local responsiveness can improve under decentralization, uneven capacity across provinces can also result in fragmented implementation. Effective food policy in Pakistan needs stronger coordination between federal and provincial institutions, as well as better links between research organizations, market actors, extension services, and community-level structures.

Agricultural research and extension need substantial strengthening. Many farmers still do not receive timely advice on improved seeds, pest control, water management, climate risks, or market opportunities. Public extension services have often been constrained by low staffing, weak field presence, and outdated methods. Digital tools offer promising opportunities, including mobile advisories, remote sensing, market information systems, and weather alerts. However, digitalization is not a complete solution unless it is accessible, locally relevant, and integrated with trusted human support.

Markets also play a decisive role in food security. Post-harvest losses in Pakistan remain significant because of poor storage, weak cold chains, limited processing, inadequate transport, and fragmented value chains. Farmers often sell at low prices immediately after harvest because they lack storage and access to credit. Consumers, meanwhile, may face high retail prices because inefficiencies and intermediaries raise costs along the chain. Investments in storage infrastructure, rural roads, refrigerated transport, aggregation centers, market information, and agro-processing can improve both producer returns and consumer access.

Social protection is equally important, particularly in times of economic crisis or climate disaster. Cash transfer programs, school feeding, targeted nutrition programs, and disaster support can help vulnerable households maintain food access when prices rise or livelihoods collapse. Social protection should not be seen as separate from agricultural policy. In fact, resilient food systems require both productive support for farmers and protective mechanisms for households who face shocks. The integration of social protection with rural development can reduce distress sales of assets, protect dietary quality, and support recovery after disasters.

Gender inclusion is fundamental. Women play major but often underrecognized roles in Pakistan's food system, especially in livestock care, dairy management, seed preservation, household nutrition, kitchen gardening, and post-harvest tasks. Yet they often have limited access to land ownership, finance, training, extension, and formal market spaces. Gender-responsive agriculture is not merely a matter of fairness; it is a matter of food system efficiency and nutritional outcomes. When women have greater access to resources and decision-making, household food security often improves (FAO, 2011). Policies that support women farmers, women-led enterprises, and women's participation in extension and producer groups can generate broad development gains.

2.6 Pathways to Harvesting: Global and Pakistan Strategies

The concept of pathways to harvesting suggests a forward-looking and systemic understanding of agriculture. Harvesting is not only the endpoint of crop growth; it is the result of a chain of conditions involving land, water, biodiversity, institutions, technology, labor, markets, and social support. To secure future harvests, countries must build systems that are resilient before crises occur. Both globally and in Pakistan, several pathways are especially important.

The first pathway is climate resilience. This involves breeding and disseminating stress-tolerant crop varieties, strengthening local forecasting systems, promoting diversified farm systems, improving livestock management, and developing risk-sharing tools such as insurance and emergency support. In Pakistan, climate resilience should include flood-resilient farming strategies, heat-adapted cropping calendars, drought planning, and climate-informed extension. Community-level preparedness and infrastructure resilience are also crucial, especially in disaster-prone districts.

The second pathway is water efficiency and governance reform. Water is central to agriculture, but its scarcity demands better management. Pakistan urgently needs more efficient irrigation, improved canal maintenance, better drainage, watercourse lining where appropriate, and stronger regulation of groundwater use. Technologies such as laser land leveling, drip irrigation, and improved irrigation scheduling can help, but they must be supported by extension, finance, and policy incentives. Crop choices should also be aligned more closely with water realities.

The third pathway is diversification. Globally, diversified farming systems tend to be more resilient to climatic and market shocks. In Pakistan, diversification beyond a narrow set of staple and cash crops can improve nutrition, reduce import dependence, stabilize farm income, and reduce ecological stress. Pulses, oilseeds, fruits, vegetables, fodder improvement, and integrated crop-livestock systems all offer potential. Nutrition-sensitive diversification is particularly important because food security should be measured by the capacity to support healthy lives, not merely by cereal output.

The fourth pathway is post-harvest and value chain development. Better storage, processing, cold chains, and logistics can reduce food losses, increase market efficiency, and create employment beyond the farm.

These investments are often overlooked in agricultural policy, yet they are essential for turning production into effective food availability and farmer income. In Pakistan, stronger value chains could especially benefit horticulture, dairy, fisheries, and other nutrient-rich sectors that are more perishable but also more valuable.

The fifth pathway is institutional renewal. Sustainable agriculture requires more responsive research systems, stronger extension, reliable data, transparent markets, and coherent public policy. Farmer organizations, cooperatives, and community institutions can also play important roles in knowledge sharing, input procurement, storage, and bargaining power. In Pakistan, institutional renewal should also involve better coordination across provinces, ministries, and agencies working on food, climate, water, and rural development.

The sixth pathway is social inclusion. Smallholders, women, tenants, youth, and climate-vulnerable households must be central to agricultural transformation. If the transition to sustainable agriculture benefits only large or capital-rich farmers, it will fail to deliver food security in any meaningful sense. Inclusive finance, affordable technology, accessible advisory systems, and targeted support for vulnerable groups are necessary to ensure that sustainability and equity advance together. Youth engagement is especially important in Pakistan, where demographic pressures and rural unemployment create both risks and opportunities. Agriculture can become a more attractive sector if linked with entrepreneurship, digital services, logistics, agro-processing, and green technologies.

Table 2.3. Sustainable Pathways for Pakistan

Pathway	Action	Benefit
Climate-smart	Resilient crops	Less risk
Water saving	Better irrigation	More efficiency
Diversification	Pulses, fruits	Better diets
Storage reform	Cold chains	Less waste
Strong extension	Farmer support	More adoption
Social protection	Cash support	Better access

Source: FAO (2011, 2013, 2019); Government of Pakistan, Finance Division (2023); World Bank (2022); World Bank Group (2022); IPCC (2022).

2.7 Conclusion

Food security and sustainable agriculture are inseparable policy goals in a world marked by ecological limits, climate instability, inequality, and repeated economic shocks. The traditional assumption that food security can be secured simply by producing more staple crops is no longer adequate. While productivity remains important, the real challenge is to produce food in ways that protect land, conserve water, support livelihoods, improve nutrition, and withstand shocks. This requires moving beyond a production-centered model toward a food systems perspective that includes markets, health, gender, infrastructure, governance, and sustainability.

At the global level, the pressures on food systems are converging. Climate change is disrupting production, biodiversity loss is weakening ecological resilience, water scarcity is constraining future growth, and economic inequality is keeping healthy diets out of reach for billions. These pressures make it clear that food security cannot be separated from sustainability. Long-term food availability depends on restoring soils, protecting water, conserving biodiversity, reducing waste, and investing in resilient institutions and inclusive development.

Pakistan’s experience reflects this broader reality in a particularly vivid way. The country has considerable agricultural potential, yet it continues to face food insecurity, malnutrition, low productivity, ecological stress, and climate vulnerability. Water inefficiency, land inequality, policy distortions, weak extension systems, and limited diversification all constrain progress. Moreover, the persistence of poor dietary outcomes shows that national food policy must move beyond staple grain sufficiency toward nutrition-sensitive and socially inclusive food systems.

The pathways to harvesting in Pakistan and elsewhere lie in climate-smart and water-efficient agriculture, diversified and nutrition-sensitive production, post-harvest improvement, institutional reform, and social inclusion. Sustainable agriculture must be seen not as a luxury or environmental add-on, but as the practical foundation of long-term food security. It is the means through which societies can protect future harvests while meeting present needs. Ultimately, the success of food systems will depend not simply on how much is harvested, but on whether harvesting remains possible, equitable, and ecologically viable for generations to come.

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