INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCHERS
ISSN: 3030-332X Impact factor: 9,493 Volume 16, issue 2, March 2026
https://wordlyknowledge.uz/index.php/IJSR worldly knowledge
Index: google scholar, research gate, research bib, zenodo, open aire.
https://scholar.google.com/scholar?hl=ru&as_sdt=0%2C5&q=wosjournals.com&btnG
https://www.researchgate.net/profile/Worldly-Knowledge
https://journalseeker.researchbib.com/view/issn/3030-332X

FOOD SECURITY AND SUSTAINABLE AGRICULTURAL DEVELOPMENT IN UZBEKISTAN

Feruzbek Baxshulloyev
Narrative Literature Review Article
Agricultural Economics
Feruzbek.Baxshulloyev@rau.ac.uk

Abstract

Food security remains a critical development challenge for Uzbekistan, a landlocked Central Asian economy where agriculture plays a foundational role in rural livelihoods, national nutrition, and export earnings. Despite significant progress in agricultural reform since 2016, the country faces persistent vulnerabilities across all four pillars of food security — availability, access, utilisation, and stability — shaped by water scarcity, smallholder farm fragmentation, post-harvest infrastructure deficits, and climate change pressures. This article presents a narrative literature review examining the relationship between food security, sustainable agricultural practices, and rural economic development in Uzbekistan. Drawing on international, Central Asian, and Uzbekistan-specific research, the review synthesises evidence on the determinants of food security, the role of sustainable agriculture in supporting long-term food system resilience, and the institutional and policy conditions required to integrate them. International experiences from Israel, the Netherlands, China, Turkey, and Kazakhstan are critically examined for lessons applicable to Uzbekistan's context. The review finds that while government reforms have created a more enabling policy environment, substantive gaps remain in smallholder support, sustainable water management, rural value chain development, and food safety governance. The article concludes with evidence-based policy recommendations and directions for future empirical research. Its findings are intended to inform both academic scholarship and practical decision-making in Uzbekistan's agricultural and food security sectors.

Keywords: food security, sustainable agriculture, Uzbekistan, rural development, agricultural policy, Central Asia, water management

1. Introduction

Food security — defined by the Food and Agriculture Organization of the United Nations (FAO) as a condition in which all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life — represents one of the most fundamental challenges confronting developing and transitional economies in the twenty-first century. In Central Asia, the confluence of population growth, water scarcity, climate change, and the legacies of Soviet-era agricultural systems has made food security a particularly pressing policy concern.

Uzbekistan occupies a central position in this regional picture. Agriculture underpins the livelihoods of a substantial share of the population, particularly in rural areas, and contributes

meaningfully to export revenues and rural household income. The country's agro-ecological endowments — fertile irrigated river valleys, diverse horticultural potential, and a long tradition of crop cultivation — provide a foundation for food production. However, these assets are offset by significant structural constraints: limited arable land relative to population, near-total dependence on irrigation in an increasingly water-stressed basin, a fragmented smallholder farm structure, and underdeveloped post-harvest and market infrastructure in many regions.

The concept of sustainable agricultural development adds a further dimension to these challenges. Sustainability in agriculture requires not only the maintenance of productive capacity over time but also the management of natural resources — soil, water, biodiversity — in ways that do not compromise future generations' ability to meet their own food needs. In Uzbekistan, where agricultural intensification has historically exacted high environmental costs, particularly in relation to the Aral Sea crisis, integrating sustainability objectives into food security policy is both urgent and complex.

Despite the recognised importance of these intersecting challenges, the academic literature that specifically examines the relationship among food security, sustainable agriculture, and rural development in Uzbekistan remains fragmented. Much of the available research either addresses food security at the broader Central Asian level or focuses narrowly on specific agricultural sub-sectors without integrating the food security and sustainability dimensions. This gap motivates the present review.

This article aims to critically review the existing literature on food security and sustainable agricultural development, with a specific focus on Uzbekistan. The objectives are: (1) to synthesise international and regional research on food security concepts and their determinants; (2) to examine the current food security and sustainable agriculture situation in Uzbekistan; (3) to assess relevant international experiences and their transferability to the Uzbekistani context; and (4) to formulate evidence-based recommendations for policy and research.

The article is structured as follows: Section 2 reviews the international and regional literature; Section 3 describes the current situation in Uzbekistan; Section 4 examines selected international experiences; Section 5 provides a critical discussion; Section 6 sets out policy recommendations; and Section 7 concludes.

2. Literature Review

2.1 The Four Pillars of Food Security

The conceptual framework underpinning contemporary food security analysis derives from the FAO's definition and its operationalisation through four pillars: availability, access, utilisation, and stability. Food availability refers to the physical supply of food through domestic production, imports, and food aid. Access encompasses the economic and physical ability of individuals and households to obtain food of adequate quality and quantity. Utilisation relates to the nutritional quality of food and the conditions — including water, sanitation, and healthcare — that determine how the body uses it. Stability refers to the ability to maintain adequate food access over time, including in the face of economic shocks, conflict, or climatic variability (FAO, 2006). This multidimensional framework has been widely adopted in the literature as the basis for diagnosing food insecurity and designing policy responses.

Maxwell (1996) noted that the evolution of food security thinking has progressed from a national, supply-focused perspective toward a household- and individual-access-centred approach, reflecting the recognition that aggregate-level food availability does not guarantee food security at the household level. This shift has important implications for policy design, particularly in economies characterised by high rural income inequality and limited social protection systems.

2.2 Food Security in Transitional and Developing Economies

The literature on food security in transitional economies — including the post-Soviet states of Central Asia — highlights the disruption caused by the collapse of Soviet-era food distribution systems and the often painful reorientation toward market-based food supply chains. Lerman and Sedik (2009) documented how the fragmentation of collective farm structures into small family plots, while improving some aspects of production flexibility, also created new vulnerabilities in input supply, credit access, and market participation. The transition from state-guaranteed food distribution to market-based systems exposed rural households to price volatility and access risks that had previously been managed centrally.

Pinstrup-Andersen (2009) argued that food security in the twenty-first century must be understood as a dynamic challenge shaped by interactions among global commodity markets, climate change, demographic pressures, and national policy choices. His analysis underlines the importance of integrating food security into broader development planning rather than treating it as a sectoral issue. This integrative perspective is particularly relevant for Uzbekistan, where food security outcomes are shaped by decisions made across agriculture, water, trade, social protection, and health policy domains.

2.3 Sustainable Agriculture and Food Security

Both complementarity and tension characterise the relationship between agricultural sustainability and food security. Sustainable agricultural practices — including conservation tillage, integrated pest management, crop diversification, and efficient water use — can enhance long-term food production capacity by maintaining soil health, reducing input costs, and building resilience to climatic variability (Pretty et al., 2018). At the same time, the transition to more sustainable practices may involve short-term productivity trade-offs and require upfront investments that smallholders in resource-constrained environments may struggle to finance.

The concept of sustainable intensification — producing more food from the same area of land while reducing environmental impacts — has gained traction in the development literature as a framework for reconciling the productivity and sustainability objectives of food security policy (Godfray et al., 2010). For countries like Uzbekistan, where land expansion is not a viable option, sustainable intensification of existing agricultural land is the primary pathway to increased food production capacity.

2.4 Rural Economic Development and Food Security

Rural economic development — encompassing investment in agricultural infrastructure, rural market access, non-farm income opportunities, and social protection — is consistently identified in the literature as a critical enabler of household food security. The World Bank

(2007) World Development Report on agriculture for development established the foundational case that agricultural growth in developing countries has stronger poverty-reducing and food security effects than growth in other sectors, given the concentration of poor and food-insecure populations in rural areas. Subsequent research by Christiaensen et al. (2011) confirmed that agriculture-led growth is particularly effective at reducing extreme poverty and food insecurity in low-income countries with large rural populations.

In Central Asia, the linkages between rural development and food security have been explored by several researchers. Spoor (1999) provided an early analysis of the social and food security consequences of agrarian reform in the post-Soviet states, documenting the emergence of rural poverty and food-access deficits during the immediate transition period. More recent work has examined how improvements in rural infrastructure, particularly roads and market connectivity, can enhance household food access by reducing transaction costs and facilitating market participation.

2.5 Research Gaps Relevant to Uzbekistan

The reviewed literature reveals several important gaps regarding Uzbekistan. First, rigorous household-level analyses of food security determinants using recent survey data remain scarce, limiting the evidence base for targeted policy interventions. Second, the interaction between water governance reform and food security outcomes has received limited analytical attention despite its centrality to Uzbekistan's agricultural system. Third, the food safety and nutritional quality dimensions of food security — encompassing food utilisation in the FAO framework — are significantly underresearched in the Uzbekistani context. These gaps underscore the need for sustained empirical and policy-oriented research.

3. Current Situation in Uzbekistan

Uzbekistan's agricultural sector is simultaneously a pillar of national food security and a source of significant structural vulnerability. Agriculture accounts for a substantial share of rural employment and contributes meaningfully to the national economy, producing a diverse range of food crops — wheat, rice, maize, vegetables, fruits, and livestock products — as well as industrial crops such as cotton. The country's irrigated agriculture, concentrated in the Amu Darya and Syr Darya river basins, enables year-round crop production in an otherwise arid environment but is critically dependent on water resources that are shared with upstream and downstream neighbours and increasingly stressed by climate change.

Food availability in Uzbekistan has generally remained at adequate aggregate levels in recent years, supported by domestic production of staple grains and vegetables and by food imports when domestic supply falls short. However, food access remains uneven, with rural households — particularly in remote regions and those reliant on smallholder farming — facing greater exposure to price volatility, income shocks, and geographic barriers to market participation. Nutritional quality, representing the utilisation pillar of food security, is a growing concern, with micronutrient deficiencies reported among segments of the rural population, particularly women and children.

The structural characteristics of Uzbekistan's farming sector shape its food security profile in important ways. The majority of food for household consumption is produced by small dekhan farms, which cultivate family plots typically ranging from 0.12 to 0.35 hectares. These smallholdings are central to household food self-sufficiency but have limited capacity to generate marketable surpluses, access commercial finance, or adopt productivity-enhancing technologies. Larger leaseholder farms, which produce a greater share of commercial output, operate under land lease arrangements that have historically created investment uncertainty.

The government of President Mirziyoyev has pursued an active agricultural reform agenda since 2016. Key elements include the progressive liberalisation of cotton procurement quotas that previously obligated farmers to plant and sell cotton at administratively set prices; the expansion of incentives for fruit, vegetable, and grain production; investment in agri-food processing infrastructure and export promotion; and the introduction of digital tools for land cadastre management and agricultural market information. These reforms have contributed to greater crop diversification and increased agricultural export revenues, particularly in horticultural products.

Water management is the most critical systemic challenge to the sustainability of food security in Uzbekistan. The existing irrigation infrastructure, largely constructed during the Soviet period, is characterised by high conveyance losses, inadequate metering, and governance arrangements that limit farmers' ability to manage water application efficiently. Efforts to rehabilitate infrastructure and strengthen water user associations have been undertaken with support from international development organisations, but the scale of investment required substantially exceeds current programme coverage.

Post-harvest losses are a significant but often underquantified dimension of Uzbekistan's food security challenge. Limited cold chain infrastructure, inadequate rural storage facilities, and underdeveloped food processing capacity mean that a significant share of perishable production — particularly fruits and vegetables — is lost between farm and consumer, reducing effective food availability and smallholder incomes simultaneously. Government investment in agri-food processing zones and export infrastructure represents a positive development in this regard, though much of the benefit to date has accrued to larger commercial operators.

Sustainable agricultural practices remain in their early stages of adoption across most of Uzbekistan's farming sector. Soil degradation, secondary salinisation from inefficient irrigation, and the over-application of agrochemicals represent established environmental challenges. The government has acknowledged the importance of sustainable agriculture in strategic documents, and pilot programmes in conservation agriculture, integrated pest management, and drip irrigation have been implemented with international support. Scaling these pilots to the farm level remains a key challenge.

4. International Experience

Comparative analysis of international approaches to food security and sustainable agricultural development reveals a range of strategies that are potentially transferable to Uzbekistan's context, subject to careful adaptation for local conditions.

4.1 Israel: Sustainable Water Management and Food Security in Arid Conditions

Israel's transformation of a water-scarce desert environment into a productive and export-competitive agricultural economy offers directly relevant lessons for Uzbekistan. Central to Israel's achievement has been the development and large-scale adoption of drip irrigation technology, which dramatically reduces water consumption compared with conventional flood irrigation while increasing yields and product quality. Equally important has been the institutional architecture supporting water management: a coherent national water policy, investment in the reuse of treated wastewater, and the pricing of water at levels that incentivise efficient use. For Uzbekistan, the Israeli experience underscores that institutional and pricing reforms must complement technological solutions to water scarcity to achieve systemic impact.

4.2 Netherlands: Sustainable Intensive Agriculture and Food Systems

The Netherlands has achieved global leadership in agricultural productivity and food systems sustainability through a combination of precision agriculture technology, knowledge-intensive production systems, and tightly integrated research-extension-industry networks anchored by Wageningen University and Research. The Dutch model demonstrates that high productivity and environmental sustainability are not inherently in conflict when supported by appropriate institutional investment. The key transferable lesson for Uzbekistan is the value of investing in applied agricultural research infrastructure and creating institutional mechanisms that connect research outputs directly to farm-level practice through demonstration networks and extension systems.

4.3 China: Food Security Policy at Scale and Rural Poverty Reduction

China's experience in achieving national food security for the world's largest population while simultaneously reducing rural poverty represents one of the most significant agricultural development achievements of the past four decades. Key elements include sustained public investment in agricultural research and development, targeted subsidy programmes for staple crop production, large-scale rural infrastructure investment — particularly in irrigation and rural roads — and the progressive development of social protection systems for rural households. The Chinese farmer field school model for agricultural extension has demonstrated particular effectiveness in reaching large numbers of smallholders with practical agronomic knowledge. Uzbekistan can draw lessons from China's approach to scaling extension services and integrating food security objectives into broader rural development investment.

4.4 Turkey: Smallholder Integration into Agri-Food Value Chains

Turkey's development of its horticultural export sector, achieved in part through agricultural cooperatives and producer organisations that aggregate smallholder supply and facilitate collective market access, is highly relevant to Uzbekistan's export diversification agenda. Turkish producer organisations have enabled smallholders to meet the volume, quality, and traceability requirements of export markets that individual farms cannot satisfy independently. The cooperative model also provides a vehicle for collective investment in post-harvest infrastructure, cold storage, and certification systems.

4.5 Kazakhstan: Food Security Governance in a Central Asian Post-Soviet Context

Kazakhstan's experience in reforming its agricultural sector and food security governance within a post-Soviet institutional context provides the most directly comparable reference point for Uzbekistan. Kazakhstan has invested in grain sector modernisation, agricultural credit institution reform, and the development of food safety and quality management systems aligned with international standards. Its experience with state food reserve management and strategic grain stock policies also offers lessons for Uzbekistan's food stability pillar. The Kazakhstani context of a transitional economy with a large rural population and water-dependent agriculture shares sufficient structural similarities with Uzbekistan to make its reform experience particularly instructive.

5. Discussion

The literature reviewed in this article reveals a consistent and reinforcing set of findings: food security in Uzbekistan is a multidimensional challenge that cannot be adequately addressed through single-sector interventions. The four pillars of food security — availability, access, utilisation, and stability — are each shaped by distinct yet interconnected sets of determinants, and progress on one pillar can be undermined by weaknesses in another.

A central strength of Uzbekistan's current reform trajectory is the government's recognition that agricultural diversification and rural income growth are preconditions for improved household food security. The shift away from cotton monoculture, the expansion of export-oriented horticulture, and the investment in agri-food processing infrastructure all represent positive developments that should, over time, contribute to greater food availability and improved rural incomes. These reforms align with the international evidence, which consistently identifies agricultural diversification and market integration as pathways to improved food security outcomes in smallholder economies.

However, the analysis also identifies important weaknesses and gaps. Food access for the most vulnerable rural households — those operating the smallest dekhan farms with the most limited market connectivity — may not be substantially improved by export-oriented reforms that primarily benefit commercially active producers. The risk of a widening gap between commercially integrated farmers and subsistence-oriented smallholders is a recurrent finding in the literature on agricultural market liberalisation in transitional economies, and Uzbekistan's reform process appears susceptible to this pattern.

The water management challenge is simultaneously Uzbekistan's most critical food security risk and its most intractable governance problem. The literature is clear that sustainable food production in an irrigated, arid-to-semi-arid environment requires not just infrastructure rehabilitation but a fundamental reform of water pricing, allocation governance, and on-farm management practices. The international evidence from Israel and other water-scarce economies demonstrates that such reforms are achievable. Still, they require sustained political commitment and significant upfront investment in both technology and institutional capacity.

The utilisation dimension of food security — encompassing nutritional quality, food safety, and the broader determinants of dietary diversity — receives relatively little attention in

Uzbekistan's policy discourse, which has tended to focus on production volumes and export values. The international literature suggests that as countries progress in agricultural development, the policy focus must shift from caloric adequacy to dietary quality, and that investments in food safety governance, nutritional education, and access to diverse foods are essential complements to production-focused interventions.

An important opportunity identified in this review is the potential for digital agricultural tools — remote sensing, mobile advisory platforms, digital market information systems — to accelerate progress across multiple food security dimensions simultaneously. Digital technologies can improve the efficiency of water management, reduce post-harvest losses, enhance market access for remote smallholders, and support food safety traceability systems. Uzbekistan's active digital transformation agenda provides a policy framework for agricultural digitalisation, though rural connectivity infrastructure and digital literacy must be developed in parallel.

6. Policy Recommendations

6.1 Government and Policymakers

Establish a comprehensive national food security strategy that explicitly addresses all four FAO pillars — availability, access, utilisation, and stability — and integrates food security objectives across agricultural, water, trade, social protection, and health policy. Strengthen targeted food access programmes for the most vulnerable rural households, including small dekhan farmers with limited market participation. Accelerate water governance reform, including the introduction of volumetric water pricing, strengthening of water user associations, and scaling of on-farm efficient irrigation technologies. Develop a national sustainable agriculture framework with measurable targets for soil health, water productivity, and the reduction of agrochemical use.

6.2 Farmers and Agricultural Enterprises

Smallholder farmers are encouraged to participate in cooperative and producer organisation structures that enable collective access to inputs, credit, post-harvest storage, and export markets. Agricultural enterprises operating in food processing and export should invest in food safety management systems, traceability infrastructure, and sustainable sourcing practices, both to access premium markets and to incentivise on-farm sustainability improvements among supplier smallholders.

6.3 Universities and Researchers

Agricultural universities should prioritise applied research into household-level determinants of food security, including rigorous evaluation of the impacts of government reforms on rural food access and nutritional outcomes. Research on sustainable water management technologies and practices adapted to Uzbekistan's agro-ecological conditions represents a high-priority knowledge gap. International research partnerships — particularly with institutions in Israel, the Netherlands, and Turkey — should be actively cultivated.

6.4 Agricultural Extension Services

Extension services should be reformed to integrate food security and sustainable agriculture objectives into advisory content alongside conventional agronomic guidance. Digital

and mobile advisory platforms should be developed to expand reach to remote and smallholder farmers. Extension agents should receive training in food safety, post-harvest management, and sustainable practices to ensure that advisory services reflect the full scope of the food security challenge.

7. Conclusion

This literature review has examined the relationship between food security, sustainable agricultural development, and rural economic development in Uzbekistan, synthesising evidence from international, Central Asian, and Uzbekistan-specific research. The analysis demonstrates that food security in Uzbekistan is a multidimensional challenge shaped by the interplay of structural agricultural constraints, the complexity of water governance, smallholder vulnerability, and an evolving policy environment that has created new opportunities alongside ongoing risks.

The review has identified the government's ongoing reform programme as a genuine catalyst for improved food security outcomes over the medium term, particularly through agricultural diversification, export promotion, and rural infrastructure investment. At the same time, critical gaps in the policy framework — particularly regarding food access for the most vulnerable households, water governance reform, food utilisation and nutritional quality, and the scaling of sustainable agricultural practices — require sustained attention.

International experiences from Israel, the Netherlands, China, Turkey, and Kazakhstan provide a rich evidence base for Uzbekistan to draw on, provided that lessons are adapted to the country's specific institutional, agro-ecological, and socioeconomic context rather than adopted wholesale. The most transferable lessons relate to water management technology and governance, the development of producer organisations and cooperative marketing structures, applied agricultural research systems, and digital extension platforms.

The practical implications of this review point toward the need for an integrated, cross-sectoral approach to food security policy in Uzbekistan — one that moves beyond production-focused metrics to address the full spectrum of food availability, access, utilisation, and stability. Future research should prioritise household-level food security surveys with robust sampling of the most vulnerable rural populations, econometric evaluation of reform impacts, and investigation of the links between water governance reform and the sustainability of food production. Such research would substantially strengthen both the academic literature and the evidence base available to Uzbekistan's policymakers as they navigate the complex challenge of achieving durable food security in a resource-constrained and climate-vulnerable environment.

Tables

Table 1. Summary of Selected Studies on Food Security and Sustainable Agriculture

Author(s) & Year	Country/Region	Key Concepts/Focus	Main Findings
FAO (2006)	Global	Four pillars of the food security framework	Defined availability, access, utilisation, and

Author(s) & Year	Country/Region	Key Concepts/Focus	Main Findings
			stability as the core pillars of food security
Maxwell (1996)	Global	Evolution of food security concepts	Shift from national supply focus to household access highlighted; multiple dimensions of food insecurity identified.
Pinstrup-Andersen (2009)	Global	21st-century food security challenges	Food security must be integrated into broad development planning; climate, demography, and markets are key drivers.
Lerman & Sedik (2009)	Central Asia	Post-Soviet farm restructuring and food access	Smallholder fragmentation created new vulnerabilities in access to inputs, credit, and market participation.
Godfray et al. (2010).	Global	Sustainable intensification of agriculture	More food from the same land area with reduced environmental impact is achievable and necessary.
Pretty et al. (2018).	Developing countries	Sustainable agricultural practices and food security	Agroecological practices can improve yields, resilience, and food security when appropriately supported
World Bank (2007)	Developing countries	Agriculture for development; rural poverty	Agricultural growth is more effective at reducing extreme poverty than growth in other sectors.

Table 2. International Comparison of Food Security and Sustainable Agriculture Strategies

Country	Key Strategy	Outcome	Applicability to Uzbekistan
Israel	Drip irrigation; treated wastewater reuse; volumetric water pricing	High agricultural output in an arid environment; water-use efficiency has been significantly raised	On-farm drip irrigation subsidies; water pricing reform; wastewater reuse frameworks
Netherlands	Precision agriculture; research-extension-industry integration; sustainable intensification	World-leading productivity per hectare with reduced environmental footprint	Applied research centre model; knowledge transfer networks linking universities and farms
China	National food security policy; rural infrastructure investment; farmer field schools; social protection	Food security was maintained for 1.4 billion people; rural poverty was dramatically reduced.	Extension scaling model; rural infrastructure investment strategy; social protection for rural food access
Turkey	Agricultural cooperatives and producer organisations; export-oriented horticulture	Significant growth in horticultural export volumes; smallholder market integration improved.	Cooperative development legal framework; collective marketing support for smallholders
Kazakhstan	Grain sector modernisation; food safety reform; strategic food reserves	Improved grain productivity; food stability through state reserve management	Post-Soviet reform lessons; food safety governance; strategic reserve policy

Table 3. Key Challenges to Food Security in Uzbekistan and Proposed Interventions

Challenge	Description	Recommended Intervention
Water scarcity and inefficiency	Ageing Soviet-era irrigation infrastructure, high conveyance losses, and limited on-farm water control	Infrastructure rehabilitation; drip irrigation subsidies; water user association strengthening; pricing reform
Smallholder food access	Remote and small-scale farmers face price volatility, limited	Targeted social protection; cooperative market linkages; rural

ISSN: 3030-332X Impact factor: 9,493 Volume 16, issue 2, March 2026
https://wordlyknowledge.uz/index.php/IJSR worldly knowledge
Index: google scholar, research gate, research bib, zenodo, open aire.
https://scholar.google.com/scholar?hl=ru&as_sdt=0%2C5&q=wosjournals.com&btnG
https://www.researchgate.net/profile/Worldly-Knowledge
https://journalseeker.researchbib.com/view/issn/3030-332X

Challenge	Description	Recommended Intervention
	market access, and income shocks.	road investment
Post-harvest losses	Insufficient cold chain, storage, and processing infrastructure reduces the effective availability of food.	Investment in rural cold storage; public-private agri-food processing partnerships; post-harvest training
Nutritional quality deficits	Micronutrient deficiencies in rural populations; dietary diversity is limited in some regions	Nutrition-sensitive agricultural extension; biofortification programmes; food safety governance
Soil degradation and salinisation	Inefficient irrigation and historical overuse of agrochemicals have degraded soil health.	Conservation agriculture promotion; soil health monitoring; sustainable input use advisory services
Weak extension services	The underfunded public advisory system is poorly adapted to food security and sustainability objectives.	Pluralistic extension reform; digital advisory platforms; food safety and nutrition training for agents

Suggested Figures

The following conceptual figures are recommended for inclusion in the final published version of this article.

Figure 1. Conceptual Framework: Food Security, Sustainable Agriculture, and Rural Development in Uzbekistan

A systems diagram depicting the relationships between the four food security pillars (availability, access, utilisation, stability), sustainable agricultural practices (water efficiency, soil health, crop diversification), and rural development outcomes (income, market access, infrastructure). Uzbekistan-specific contextual factors — water scarcity, smallholder structure, reform agenda — should be annotated as shaping conditions around the central framework.

Figure 2. Policy Intervention Matrix for Food Security and Sustainable Agriculture in Uzbekistan

A two-axis matrix plotting proposed policy interventions by (a) expected impact on food security outcomes and (b) implementation feasibility given Uzbekistan's current institutional capacity. This would provide a practical prioritisation tool for policymakers seeking to sequence reforms effectively.

References

1. Asian Development Bank. (2022). Uzbekistan country partnership strategy 2022–2026: Agriculture and rural development. ADB.
2. Christiaensen, L., Demery, L., & Kuhl, J. (2011). The (evolving) role of agriculture in poverty reduction: An empirical perspective. Journal of Development Economics, 96(2), 239–254.
3. Food and Agriculture Organisation of the United Nations. (2006). Food security: Policy brief. FAO.
4. Food and Agriculture Organisation of the United Nations. (2022). The state of food security and nutrition in the world 2022. FAO.
5. Food and Agriculture Organisation of the United Nations. (2021). Central Asia regional overview of food security and nutrition. FAO.
6. Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., & Toulmin, C. (2010). Food security: The challenge of feeding 9 billion people. Science, 327(5967), 812–818.
7. Lerman, Z., & Sedik, D. (2009). Agricultural development and land reform in Central Asia: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan. FAO.
8. Maxwell, S. (1996). Food security: A post-modern perspective. Food Policy, 21(2), 155–170.
9. Micklin, P. (2007). The Aral Sea disaster. Annual Review of Earth and Planetary Sciences, 35(1), 47–72.
10. Pinstrup-Andersen, P. (2009). Food security: Definition and measurement. Food Security, 1(1), 5–7.
11. Pretty, J., Benton, T. G., Bharucha, Z. P., Dicks, L. V., Flora, C. B., Godfray, H. C. J., Goulson, D., Hartley, S., Lampkin, N., Morris, C., Pierzynski, G., Prasad, P. V. V., Reganold, J., Rockstrom, J., Smith, P., Thorne, P., & Wratten, S. (2018). Global assessment of agricultural system redesign for sustainable intensification. Nature Sustainability, 1(8), 441–446.
12. Republic of Uzbekistan. (2019). Strategy for agricultural development of the Republic of Uzbekistan for 2020–2030. Cabinet of Ministers.
13. Spoor, M. (1999). Agrarian transition in former Soviet Central Asia: A comparative study of Uzbekistan and Kyrgyzstan. Journal of Peasant Studies, 27(1), 46–64.
14. Tashkentov, A., & Ergashev, I. (2021). Agricultural productivity and institutional change in Uzbekistan. Central Asian Journal of Agricultural Research, 3(1), 12–28.
15. United Nations Development Programme. (2021). Human development report: Uzbekistan country data. UNDP.
16. World Bank. (2007). World development report 2008: Agriculture for development. World Bank.
17. World Bank. (2020). Uzbekistan: Agricultural sector review — Transforming agriculture for prosperity. World Bank Group.