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Research Article

FOOD SECURITY IN CENTRAL ASIA: CHALLENGES AND PATHWAYS TO RESILIENCE

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ABSTRACT

Food security is a complex challenge in Central Asia, impacted by climate change, water scarcity, land degradation, and disconnected governance systems. Although the region has high agricultural potential, particularly in cereals and irrigated agriculture, food security conditions differ across countries. This research explores the major issues underlying food security in Central Asia, including limited agricultural land, production trends, socio-economic vulnerabilities, and policy context. It also identifies systemic weaknesses, including inconsistencies across agriculture, water, and energy policies. At the same time, it highlights opportunities to strengthen food system resilience through better data, early warning systems, climate-smart agriculture, sustainable water governance, regional cooperation, and stakeholder engagement. This work adopts a qualitative comparative analysis based on national strategies, official government reports, and academic literature. The findings recommend a regional roadmap for long-term food security and conclude that strengthening regional coordination, improving water governance, and investing in climate-resilient agriculture are essential for Central Asia.

Keywords: Food security, Central Asia, Climate change, Water governance, Regional cooperation.

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INTRODUCTION

Food security is a core global and developmental challenge, impacting poverty reduction, social stability, and economic resilience. Its absence negatively affects public health and the ability of individuals and communities to fully exercise their rights and achieve equitable development (Committee on World Food Security, 2013; Food and Agriculture Organization of the United Nations [FAO], 2001; World Bank, 2024a). This issue has received global attention at all levels and continues to be discussed in many international forums. Its impact is particularly evident in regions known for difficult environmental conditions, economic transition, and geopolitical circumstances, as is the case in Central Asia.

The concept of food security emerged in the 1970s following a series of global food crises characterized by soaring prices and supply shortages, which significantly impacted developing regions in Asia and Africa (Shaw, 2007). Initially, the goal was to ensure sufficient global food supplies, but the concept has evolved considerably over time. By the mid-1990s, FAO (1996) proposed a definition of food security that includes not only the availability of food, but also physical, social, and economic access to safe and nutritious food for all people at all times.

Despite all the efforts made, ensuring food security remains extremely complex. Governments continue to face numerous challenges in meeting the growing demand for food resulting from population growth and changing food consumption patterns (FAO, 2021; World Bank, 2024a), while simultaneously facing increasing pressure on natural resources and accelerating climate change. These challenges are particularly evident in arid and semi-arid regions, where water scarcity, environmental degradation, and high transportation costs affect agricultural productivity and food system efficiency (FAO, 2021; FAO, 2024a). In response to these challenges, global initiatives such as the Sustainable Development Goals and the 2015 Paris Agreement have placed food security, sustainable agriculture, and climate change resilience at the heart of international development agendas (United Nations, 2015a; United Nations, 2015b).

Central Asia is a special and priority case in global food security discussions (Lerman & Sedik, 2018; Svanidze et al., 2019). Despite the region's enormous agricultural potential, it suffers from deep structural vulnerabilities (Pomfret, 2019; Abdullaev & Rakhmatullaev, 2015). Its vast steppes and irrigated lowlands support cereal, cotton, and horticultural production (FAO, 2016; Lerman & Sedik, 2018), while agriculture remains a primary source of employment and rural livelihoods, particularly in Uzbekistan, Kyrgyzstan, and Tajikistan. As one of the world's most landlocked regions, Central Asia is vulnerable to high logistics and food transportation costs, which affect food prices, market integration, and accessibility in this import-dependent region (FAO, 2021). In addition, the region is characterized by harsh climatic conditions, increasing drought frequency, and heavy reliance on transboundary river systems. Ongoing climate change in the region is exacerbating water scarcity, accelerating glacial retreat, and increasing competition between water uses for agriculture, energy, and domestic purposes. On the other hand, land degradation, salinization, and desertification, particularly in irrigated areas, continue to undermine agricultural

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productivity and the long-term sustainability of the food system (FAO, 2022; Asian Development Bank [ADB], 2021a, 2021b).

In addition to environmental constraints, food security in Central Asia is affected by governance factors and institutional dynamics (Zhiltsov et al., 2018). At the national level, agricultural, water, trade, and climate policies are often fragmented and cross-border coordination remains limited despite shared ecosystems and markets (Sehring, 2009). The regional cooperation structure remains fragmented, and the integration of scientific evidence into policymaking varies across contexts. These governance gaps reduce the effectiveness of national strategies and weaken collective resilience to shocks such as global price volatility, supply chain disruptions, and extreme weather events (Svanidze et al., 2019; Organisation for Economic Co-operation and Development [OECD], 2021).

This review article offers a comprehensive and critical examination of the factors influencing food security in Central Asia, addressing environmental conditions, agricultural constraints, socioeconomic vulnerabilities, and governance challenges through an integrated framework. It aims to identify key structural impediments while highlighting ways to enhance resilience and proposes a regional roadmap for food security that focuses on policy coherence, enhanced regional cooperation, innovation, and institutional capacity as fundamental pillars for building sustainable and inclusive food systems. This study employs a qualitative comparative-analytical approach based on a systematic review of international reports and academic literature. Sources were selected according to their relevance to food security in Central Asia, institutional credibility, availability of comparable data, and publication within the past decade. The analysis is conducted through thematic comparison focusing on climate change, water resources, agricultural productivity, and governance systems.

EXAMINING THE CENTRAL ASIAN CONTEXT

Agriculture, drought, and water use

The Central Asian countries share common food security conditions, but they differ significantly depending on natural resources, economic and demographic pressures, and political decisions. Although all five countries had systems of centrally planned agriculture emphasizing strategically important crops from the Soviet era, diverging post-independence paths led to widely different food security outcomes (Pomfret, 2019; Lerman & Sedik, 2018).

Kazakhstan is a leading agricultural and food producer in the region and plays a pivotal role in regional and global grain markets as one of the world's top ten wheat exporters. Its rainfed grain farming systems are concentrated in the northern steppe regions, which account for the majority of production (OECD, 2018; FAO, 2021). The country relies on extensive agricultural infrastructure, relatively advanced farming technologies, and export potential to ensure national food security and boost foreign exchange earnings. However, climate variability, and especially drought affecting rainfed wheat production, put the food system in this country at risk (Svanidze et al., 2019), while logistical challenges further exacerbate domestic price volatility across its vast territory. Regional inequalities remain, with remote rural areas having limited physical access to diverse and nutritious foods despite surplus production in the country (World Bank, 2024b).

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Uzbekistan is the most populous country in Central Asia, and this population growth exacerbates the ongoing pressure to balance food availability with increasing demand. The agricultural sector is subject to strict government control, particularly in irrigation systems that produce cotton and wheat in the Amu Darya River basin (Djanibekov et al., 2012). Although recent reforms have helped reduce imports and government procurement and have encouraged diversification in horticulture and livestock farming, food security remains closely linked to water availability and irrigation efficiency (FAO, 2022). Despite progress in increasing domestic food production, its heavy reliance on irrigated agriculture exposes it to climatic and hydrological risks, especially with declining river flows and increasing competition for water (ADB, 2021b).

Kyrgyzstan's mountainous terrain limits the availability of arable land, while agricultural production is dominated by small, low-productivity farms with limited access to finance and technology, making them structurally dependent on food imports and highly vulnerable to external shocks (Lerman & Sedik, 2018). Food security is also affected by remittances from migrant workers, which constitute a significant portion of food access, particularly in rural areas (World Bank, 2025). Price volatility, high transport costs, and limited storage infrastructure further exacerbate this vulnerability, especially during global supply disruptions (FAO, 2021). Agriculture in Tajikistan remains labor-intensive and low-productivity, resulting in some of the highest levels of food insecurity in the region. Cotton continues to occupy a large portion of irrigated land despite its limited contribution to food production (Lerman & Sedik, 2008), making food access highly dependent on imports and thus highly vulnerable to global price fluctuations (World Bank, 2024a). Turkmenistan maintains a highly centralized agricultural system, with the state tightly controlling land use. Wheat and cotton dominate irrigated production, supported by large water diversions from the Amu Darya River (Pomfret, 2019). Despite significant government investment in irrigation infrastructure, soil salinization (United Nations Economic Commission for Europe [UNECE], 2020a) and limited transparency and data availability complicate independent assessments of food security outcomes. However, available evidence suggests continued vulnerability to water scarcity (FAO, 2021).

Table 1
Country-specific food security context in Central Asia

Indicator	Kazakhstan	Uzbekistan	Kyrgyzstan	Tajikistan	Turkmenistan
Agriculture's contribution to GDP (%)	4–5%	25–28%	12–14%	22–25%	10–12%
Agricultural employment (% of total)	15%	26–28%	18–20%	45–50%	38–40%
Arable land (% of total land area)	10%	11%	7%	~6%	~4%
Irrigated land (% of cultivated land)	7–8%	85–90%	75–80%	85–90%	90%

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Rainfed cereal dependence	High (dominant wheat system)	Low	Low–medium	Low	Very low
Wheat production (million tons/year)	14–16	6–7	0.7–0.8	1.2–1.4	1.6–1.8
Net wheat trade status	Major exporter	Near self-sufficient	Net importer	Net importer	Near self-sufficient
Food import dependency (% kcal)	30–35%	20–25%	45–50%	55–60%	30–35%
Undernutrition prevalence (% population)	<5%	6–8%	8–10%	15–18%	6–8%
Child stunting (% under 5)	8%	10%	13%	18–20%	11–13%
Remittances (% of GDP)	<1%	12–14%	30–33%	30–35%	<1%
Drought vulnerability	High (rainfed zones)	High (irrigated water stress)	Medium–high	High	High
Water withdrawal for agriculture (% total)	65%	90%	90%	95%	94%
Data transparency and availability (qualitative index)	Medium–high	Medium	Medium	Medium	Low
Overall food vulnerability	Low–medium	Medium	High	Very high	Medium

Source: Compiled by the authors on the basis of data from FAO (2024b) and World Bank (2023)

Table 1 shows the index of key structural, productivity, and vulnerability indicators affecting food security outcomes across the five Central Asian countries. These indicators clearly reflect differences in dependence on agriculture, access to resources for food production systems, and exposure to food security risks. A distinctive point in the region is Kazakhstan's internal structure, as agriculture accounts for a small proportion of GDP (about 4–5%) and employment (15%). However, as a major wheat producer and exporter, producing over 14 million tons per year, Kazakhstan plays a role in regional food security and is particularly vulnerable to drought and climatic variability in the northern steppe regions due to its heavy reliance on rainfed cereal farming.

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Table 1 also shows that agriculture in Uzbekistan and Tajikistan continues to contribute directly to GDP (25–28% and 22–25%) and employment (26–28% and 45–50%), respectively, with over 85–90% of cultivated land being irrigated. This reliance on irrigation can be explained by extremely high agricultural water withdrawals, which directly link food security to the availability of transboundary water and irrigation efficiency. Although both countries are nearing self-sufficiency in wheat, their vulnerability to drought and water stress poses structural risks, particularly given declining river flows and increasing competition for water. Table 1 shows Turkmenistan as near self-sufficient in wheat and gives its food import dependency as 30-35%. These indicators still point to vulnerabilities in food access, diet quality, and resilience to economic and climate shocks.

In the five countries, agriculture remains the primary consumer of water resources, accounting for between 65% and 95% of total water withdrawals. High drought vulnerability highlights the crucial importance of water management for achieving food security. Data transparency presents challenges, particularly in Turkmenistan, where data scarcity hinders monitoring and decision-making.

Climate impact

The Central Asian countries are characterized by an extreme continental climate with hot summers and cold winters, and significant interannual rainfall variation. These conditions, through rising average temperatures, increased frequency and intensity of droughts, and altered rainfall patterns, undermine the stability of agricultural production systems (Intergovernmental Panel on Climate Change [IPCC], 2022). The impacts of climate change differ among Central Asian countries due to differences in their agroecological conditions, dependence on water, and production systems. In Kazakhstan, where extensive rainfed cereal farming systems dominate agriculture, the increasing frequency of droughts and heat stress has led to greater crop variability, particularly for wheat in the northern steppe regions (ADB, 2021b). These climatic pressures directly affect national export capacity and regional grain supplies, increasing their vulnerability to domestic price volatility. In contrast, Uzbekistan and Turkmenistan rely heavily on irrigated agriculture, especially for wheat and cotton production in river basins downstream. Decreased river flows and increased competition for water have led to reduced irrigation reliability, particularly during critical growing seasons, limiting productivity and increasing vulnerability to climate-induced water scarcity (FAO, 2021; ADB, 2021b). Inefficient irrigation systems, high water loss rates, and poor water management increase the impacts of climate stress in these countries.

As upstream countries, Kyrgyzstan and Tajikistan face a distinct but equally severe set of climate risks. The accelerated retreat of glaciers in the Tian Shan and Pamir mountain ranges, major sources of seasonal river flow, threatens the long-term water management of both agriculture and hydropower generation (IPCC, 2022; Sorg et al., 2012). While short-term increases in meltwater may contribute to the temporary sustainability of flows, long-term glacial loss is expected to reduce water availability, undermining irrigation, energy security, and rural livelihoods in both upstream and downstream areas.

Across the region, climate shifts in hydrological systems have led to reduced water availability during critical growing periods, increasing the vulnerability of both rainfed and irrigated crops (FAO, 2021). Rising temperatures have also

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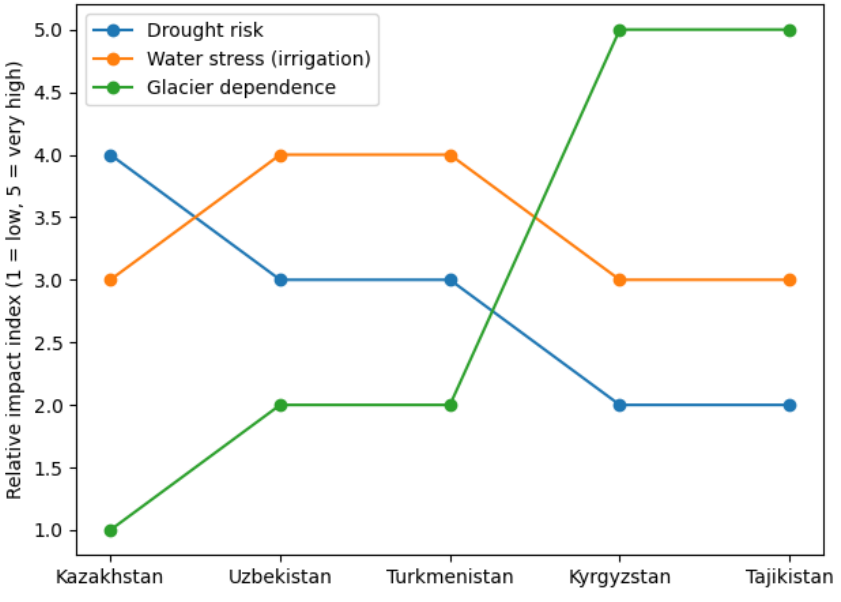
expanded the geographic range and spread of agricultural pests and diseases, increasing production risks in the cereal, horticultural, and livestock sectors (Nelson et al., 2010), and these conditions interact with socioeconomic conditions, rapidly translating climate shocks into income instability, food price inflation, and exacerbated food insecurity, particularly in countries where agriculture remains a major source of employment and household income (World Bank, 2024a).

Figure 1 presents a comparative country-level graph of the main climate risks affecting food security in Central Asia using a relative impact index (1 = low, 5 = very high) to highlight differences between countries in terms of drought risk, water stress from irrigation, and reliance on glacial-fed water systems. This figure shows the divergent nature of climate vulnerability between downstream countries that rely on irrigated agriculture (Uzbekistan, Turkmenistan), rain-fed grain systems that are susceptible to drought (Kazakhstan), and upstream countries that depend heavily on glacial melt for water regulation (Kyrgyzstan, Tajikistan).

Figure 1
Climate-related risks affecting food security in Central Asia



Source: Compiled by the authors on the basis of data from IPCC (2022)

Recent droughts have revealed vulnerabilities in water management, leading to reduced crop yields and intensified competition between agricultural, domestic, and energy uses (UNECE, 2020a). Climate projections suggest further reductions in river flows due to glacier retreat, increasing dependence on groundwater extraction and raising concerns about the overexploitation of water (IPCC, 2022).

According to SESRIC's water resource indicators (Table 2), Central Asia exhibits pronounced upstream–downstream asymmetries in water availability, with downstream countries highly dependent on transboundary rivers and irrigation withdrawals, while upstream countries control seasonal flows derived from

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snow and glacier melt. Declining per capita water availability and inefficient irrigation systems further exacerbate food security risks across the region (Statistical, Economic and Social Research and Training Centre for Islamic Countries [SESRIC], 2022).

Table 2
Water stress indicators relevant to food security in Central Asia

Country	Hydrological Position	Per Capita Water Stress	Dependence on Irrigation Systems	Food Security Implications
Kazakhstan	Medium	Moderate–High	Medium	Drought-sensitive cereals
Uzbekistan	Downstream	High	Very High	Irrigation vulnerability
Turkmenistan	Downstream	Very High	Very High	Severe water stress
Kyrgyzstan	Upstream	Low	Medium	Glacier-dependent flows
Tajikistan	Upstream	Low	Medium	Glacier & hydropower risk

Source: Compiled by the authors on the basis of data from SESRIC (2022)

The governments of these countries are adopting adaptation and mitigation strategies to prevent projected temperature increases and water scarcity from further reducing agricultural productivity across large swaths of Central Asia by mid-century, in order to achieve the Sustainable Development Goals related to eradicating hunger, reducing poverty, and ensuring environmental sustainability (ADB, 2021b; IPCC, 2022). The varying impacts of climate change in Central Asia highlight the need for country-specific adaptation measures within a coordinated regional framework to build climate-resilient food systems.

Biodiversity degradation

Reliance on intensive monoculture farming, excessive irrigation, and poor land management practices has led to widespread soil degradation, including erosion, salinization, and a decline in soil organic matter, particularly in downstream irrigated areas (FAO, 2015). The loss of agricultural biodiversity has further reduced adaptive capacity. Traditional crop varieties and livestock breeds adapted to local conditions have been replaced by standardized production systems that are more vulnerable to water stress and disease outbreaks (FAO, 2019). Climate variability, reduced livestock movement, and overgrazing have also weakened rangeland ecosystems, which remain crucial for livestock production (Nelson et al., 2010).

Healthy ecosystems support long-term food system resilience by facilitating pollination, nutrient cycling, and natural pest regulation. Therefore, the loss of biodiversity undermines both current food production and future adaptive capacity, calling for the integration of ecosystem-based approaches into agricultural and land-use policies (FAO, 2021).

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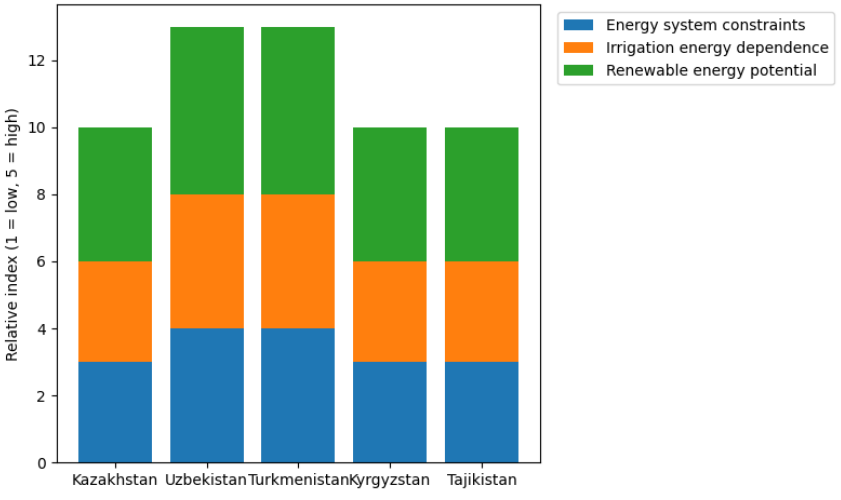
Energy

Agricultural production depends on energy inputs for irrigation pumping, mechanization, treatment, storage, and transportation. Energy availability and cost directly affect production costs, water use efficiency, and post-harvest losses (ADB, 2021a). Most Central Asian countries face seasonal electricity shortages, aging infrastructure, and high energy prices, which limit irrigation reliability and hinder the adoption of modern agricultural technologies (ADB, 2021b). Figure 2 illustrates the relative importance of energy-related factors in shaping food security outcomes in these countries. The figure highlights three interrelated dimensions: (1) energy system constraints, (2) energy dependence of irrigation systems, and (3) renewable energy potential. As shown in Figure 2, Uzbekistan and Turkmenistan exhibit the highest combined pressure from energy constraints and dependence on irrigation energy, which explains their heavy reliance on energy-intensive irrigated agriculture and outdated electricity infrastructure. Kazakhstan, Kyrgyzstan, and Tajikistan exhibit relatively fewer constraints due to their stronger energy capacity, but they remain vulnerable due to their reliance on energy-intensive mechanized agriculture, particularly Kazakhstan, which depends on long-distance transport systems (ADB, 2021a). Seasonal electricity shortages and fluctuations in hydropower directly impact the reliability of irrigation and rural food production. In all these countries, the high potential of renewable energy, especially solar and wind power, represents a strategic opportunity to enhance climate change resilience, reduce production costs, and strengthen the water-energy-food nexus, provided it is supported by coherent policies and targeted investments.

Figure 2

Energy-related constraints and opportunities influencing food security in Central Asia



Source: Compiled by the authors on the basis of data from ADB (2021a)

FOOD SECURITY CHALLENGES IN CENTRAL ASIA

Despite the region's considerable agricultural potential, particularly in cereal production, irrigated agriculture, and livestock systems, food security outcomes remain inconsistent after the transition period from the Soviet regime (Spoor,

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1995; Pomfret, 2019). As previously mentioned, structural weaknesses, including climatic pressures, water scarcity, landlocked geography, and fragmented governance frameworks, contribute to limiting the performance and resilience of the food system (Lioubimtseva & Henebry, 2009; Wegerich, 2011). During the Soviet era, Central Asian agricultural systems were geared towards high-volume production, especially of strategic commodities like wheat and cotton, within a centrally planned framework, often at the expense of efficiency, environmental sustainability, and dietary diversity (Pomfret, 2019). Following independence, countries began pursuing market liberalization and land reform policies, which helped some achieve productivity gains while others experienced declining investment, weakened institutions, and increased dependence on food imports (Swinnen & Vranken, 2010; Lerman & Sedik, 2018). However, rising transportation and logistics costs have driven up food prices, limited market integration, and reduced the affordability of diverse diets, particularly for import-dependent countries like Kyrgyzstan and Tajikistan (FAO, 2021; EBRD, 2025). These structural constraints are exacerbated by demographic pressures, climate change, and increased exposure to global market volatility, placing Central Asia at a critical juncture where incremental policy adjustments alone are insufficient to guarantee the long-term resilience of its food system. Therefore, addressing food security in Central Asia requires moving beyond narrow, production-focused approaches and toward integrated strategies that combine data-driven policymaking, institutional coordination, broad stakeholder engagement, investment mobilization, scaling up innovation, and sustainable capacity building (Bobojonov & Aw-Hassan, 2014; FAO, 2021). In this context, we highlight seven interconnected components as pivotal challenges and opportunities that shape food security outcomes across the region.

Data, analytics, and assessment tools

Food and agricultural data systems in Central Asia remain fragmented, inconsistent in quality, and often outdated (UNECE, 2020a; FAO, 2021). The collection and analysis of accurate and reliable data are fundamental to effective food security governance. While agricultural statistics, crop estimates, and water use data are obtained in many countries using different methodologies, they are not comparable between countries and over time. To address this, it is necessary to strengthen data infrastructure and expand digital agriculture platforms to improve forecasting, policy evaluation, and cross-border food security cooperation in Central Asia (World Bank, 2024a).

Coherence of food security governance in the region

At the regional level, national strategies have historically lacked systematic coordination. Despite shared ecosystems, transboundary river networks, and interconnected markets, the region continues to face challenges related to water allocation in the Amu Darya and Syr Darya river basins, cross-border trade logistics, plant health coordination, and climate change adaptation. This explains why most regional governance mechanisms have remained advisory rather than executive (UNECE, 2020b). Recognizing that food security challenges transcend national borders, the Ministries of Agriculture of Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan adopted the Central Asian Food Security Action Plan to 2030, signed in Tashkent on November 10, 2025 (Interfax, 2025; Astana Times, 2025). The Action Plan, adopted within the framework of the Regional Ministerial Dialogue on Agricultural Cooperation, reflects a formal commitment to

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coordinating policy action in the areas of production, trade, water management, and climate change adaptation (Interfax, 2025).

Establishing integrated information-sharing mechanisms is a key pillar of the Action Plan, including the development of a unified regional digital platform for crop forecasting, price monitoring, seed certification, and phytosanitary control. According to the Joint Ministerial Statement, the integration of national databases into a common system by 2030 aims to enhance transparency, reduce trade frictions, and improve regional market stability (Interfax, 2025). The planned operational compatibility between regional phytosanitary systems and the International Plant Protection Convention (ePhyto Solution) platform, developed under the International Plant Protection Convention (IPPC), aims to streamline border procedures and strengthen cooperation in plant and animal health (International Plant Protection Convention, 2022).

The Action Plan also emphasizes regional cooperation in seed production, plant breeding, and genetic resource management. Official documents highlight the creation of a unified electronic register of crop varieties and access to global genetic databases as strategic measures to reduce technological dependence and enhance regional food sovereignty (Interfax, 2025).

Water management and climate change adaptation constitute another key dimension of the plan. It anticipates the widespread deployment of water-saving irrigation technologies, the modernization of pumping stations, and the coordinated exchange of data related to hydrology and climate risks. These measures align with broader regional water cooperation efforts under the International Fund for Saving the Aral Sea (IFAS) and the Interstate Commission for Water Coordination in Central Asia (ICWC), which provide institutional platforms for managing transboundary water allocations (UNRCCA, 2024; UNECE, 2020b).

Furthermore, the plan supports the expansion of agri-food trade within the region and the development of coordinated logistics strategies between 2025 and 2030. These commitments align with the growing emphasis on regional economic integration within Central Asia, as evidenced by recent high-level consultative meetings of Central Asian heads of state (Consultative Meeting of the Heads of State of Central Asia, 2023).

Overall, the Central Asian Food Security Action Plan 2030 represents a shift from fragmented national approaches to a more structured and institutionalized regional governance framework. While its implementation depends on sustained political commitment, financial mobilization, and data transparency, the formal adoption of this plan by national ministries marks a significant step toward coordinated food security governance in Central Asia.

Science–policy dialogue

Limited funding for scientific research, weak institutional cohesion, and inadequate mechanisms for integrating scientific evidence into policymaking are among the most significant and widely discussed obstacles facing the region (Nelson et al., 2010). For this reason, agricultural and food policies in the region often rely on outdated practices or short-term considerations rather than long-term sustainability and climate change resilience. Regional research collaboration is also limited, with few platforms for knowledge exchange among universities, research institutes, and policy actors across Central Asia. This ne-

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cessitates greater efforts from governments to foster science-policy dialogue through joint research programs, advisory bodies, and applied research partnerships to significantly improve innovation, resilience, and policy responsiveness to climate and market shocks (FAO, 2022).

Stakeholder engagement and outreach

Inclusive stakeholder engagement is essential for effective and equitable food security strategies. Smallholder farmers, pastoralists, women, and youth are often underrepresented in policymaking and decision-making processes. Weak rural cooperatives and limited agricultural extension services further reduce opportunities for participation and knowledge sharing (FAO, 2022). This lack of participation hinders the adoption of improved agricultural practices, climate-smart technologies, and market-driven innovations. Expanding participatory platforms, strengthening farmers' organizations, and enhancing collaboration with civil society and the private sector can strengthen the capacities of local actors and improve the relevance and sustainability of food security interventions. Regional and international organizations can also play a pivotal role in facilitating dialogue and capacity building at multiple levels.

Financing and investment

As with most programs, financial constraints are a major obstacle to enhancing food security, leading to limited investment in agriculture, irrigation, storage, and logistics in many countries, even as governments in the region strive to provide farmers and agri-food companies with access to concessional loans (ADB, 2021a). High interest rates, limited risk-sharing mechanisms, and weak financial inclusion disproportionately affect small and medium-sized producers. Furthermore, labor displacement and brain drain reduce the availability of skilled professionals in agricultural research, data analysis, and rural development. Mobilizing public and private investment through blended finance, development banks, and targeted incentives offers an opportunity to modernize food systems, reduce post-harvest losses, and enhance regional trade connectivity (World Bank, 2024a).

Scaling up successful innovations

Central Asia has witnessed a growing number of successful pilot initiatives in areas such as digital water management, climate-smart agriculture, improved seed systems, and renewable energy for irrigation. However, these innovations often remain localized and fail to scale due to financing gaps, policy uncertainty, and limited institutional support (FAO, 2021). Public–private partnerships (PPPs) represent a promising mechanism for scaling innovations, particularly in logistics, storage, and agri-processing. Creating an enabling environment through regulatory clarity, risk-sharing instruments, and market incentives can accelerate the diffusion of proven technologies and practices across countries and agro-ecological zones.

Capacity building

Limited institutional capacity within government agencies, extension services, and research institutions constrains long-term planning, crisis response, and policy implementation. Rural advisory services often lack resources and technical expertise, while digital literacy remains low in many farming communities (FAO, 2022). Enhancing human capital through targeted training, regional learning plat-

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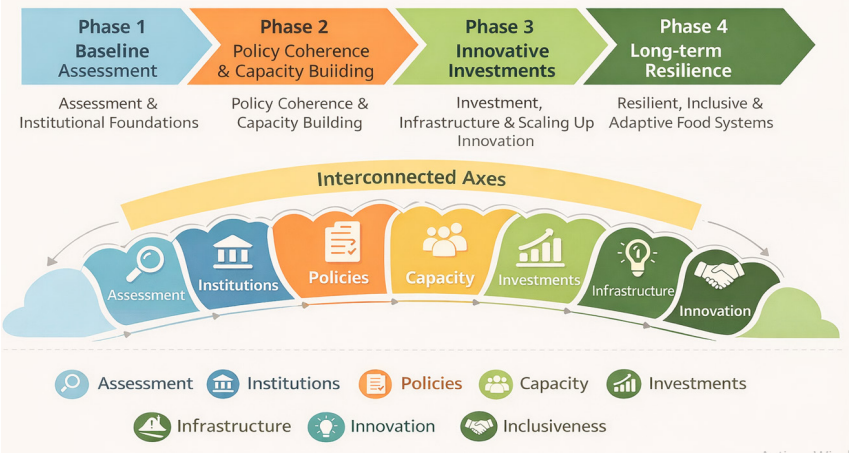
forms, and South–South cooperation initiatives can significantly improve adaptive capacity and innovation uptake. Engaging the private sector and academia in capacity development efforts, supported by regional organizations, offers a pathway toward more resilient and knowledge-driven food systems.

PROPOSED FOOD SECURITY ROADMAP FOR CENTRAL ASIA

Building on the preceding diagnostic analysis in this article, we propose in this roadmap a practical and phased pathway to strengthen food security across Central Asia, which can serve as regional recommendations for coordinated actions reflecting how food systems should function in the region. The approach recognizes that Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan face different structural conditions and share common pressures, as detailed in this article. As illustrated in Figure 3, the proposed roadmap comprises four sequential phases, beginning with a baseline assessment and culminating in long-term resilience, and is based on eight interconnected axes. The first phase starts with a baseline assessment and institutional foundations; then moves to regional joint efforts for policy coherence and capacity building in collaboration with international organizations dealing with food security; and the third phase focuses on innovative investment, infrastructure, and scaling up innovation. The last phase represents the transition toward resilient, inclusive, and adaptive food systems.

Figure 3

Proposed roadmap for strengthening food security in Central Asia



Source: Compiled by authors

The fundamental starting point proposed in this plan is improving data systems by enhancing the collection and analysis of information related to agricultural production, food availability, nutrition, and climate risks, based on databases that allow for comparisons between countries and support early risk detection. A joint ministerial commission should be established across the ministries of agriculture, water, energy, trade, and social affairs to avoid any conflicting priorities and improve overall effectiveness at both national and regional levels and should be supported by stronger regional cooperation mechanisms, particularly in managing shared water resources, facilitating food trade, and coordinating food crisis responses. Modernizing agriculture remains crucial, not only to increase productivity but also to ensure sustainability through climate-smart practices, diversifi-

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cation of high-value crops, and better support for smallholder farmers. Efficient water use is also essential, requiring investment in irrigation systems, improved canal infrastructure for more efficient water transfer and reduced water loss, wider adoption of water-saving technologies, and stronger institutional capacities for water management. In parallel, improving logistics and infrastructure, such as rural roads, storage facilities, and cold chains, can reduce losses, stabilize markets, and enhance access to food, particularly in remote areas.

Food security policies must extend beyond production to encompass nutrition, promote diverse diets, support food safety, and assist the most vulnerable through targeted social programs. As climate change risks intensify, integrating adaptation measures into agricultural planning, expanding risk management tools, and strengthening regional cooperation in climate information sharing become increasingly important. Finally, long-term progress depends on building institutional capacity and fostering knowledge sharing to ensure that research informs policymaking and that stakeholders at all levels possess the skills necessary to address evolving food security challenges.

CONCLUSION

In conclusion, ensuring food security in Central Asia requires a comprehensive and coordinated approach that reflects the region's distinctive environmental challenges, socio-economic structures, and governance dynamics. The analysis demonstrates that food security challenges in Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan are deeply interconnected and shaped by climate change, water scarcity, land degradation, logistical barriers, and disconnected policy systems. Addressing these challenges begins with a systematic and regionally harmonized assessment of food security conditions to inform targeted and evidence-based interventions.

Strengthening policy coherence and governance is important to bridge gaps between agriculture, water, energy, trade, and climate strategies, both at national and regional levels. Enhancing agricultural productivity through innovation, climate-smart practices, and inclusive support for smallholder farmers can improve resilience while reducing environmental pressures. Efficient and cooperative water resource management, combined with strategic investments in infrastructure, storage, and transport, is critical for stabilizing food supply chains and reducing vulnerability linked to landlocked geography.

Equally important is the transformation of food systems toward improved nutritional outcomes, ensuring that food security strategies address not only availability but also access, quality, and dietary diversity. Climate change adaptation and resilience-building must be integrated across all food security policies, supported by early warning systems and risk management tools. Robust monitoring and evaluation frameworks will enable continuous learning, accountability, and policy adjustment in response to emerging risks.

Finally, sustained capacity building and regional knowledge sharing are indispensable for long-term food security in Central Asia. Strengthening human capital, research–policy linkages, and regional cooperation platforms will foster innovation and collective resilience. A coordinated regional approach, grounded in shared priorities and institutional collaboration, offers the most viable pathway toward resilient, inclusive, and sustainable food systems in Central Asia.

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Ethical Commission Approval

This work did not require approval from an ethics committee as it did not involve human participants, animals, or sensitive personal data. All data used in this research were obtained from publicly available sources.

Conflict of Interest Statement

There is no conflict of interest with any institution or person within the scope of this study.

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