STRATEGIC PATHWAYS FOR ENHANCING FOOD SYSTEM RESILIENCE IN UZBEKISTAN THROUGH AGRIFOOD INNOVATION AND RESOURCE EFFICIENCY

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Abstract. Under the cumulative pressure of intensifying climate variability, acute water deficit, and global agrifood market instability, transitioning toward an innovation-driven economic model has become an imperative for national sovereignty and socio-economic resilience. This study conducts a comprehensive analysis of the structural, economic, and institutional mechanisms required to modernize and fortify Uzbekistan's food security framework within a rapidly transforming macroeconomic environment. Moving beyond narrow, output-centric paradigms, the paper conceptualizes food security as a complex, multidimensional system encompassing production, infrastructural transformation, resource stewardship, and market stability.

Keywords: food security, innovation-driven economy, agricultural innovation, digital agriculture, food supply, resource efficiency, food processing, logistics, value chain, food market, Uzbekistan.

Introduction

Contemporary macroeconomic stability relies heavily on the structural resilience of national food systems. The traditional conceptualization of food security-historically centered almost exclusively on volumetric agricultural output-has evolved into a complex, multidimensional paradigm. Modern frameworks, including those established by international bodies such as the FAO, frame food security as an integrated matrix consisting of resource availability, physical and financial accessibility, qualitative utilization, long-term systemic stability, agency, and ecological sustainability. As global food architecture encounters severe external shocks-ranging from accelerated climate instability and acute water depletion to input price volatility and international trade choke points-ensuring national food security requires a shift from isolated agrarian interventions toward comprehensive economic strategies.

However, output expansion alone is insufficient to guarantee durable food security. The agrifood sector continues to face structural bottlenecks, including post-harvest losses,

insufficient cold-chain and storage capacity, market price instability, and unsustainable water consumption. Resolving these challenges necessitates a transition toward an innovation-driven agrifood model. Technologies such as precision farming, satellite-based crop monitoring, automated micro-irrigation, and digitized supply-chain platforms provide critical pathways to enhance productivity while simultaneously alleviating pressure on natural ecosystems.

Analysis and results

1.Factors affecting food security in Uzbekistan

The national food system is influenced by numerous factors operating at different levels. Their effects are not independent; rather, they interact and can strengthen or weaken each other.

Table 1.

Factors influencing food security and their transmission mechanisms

Factor	**Transmission mechanism**	**Potential impact**
Population growth	Expands demand for food products	Increases pressure on supply
Household income	Determines purchasing power	Influences affordability
Water availability	Determines production conditions	Affects output stability
Climate variability	Changes yields and production costs	Increases agricultural risks
Technological innovation	Raises productivity and resource efficiency	Strengthens supply capacity
Processing capacity	Converts raw materials into finished products	Increases value added
Storage infrastructure	Preserves agricultural products	Reduces effective supply losses
Logistics	Connects producers with markets	Improves supply continuity
Market information	Improves decision-making	Increases price transparency

Source: Developed by the author.

The results of the factor analysis indicate that food security should be addressed through coordinated policies rather than isolated measures.

For example, investment in agricultural production will have a limited effect if insufficient storage capacity causes significant losses after harvesting. Similarly, increasing production without improving logistics may create regional surpluses and shortages simultaneously.

Thus, the effectiveness of food-security policy depends on the degree of integration among the individual components of the food system.

2. Current agricultural production dynamics

The 2025 results demonstrate that agricultural production in Uzbekistan continued to expand. According to the Ministry of Economy and Finance, agricultural, forestry and fishery production grew by 4.4% in 2025. Crop production increased by 7.2%, whereas livestock production increased by 1.6%. The stronger growth of crop production is explained partly by the expansion of vegetable, grain and other crop production. In particular, grain production increased by 13%, cotton by 25.4%, melons by 16.2%, fruits by 6.4% and grapes by 7.7%.

An important characteristic of Uzbekistan's agricultural structure is the contribution of household and dehkan farms. Government data for 2025 indicate that 5.1 million household plots in 8.9 thousand mahallas produced more than 8 million tons of agricultural products. This demonstrates that food-security policy must include small producers rather than focusing exclusively on large agricultural enterprises. The involvement of household and dehkan farms is also important from the perspective of technological modernization. The introduction of accessible digital advisory services, modern irrigation technologies, improved seeds and small-scale processing equipment could substantially increase their productivity.

3.The role of food processing in food security

Food processing plays a strategic role because it transforms agricultural raw materials into products with higher added value and longer storage periods.

Government information on the food industry indicates that ensuring food security is becoming increasingly important in the context of population growth, climate change and constraints related to land and water resources.

The development of processing capacity can therefore simultaneously address several objectives: reduce post-harvest losses, extend product shelf life, increase value added, diversify food supplies and create additional employment.

Table 3.

Structural problems in the food-value chain and their economic consequences

Stage of the food chain	Main vulnerability	Economic consequence	Priority intervention
Production	Low resource efficiency	Higher unit costs	Precision agriculture
Harvesting	Seasonal concentration	Temporary supply imbalance	Better planning and forecasting
Processing	Limited technological capacity	Low value added	Modern processing equipment
Storage	Insufficient cold-chain facilities	Product losses	Refrigerated storage
Transportation	High transaction costs	Higher final prices	Digital logistics
Wholesale trade	Information asymmetry	Price differences	Digital market platforms
Retail	Uneven market access	Regional disparities	Distribution modernization
Consumption	Limited purchasing power	Reduced food access	Income and social-support measures

Source: Developed by the author.

The table demonstrates that food-security risks accumulate throughout the value chain. A product can be successfully produced but lose part of its economic value during transportation or storage. Therefore, food-security policy should evaluate not only gross production but also the **effective quantity and value of food reaching consumers**. This provides a strong argument for integrating agricultural policy with industrial, infrastructure and digital-development policies.

Conclusions and recommendations

Analytical evidence reveals that Uzbek agrifood architecture stands on the verge of a structural transition, where technological adoption functions as the main catalyst for long-term food stability.

First, an integrated food-security indicator system should be developed. It should combine production, household purchasing power, food-price stability, import dependence, food quality, resource efficiency and supply-chain resilience.

Second, a unified digital food-security monitoring platform should be established. The platform should integrate data on agricultural production, food stocks, prices, imports, exports, logistics and regional demand.

Third, precision agriculture should be expanded. Satellite monitoring, sensors, drones and digital field-management systems can increase productivity and reduce unnecessary use of water, fertilizers and other inputs.

Fourth, smart irrigation technologies should be developed as a strategic component of food-security policy. Water-saving technologies should be accompanied by digital monitoring of water consumption.

Fifth, regional food-processing centers should be established in areas with strong agricultural specialization but insufficient processing capacity. Such centers should combine sorting, packaging, refrigeration and processing functions.

Sixth, small producers should receive greater access to innovation. Preferential financing, digital agricultural advisory services, cooperative mechanisms and technology-transfer programs should be expanded.

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