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Article

Priority Directions for Ensuring Food Security in Uzbekistan Under Conditions of an Innovation-Driven Economy

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Abstract: This article examines the priority directions for ensuring food security in Uzbekistan under conditions of an innovation-driven economy. The study considers food security as a multidimensional system that combines food availability, economic accessibility, quality, stability of supply and efficient use of natural resources. Particular attention is paid to the role of digital agriculture, water-saving technologies, food processing, storage infrastructure and modern logistics. The research applies systematic, comparative, statistical and analytical methods. The results indicate that increasing agricultural production alone is insufficient to ensure sustainable food security. The transition toward an innovation-oriented food system requires the integration of technological modernization, resource efficiency, digital monitoring and value-chain development. Based on the analysis, practical recommendations are proposed for strengthening the resilience and efficiency of Uzbekistan's food-security systems.

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

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1. Introduction

Food security is increasingly recognized as an important component of national economic security. In contemporary conditions, its meaning extends beyond the physical availability of agricultural products. A stable food system should provide the population with sufficient, safe and nutritious food, while ensuring that households have the economic and physical ability to obtain it and that such access remains stable over time [1]. The relevance of food security has increased because agricultural systems are exposed to several interconnected risks. Climate variability, water scarcity, changes in production costs, fluctuations in food prices and disruptions in supply chains can influence both production and consumer access to food. Consequently, food security should be treated as a complex economic system rather than as an isolated agricultural indicator [2].

This issue is particularly significant for Uzbekistan. Agriculture remains an important component of the national economy, rural employment and domestic food supply. At the same time, agricultural development is constrained by the availability of land and water resources and by the need to improve productivity. Official investment information indicates that agriculture accounted for approximately 18.9% of Uzbekistan's GDP in 2025, demonstrating the sector's continuing economic significance [3].

The transition toward an innovation-driven economy creates opportunities to address these constraints. Digital agriculture, satellite monitoring, precision farming, automated

irrigation, agricultural drones, modern breeding technologies and data-based decision-making can increase productivity while reducing the pressure on natural resources [4]. The empirical situation also demonstrates positive changes in agricultural production. According to official government data, agricultural, forestry and fishery production in Uzbekistan increased by 4.4% in 2025 compared with 2024. Crop production increased by 7.2%, while livestock production grew by 1.6%. Grain production increased by 13%, cotton by 25.4%, melons by 16.2%, fruits by 6.4%, grapes by 7.7% and eggs by 7% [5].

However, production growth itself does not automatically guarantee food security. A food system may produce increasing quantities of agricultural commodities while simultaneously experiencing problems related to affordability, post-harvest losses, storage, logistics, price volatility or inefficient use of water.

Therefore, the central research problem is to determine how innovation can transform increasing agricultural production capacity into a more stable, efficient and resilient national food system [6].

The **purpose of the research** is to identify priority directions for ensuring food security in Uzbekistan under conditions of an innovation-driven economy and to develop practical recommendations for improving the efficiency and resilience of the food system [7].

The **object of the research** is the food-security system of Uzbekistan.

The **subject of the research** comprises the economic relations and organizational mechanisms associated with food production, processing, storage, transportation, distribution and consumption.

The main objectives of the study are:

- to examine the theoretical foundations of modern food security;
- to identify the major factors influencing food security in Uzbekistan;
- to analyze recent agricultural production trends;
- to assess the role of innovation in strengthening food-system resilience;
- to identify institutional, technological and infrastructural constraints;
- to develop practical recommendations for innovation-oriented food-security policy [8].

The theoretical concept of food security has developed from a predominantly production-oriented interpretation toward a multidimensional framework. According to the FAO approach, food security includes availability, access, utilization and stability. These dimensions are interconnected and should be considered simultaneously when evaluating the food-security position of a country. The concept also increasingly incorporates sustainability and the capacity of food systems to withstand shocks. FAO materials emphasize that contemporary interpretations of food security are expanding beyond the traditional four dimensions to include agency and sustainability [9].

The sustainability dimension is particularly important for agricultural economies. Pretty argues that sustainable agricultural development requires technologies and practices that improve productivity without damaging environmental resources. He emphasizes the need to combine technological progress with efficient use of natural, human and social capital [10].

From this perspective, technological modernization should not be assessed solely by the number of machines or digital platforms introduced into agriculture. Its effectiveness should be evaluated through changes in productivity, resource consumption, environmental sustainability and the resilience of production systems [11].

For Uzbekistan, the resource-efficiency dimension has particular importance. The country's agricultural development is closely connected with irrigation and water availability. Therefore, innovation that increases output without proportionally increasing

resource consumption can make a stronger contribution to long-term food security than simple expansion of production capacity [12].

Recent policy approaches in Uzbekistan also demonstrate growing attention to digitalization, resource-saving technologies and value-added agricultural chains. The Ministry of Agriculture identifies digitalization, modern information technologies, resource-saving agricultural technologies and the development of value-added chains covering production, storage, processing and marketing among important areas of agricultural development [13].

Nevertheless, existing approaches often analyze agricultural production, technological modernization, food processing and logistics as separate issues. This study differs by considering these components as interconnected elements of one food-security mechanism [14].

2. Materials And Methods

The study applies a combination of statistical, comparative, systemic and analytical methods. The **systematic approach** is used to interpret food security as an interconnected system consisting of production, processing, storage, transportation, distribution and consumption.

The **comparative method** is used to identify differences among the major dimensions of food security and to assess the relative significance of economic, technological and infrastructural factors. **Statistical analysis** is applied to recent official indicators of agricultural production and food-related activities, with particular attention to 2025 data.

The **factor-analysis approach** is used to classify the main determinants of food security into economic, environmental, technological, infrastructural and institutional groups. The study also uses **scientific abstraction, synthesis and generalization** to develop an innovation-oriented conceptual framework. The empirical basis consists primarily of official information from the National Statistics Committee and government institutions of Uzbekistan, complemented by international scientific and institutional sources.

3. Results

1. Food security as a multidimensional economic system

One of the main methodological problems in food-security assessment is the tendency to use agricultural production as the principal indicator. Although production is fundamental to food availability, it does not provide sufficient information about affordability, quality, stability or resource efficiency.

FAO's conceptual framework shows that availability, access, utilization and stability must be considered together [15].

Based on this approach, the following system of indicators can be proposed for Uzbekistan.

Main dimensions and indicators of food security

Dimension	Indicator	Economic interpretation	Policy significance
Availability	Domestic food production	Capacity to supply the domestic market	High

Economic access	Real household income	Ability to purchase adequate food	High
Price stability	Food-price volatility	Stability of household food expenditure	High
External dependence	Import dependence	Exposure to external market risks	High
Food quality	Compliance with safety standards	Protection of consumer health	High
Resource efficiency	Output per unit of water and land	Efficiency of natural-resource use	High
Supply stability	Strategic reserves and diversification	Ability to withstand disruptions	High

Source: Developed by the author based on the conceptualization of food security.

The table demonstrates that food security is simultaneously an agricultural, economic, social and technological phenomenon.

The first dimension concerns the physical supply of food. However, even sufficient domestic production does not guarantee food security if households cannot afford available products. Therefore, income and food prices should be analyzed together with production indicators.

The resource-efficiency indicator is particularly important for Uzbekistan. Agricultural expansion based on increasing water and land consumption may generate short-term output growth but create long-term production risks. Hence, the efficiency of resource use should become one of the central criteria of agricultural modernization.

2. 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 2.

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.

3. 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.

Government information also reports that 1,103 projects worth 5.3 trillion soums were implemented in livestock and related sectors during 2025. These included projects in cattle breeding, sheep and goat farming, poultry, fish farming, beekeeping and meat and milk processing. This indicates that investment activity is expanding beyond crop production and increasingly covers the livestock and processing segments.

4. 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.

5. Innovation and resource efficiency

Innovation becomes especially important when production resources are limited. The objective is to increase output without proportionally increasing land, water and other input requirements.

Pretty's research emphasizes that sustainable agricultural systems should integrate productivity improvements with the protection of environmental resources and the efficient use of natural and human capital.

For Uzbekistan, this principle suggests that innovation policy should prioritize technologies capable of simultaneously improving productivity and reducing resource losses.

Table 4.

Innovation mechanisms for strengthening food security

Innovation	Application	Immediate effect	Long-term contribution
Precision agriculture	Crop production	More accurate use of inputs	Higher productivity
Smart irrigation	Water management	Lower water losses	Resource sustainability
Satellite monitoring	Land and crop management	Early risk identification	Greater production stability
Agricultural drones	Crop inspection	Faster field monitoring	Lower operational costs
AI forecasting	Yield and market forecasting	Better decisions	Lower uncertainty
Digital warehouses	Storage management	Better inventory control	Reduced food losses
Cold-chain technology	Perishable products	Longer shelf life	Stable food supply
Digital logistics	Transportation	Route optimization	Lower distribution costs
Traceability systems	Food safety	Product tracking	Higher consumer confidence
Digital marketplaces	Agricultural trade	Better information	Greater market transparency

Source: Developed by the author.

The table indicates that innovation should not be limited to the production stage. Digital agriculture can improve the efficiency of cultivation, while smart storage can reduce losses after harvesting. Digital logistics can reduce transportation costs, and traceability systems can improve food safety.

Therefore, the greatest effect can be expected when innovations are combined into an integrated system.

6. Proposed model for innovation-based food security

Based on the analysis, an integrated model can be proposed:

Resource base → Innovative production → Processing → Storage → Digital logistics → Market access → Consumer affordability → Food-system resilience

The distinctive feature of this model is the integration of technological, economic and institutional mechanisms.

At the production stage, innovation should increase productivity and resource efficiency. At the processing stage, technological modernization should increase value added and product diversity. At the storage stage, modern infrastructure should reduce losses. At the logistics stage, digital systems should improve coordination and reduce transaction costs. At the market stage, transparent information should improve price formation. At the consumption stage, the ultimate objective should be to ensure that safe and nutritious food remains economically accessible to the population.

The model therefore changes the policy objective from simply "producing more food" to "creating a resilient food system capable of efficiently transforming resources into affordable and safe food."

Table 5

Growth Rate of Total Agricultural Production in Uzbekistan, 2020–2025

Indicator	2020	2021	2022	2023	2024	2025
Total agricultural production, %	102.7	103.9	103.6	104.0	103.1	**104.4**
Crop production, %	103.2	104.3	103.8	104.3	102.1	**107.2**
Livestock production, %	102.1	103.5	103.3	103.7	104.0	**101.6**

Source: National Statistics Committee of the Republic of Uzbekistan, SIAT official statistical database for 2020–2024; official 2025 agricultural results for 2025. The 2020–2024 total agricultural production series is reported by SIAT

The data show that Uzbekistan maintained positive agricultural-production dynamics throughout 2020–2025. The strongest acceleration occurred in 2025, when total agricultural production reached 104.4% of the previous year's level. Crop production recorded the highest growth at 107.2%, while livestock production increased only to 101.6%. This difference indicates that future food-security policy should pay greater attention to technological modernization, productivity and innovation in livestock production.

Table 6

Structure of Agricultural Production by Farm Category in Uzbekistan, 2025

Farm category	Agricultural output, billion UZS	Share of total output, %
Dekhkan and subsidiary farms	316,?	62.3
Commercial farms	149,?	29.4
Organizations engaged in agricultural activities	42,?	8.3
Total	**508,711.1**	**100.0**

Source: National Statistics Committee of the Republic of Uzbekistan, Socio-economic situation of the Republic of Uzbekistan, January–December 2025.

Note: The official source reports the structural shares as 62.3%, 29.4% and 8.3%, respectively. The total agricultural output in 2025 amounted to 508,711.1 billion UZS. The structure of agricultural production demonstrates the substantial role of small-scale producers in Uzbekistan's food-security system. Dekhkan and subsidiary farms generated 62.3% of total agricultural output, while commercial farms accounted for 29.4% and organizations engaged in agricultural activities for 8.3%.

This structure has important implications for innovation policy. A food-security strategy based exclusively on large agricultural enterprises would not address the production potential of the largest group of agricultural producers. Consequently, digital agricultural services, modern irrigation systems, improved seeds, agricultural advisory platforms and affordable technological financing should also be designed for dekhkan and subsidiary farms.

From the perspective of the article's research objective, the key issue is therefore not simply how much agricultural output is produced, but which producers generate it and whether they have sufficient access to innovation. Expanding technological access among small producers could create a significant reserve for improving productivity and strengthening the resilience of the national food system.

Table 7

Production of Selected Food-Security-Related Agricultural Products in Uzbekistan, 2025

Product	**Production volume, thousand tons**	**Change compared with 2024, %**
Grain and leguminous crops	10,112.1	113.0
Cotton	—	125.4
Melons	—	116.2
Fruits	—	106.4
Grapes	—	107.6
Eggs	—	107.0

Source: National Statistics Committee of the Republic of Uzbekistan, official 2025 agricultural statistics.

Grain and leguminous crops amounted to 10,112,087 tons, representing a 13% increase over 2024. The annual agricultural report records increases of 25.4% for cotton, 16.2% for melons, 6.4% for fruits, 7.6% for grapes and 7.0% for eggs. Important: I have deliberately left the production-volume cells for cotton, melons, fruits, grapes and eggs blank rather than inserting unverified numbers. The official sources cited here provide their growth rates, while the exact annual volumes require the corresponding SIAT series. This is preferable for a scientific article to using estimated or invented figures.

The data indicate a positive diversification of agricultural output in 2025. Grain and leguminous crop production exceeded 10.1 million tons, increasing by 13% compared with 2024. Particularly high growth was recorded for cotton and melons, while fruits, grapes and eggs also demonstrated positive dynamics.

From the food-security perspective, this growth is important because diversification reduces excessive dependence on a single agricultural product. However, production growth should be accompanied by improvements in storage, processing and logistics. Otherwise, higher output may not translate proportionally into greater food availability for consumers.

The results also support the argument that innovation should cover the entire food-value chain. For example, precision farming can increase production efficiency at the farm level, while cold-storage technologies, digital logistics and modern processing facilities can preserve the economic value of agricultural output after harvesting.

4. Conclusion

The study demonstrates that Uzbekistan has considerable potential to strengthen food security through technological modernization and innovation; however, growth in agricultural production alone cannot ensure sustainable food security, which depends on the interconnected dimensions of food availability, affordability, quality, stability, resource efficiency, and supply-chain resilience. The findings therefore support a gradual transition from a predominantly production-centered approach toward an innovation-integrated food-security model in which agricultural production, processing, storage, logistics, market mechanisms, digital technologies, and resource management function as an interconnected system. To facilitate this transition, it is recommended to develop an integrated food-security indicator system and a unified digital monitoring platform covering production, food stocks, prices, trade flows, logistics, and regional demand; expand precision agriculture through satellite monitoring, sensors, drones, and digital field-management systems; promote smart irrigation and digital water-use monitoring; establish regional food-processing centers equipped with sorting, packaging, refrigeration, storage, and processing facilities; and improve small producers' access to preferential financing, digital advisory services, cooperative mechanisms, and technology-transfer programs. Further priorities include developing integrated agricultural and food-value chains, expanding digital traceability to strengthen food quality and market transparency, introducing climate-smart technologies and drought-resistant varieties, and strengthening cooperation among universities, research institutions, technology companies, and agricultural producers. Overall, the principal conclusion is that food security should be treated as an integrated economic system rather than merely as an indicator of agricultural output, while innovation should become a structural mechanism of long-term food-security policy. The coordinated implementation of these measures can increase productivity and resource efficiency, reduce post-harvest losses and waste, improve market transparency and supply-chain resilience, and contribute to a more stable and sustainable food-security system in Uzbekistan.

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