ANALYSIS OF FOOD SECURITY PROVISION AND THE FACTORS AFFECTING IT IN THE KHOREZM REGION

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Abstract. *This article analyzes the provision of food security in Khorezm region and the complex impact of economic, social, and environmental factors on it. Based on data for the period 2010–2024, an integrated Food Security Index was constructed using indicators such as average household income, food price index, level of water supply, employment rate, environmental condition index, consumption, and production volume of basic food products. The indicators were standardized using the min–max normalization method, and the factors influencing food security were assessed through econometric models. The results of the analysis reveal that household income, water supply, and environmental conditions have a positive impact on food security, while food prices exert a negative effect. The findings of the study have significant scientific and practical importance for developing strategic decisions aimed at strengthening food security in the Khorezm region.*

Keywords: *food security, Khorezm region, economic factors, social factors, environmental conditions, food price index, household income, water supply, employment rate, consumption and production, composite index, econometric analysis.*

Introduction

Under the conditions of current globalization and climate change, ensuring food security has become a priority strategic task for every country. On a global scale, instability in food supply and prices, resource scarcity, economic crises, pandemics, and environmental problems have brought the need for systematic and in-depth scientific analysis in this field to the forefront. Against the background of continuous population growth, income inequality, and increasing demand for food products, the inability of domestic production capacity to fully meet public demand poses a serious threat to food security. The Decree of the President of the Republic of Uzbekistan No. PQ-4477 dated October 4, 2019, "On the Approval of the Strategy for the Transition of the Republic of Uzbekistan to a 'Green' Economy for 2019–2030," defines such priorities as increasing the average productivity and yields of key agricultural food products, effectively implementing drip irrigation technologies, achieving a neutral balance in land degradation, attracting investments into production and processing, and creating value-added chains in agriculture and food industries [1].

In addition, although significant measures have been implemented in the Republic of Uzbekistan to ensure food security, at the regional level—particularly in the Khorezm region—the issue remains increasingly urgent due to rapid population growth, limited arable land, and the deterioration of environmental conditions. While the national average food security index stands at 57.6, lower values observed in some regions indicate insufficient utilization of available resources and territorial imbalances in production.

Literature review

In recent years, the issue of ensuring food security has been widely studied worldwide as one of the most important socio-economic problems. The concept of food security is defined by the Food and Agriculture Organization of the United Nations (FAO) as "the physical and economic availability of sufficient, safe, and nutritious food for all segments of the population at all times" [2]. Based on this approach, scientific studies have extensively highlighted the close interrelationship between food security and economic, social, and environmental factors.

In the studies of foreign scholars, income levels, food prices, agricultural production, climate change, and the efficiency of resource use are identified as the main factors influencing food security. For instance, Walaa Mahrous (2019), using panel data and economic-statistical methods, analyzed the relationship between climate change, agricultural production, and food security, and substantiated that environmental risks have a significant negative impact on food supply [3]. Salvatore Di Falco and co-authors (2011), in turn, examined the dynamic interrelationships between food prices, inflation, and exchange rates using the VAR model and scientifically proved that price stability is a key factor in ensuring food security [4].

Other foreign studies emphasize the importance of public policy, subsidies, digitalization of agriculture, water resource management, and the principles of the "green economy" in ensuring the sustainability of food security [5]. In particular, under conditions of climate change, the efficient use of water and land resources is considered one of the main determinants of food security.

Food security issues have also been widely studied by Uzbek scholars. In particular, A.A. Alimov and Sh.M. Zaynutdinov analyzed agricultural economics and agrarian policy issues and substantiated that food security is directly related to production volumes and the efficiency of resource use [6]. A.G. Gafurov and N.A. Yuldashev presented scientific conclusions on increasing food production, developing the processing industry, and strengthening food security based on regional specialization [7].

Moreover, the studies conducted by X.A. Hakimov, M.M. Yusupov, and A.A. Kholboev examined the impact of household income, food prices, employment levels, and consumption structure on food security using economic and statistical analysis methods [8]. Their research pays special attention to regional self-sufficiency in food supply, the share of imports, and imbalances between domestic production and consumption.

However, the analysis of the existing scientific literature shows that in most studies food security has been approached mainly from the perspective of individual economic or social factors, while the combined and complex interaction of these factors with environmental conditions has not been sufficiently analyzed. In particular, there is a lack of studies devoted to the comprehensive assessment of factors affecting food security at the regional level, especially in the case of the Khorezm region, based on an econometric approach.

Therefore, the purpose of this study is to conduct a comprehensive analysis of the economic, social, and environmental factors affecting food security in the Khorezm region, to assess their interrelationships using econometric models, and to develop practical recommendations for regional development.

Research methodology

This study is aimed at identifying the economic, social, and environmental factors affecting food security in the Khorezm region and assessing their interrelationships using economic-statistical and econometric methods. During the research process, a комплекс approach was applied through

the use of systematic analysis, comparison, grouping, index methods, regression analysis, and normalization techniques.

The initial data for the study were obtained from official sources, including the Statistical Agency of the Republic of Uzbekistan, FAO, the World Bank open databases, as well as the Environmental Protection Department of the Khorezm region. The study period covers the years 2010–2024. The main indicators selected for analysis include average household income, food price index, level of water supply, employment rate, environmental condition index, consumption of basic food products, and volume of food production.

The food price index was calculated using the Laspeyres-type index formula, where base-period prices and quantities were used as weights. The Environmental Condition Index (ECI) was developed in cooperation with the Khorezm Regional Environmental Authority based on expert assessments. The index was evaluated on a scale from 1 to 10 using indicators such as air pollution level, drinking water quality, share of green areas, waste management status, and climate risk, and an integral index was formed based on their average values.

Since the indicators were expressed in different units (thousand UZS, %, kg/year), all variables were transformed into a unified scale ranging from 0 to 100 using the min–max normalization method to ensure comparability. Considering that an increase in the food price index has a negative impact, its normalization was carried out in the inverse direction.

The Food Security Index was calculated as an integrated indicator based on normalized income, water supply, food consumption, and the inversely normalized food price index. This composite index was adopted as the main outcome variable reflecting the overall state of food security in the Khorezm region over time.

During the econometric analysis, the stationarity of all variables was first tested using the Augmented Dickey–Fuller (ADF) test. Subsequently, a multivariate regression model was constructed to assess the factors affecting the Food Security Index. To identify dynamic interrelations and cause-and-effect relationships among the variables, a Vector Autoregression (VAR) model and the Granger causality test were employed.

All calculations and modeling procedures were carried out using EViews, SPSS, and Python software packages. The reliability of the obtained results was evaluated based on the coefficient of determination (R^2), Fisher's F-test, and Student's t-test. Based on the results, scientifically grounded conclusions and practical recommendations for strengthening food security in the Khorezm region were developed.

Analysis and results

The prevalence of undernourishment among the population of the country составляет 2.5%. This indicator suggests that food insufficiency is not a major problem among the population of Uzbekistan. The majority of the population has access to basic food products, and the level of malnutrition remains relatively low. This reflects the relatively effective implementation of state policies in the production, import, and distribution of food products.

Children account for 9.9% of the total population. The high share of children indicates the need to pay special attention to promoting proper nutrition and a healthy lifestyle among the younger generation. The proportion of underweight children is 2.9%. At the same time, the prevalence of obesity in the country amounts to 15.3%, which represents a critical indicator and reflects an insufficient culture of healthy eating, high consumption of sugar- and fat-rich foods, and low levels of physical activity. Considering that food security implies not only the elimination of hunger but

also the provision of healthy nutrition, it is necessary to strengthen measures aimed at combating obesity.

The population growth index of the country is 0.72. A low population growth index may be associated with birth rates, nutritional status, health conditions, and overall living standards. This indicator implies the need to implement additional social and economic measures to maintain demographic stability in the country.

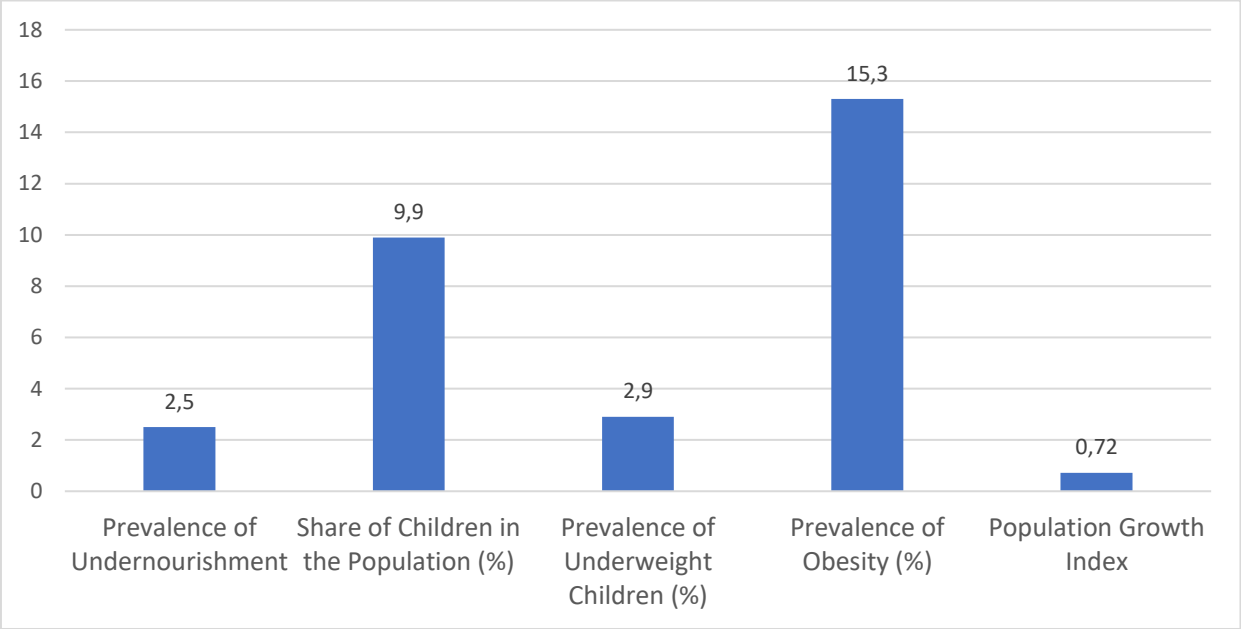

Figure 1. Indicators of Food Security in Uzbekistan (in 2024 y) [9]

Figure 1 demonstrates the relative stability of the food security system in Uzbekistan. Despite the low levels of undernourishment and the proportion of underweight children, the high prevalence of obesity indicates the need to place particular emphasis on the quality aspect of food security. This suggests that ensuring food security requires not only addressing quantitative sufficiency but also improving nutritional quality.

The Global Food Security Index (GFSI) reflects Uzbekistan's position in the international context with regard to food security. Based on the presented indicators, it is possible to identify the country's achievements and weaknesses in this area. The overall score amounts to 57.5 points, placing Uzbekistan 73rd out of 113 countries in the global ranking. This result indicates that Uzbekistan demonstrates a medium level of food security. Although the country has achieved certain progress in this direction, there remains a significant need for further improvement. The efficient use of existing resources, enhancement of production potential, and digitalization of agriculture can contribute to further improving this indicator.

Table 1

Uzbekistan's position in ensuring food security in the global ranking (in 2024) [9]

No.	Indicator	Score	Global Rank
1	Overall Score	57.5	73
2	Affordability	52.7	85
3	Availability	56.4	66
4	Quality and Safety	64.6	64
5	Sustainability and Adaptation	57.9	38

The purpose of this study is to develop an econometric model for ensuring food security in the Khorezm region. To achieve this objective, it is necessary to calculate key indicators such as the consumption of food products, the regional environmental index, household income, and production indicators, as well as to determine the food price index.

The food price index is an indicator that reflects changes in the overall price level of food products. It is usually calculated by statistical organizations (for example, FAO – the Food and Agriculture Organization of the United Nations). The general principles for calculating the food price index are presented below:

$$O'ONI = \frac{\sum(P_t \cdot Q_0)}{\sum(P_0 \cdot Q_o)} \cdot 100 \quad (1)$$

P_t – Prices in the reporting period

P_0 – Prices in the base period

Q_0 – Quantities in the base period (used as weights**)**

The Environmental Condition Index (ECI) is an integrated indicator used to quantitatively assess the ecological (environmental) condition of a specific area or объект. This index takes into account several factors that affect the environment, including air, water, and soil pollution, waste management, green areas, the state of the biosphere, and other related indicators. The use of a scoring scale from 1 to 10 represents a simplified or expert-based assessment approach.

In this study, the research was conducted in cooperation with the Environmental Department of the Khorezm region, and the environmental condition index was formed for each year on the basis of expert evaluations using the data presented in Table 2. The formula for calculating the Environmental Index is given as follows:

$$EHI = \frac{(HS + IS + YH + CHB + IX)}{o} \quad (2)$$

Table 2.

Environmental indicators of the Khorezm region

Indicator Code	Indicator	Evaluation Criteria	Score (1–10)
HS	Air Quality	SO_2, NOx, dust concentration	5
IS	Drinking Water Quality	Microbiological indicators	5
YH	Share of Green Areas	m^2 per capita	4
CHB	Waste Management	Disposed waste, recycling	5
IX	Climate Risk and Its Impact	Temperature change, extreme events	5

These scores are then calculated either as a simple average or as a weighted average:

$$EHI = \frac{(5+5+4+5+5)}{5} = 4,9$$

In our study, since the indicators used to assess food security are expressed in different units (thousand UZS, %, kg/year), they are normalized to a 0–100 scale using the min–max normalization method:

$$\text{Normalized value} = \frac{X_i - X_{min}}{X_{max} - X_{min}} 100 \quad (3)$$

However, since an increase in the food price index has a negative effect, its normalization is performed in the inverse direction:

$$Norm(Price\ Index) = \left(1 - \frac{X_i - X_{min}}{X_{max} - X_{max}}\right) 100 \quad (4)$$

Index formula

$$oziq\ ovqat\ index = \frac{1}{4}\left(N_{daromad} + N_{narx} + N_{istemol} + N_{suv}\right) \quad (5)$$

$$Food\ index = \frac{1}{4}\left(N_{income} + N_{Price} + N_{\text{consumption}}\right)$$

N_{income} -normalised average household income

N_{Price} -inverse normalisation of the food price index

$N_{\text{consumption}}$ -normalised value of food consumption

Table 3.

Indicators of factors influencing food security in the Khorezm region

Year	Average Household Income (thousand UZS)	Food Price Index	Water Supply (%)	Employment Rate (%)	Environmental Condition Index (1–10)	Consumption of Basic Food Products* (kg/year)	Production Volume of Basic Food Products* (kg/year)	Food Security Index (1–100)
2010	2105.3	101.9	63.6	63.2	6.2	445.0	485.0	46.8
2011	2815.8	106.6	63.6	63.0	6.0	450.0	490.0	45.5
2012	3362.8	105.1	63.4	63.9	6.3	455.0	495.0	49.6
2013	4066.0	103.9	62.9	64.2	6.2	457.0	500.0	51.1
2014	4629.1	103.7	63.0	64.8	6.3	462.0	505.0	56.1
2015	5052.2	100.3	58.6	66.3	6.4	465.0	510.0	57.4
2016	5840.3	115.9	42.5	66.5	4.3	470.0	515.0	43.2
2017	7566.2	115.9	41.6	64.6	4.5	472.0	520.0	44.0
2018	9830.1	114.9	42.0	66.0	4.6	475.0	525.0	45.0
2019	11581.7	118.6	40.6	63.7	4.7	478.0	530.0	45.5
2020	12674.0	115.3	40.0	63.5	4.8	480.0	535.0	45.9
2021	16292.2	116.2	40.6	64.0	5.0	485.0	540.0	53.2
2022	20155.2	119.2	61.0	64.7	6.1	490.0	550.0	54.3
2023	20509.2	120.3	62.1	66.9	6.1	495.0	560.0	59.0
2024	23410.8	120.4	63.2	64.5	6.0	500.0	570.0	58.7

Note: Wheat, rice, potatoes, vegetables, and meat from slaughtered cattle.

The data presented in Table 3 reflect the dynamics of the main economic, social, and environmental factors influencing food security in the Khorezm region during 2010–2024. The analysis shows that over this period, the average per capita income increased from 2,105.3 thousand UZS to 23,410.8 thousand UZS, representing an almost elevenfold growth. This trend indicates a significant improvement in the population's purchasing power and economic access to food. In particular, the acceleration of income growth after 2018 had a positive impact on consumption levels and contributed to the relative stabilization of the food security index.

The analysis of the food price index demonstrates that during 2010–2015 prices remained relatively stable within the range of 100–106. However, since 2016 the index increased sharply, reaching 120.4 points by 2024. Such a rise in food prices had a direct negative impact on the food security index, especially during 2016–2020. For instance, in 2016, when the price index rose to 115.9, the food security index dropped from 57.4 to 43.2. This clearly reflects the decisive role of food prices in shaping food security conditions.

The level of water supply was around 62–63% during 2010–2014, but it declined sharply to 40–42% in 2016–2021. At the same time, the environmental condition index decreased from 6.4 to 4.3. These trends confirm that water scarcity and environmental degradation had a significant negative impact on agricultural production and food security. In contrast, during 2022–2024, the recovery of water supply to 61–63% contributed positively to the increase of the food security index to 54.3–58.7 points.

The analysis of the employment rate shows that it remained relatively stable throughout the entire period, fluctuating between 63% and 67%. However, the growth in employment was not always directly proportional to the food security index. For example, during 2016–2018, despite relatively high employment rates, the food security index remained at a low level. This indicates that not only employment, but also income levels, price dynamics, and environmental factors jointly determine food security outcomes.

The environmental condition index ranged between 6.0 and 6.4 points in 2010–2015, but declined to 4.3–4.7 during 2016–2019, indicating a deterioration of the ecological environment. During the same period, the food security index also fell sharply (within the range of 43.2–45.5). With the subsequent improvement of the environmental index to 5.0–6.1 in 2021–2024, the food security index also increased to 53.2–59.0, confirming the strong interdependence between environmental sustainability and food security.

The consumption and production volumes of basic food products showed a steady upward trend over the years. Specifically, consumption increased from 445 kg per year to 500 kg per year, while production rose from 485 kg per year to 570 kg per year. However, despite the growth in both consumption and production, the decline in the food security index in certain years indicates that the negative effects of rising prices and environmental deterioration were sufficient to offset the positive effects of increased production.

Overall, the data in Table 3 scientifically confirm that the level of food security in the Khorezm region is closely interrelated with population income, food prices, water supply, and environmental conditions. In particular, changes in the food price index and the environmental condition index emerge as the most influential factors affecting the food security index. This justifies the conclusion that ensuring price stability, improving water resource management, and enhancing the ecological environment should be prioritized as key policy directions for strengthening food security in the region.

Conclusion

The results of this study demonstrate that ensuring food security in the Khorezm region is a multifactorial, complex, and pressing socio-economic issue that requires a systematic and integrated approach. Based on the conducted analysis, it was scientifically substantiated that there are close interconnections among the main factors directly and indirectly affecting food security in the region, including population income, food prices, water supply level, employment, environmental conditions, consumption of basic food products, and production volumes.

The integral food security index constructed using the min–max normalization method revealed that during 2010–2024 the food security level in the Khorezm region followed an unstable pattern characterized by alternating periods of growth and decline. In particular, increases in population income and improvements in water supply had a positive impact on food security, whereas rising food prices and the deterioration of environmental conditions in certain years exerted a negative influence on this indicator.

Overall, ensuring food security in the Khorezm region is not limited solely to the expansion of agricultural production; it is closely linked with increasing household incomes, maintaining price stability, efficient management of water resources, improving environmental conditions, and developing social infrastructure. The comprehensive econometric approach proposed in this study serves as a reliable scientific basis for assessing and forecasting regional food security and has significant practical relevance for making effective strategic decisions in this sphere.

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