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MODERNIZATION OF THE FRUIT AND VEGETABLE SECTOR: THEORETICAL FRAMEWORKS AND AN INTEGRATED ASSESSMENT MODEL

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ABSTRACT----------
The fruit and vegetable sector is one of the strategically important branches of agriculture, playing a significant role in ensuring food security for the population, supplying raw materials to the agro-industrial complex, and increasing export potential. In modern economic conditions, the sustainable development of this sector requires a scientifically grounded analysis of modernization processes and their comprehensive assessment. The article analyzes theoretical approaches to the modernization of the fruit and vegetable sector and proposes a system of indicators covering technological, agro-ecological, economic, institutional, and innovative factors for assessing the sector. Based on these indicators, a conceptual model for the comprehensive evaluation of sectoral modernization has been developed. The results of the study contribute to a systematic assessment of sector development, more efficient use of resources, and an increase in its competitiveness.

KEYWORDS: *Modernization, Fruit And Vegetable Sector, Agricultural Modernization, Comprehensive Assessment, Indicator System, Innovative Development, Value Chain, Competitiveness----------*

INTRODUCTION

The fruit and vegetable sector is one of the strategic branches of agriculture that generates high value added and plays an important role in providing the population with high-quality food products. This sector has significant economic and social importance in diversifying agricultural production, supplying raw materials to the processing industry, expanding export potential, and increasing the incomes of the rural population. Therefore, in many countries the modernization of the fruit and vegetable sector and the enhancement of its competitiveness are considered among the priority directions of agricultural policy. [5; 9].

In recent years, Uzbekistan has also been implementing comprehensive reforms aimed at the modernization and structural development of the agricultural sector. In particular, the “Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020–2030” identifies innovative development in the agricultural sector, efficient use of resources, development of value chains, and enhancement of export potential as key priority areas [1]. These reforms contribute to expanding the production of fruit and vegetable products, developing the processing industry, and increasing opportunities for access to foreign markets.

The fruit and vegetable sector represents a complex economic system associated with natural and climatic conditions, biological characteristics, technological processes, and market relations. Therefore, the sustainable development of this sector requires a scientifically grounded analysis of modernization processes and their comprehensive assessment. In the scientific literature, modernization is interpreted as a complex transformation process aimed at increasing economic efficiency through technological renewal, institutional reforms, and innovative development [6; 8].

In the theory of agricultural economics, the issue of modernization has been studied by a number of scholars. In particular, Theodore W. Schultz emphasized the importance of human capital and innovative technologies in the modernization of agriculture, while Douglass North substantiated that the institutional environment and economic institutions play a decisive role in modernization processes [6; 8]. National economists have also studied various aspects of agricultural sector modernization, emphasizing that the efficient use of resources and the introduction of innovations are among the key factors of sectoral development [2; 3; 4].

From this perspective, the comprehensive assessment of modernization processes in the fruit and vegetable sector has significant scientific and practical importance. However, existing studies have not sufficiently developed a system of indicators that would allow a comprehensive evaluation of the level of modernization in the fruit and vegetable sector. In practice, modernization is often assessed based on individual indicators, which may not fully

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reflect the actual state of sectoral development. Therefore, there is a need to conduct a comprehensive assessment of modernization processes across technological, agro-ecological, economic, institutional, and innovative dimensions.

The purpose of this study is to analyze theoretical approaches and modern concepts related to the modernization of the fruit and vegetable sector and to develop a conceptual model that enables a comprehensive assessment of the sector.

The object of the research is the development and modernization processes of the fruit and vegetable sector in the Republic of Uzbekistan.

LITERATURE REVIEW

In agricultural economics, modernization processes are considered one of the important directions of economic development theories. In the scientific literature, modernization is interpreted as a complex process associated with production relations, the institutional environment, technological renewal, and socio-economic transformation. From this perspective, the issue of modernizing the fruit and vegetable sector also requires a comprehensive approach in both economic theory and applied research.

The theory of modernization is closely linked with concepts of economic growth. In particular, W. Rostow interprets economic development as a step-by-step process and considers modernization as one of the key stages of economic growth [7]. In addition, T.W. Schultz emphasizes the importance of human capital and innovative technologies in the modernization of agriculture [8].

The institutional aspects of agricultural sector modernization were substantiated by Douglass North, whose theory posits that effective institutions play a decisive role in economic development processes [6]. J. Mellor evaluates the modernization of the agricultural sector as an important driver of economic transformation, linking it to improvements in agricultural production efficiency and increases in rural household incomes [5]. Contemporary studies analyze agricultural sector modernization in connection with innovative development, resource-saving technologies, and the development of market infrastructure.

National economists have also studied various aspects of agricultural sector modernization, emphasizing that the efficient use of resources, the introduction of innovations, and state economic incentive mechanisms play a significant role in the development of the sector.

RESEARCH METHODOLOGY

Assessing the modernization processes in the fruit and vegetable sector requires a multi-factorial analysis, as technological, economic, agro-ecological, institutional, and innovative factors are interconnected within this sector. Therefore, it is appropriate to use a comprehensive approach based on a system of indicators when evaluating sectoral development.

In the scientific literature, methods based on integral indices are widely applied for assessing economic systems, as they allow for the unification of various indicators into a single system, providing an overall assessment of the development level of the object under study [6; 9]. From this perspective, the present study employs a scientific-methodological approach based on an indicator system to evaluate the degree of modernization in the fruit and vegetable sector.

During the research, comparative analysis of scientific literature, economic and statistical analysis, index calculation, grouping and comparison, as well as integral assessment methods were applied. These methods make it possible to analyze sectoral development across different directions and to assess the level of modernization.

To evaluate the modernization of the fruit and vegetable sector, the indicator system was structured around several key areas: technological modernization, agro-ecological sustainability, economic efficiency, institutional environment, innovative development, and export potential. These areas encompass the main components of sectoral modernization (Table 1).

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Table 1. System of indicators for assessing the modernization of the fruit and vegetable industry

Direction	Key Indicators
Technological Modernization	• share of area using modern irrigation technologies, % • level of renewal of agricultural machinery, % • degree of automation of production processes %
Agro-ecological Sustainability	• efficiency of water use (water-saving coefficient) • soil fertility index
Economic Efficiency	• product output profitability, % • gross income per hectare, UZS/ha
Institutional Environment	• share of farms involved in agricultural cooperatives, % • volume of state support provided
Innovative Development	• share of farms using innovative technologies, % • level of application of digital agrotechnologies, %
Export Potential	• share of fruit and vegetable products exported, % • share of products certified according to international standards (GlobalGAP, ISO, etc.), %

Source: Author's compilation.

In selecting the indicators, criteria such as their ability to objectively reflect the development of the sector, the availability of statistical data, and their relevance for economic analysis were taken into account. Based on these indicators, an integral index is calculated to determine the overall level of sector modernization. The integral index allows for a comprehensive assessment of the overall state of modernization processes by combining various indicators [6].

Thus, the proposed methodological approach serves as a basis for the comprehensive assessment of modernization processes in the fruit and vegetable sector and for making scientifically grounded decisions regarding its development. The integral index is calculated based on the normalization and aggregation of indicators and reflects the overall level of sector modernization.

ANALYSIS AND RESULTS

The modernization processes in the fruit and vegetable sector are closely linked to the economic efficiency of the agricultural sector, the level of resource utilization, and export potential.

In recent years, particular attention in our country has been paid to diversifying agriculture and expanding the production of high value-added products. This has stimulated modernization processes in the fruit and vegetable sector through the introduction of innovative technologies, the use of resource-saving agrotechnologies, and the development of value chains.

To assess the overall trends in the development of the fruit and vegetable sector, its main economic indicators were analyzed. In particular, per capita production volumes are considered one of the key indicators of sector development and of ensuring food security (Table 2).

Table 2. Dynamics of Per Capita Fruit and Vegetable Production in Uzbekistan (kg/person)

Indicator Name	Years					2024 compared to 2016, %
	2016	2018	2020	2022	2024	
Fruits and Berries	82,0	82,1	82,9	85,7	87,1	106,2
Vegetables	319,8	296,2	295,5	313,1	322,7	100,9
Potatoes	87,6	88,4	92,7	96,6	100,0	114,2
Grapes	50,7	48,2	47,3	47,6	49,3	97,2

Source: Calculated by the author based on data from the National Committee of the Republic of Uzbekistan on Statistics.

According to the data in the table, during the period 2016–2024, a positive trend has been observed in per capita production of fruit and vegetable products. In particular, fruit and berry production increased from 82.0 kg to 87.1 kg per capita, representing a growth of 6.2%. Potato production also demonstrated a stable growth trend, rising from 87.6 kg to 100 kg per capita.

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Although vegetable production volumes declined in some years, by 2024 they again showed an upward trend, reaching 322.7 kg per capita. Grape production, in turn, exhibited a relatively stable but slow growth dynamic.

The analysis indicates that per capita production of fruit and vegetable products exceeds the medical consumption standards. Specifically, in 2024, per capita fruit production reached 87.1 kg, corresponding to 116% of the recommended medical consumption standard. Vegetable production reached 322.7 kg per capita, which is several times higher than the medical consumption norm. This situation reflects that the country ensures food security for these product categories and has opportunities to further enhance export potential.

Technological factors play a crucial role in assessing the modernization of this sector. In particular, the introduction of modern irrigation technologies, development of intensive horticulture, and renewal of agricultural machinery contribute to increasing production efficiency. Moreover, sector modernization encompasses the development of value chains, improvement of storage and processing infrastructure, as well as the enhancement of logistics and marketing systems.

The processes of modernization in the fruit and vegetable sector can be systematically assessed using the following conceptual model (Figure 1).

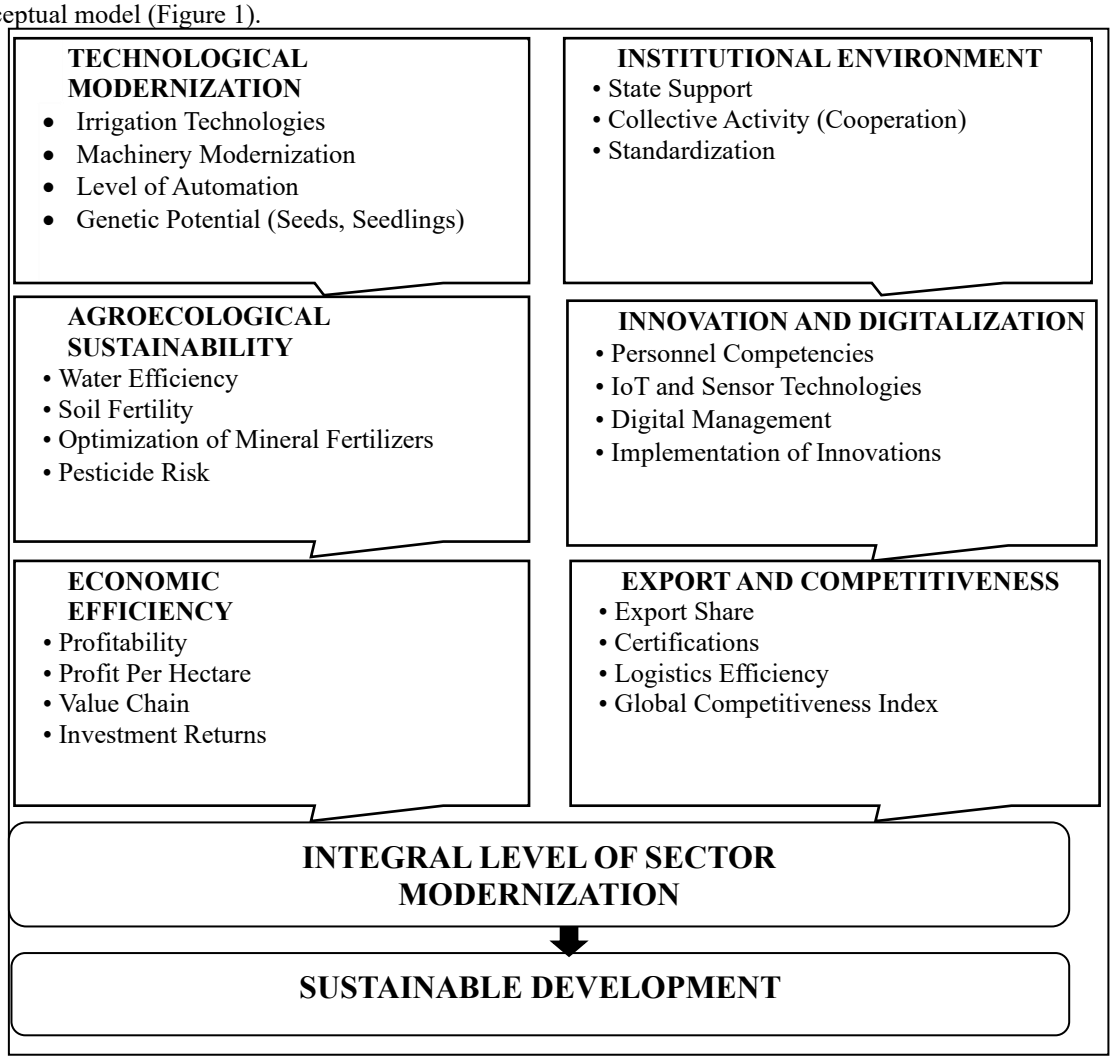

Figure 1. Comprehensive Assessment Model for the modernization of the fruit and vegetable sector.
Source: Author's elaboration.

This conceptual model enables a systematic analysis of the factors influencing sector modernization and an assessment of their interrelationships. The figure illustrates the main factors affecting sector modernization across technological, economic, institutional, innovative, and agroecological dimensions. Technological factors are associated with the introduction of resource-saving irrigation technologies, the development of intensive horticulture, and the use of modern agricultural machinery. Economic factors encompass increasing investment

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activity, expanding the level of product processing, and enhancing export potential. Institutional factors relate to agricultural policy, state support mechanisms, and the development of cooperation and cluster systems.

Thus, the comprehensive assessment model for the modernization of the fruit and vegetable sector provides a tool for systematically analyzing ongoing reforms in the sector and scientifically evaluating its development prospects.

CONCLUSION

The fruit and vegetable sector plays a crucial role in the country's agricultural economy by ensuring food security, increasing employment, and expanding export potential. In recent years, as a result of reforms aimed at modernizing the sector, positive dynamics have been observed in production volumes and yield indicators. In particular, during 2016–2024, per capita fruit production increased by 6.2%, exceeding the recommended medical consumption standards, which indicates a stable food supply in the country and significant opportunities for export expansion.

The development of the sector largely depends on the introduction of resource-saving irrigation technologies, the advancement of intensive horticulture, and the use of modern agricultural machinery. At the same time, the improvement of storage and processing infrastructure, expansion of value chains, and enhancement of market mechanisms contribute to increasing the sector's competitiveness.

Modernization of the fruit and vegetable sector, when implemented through the coordinated development of technological, economic, and institutional factors, promotes sustainable growth and enhances opportunities to generate high value-added in the agricultural sector.

The indicator system and comprehensive assessment model proposed in this study can serve as a methodological basis for systematically evaluating the level of sector modernization and for making informed economic decisions regarding its development.

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