DOI: https://doi.org/10.5281/zenodo.14556646

UDK raqami: 338.43

O‘ZBEKISTONDA QISHLOQ XO‘JALIGIDA TEXNOLOGIK YANGILANISHLARNING IQTISODIY SAMARADORLIGI: SABZAVOT YETISHTIRISH MISOLIDA

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ANNOTATSIYA

Mazkur tadqiqotda O‘zbekistonning qishloq xo‘jaligi sektorida, xususan, sabzavot yetishtirish sohasida texnologik innovatsiyalarning iqtisodiy samaradorligi ko‘rib chiqildi. Zamonaviy dehqonchilik usullari, takomillashtirilgan sug‘orish tizimlari va ilg‘or qishloq xo‘jaligi amaliyotlarini joriy qilish orqali texnologik yangiliklarning mahsuldorlikka, iqtisodiy samaradorlikka va resurslardan foydalanishga ta’siri baholandi. Tadqiqotda keys-stadiyalar va miqdoriy tahlilni birlashtirgan holda samaradorlikni oshirishning asosiy omillari aniqlandi hamda O‘zbekiston qishloq xo‘jaligi sektoriga xos bo‘lgan muammolar, jumladan, moliyalashtirish va infratuzilma bilan bog‘liq cheklovlar ko‘rsatib o‘tildi. Olingan natijalar texnologiyaga asoslangan o‘sishning sabzavot yetishtirishdagi potensialini ta’kidlab, texnologiyalarni joriy qilishni rag‘batlantirish, barqarorlikni ta’minlash va fermerlar daromadlarini oshirish bo‘yicha tavsiyalarni o‘z ichiga oldi. Ushbu tadqiqot texnologik yutuqlar rivojlanayotgan mamlakatlarda qishloq xo‘jaligi rivojlanishini qanday qo‘llab-quvvatlashi mumkinligi haqidagi kengroq tushunchani shakllantirishga hissa qo‘shdi.

Kalit so‘zlar: *iqtisodiy samaradorlik, texnologik modernizatsiya, qishloq xo‘jaligi, O‘zbekiston, sabzavot sektori, mahsuldorlik, innovatsiyalar.*

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Номер УДК: 338.43

ЭКОНОМИЧЕСКАЯ ЭФФЕКТИВНОСТЬ ТЕХНОЛОГИЧЕСКОЙ МОДЕРНИЗАЦИИ СЕЛЬСКОГО ХОЗЯЙСТВА В УЗБЕКИСТАНЕ: НА ПРИМЕРЕ ОВОЩЕВОДСТВА

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АННОТАЦИЯ

В данном исследовании рассматривается экономическая эффективность технологических инноваций в сельскохозяйственном секторе Узбекистана с акцентом на производство овощей. Путем интеграции современных методов земледелия, усовершенствованных систем орошения и передовых сельскохозяйственных практик оценивается влияние технологических нововведений на продуктивность, экономическую эффективность и использование ресурсов. Используя сочетание кейс-исследований и количественного анализа, исследование выделяет ключевые факторы повышения эффективности и определяет проблемы, характерные для сельскохозяйственного сектора Узбекистана, такие как ограниченный доступ к финансированию и инфраструктуре. Полученные результаты подчеркивают потенциал технологически ориентированного роста в производстве овощей, а также содержат рекомендации по стимулированию внедрения технологий, обеспечению устойчивости и увеличению прибыльности фермеров. Данное исследование способствует более глубокому пониманию того, как технологические достижения могут поддерживать развитие сельского хозяйства в развивающихся странах.

Ключевые слова: *экономическая эффективность, технологическая модернизация, сельское хозяйство, Узбекистан, овощной сектор, продуктивность, инновации.*

UDC number: 338.43

ECONOMIC EFFICIENCY OF TECHNOLOGICAL UPGRADING IN AGRICULTURE IN UZBEKISTAN: THE CASE OF VEGETABLES

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ABSTRACT

This research examines the economic efficiency of technological innovation in Uzbekistan agricultural sector, focusing on vegetable production. By integrating modern farming techniques, improved irrigation systems, and advanced farming practices, the research assesses the impact of technological innovations on productivity, economic efficiency, and resource utilization. Using a combination of case studies and quantitative analysis, the study highlights the key drivers of efficiency gains and identifies challenges specific to the Uzbekistan agricultural context, such as limited access to finance and infrastructure. The findings highlight the potential for technology-driven growth in vegetable production, and highlight policy recommendations to increase adoption, ensure sustainability, and increase farmer profitability. This research contributes to a broader understanding of how technological advances can support agricultural development in developing countries.

Keyword: *Economic efficiency, technological upgrading, agriculture, Uzbekistan, vegetable sector, productivity, innovation.*

I. INTRODUCTION

Agriculture has historically been a cornerstone of Uzbekistan's economy, employing a significant portion of the population and contributing substantially to national Growth Domestic Product. As the country undergoes economic and structural reforms, the modernization of the agricultural sector has emerged as a key priority. Among the various subsectors, vegetable farming holds particular importance due to its potential for high value-added production, export opportunities,

and its role in ensuring food security. However, traditional farming practices, resource inefficiencies, and climate vulnerabilities have constrained the sector's performance, highlighting the urgent need for technological upgrading.

Technological advancements in agriculture—such as precision farming, improved irrigation methods, and high-yield crop varieties—have demonstrated transformative impacts worldwide. In the context of Uzbekistan, these innovations are especially relevant given the country’s arid climate, water resource challenges, and the growing demand for sustainable farming practices. The introduction and adoption of advanced technologies can improve productivity, reduce costs, and enhance the economic viability of vegetable farming. Despite these potential benefits, the adoption rate of modern agricultural technologies in Uzbekistan remains uneven, hindered by factors such as limited access to capital, knowledge gaps, and infrastructural constraints.

This research focuses on evaluating the economic efficiency of technological upgrading in Uzbekistan's vegetable farming sector. By analyzing case studies and empirical data, it aims to provide insights into how modern technologies influence production costs, yields, and profitability. The research also identifies barriers to technological adoption and offers policy recommendations to facilitate a transition towards more efficient and sustainable farming practices. Ultimately, this research seeks to contribute to the broader discourse on agricultural modernization in Uzbekistan, underscoring the critical role of technological innovation in driving economic development and food security.

II. LITERATURE REVIEW

Technological upgrading in agriculture is critical for enhancing productivity, profitability, and sustainability in the agricultural sector. In the context of Uzbekistan, the agricultural sector faces several challenges, including outdated farming practices, land fragmentation, and resource constraints, particularly in the vegetable farming sub-sector. This literature review explores the economic efficiency of technological upgrades in Uzbekistan’s agriculture, with a specific focus on vegetables, drawing from key studies and reports.

Abdullaev, Akramkhanov, and Mavlyanov emphasize the importance of integrating value chains in improving agricultural productivity and profitability in Uzbekistan. They argue that enhancing the efficiency of agricultural production requires not only technological advancements but also improvements in the entire value chain—from production to marketing. Value chain integration allows for better coordination among farmers, suppliers, and buyers, which can result in more efficient use of resources and higher market value for crops. For vegetable farming, technological upgrades such as mechanization, improved irrigation techniques, and

better post-harvest handling can significantly reduce costs and improve profitability. The authors suggest that integrating these technologies across the value chain can lead to higher economic efficiency and long-term sustainability in agriculture.[1]

Land fragmentation has been a persistent issue in Uzbekistan's agricultural sector, influencing the adoption and economic efficiency of new technologies. Alimukhamedova, Petrick, and Wandel[2] investigate the relationship between land fragmentation and cultivation costs, finding that fragmented land holdings often result in higher costs of cultivation. Small, fragmented plots increase transaction costs, complicate the adoption of large-scale technologies, and reduce economies of scale. This challenge is particularly relevant for vegetable farming, where space and efficient land use are essential for the successful implementation of modern farming technologies like mechanized harvesters and drip irrigation systems. The study suggests that addressing land fragmentation through policy reforms could help reduce cultivation costs and enhance the adoption of technology, improving the overall economic efficiency of vegetable production.

Khamraeva S. N[3] discusses food security challenges in Uzbekistan, noting that food production efficiency, particularly in the vegetable sector, is a key factor in meeting the growing demand for food. Technological innovations, such as advanced irrigation systems and greenhouses, are essential to increasing vegetable production in a sustainable manner. However, the economic efficiency of these technologies depends on the cost-benefit analysis of their implementation. While innovations can boost productivity, the initial capital investment and operating costs must be justified by the increased yield and profitability. Khamraeva’s research underscores the need for a more effective policy framework to support technological adoption, especially in regions where food insecurity remains a pressing concern.

Khamraeva and Alimova provide a methodological framework for assessing the level of innovative development in agriculture and its supporting infrastructure. Their work highlights that the adoption of innovative agricultural technologies, such as precision farming and advanced irrigation methods, is closely tied to the availability of supportive infrastructure, including training programs, access to finance, and efficient supply chains. For Uzbekistan, their study indicates that while there are advancements in technological adoption, the overall impact on economic efficiency has been uneven due to infrastructural and institutional challenges.

[1] Abdullaev, I., Akramkhanov, A., & Mavlyanov, G. (2019). Enhancing agricultural productivity and profitability through value chain integration in Uzbekistan. Agricultural and Food Economics, 7(1), 1-19.
[2] Alimukhamedova, N., Petrick, M., & Wandel, J. (2018). Does land fragmentation increase the cost of cultivation? Evidence from Uzbekistan. Journal of Agricultural Economics, 69(3), 810-827.
[3] Khamraeva S. N. (2020). Analysis and problematic issues of food security in Uzbekistan. Trans Asian Journal of Marketing & Management Research. 4, 31-35.

Vegetable farming, with its seasonal production cycles and high reliance on water resources, stands to benefit from innovations, but the economic returns depend on addressing these barriers.[1]

Kholmatova and Kamilov explore the development of agribusiness in Uzbekistan, identifying both challenges and opportunities in the sector. They suggest that technological upgrades in agriculture, particularly in areas like vegetable farming, can significantly improve productivity and economic efficiency. However, the adoption of these technologies requires overcoming financial and logistical barriers, including access to credit and the availability of modern machinery. For vegetable farmers, the transition to more advanced technologies, such as automated greenhouse systems and efficient irrigation methods, could lead to substantial improvements in output, yet such transitions often involve significant financial risks.[2]

Muminov, Mukhamedova, and Wandel focus on the interplay between land tenure, land use, and environmental factors in Uzbekistan's irrigated agriculture. Their research highlights that technological upgrades in irrigation systems are crucial for enhancing agricultural productivity in water-scarce regions. However, the economic efficiency of these upgrades is closely tied to secure land tenure, as farmers are more likely to invest in long-term technologies when they have secure rights to their land. For vegetable farming, efficient irrigation technologies, such as drip irrigation, can lead to substantial water savings and increased crop yields, but their implementation depends on the security of land tenure and the institutional framework that supports such investments.[3]

International databases such as FAOSTAT and OECD provide comprehensive data on global agricultural trends, which can offer valuable insights into the potential benefits of technological upgrades in Uzbekistan. These sources highlight that countries with higher levels of technological adoption tend to exhibit better agricultural productivity and economic efficiency. Uzbekistan, as a country heavily reliant on agriculture, could learn from global experiences where technological advancements have led to increased yields, reduced costs, and enhanced food security. However, the country's ability to replicate these successes depends on its specific socio-economic context, including infrastructure, policy support, and institutional capacity.[4]

[1] Khamraeva S. N., Alimova M. Y. (2021). Methodological bases for assessing the level of innovative development of agriculture and its service infrastructure activities. Journal of Contemporary Issues in Business and Government, 2, 4063.

[2] Kholmatova, N., & Kamilov, B. (2018). The development of agribusiness in Uzbekistan: Challenges and opportunities. International Journal of Economics and Financial Issues, 8(4), 160-165.

[3] Muminov, K., Mukhamedova, N., & Wandel, J. (2018). Land tenure, land use, and environment in Uzbekistan: case study of irrigated agriculture in the Khorezm region. Journal of Environmental Planning and Management, 61(11), 1916-1939.

[4] OECD. (2024). OECDSTAT database. Retrieved from https://www.oecd-ilibrary.org/en/#home.

In conclusion, the literature highlights that technological upgrading in Uzbekistan's vegetable agriculture can enhance economic efficiency by improving productivity, reducing costs, and increasing profitability. However, the adoption of new technologies faces several challenges, including land fragmentation, inadequate infrastructure, and financial constraints. Addressing these barriers, alongside strengthening value chain integration, securing land tenure, and providing policy support, could significantly improve the economic efficiency of vegetable farming in Uzbekistan. Future research should continue to explore these issues, focusing on specific technological innovations and their economic impacts on vegetable production in different regions of the country.

III. METHODOLOGY

This research employs both qualitative and quantitative methods to gather data and analyze the factors influencing economic performance in Uzbekistan's vegetable sector. Initially, field interviews were conducted with farmers and other stakeholders to collect information on farming practices, yields, and challenges. The surveys focused on key factors such as productivity, input use, access to credit and markets, and infrastructure issues.

Subsequently, interviews were held with policymakers, agricultural experts, and private sector representatives to gain insights into their views on the sector's challenges and opportunities. These interviews provided valuable perspectives on the policy and institutional factors impacting the horticultural industry, as well as potential strategies for improving its economic performance.

The 14 years of data collected were analyzed using both qualitative and quantitative approaches. Qualitative data from field surveys and interviews were examined through content and thematic analysis to identify key themes and patterns. Quantitative data on crop yields, input use, and other productivity indicators were analyzed using descriptive statistics and econometric models to uncover the factors affecting economic performance in the sector.

Data on total vegetable production from all categories of farms—submitted by farms, mahalla citizen assemblies (dehkan and subsidiary farms), and agricultural organizations—are compiled quarterly and annually. The data are reported in several forms, including Form 1 fx (annual), Form 4 fx (quarterly) "Report on the activities of the farm," Form 4 dx (quarterly) "Report on the activities of dehkan farms and subsidiary farms," Form 1 qx (annual), Form 4 qx (quarterly) "Report on agricultural activities," Appendix to Form 1 kb (qx) (annual) "Report on agricultural activities of micro firms and small enterprises," and Form 4 kb (qx) "Questionnaire on agricultural activities of micro firms and small enterprises." The production data in

these reports are initially expressed in centners and then converted to tons by dividing by 10.[1]

IV. RESULTS AND DISCUSSION

This research will provide key insights into the factors influencing the economic efficiency of vegetable cultivation in Uzbekistan. The qualitative analysis of field surveys and interviews will highlight the main challenges faced by farmers, including limited access to credit and markets, inadequate infrastructure, and slow adoption of modern farming practices and technologies.

The quantitative analysis of data on crop yields, input use, and other productivity indicators will help identify the factors that most significantly affect economic efficiency in the sector. These may include the adoption of modern farming practices and technologies, improved access to credit and markets, and enhancements in infrastructure.

Code	Klassifikator	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1700	Republic of Uzbekistan	6262.4	6828.8	7459.1	8087.9	8753.9	9390	10184	10219.9	9760.3	10215.1	10431.4	10850.2	11162.9	11553.7
1735	Republic of Karakalpakstan	134.2	145.5	166.4	201.6	227.5	241.2	256.3	244.1	253	273.9	286.8	301.5	319.1	333.3
1703	Andijan region	861.7	952.4	1053.9	1166.3	1269.3	1368.6	1473.9	1478.1	1570.9	1596.9	1611.1	1676.4	1730.6	1772.6
1706	Bukhara region	354.8	391.2	438	478.1	520	567.2	659.1	695.5	688.8	729	768.7	831.8	889.5	914.6
1708	Jizzakh region	230.8	258.2	282.2	309	341.1	370.8	393.9	398.5	394.9	424.1	425.3	436.5	454.3	472.9
1710	Kashkadarya region	321.5	362.8	398	434	462.9	491.1	520.4	525.1	495.9	494.8	493.1	496	533.9	559.3
1712	Navoi region	149.1	171.3	184.4	202	215.2	236.8	258.7	265.6	279.2	284.6	291.3	304.4	320.4	335
1714	Namangan region	439.4	488.7	529.5	574.6	622.6	654.6	721.7	765.7	795	811.9	831.9	886	951	989.3
1718	Samarkand region	1049.7	1149.2	1253.4	1350.8	1457.7	1584.4	1767.9	1786.5	1438.9	1584.8	1636.3	1643	1533.7	1576.7
1722	Surkhandarya region	486.4	540.2	632.9	689.8	807	896.5	966.8	1013.4	914	971.9	1013.6	1096.6	1145.6	1169.2
1724	Syrdarya region	182.7	195.7	217.5	247.9	263.8	280	296.7	302.8	270.5	300.9	309.1	323.2	294.2	302.6
1727	Tashkent region	1215	1253	1286.7	1323.5	1352.9	1368.2	1372.1	1238.7	1081.3	1065.7	1038.9	1039.6	1101.5	1154.7
1730	Fergana region	459.4	520.1	578	638.7	712.1	783.1	867.2	874.2	1008.2	1090.4	1128.6	1193.9	1249.9	1319.1
1733	Khorezm region	377.7	400.5	438.2	471.6	501.8	547.5	629.3	631.2	568.8	585.7	596.2	620.5	638.2	653.4
1726	Tashkent city	0	0	0	0	0	0	0	0.5	0.9	0.5	0.5	0.8	1	1

***Table 1**-" Vegetable production – total in all categories of farms"*

[1] Stat.uz/en/official-statistics/agriculture

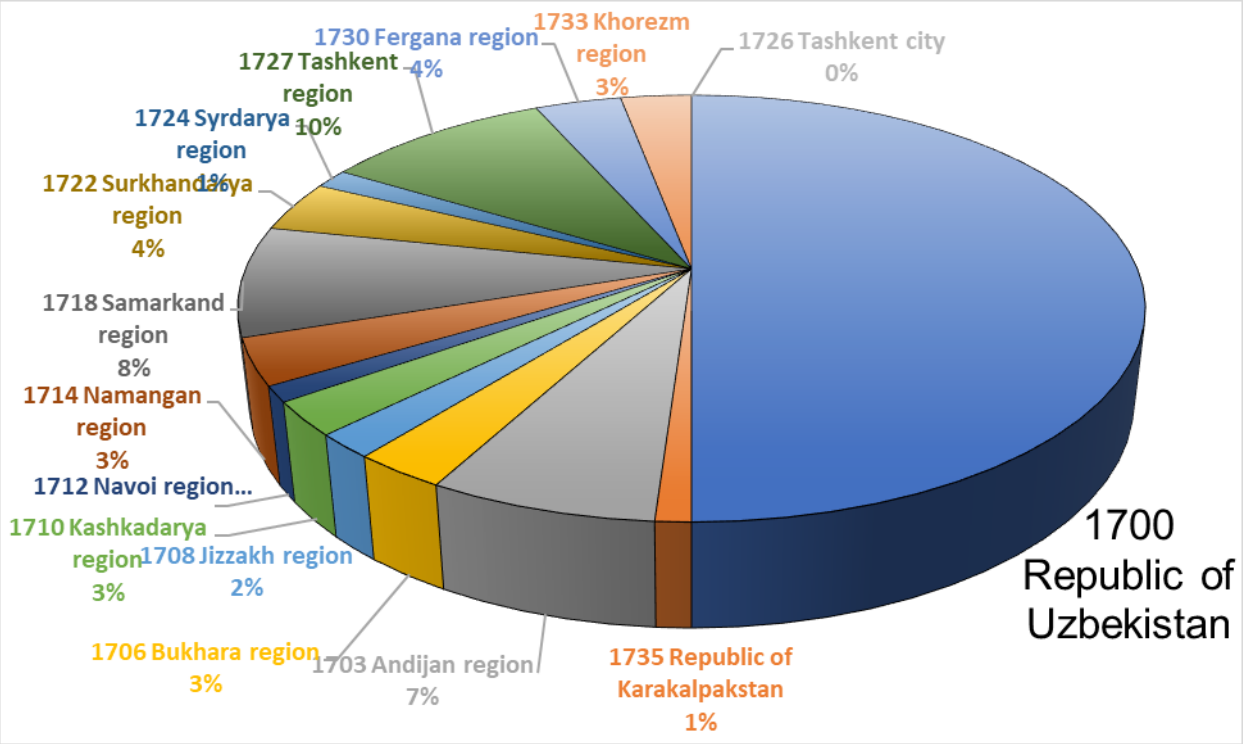

***Figure 1**-" Vegetable production – total in all categories of farms"*

The findings will offer valuable guidance for policymakers and stakeholders in Uzbekistan's vegetable sector. The insights will assist in developing strategies to improve the economic efficiency of the sector, such as expanding access to credit and markets, promoting the adoption of modern farming technologies, and addressing infrastructure deficiencies.

V. CONCLUSION

In the agricultural sector, implementing cluster-based integration to fill the food market has a significant impact on our country's socio-economic development. The formation of such structures leads to solutions for numerous economic and social problems. Specifically, efforts have been made in areas such as the sale of agricultural products, the acquisition of modern, high-performance agricultural machinery, the application of advanced technologies in processing and storage, reducing unemployment in rural areas, increasing income levels, and improving the quality of life for the population. To effectively implement these tasks in the future, especially within fruit and vegetable clusters, a large amount of investment will be required.

To achieve this, it is essential to increase the scale of foreign investments aimed at improving the production, processing, and international standard-compliant final products of agricultural goods for export. The influx of foreign investments will bring new, modern equipment, tools, and technologies to rural areas for fruit and

vegetable processing, thus laying the foundation for the establishment of numerous processing and manufacturing enterprises. This will, in turn, create new job opportunities for workers previously without temporary employment and allow for the production of modern products that meet the demands of the fruit and vegetable industry.

The activities of vegetable clusters will be fully encompassed, as the effectiveness of these operations is crucial. Every participant in this sector contributes to overall efficiency. Enhancing the competitiveness of products produced in vegetable clusters to fill the food market requires implementing several measures. Therefore, it is important to consider the following key product indicators that directly impact harvesting, sorting, market valuation, and the formation of consumer demand:

- The external appearance of vegetable products, their shape, color, ripeness, and any defects resulting from external mechanical impacts;
- The uniformity of vegetable sizes should be given special attention. Observations indicate that the heterogeneity of the product largely depends on whether the vegetables are sorted by uniform size or by larger sizes;
- The consumer suitability of vegetable products is also related to their chemical composition. Therefore, regular checks on the chemical composition of vegetables are necessary, and when deviations from the standards are detected, immediate preventive measures should be taken. Additionally, the specific taste, aroma, appearance, and other similar characteristics of vegetables should be considered.

To increase the production and economic efficiency of vegetable products with the involvement of innovative technologies, the necessary conditions and timely implementation of various agro-technical measures are crucial, which will enable an increase in crop production volumes. Moreover, the economic efficiency of the proposed measures can be assessed. Currently, many clusters have incorporated service-related activities into their operations and are functioning on a lease basis. To achieve efficiency in this process, it is necessary to ensure that sufficient financial resources are provided to lessees.

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