

ECONOSCITECH INTEGRATION

ISSUE
6

INTERNATIONAL SCIENTIFIC
ELECTRONIC JOURNAL



**TASHKENT STATE
UNIVERSITY OF ECONOMICS**



**American University
of Technology**

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ISSN: 3060-5075



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ELECTRONIC JOURNAL
"ECONOSCITECH-INTEGRATION"
HAS BEEN REGISTERED UNDER
THE NUMBER C-5669651 BY THE
AGENCY FOR INFORMATION AND
MASS COMMUNICATIONS (AOKA)
OF THE REPUBLIC OF UZBEKISTAN,
EFFECTIVE FROM OCTOBER 9, 2024.

In accordance with Resolution No. 384/6 dated April 10, 2026, issued by the Presidium of the Supreme Attestation Commission under the Ministry of Higher Education, Science and Innovation of the Republic of Uzbekistan, this journal is included in the list of recommended international scientific publications for publishing the primary research findings of doctoral dissertations in the field of Economic Sciences.

Partners: Tashkent State University of Economics / American University of Technology in Tashkent (AUT)

Electronic publication, Issue 6. 374 pages.
Approved for publication on Iyun, 2026.

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THEORETICAL AND ECONOMIC FOUNDATIONS OF INNOVATIVE TECHNOLOGIES IN THE SUPPLY SYSTEM OF NURSERY FARMS

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Abstract. The development of nursery farming plays a crucial role in ensuring sustainable agricultural production, environmental protection, and food security. In modern agricultural systems, nursery farms require efficient and well-integrated supply systems that provide high-quality planting materials, advanced technological resources, reliable input supplies, and effective logistics support. The introduction of innovative technologies into the supply chains of nursery farms contributes to higher productivity, lower production and transaction costs, improved quality control, and stronger competitiveness of nursery enterprises.

This article examines the theoretical and economic foundations of applying innovative technologies in the supply systems of nursery farms. It analyzes the key factors influencing the adoption of innovations, including technological readiness, investment capacity, institutional support, digital infrastructure, and access to modern logistics services. Particular attention is paid to digital technologies, automation, precision agriculture, smart monitoring systems, and modern logistics solutions that enhance the sustainability, efficiency, and profitability of nursery production. The findings suggest that modernizing nursery farm supply systems through innovative technologies can serve as an important mechanism for improving agricultural productivity, strengthening horticultural value chains, and enhancing the long-term competitiveness of the agricultural sector.

Keywords: nursery farms, innovative technologies, supply system, economic efficiency, digitalization, precision agriculture, logistics, sustainable development, horticulture, agricultural modernization.

Аннотация. Развитие питомниководства играет важную роль в обеспечении устойчивого сельскохозяйственного производства, охраны окружающей среды и продовольственной безопасности. В современных аграрных системах питомниководческие хозяйства нуждаются в эффективных и интегрированных системах снабжения, способных обеспечивать высококачественный посадочный материал, современные технологические ресурсы, надежное обеспечение производственными ресурсами и эффективную логистическую поддержку. Внедрение инновационных технологий в цепочки снабжения питомниководческих хозяйств способствует повышению производительности, снижению производственных и транзакционных издержек, совершенствованию контроля качества, а также укреплению конкурентоспособности питомниководческих предприятий.

В данной статье рассматриваются теоретические и экономические основы применения инновационных технологий в системах снабжения питомниководческих хозяйств. Анализируются ключевые факторы, влияющие на внедрение инноваций, включая технологическую готовность, инвестиционный потенциал, институциональную поддержку, цифровую инфраструктуру и доступ к современным логистическим услугам. Особое внимание уделяется цифровым технологиям, автоматизации, точному земледелию, интеллектуальным системам мониторинга и современным логистическим решениям, которые повышают устойчивость, эффективность и рентабельность питомниководческого производства. Полученные выводы показывают, что модернизация систем снабжения питомниководческих хозяйств на основе инновационных технологий может выступать важным механизмом повышения продуктивности сельского хозяйства, укрепления цепочек добавленной стоимости в садоводстве и роста долгосрочной конкурентоспособности аграрного сектора.

Ключевые слова: питомниководческие хозяйства, инновационные технологии, система снабжения, экономическая эффективность, цифровизация, точное земледелие, логистика, устойчивое развитие, садоводство, модернизация сельского хозяйства.

INTRODUCTION

In recent decades, global agricultural development has increasingly depended on technological progress and innovation. As agricultural markets become more competitive and consumer demand for high-quality products continues to grow, nursery farms face new challenges related to production efficiency, resource management, and supply chain optimization. Nursery farms play a critical role in providing planting materials for horticulture, forestry, landscaping, and environmental restoration projects. Consequently, the effectiveness of their supply systems directly influences the productivity and sustainability of broader agricultural sectors.

Traditional supply systems in nursery farming are often characterized by inefficient resource allocation, limited access to real-time information, inadequate inventory control, and significant transportation costs. These challenges can negatively affect the quality of seedlings and planting materials, increase production expenses, and reduce the competitiveness of nursery enterprises. Under such conditions, the adoption of innovative technologies becomes an essential mechanism for improving the efficiency and sustainability of supply operations.

The development and modernization of nursery farms in Uzbekistan are closely linked to the implementation of national agricultural and innovation policies. In recent years, the Government of the Republic of Uzbekistan has adopted a number of strategic and regulatory documents aimed at increasing agricultural productivity, strengthening food security, promoting export-oriented horticulture, and introducing innovative technologies into agricultural production systems.

A key policy document is Presidential Decree No. PF-5853¹ of October 23, 2019, “On Approval of the Strategy for Agricultural Development of the Republic of Uzbekistan for 2020–2030,” which defines the priorities of agricultural modernization, digital transformation, efficient resource management, value chain development, and expansion of export potential. The strategy emphasizes the introduction of innovative technologies, modernization of agricultural infrastructure, and improvement of logistics systems throughout the agri-food sector.

In addition, the implementation of the Agricultural Development Strategy is supported by Resolution No. PQ-4575², which establishes practical measures for achieving the objectives of agricultural reform and improving the competitiveness of agricultural enterprises. Particular attention is paid to increasing labor productivity, improving product quality, and creating high-value-added agricultural products.

The development of nursery farms is also influenced by the Concept for the Development of Organic Agriculture, approved by Presidential Decree No. PF-5995³ of May 18, 2020, which promotes environmentally friendly agricultural production and the use of certified planting materials. Furthermore, the Concept for the Development of the Water Sector of the Republic of Uzbekistan for 2020–2030, approved by Presidential Decree No. PF-6024⁴, creates favorable conditions for the introduction of water-saving technologies, including modern irrigation systems widely used in nursery farming.

An important role is also played by the Development Strategy of New Uzbekistan for 2022–2026 and the “Uzbekistan — 2030” Strategy, which prioritize innovation, digitalization, sustainable economic growth, and the modernization of agriculture through advanced technologies and scientific achievements. These policy documents encourage the adoption of precision agriculture, digital supply chain management, smart logistics, and innovative approaches to resource utilization.

Therefore, the existing regulatory framework of Uzbekistan provides a favorable institutional environment for the introduction of innovative technologies into nursery farm supply systems. The strategic objectives established by national development programs create opportunities to increase the efficiency, sustainability, and competitiveness of nursery enterprises, thereby contributing to the long-term development of the horticultural sector and the national economy as a whole.

The theoretical foundations of innovation in agriculture are rooted in the works of economists who emphasized the role of technological advancement as a key driver of economic growth. Innovation is generally understood as the implementation of new technologies, processes, organizational methods, and management practices that improve productivity and create additional value. In nursery farming, innovation involves integrating advanced technological solutions into production and supply processes to achieve greater economic and environmental efficiency.

1 <https://lex.uz/docs/-4567334>

2 <https://lex.uz/uz/docs/-4714632>

3 <https://lex.uz/docs/-4815923>

4 <https://lex.uz/uz/docs/-4892953>

LITERATURE REVIEW

The introduction of innovations into agricultural production and supply systems constitutes an important field of scholarly inquiry from the perspectives of economic development, competitiveness, efficient resource utilization, and export potential. The theoretical foundations of this subject are primarily associated with Joseph A. Schumpeter's theory of innovation-driven development. Schumpeter viewed innovation as an internal driving force of economic progress and defined it as the implementation of "new combinations." According to his approach, the introduction of new products, technologies, markets, sources of raw materials, or forms of industrial organization enables enterprises to increase productivity and gain sustainable competitive advantages⁵. From this perspective, innovation in agriculture should be understood not merely as the adoption of new technologies, but as a comprehensive mechanism for modernizing production, storage, processing, logistics, and market access.

Michael E. Porter identifies innovation as a fundamental determinant of competitive advantage. According to his value chain concept, an enterprise's competitiveness depends on the efficiency of interconnected activities, including production, inbound and outbound logistics, marketing, sales, customer service, technology development, and procurement⁶. Applied to agricultural supply systems, Porter's framework demonstrates that innovation creates added value throughout the entire production chain—from seed production and nursery farming to cultivation, sorting, storage, packaging, certification, and distribution to domestic and international markets.

The diffusion of innovations among producers is comprehensively explained by Everett M. Rogers' Diffusion of Innovations Theory. Rogers argues that the adoption of new technologies depends on their relative advantage, compatibility with existing practices and needs, complexity, trialability, and observability⁷. This theory is particularly relevant to agriculture, where farmers, agro-clusters, and nursery farms tend to adopt innovative technologies only when they offer clear economic benefits, institutional support, financial accessibility, and demonstrable practical outcomes.

From the perspective of supply chain and logistics management, the work of Martin Christopher is especially significant. Christopher views the supply chain as a strategic system integrating markets, distribution networks, production processes, and procurement activities. He emphasizes that effective logistics and supply chain management reduce operational costs while simultaneously increasing customer value⁸. This approach provides a strong theoretical basis for integrating digital monitoring systems, cold-chain logistics, warehouse management, export documentation, and quality assurance into agricultural supply systems.

The contribution of agricultural innovations to production efficiency has also been extensively examined by international organizations. According to the Food and Agriculture Organization of the United Nations (FAO), digitalization, automation, and precision agriculture technologies can substantially improve production efficiency, product quality, and environmental sustainability. However, their widespread adoption is often constrained by high investment costs, limited digital competencies, inadequate infrastructure, and institutional barriers⁹. Similarly, the Organisation for Economic Co-operation and Development (OECD) emphasizes that innovation and digital transformation strengthen resource efficiency, productivity, environmental sustainability, and market accessibility within agricultural systems¹⁰. The World Bank's studies on horticulture in Uzbekistan further demonstrate that innovative agrotechnologies, greenhouse production systems, and improved value chain infrastructure can significantly increase both agricultural productivity and farmers' incomes¹¹.

Uzbek scholars have also made important contributions to the study of agricultural modernization, the adoption of innovative technologies, and the development of agro-clusters and nursery farming systems. B. Mirzaev and his co-authors emphasize that technical modernization, improved machinery supply, and the efficient application of mechanization are essential prerequisites for increasing agricultural productivity in Uzbekistan¹². According to their approach, agricultural innovation extends beyond the acquisition of modern machinery to include scientifically based land management, water-saving technologies, energy-efficient practices, and the optimization of production processes.

5 Schumpeter, J. A. *The Theory of Economic Development*. Cambridge, MA: Harvard University Press, 1934; Schumpeter, J. A. *Capitalism, Socialism and Democracy*. New York: Harper & Brothers, 1942.

6 Porter, M. E. *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: Free Press, 1985.

7 Rogers, E. M. *Diffusion of Innovations*. 5th ed. New York: Free Press, 2003.

8 Christopher, M. *Logistics and Supply Chain Management*. 6th ed. London: Pearson / FT Publishing International, 2022.

9 FAO. *Leveraging Automation and Digitalization for Precision Agriculture: Evidence from the Case Studies*. FAO Agricultural Development Economics Technical Study No. 24. Rome: Food and Agriculture Organization of the United Nations, 2022.

10 OECD. *Innovation and Digitalization in Agriculture*. Paris: Organization for Economic Co-operation and Development, 2026.

11 World Bank. *From Root to Fruit: Growing the Horticulture Sector in Uzbekistan*. Washington, DC: World Bank, 2025.

12 Amonov, M. O., Steward, B. L., Mirzaev, B. S., & Mamatov, F. M. "Agricultural Development and Machinery Usage in Uzbekistan." ASABE Annual International Meeting, 2021.

M.Q. Rasulov analyzes the economic, environmental, and social effectiveness of innovative technologies in agriculture. He argues that modern technologies contribute significantly to increasing productivity, improving resource efficiency, and reducing manual labor¹³. This perspective confirms the multidimensional character of agricultural innovation, which simultaneously enhances economic efficiency, environmental sustainability, and social welfare.

Sh.Sh. Fayzieva, in her research on the fruit and vegetable sector and export development, substantiates the necessity of improving the legal and institutional foundations of agricultural production, strengthening cluster and cooperative mechanisms, and enhancing processing, storage, packaging, and quality management systems in accordance with international market requirements¹⁴. Her studies demonstrate that the competitiveness of fruit and vegetable products depends not only on production volume but also on product quality, logistics efficiency, standardization, investment, and the capacity to meet the requirements of international markets.

K. Shavazov and his co-authors specifically examine the role of innovation in the sustainable development of farms and the strengthening of food security. Their research demonstrates that innovative technologies are fundamental to improving farm productivity, competitiveness, and financial sustainability¹⁵. The authors identify drip irrigation, precision agriculture, greenhouse technologies, modern livestock production systems, improved access to finance, and effective government support mechanisms as key components of an innovative agricultural ecosystem.

Local and institutional studies on nursery farming indicate that high-quality seedlings and planting materials are strategic factors determining horticultural productivity, product quality, disease resistance, and export potential. In Uzbekistan, the development of intensive horticulture, in vitro laboratories, virus-free planting materials, resource-efficient irrigation technologies, and “farm-to-table” value chain mechanisms is recognized as one of the priority directions of state agricultural policy¹⁶. Consequently, the modernization of nursery farm supply systems through improvements in planting material quality, logistics, certification, agrotechnical services, digital management, and market integration represents an important scientific and practical priority for the sustainable development of the horticultural sector.

Overall, the analysis of both international and domestic literature demonstrates that the successful introduction of innovations into agricultural production and supply systems requires the effective integration of technological, organizational, institutional, and market-related factors. Schumpeter identifies innovation as the primary driver of economic development; Porter explains its role in creating competitive advantage through the value chain; Rogers clarifies the mechanisms governing technology adoption; and Christopher emphasizes the importance of supply chain integration and logistics efficiency. Uzbek scholars complement these theoretical perspectives by adapting them to the practical realities of the national agricultural sector, including farms, fruit and vegetable exports, agro-clusters, and nursery farming. Therefore, the development of innovative supply systems for nursery farms should be regarded as a strategic direction for modernizing horticulture, increasing export potential, and strengthening the long-term competitiveness of Uzbekistan’s agricultural sector.

RESEARCH METHODOLOGY

The present study employs a qualitative analytical approach based on the examination of theoretical concepts and practical applications of innovative technologies in nursery farm supply systems. The research methodology includes a comprehensive review of scientific publications, reports of international agricultural organizations, and contemporary studies focusing on agricultural innovation, supply chain management, digital transformation, and sustainable development.

Comparative analysis was used to evaluate the economic effects of traditional and innovative supply systems, while a systems approach was applied to examine the interactions among suppliers, producers, logistics operators, and consumers within nursery farm supply chains.

Particular attention was paid to analyzing modern technological solutions, including digital information platforms, Internet of Things technologies, automation systems, precision agriculture tools, artificial intelligence applications, and blockchain-based traceability systems. Economic indicators such as production costs, labor

13 Rasulov M.Q. Qishloq xo'jaligida innovatsion texnikalarni qo'llanishdagi samaradorligini o'rganish // Экономика и социум. 2025. №7-1 (134). URL: <https://cyberleninka.ru/article/n/qishloq-xojaligida-innovatsion-texnikalarni-qollanishdagi-samaradorligini-organish> (дата обращения: 23.06.2026).

14 Fayzieva, Sh. Sh. “Potential and Efficiency of Fruit and Vegetable Export in Uzbekistan.” *Economics and Society*, No. 12(127), 2024; Fayzieva, Sh. Sh. “Economic Mechanisms and Possibilities of Supporting and Strengthening Fruit and Vegetable Growing in Uzbekistan.” *Economics and Society*, 2025.

15 Shavazov, K., Khojibekova, Sh., Mukimov, B., Umirov, A., & Kadirova, Sh. “State and Development of Farms in Uzbekistan as a Basis for Food Security.” *BIO Web of Conferences*, 2025.

16 Agency for the Development of the Agro-Industrial Complex under the Ministry of Agriculture of the Republic of Uzbekistan. “About the Agency”; World Bank. *From Root to Fruit: Growing the Horticulture Sector in Uzbekistan*. Washington, DC: World Bank, 2025.

productivity, resource efficiency, operational risks, and return on investment were considered to evaluate the effectiveness of innovation implementation.

ANALYSIS AND RESULTS

Agriculture remains one of the leading sectors of Uzbekistan's economy. According to official statistics, agriculture, forestry, and fisheries accounted for approximately 18.2–18.9% of national GDP in 2024–2025, demonstrating the sector's significant contribution to economic development.

The importance of horticulture and nursery farming has increased considerably due to the rapid growth of fruit and vegetable production and exports. In 2024, Uzbekistan exported more than 500 thousand tons of fruits and vegetables worth approximately USD 300 million during the first quarter alone, representing growth of more than 43% compared with the same period of the previous year.

According to national and international statistical sources, Uzbekistan produced approximately 16 million tons of vegetables, 5 million tons of fruits, and 4 million tons of potatoes in 2024. These indicators demonstrate substantial demand for high-quality seedlings and planting materials supplied by nursery farms. Furthermore, fruit and vegetable exports reached 722.1 thousand tons during the first five months of 2024, generating export revenues exceeding USD 420 million. Export volumes increased by more than 10% compared with the corresponding period of 2023 (Figure 1).

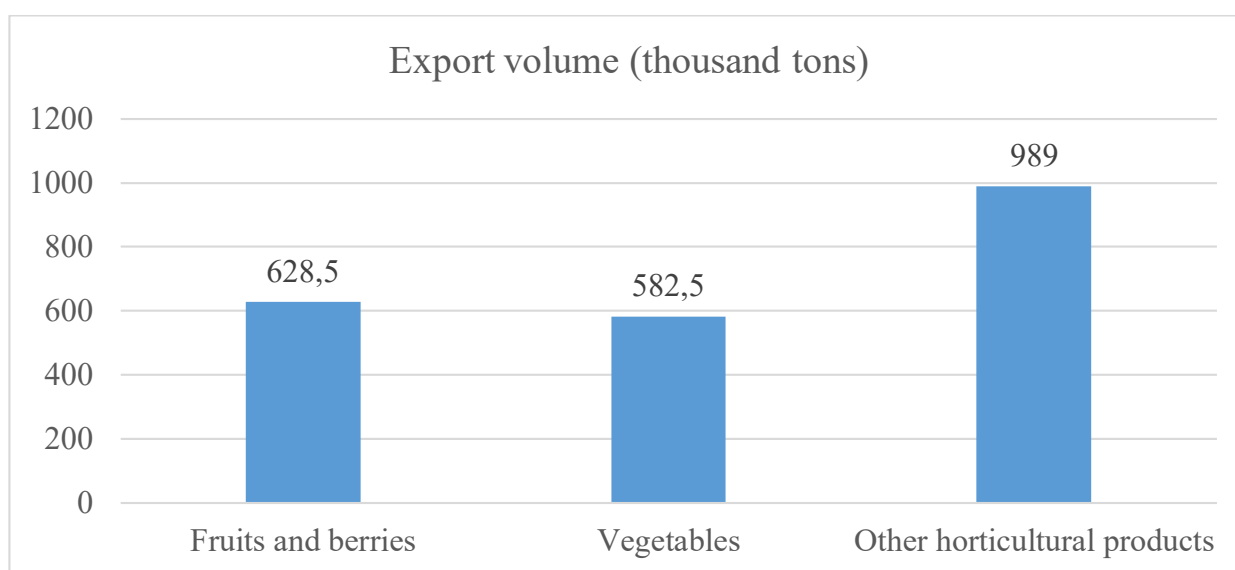


Figure 1. Structure of fruit and vegetable exports of Uzbekistan in 2025 (thousand tons)¹⁷

According to the National Statistics Committee of the Republic of Uzbekistan, in 2025 the country exported approximately 2.2 million tons of fruit and vegetable products worth USD 2.1 billion. Fruit and vegetable exports accounted for 6.3% of the total national export volume. The largest share of exports was represented by fruits and berries, amounting to 628.5 thousand tons, followed by vegetables, with 582.5 thousand tons. The remaining export volume consisted of melons, legumes, nuts, and other horticultural products.

The growth of export-oriented horticulture increases demand for high-quality planting materials and highlights the strategic importance of innovative technologies in nursery farm supply systems. Modern nursery enterprises contribute to export growth through the production of certified seedlings, the introduction of precision agriculture technologies, and the implementation of digital logistics solutions.

The expansion of export-oriented horticulture requires the development of efficient nursery farm supply systems. Modern nursery farms increasingly utilize innovative technologies such as automated irrigation systems, greenhouse climate control technologies, sensor-based monitoring systems, geographic information systems, and digital supply chain platforms.

The World Bank reports that modernization programs in Uzbekistan's horticulture sector have contributed to increased productivity, higher crop yields, and the creation of more than 60,000 jobs in agriculture and food distribution. Economic analysis indicates that the implementation of innovative technologies within nursery farm supply systems generates several positive outcomes.

¹⁷ author's development

First, digital inventory management systems reduce losses associated with poor storage and transportation conditions. Second, precision agriculture technologies improve water and fertilizer use efficiency, which is particularly important in the arid regions of Uzbekistan. Third, automated production systems reduce labor costs and increase productivity. Finally, modern logistics and traceability technologies improve product quality and strengthen export competitiveness.

The findings suggest that innovative technologies should be considered a strategic factor in the sustainable development of nursery farming in Uzbekistan. Given the growing demand for high-quality planting materials and the expansion of fruit and vegetable exports, investments in digitalization, automation, and smart logistics are expected to generate substantial economic benefits for both producers and the national economy.

CONCLUSION AND RECOMMENDATIONS

The study demonstrates that innovative technologies play a crucial role in improving the efficiency and sustainability of nursery farm supply systems in Uzbekistan. Theoretical analysis confirms that innovation serves as a key driver of economic growth, competitiveness, and resource optimization in agricultural production. The integration of digital technologies, automation systems, precision agriculture tools, and modern logistics solutions contributes to increased productivity, reduced operational costs, improved product quality, and more efficient management of material and information flows.

The analysis of Uzbekistan's horticultural sector indicates growing demand for high-quality planting materials due to the expansion of fruit and vegetable production and exports. In 2025, Uzbekistan exported approximately 2.2 million tons of fruit and vegetable products valued at more than USD 2.1 billion, highlighting the strategic importance of nursery farms in supporting export-oriented agricultural development. Under these conditions, the modernization of nursery farm supply systems becomes an essential prerequisite for ensuring stable production growth and strengthening the country's position in international agricultural markets.

The findings suggest that the implementation of innovative technologies enables nursery enterprises to increase resource efficiency, reduce production risks, and improve supply chain transparency. Furthermore, digital transformation supports better decision-making and facilitates the adoption of sustainable agricultural practices. Despite existing challenges, including high investment costs and the need for qualified personnel, the long-term economic benefits of innovation significantly outweigh the associated implementation expenses.

Therefore, the further development of nursery farming in Uzbekistan should be based on expanding digital infrastructure, increasing investment in technological modernization, strengthening cooperation between research institutions and agricultural enterprises, and introducing effective government support mechanisms. The successful implementation of these measures will contribute to the sustainable development of nursery farms, improve the competitiveness of the horticultural sector, and support the achievement of national agricultural development objectives.

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Proofreader: Xondamir Ismoilov
Layout and Designer: Hasan Maqsudov

2026. № 6

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