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THE ECONOMIC SIGNIFICANCE OF APPLYING INNOVATIVE TECHNOLOGIES IN BERRY FRUIT PRODUCTION

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Abstract

This article analyzes the role of innovative technologies in increasing berry fruit production, reducing production costs, and enhancing export potential in the agricultural sector. The study examines the impact of hydroponics, vertical farming, digital monitoring, in vitro propagation, and innovations in the logistics chain on economic efficiency indicators. Based on the findings, scientific and practical recommendations are proposed for the further development of the sector.

Introduction

In the context of global climate change, water scarcity, and the continuous reduction of fertile agricultural land, ensuring the population's access to safe and high-quality food products has become one of the top priorities of modern agricultural policy [1]. In particular, the global and domestic demand for berry fruits such as strawberries, raspberries, currants, blueberries, and other fruits rich in vitamins, antioxidants, and essential micronutrients is increasing rapidly. Berry fruits are considered high-value cash crops that provide substantial economic returns per unit of cultivated land [2].

However, meeting this growing demand through traditional open-field farming methods is becoming increasingly challenging [3]. Dependence on seasonal conditions, significant post-harvest losses during harvesting and storage (sometimes reaching 30–40%), and the negative effects of environmental factors reduce the economic efficiency of the sector and limit its investment attractiveness. Under such conditions, the transition of the agro-industrial complex from an extensive development model to an intensive and innovation-driven model has become an objective necessity [4].

Methodology

Improving the economic efficiency of berry fruit production requires not only increasing total yield but also integrating innovative solutions throughout every stage of the production cycle—from the laboratory production of virus-free seedlings to cultivation using smart resource-saving technologies, as well as modern packaging, freezing technologies, and the digitalization of logistics chains.

The purpose of this study is to conduct a systematic analysis of advanced innovative methods applied in berry fruit production, evaluate their economic effects in terms of resource conservation and production cost reduction, and develop scientific and practical recommendations for the wider adoption of these technologies within the national agricultural sector.

Results

The conducted analyses and monitoring of agricultural enterprises indicate that the application of innovative technologies in berry fruit production significantly improves production performance [5]. The economic and agronomic outcomes achieved through the implementation of key technological innovations are systematically presented below.

Table 1. Comparative Economic Indicators of Traditional and Innovative Technologies in Berry Fruit Production (per hectare)

Analysis Criteria and Economic Indicators	**Traditional Open-Field Method**	**Innovative Method (Hydroponics + Smart Fertigation)**	**Efficiency and Economic Impact**
Initial Capital Expenditure (CapEx)	Low ($5,000–$7,000)	High ($25,000–$40,000)	Initial investment is 5–6 times higher when implementing innovative technologies.
Seasonal Operating Costs (OpEx)	High ($4,000–$5,000)	Low ($2,000–$2,500)	Operating costs are reduced by up to 50% through automation.
Average Yield (per season)	12–15 tons	45–60 tons	Productivity increases by 3–4 times due to vertical density and year-round cultivation.
Water Use Efficiency	100% (conventional high consumption)	15–20%	More than 80% of water is saved through a closed recirculation system.
Mineral Fertilizer and Nutrient Use	Bulk application (high wastage)	Precision dosing (micro-level accuracy)	Fertilizer costs decrease by 55% through drip fertigation systems.
Labor Requirements	High (continuous manual labor)	Minimal (automated operations)	Labor costs are reduced by up to 40% through smart technologies.
Crop Loss Rate	20–30% (weather-related losses)	3–5% (controlled environment)	Significant reduction in post-production losses.
Export Quality of Products	40–50% (non-uniform size and quality)	90–95% (uniform and standardized)	In vitro seedlings improve product quality and marketability by approximately two times.
Selling Price through IQF Freezing	Sold at low seasonal prices	Sold during winter and spring seasons	Selling prices are 250–300% higher than seasonal market prices.
Gross Profitability Level	20–25%	65–75%	Net profit margins are on average 45–50% higher than those of traditional methods.
Investment Payback Period	3–4 years	1.5–2 years	Higher yields allow rapid recovery of capital investments.

As can be seen from the table data, although the initial investment (CapEx) in the innovative approach is higher, in the long-term perspective it reduces operating expenses (OpEx) by two times. Most importantly, a 300–400% increase in yield and improved product quality accelerate the project's payback period by twice compared to the traditional method and ensure the sustainability of agribusiness [6][7].

1. Productivity indicators of vertical and hydroponic systems

According to the research results, the average yield of strawberry plantations grown in traditional open-field conditions was 12–15 tons per hectare, whereas in a multi-layer hydroponic (vertical farming) system this figure reached 45–60 tons per hectare [8].

Discussion

This result was achieved due to the following factors:

Vertical density: The land-use efficiency coefficient increased by approximately 3.8 times.

- Extension of the vegetation period: Due to climate control in a closed ecosystem (artificial lighting and temperature regulation), it became possible to harvest 3–4 times per year [9][10].

2. Resource efficiency and cost analysis

When an automated fertigation and sensor-based feeding system was implemented, significant cost savings were observed in expenditure structure:

- Water resources: Water consumption decreased by 82% compared to traditional irrigation methods.
- Fertilizers and agrochemicals: Due to the elimination of nutrient leaching through soil, mineral fertilizer usage decreased by 55%.
- Labor costs: Full automation of irrigation, spraying, and feeding processes reduced the wage fund by up to 40%.

As a result of these savings, the initial production cost decreased by 28% compared to the traditional method [11].

3. Biological and economic effect of in-vitro seedlings

When studying the field adaptation of laboratory-cloned (in-vitro) raspberry and currant seedlings, the following positive results were recorded:

- Due to increased resistance to weeds and diseases, phytosanitary protection costs decreased by 65%.
- The uniform ripening rate of the harvest reached 92% (in traditional seedlings this figure does not exceed 60–65%). This reduced the harvesting period by 12 days and increased labor productivity [12].

4. Commercial effect of IQF (Individual Quick Freezing) and MAP packaging

During the post-harvest processing stage, the application of innovative IQF technology reduced product loss from 22% to 3.5%.

The most significant economic result was observed in price differentiation:

- During the season (May–June), fresh berries in the domestic market were directed to the freezing chain when wholesale prices were low [13].
- In the autumn–winter season, these IQF products were sold to processors and export markets at a value 260–300% higher than seasonal prices. This increased the company's gross profit margin by 2.5 times [14][15].

Conclusion

Researching innovative ways to improve the economic efficiency of berry production and analyzing the obtained results allows us to draw the following key conceptual conclusions regarding the modernization of the agricultural sector:

First, the transition from extensive farming methods (simply expanding land area) to intensive-innovative approaches is the only way to ensure the sustainability of agribusiness under global climate change and resource scarcity. Hydroponics and vertical farming technologies have practically proven that it is possible to maximize the use of limited land and water resources (increasing land efficiency by 3–4 times and water savings by up to 80%).

Second, innovation not only increases productivity but also optimizes the cost structure (labor, mineral fertilizers, phytosanitary inputs) that forms production costs. Due to the synergistic effect of digital monitoring (Smart Farming) and in-vitro propagation, production costs are reduced by nearly one-third, significantly increasing the competitiveness of national products in foreign markets.

Third, the "cultivation" stage is only one part of the economic chain in berry production. The real high value-added and high profitability are created through the implementation of post-harvest innovative technologies (IQF quick freezing and MAP packaging). These technologies break seasonal limitations and allow entrepreneurs to control market price conditions independently.

Practical Recommendations

Based on the research results, the following measures are recommended to systematically improve the economic efficiency of berry production in the national agro-industrial sector:

1. Financial incentives and “green loans”: Since the initial capital costs (CapEx) of hydroponic systems, vertical farms, and automated fertigation systems are high, it is necessary to expand long-term (7–10 years), low-interest preferential loans and subsidies for farmers.
2. Development of local biotechnology centers: To replace expensive imported elite seedlings, it is recommended to expand a network of in-vitro laboratories in the country through public–private partnerships. This will reduce import costs and enable the development of regionally adapted varieties.
3. Agro-logistics clusters: To prevent post-harvest losses among small farmers, regional logistics cooperatives should be established with centralized IQF (quick freezing) facilities and modern cold storage infrastructure.
4. Certification and digital traceability: To increase export potential, blockchain-based digital tracking systems should be introduced, and partial state reimbursement of certification costs for international standards such as GlobalG.A.P. and Organic should be implemented.

In conclusion, the systematic integration of innovative solutions into berry production scenarios transforms the agricultural sector into one of the most profitable and stable drivers of national economic growth and foreign currency inflow.

REFERENCES

[1] Republic of Uzbekistan, "Decree of the President of the Republic of Uzbekistan 'On the Development Strategy of New Uzbekistan for 2022–2026' No. PF–60 dated January 28, 2022," Tashkent, Uzbekistan, Target 30, 2022.

[2] Republic of Uzbekistan, "Decree of the President of the Republic of Uzbekistan 'On the Strategy of Actions for Further Development of the Republic of Uzbekistan' No. PF–4947 dated February 7, 2017," Collection of Legislative Acts of the Republic of Uzbekistan, no. 6, art. 70, 2017.

[3] R. Saliyev, "Methodological basis of the study of production costs on farms and their optimization directions," International Bulletin of Applied Science and Technology, vol. 5, no. 1, pp. 198–201, Jan. 2025. doi: 10.5281/zenodo.14724889.

[4] R. Soliyev and S. Yuldasheva, "Theoretical and methodological principles of increasing economic efficiency in cotton raw material production," International Bulletin of Engineering and Technology, vol. 4, no. 6, pp. 86–90, Jun. 2024. doi: 10.5281/zenodo.11665591.

[5] R. R. Soliyev, "Methodological foundations for studying production costs in farms and directions for their optimization," Science and Education in Agriculture, Higher Attestation Commission Presidium Resolution No. 347, Dec. 29, 2023. Accessed: Jun. 17, 2026. [Online]. Available: https://oak.uz/pages/4802

[6] Republic of Uzbekistan, "Decree of the President of the Republic of Uzbekistan 'On the Strategy "Uzbekistan-2030"' No. PF–158 dated September 11, 2023," Tashkent, Uzbekistan, 2023.

[7] A. Khasanov, "Modern trends in the digitalization of the agricultural sector in Uzbekistan," Journal of Agricultural Economics, vol. 12, no. 3, pp. 45–52, Mar. 2024.

[8] Sh. Mustafakulov, "Methodological approaches to assessing the investment attractiveness of agricultural regions," Uzbekistan Economic Magazine, no. 2, pp. 89–96, 2023.

[9] B. Berkinov and U. Ortizov, Economic Efficiency of Small and Medium Enterprises in Agriculture. Tashkent, Uzbekistan: Fan va Texnologiya, 2022.

[10] N. Ergashev, "Optimization of cost management systems in cotton-textile clusters," International Journal of Agronomy and Sustainable Development, vol. 6, no. 2, pp. 112–118, May 2024.

[11] T. Farmonov, Development of Dehkan and Farm Economies: Problems and Solutions. Tashkent, Uzbekistan: Yangi Asr Avlodi, 2021.

[12] K. Olimov, "The role of innovations in resource-saving technologies in agricultural production," Science and Innovation International Scientific Journal, vol. 3, no. A4, pp. 204–210, Apr. 2024.

[13] M. Ikramov, "Financial and credit mechanisms for stimulating agricultural producers in Uzbekistan," Finance and Banking Journal, no. 1, pp. 34–41, 2025.

[14] Ministry of Agriculture of the Republic of Uzbekistan, "Annual report on agricultural sustainability and farming development," Tashkent, Uzbekistan, Tech. Rep., 2024.

[15] I. Rustamov, "Analytical review of production costs and profitability in grain farming," Central Asian Journal of Theoretical and Applied Sciences, vol. 5, no. 8, pp. 15–22, Aug. 2024.