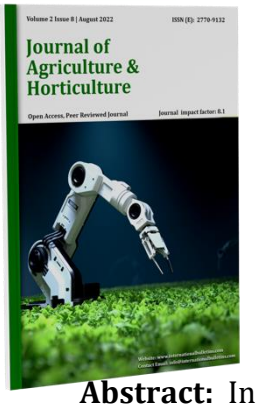

TECHNOLOGIES AND ECONOMIC EFFICIENCY IN SMART AGRICULTURE

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Abstract: In developing countries, modern technologies, artificial intelligence, smart drones, and the development of big data systems are aimed at automating and optimizing agricultural processes. These approaches are increasingly being proven through scientific and practical evidence. The economic efficiency of smart agriculture technologies, including their impact on resource savings, productivity enhancement, and farmer incomes, is being studied. Research results indicate that the use of drones for the precise application of pesticides and fertilizers has reduced costs and created favorable conditions for plant growth. However, the high initial costs of implementing smart agricultural technologies and the lack of technical knowledge among farmers remain key challenges. Smart agriculture technologies play an important role in modernizing agriculture and increasing economic efficiency. Government support is crucial for the widespread implementation and development of smart agricultural technologies, as state-provided incentives can promote adoption in the private sector as well.

Keywords: Smart agriculture, economic efficiency, increasing productivity, farmer income, artificial intelligence, drones, big data systems.

Introduction.

As climate risks to agriculture increase, the global agricultural community forecasts that to meet current food demand, agricultural productivity must increase by 60% [1]. In response, the international agricultural community supports innovative approaches adapted to climate change to ensure long-term food security and agricultural sustainability [2][3][4]. Practices of Energy Smart Agriculture (ESA), such as laser land leveling, precision planting, and nutrient and irrigation management, are at the forefront. Energy-based agriculture takes into account reduced diesel fuel usage, less labor time, and slower equipment depreciation. All of this contributes to reducing energy consumption in various agricultural operations, particularly land preparation and machinery production processes [5]. Today, alongside economic development, environmental issues are also intensifying. According to the World Economic Forum, over the past decade, global climate change and environmental pollution have had a significant impact on economic losses [6]. Each year, climate change causes approximately $1.5 trillion in economic losses globally [7]. Additionally, the United Nations Environment Programme (UNEP) reports that by using natural resources efficiently and reducing waste, up to $7 trillion in annual economic benefits could be achieved worldwide [8]. Green economy is gaining global attention as an alternative economic model aimed at addressing these issues and ensuring sustainable development. For instance, countries like Germany and Sweden have successfully integrated economic stability with environmental protection by transitioning to renewable energy sources. In Uzbekistan, the Strategy for Transition to a Green Economy for 2019–2030 has been adopted, with active efforts underway to develop renewable energy sources [9]. The modern agrarian revolution

envisions the introduction of advanced information technologies that reduce manual labor and costs while increasing efficiency. Achieving targeted indicators requires transitioning to a modern smart agriculture system based on knowledge and intelligence, including digitalization processes utilizing information and communication technologies. This can only be achieved by fostering the application of knowledge and innovations [10].

Research Methodology:

The methodological foundation for the digitization of agriculture involves the practical implementation of innovative technologies, the development of agriculture-related education, and the enhancement of scientific research activities through a comprehensive approach. In this process, agricultural higher education institutions play a crucial role in disseminating innovations and ensuring their application across regions. The study utilized economic, comparative, and statistical analysis methods. Theoretical foundations were based on decrees and resolutions of the President of the Republic of Uzbekistan related to the sector, as well as legal and regulatory documents on agricultural management. Taking into account the rapid development of information and communication technologies, recommendations were developed based on modern management principles and concepts. The study widely applied process-oriented approaches, comparative analysis, system analysis and synthesis, induction, and deduction methods. Due to the rapid global development of digital technologies, recent years have seen increased attention in Uzbekistan to the improvement of digital economy and agricultural management systems. In particular, developing "Smart Agriculture" technologies has been defined as a strategic direction to ensure effective use of land, water, material-technical, and labor resources in agriculture. To systematically implement this process, the Cabinet of Ministers of the Republic of Uzbekistan adopted Resolution No. 794 on December 17, 2020, "On measures to develop the digitization system in the agro-industrial complex and agriculture of the Republic of Uzbekistan" [11]. This resolution approved the strategy for developing "Smart Agriculture" technologies and an action plan for 2021–2023. It also outlined directions for developing agricultural and food product statistics and implementing modern information systems. Within the framework of agricultural digitization, the state institution "Center for Agricultural Digitization" has implemented several innovative developments. For example, the "Electronic Accounting and Real-Time Monitoring of Mechanization Services" information system for agricultural machinery has been developed and implemented. Currently, over 3,500 agricultural machines are monitored online via GPS systems. More than 200 "Smart Water" devices have been installed to automate water resource management, and the system is continuously monitored. The transformation of the agricultural management system is being carried out in two main directions: first, the digitization of agricultural production, and second, the digitization of the sector's management system. These two directions are interconnected, and their effective implementation facilitates the application of advanced technologies in agriculture and improves the quality of management processes. Today, analyses in agricultural management are being conducted based on the rapid development of information and communication technologies, and interconnected functional models are being developed. These models and strategies aim to foster innovative development in agriculture and further improve the digitalization processes.

Analysis and Results.

The positions we hold in global development rankings clearly indicate the tasks and opportunities ahead for our country. In particular, the Global Innovation Index (GII) is one of the leading international studies assessing innovative development. Since 2007, it has been developed by Cornell University, the INSEAD Business School, and the World Intellectual Property Organization. The index consists of 80 indicators grouped into 7 pillars and 21 sub-categories. In the current year's Global Innovation Index, Uzbekistan ranked 83rd out of 133 countries. Our country has been listed among the nations that have achieved high efficiency in innovation relative to their level of national economic development. Among lower-middle-income countries, Uzbekistan ranked 10th out of 38 countries, and 4th in the Central and South Asia region. In the sub-index on innovation inputs, which assesses available resources and conditions for implementing innovations, our country ranked 71st, while in the innovation outputs sub-index, which evaluates the results achieved in implementing innovations, it held the 91st position. At the same time, significant improvements were observed in the infrastructure (+3) and business development (+7) categories. Out of the 78 indicators included in the GII, 40 indicators showed improvement compared to the previous year, 13 indicators remained unchanged, and 23 indicators declined. Additionally, Uzbekistan achieved high results in several areas: entrepreneurial policy and culture (4th place), gross capital formation (7th place), labor productivity growth (7th place), graduates in science and engineering (12th place), utility models (14th place), and financing of startups and scaleups (19th place). For the first time, Uzbekistan participated in the international Global Entrepreneurship Monitor survey and was ranked 4th globally. The UK-based Brand Finance company studied the country’s top-valued brands, and “UzTelecom” was included in the list of the world’s top 5000 brands. Furthermore, the digital ecosystem “Uzum” achieved unicorn status. Studies on venture financing were also conducted in our country, and for the first time, data on transactions involving venture capital were reflected in the ranking report. The volume of funds allocated to research and development increased, with Uzbekistan rising by five positions in the relevant indicator.

Conclusion:

In conclusion, it should be noted that the development of digitalization processes in agriculture is closely linked to the introduction of innovations into the sector, the modernization of the education system, and the creation of a scientific research environment. Within the framework of the Presidential Decree of the Republic of Uzbekistan dated October 5, 2020, on the approval of the "Digital Uzbekistan – 2030" Strategy [12], extensive efforts are being made to digitalize the agricultural sector. This strategy is aimed at transforming the agricultural management system, developing electronic public services, and increasing efficiency. The results of the study show that the development and gradual implementation of the integrated "Digital Agriculture" platform will optimize production processes, increase economic efficiency, and widely apply innovative solutions in agriculture through public-private partnerships. Overall, the successful implementation of digitalization processes in agriculture contributes to increased production efficiency, economical use of resources, and the improvement of public services. Therefore, the consistent implementation of measures for the introduction of advanced technologies and the development of information and communication technologies in the sector is of critical importance.

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