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THE ROLE OF THE INTERNET AND DIGITAL TECHNOLOGIES IN AGRICULTURE

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Abstract: In the context of rapid digital transformation, the Internet and digital technologies are becoming increasingly important in the agricultural sector. These technologies offer significant opportunities to improve agricultural productivity, optimize the use of land and water resources, reduce production costs, and enhance farm management. This article examines the role of Internet-based services, precision agriculture, remote sensing, the Internet of Things (IoT), artificial intelligence (AI), and geographic information systems (GIS) in modern agricultural production. Particular attention is paid to the efficient management of water resources, the economic benefits of digitalization, and the challenges associated with the adoption of digital technologies in rural areas. The article also discusses prospects for advancing digital agriculture in Uzbekistan. It concludes that the effective integration of digital technologies, supported by appropriate infrastructure, digital literacy, reliable data, and institutional cooperation, can contribute to sustainable agricultural development and improved food security.

Keywords: agriculture, Internet, digital technologies, digital agriculture, precision farming, artificial intelligence, Internet of Things, remote sensing, water management, agricultural productivity, Uzbekistan.

Introduction: In the era of globalization and the digital economy, information and communication technologies are playing an increasingly significant role in all sectors of society, including agriculture. Ensuring food security, increasing agricultural productivity, using natural resources efficiently, and improving production processes are among the major priorities of modern agricultural development. In this context, the Internet and digital technologies provide valuable opportunities to address emerging challenges and improve the efficiency of agricultural production. Traditional farming practices often rely on farmers' experience, observations, and established methods of cultivation. Although practical experience remains essential, digital technologies enable farmers to make more informed decisions based on data concerning soil conditions, moisture levels, weather patterns, crop development, and pest outbreaks. Consequently, digital solutions can support more accurate planning, timely interventions, and more efficient agricultural management. The integration of digital technologies into agriculture is therefore not merely a technological improvement; it is also an important step towards developing a more productive, resource-efficient, and sustainable agricultural sector.

The Importance of the Internet in Agriculture: The Internet facilitates the rapid exchange of information among farmers, agronomists, researchers, agricultural enterprises, suppliers, and consumers. Through online platforms, farmers can access weather forecasts, agricultural guidelines, market prices, information about seeds and fertilizers, and recommendations on crop cultivation and livestock management. For example, before planting crops, farmers can examine local weather forecasts, temperature patterns, and expected precipitation to determine appropriate planting schedules. Access to market information also enables agricultural producers to compare prices, identify potential buyers, and make better-informed decisions regarding the timing and marketing of their products. Furthermore, Internet-based services facilitate access to electronic government services, online training

programmes, agricultural consultations, and digital marketplaces. These services can reduce administrative burdens, save time, and improve communication between farmers and relevant institutions. However, the benefits of Internet access depend on the availability of reliable connectivity, relevant information, and the ability of agricultural producers to use digital resources effectively.

Digital Technologies and Smart Agriculture: The development of digital technologies has contributed to the emergence of smart agriculture, an approach that uses digital tools, connected devices, and data analysis to monitor and improve agricultural production. Several technologies are particularly important in this context.

Sensors and the Internet of Things: The Internet of Things (IoT) refers to a network of interconnected devices that collect and exchange data. In agriculture, IoT-enabled sensors can measure soil moisture, temperature, humidity, and other environmental conditions. These measurements provide farmers with timely information about field conditions and crop requirements. When integrated with irrigation systems, sensors can support more precise water application and help prevent unnecessary irrigation. Similarly, environmental monitoring systems can improve the management of greenhouses, livestock facilities, and storage facilities.

Satellite Imagery and Unmanned Aerial Vehicles: Satellite imagery and unmanned aerial vehicles, commonly known as drones, are increasingly used to monitor agricultural land and assess crop conditions. These technologies can help identify areas affected by water stress, uneven crop development, or potential disease outbreaks. Remote sensing also enables the observation of large agricultural areas without requiring continuous on-site inspections. When combined with field measurements and other reliable data, satellite imagery can support crop monitoring, land assessment, and agricultural planning.

Artificial Intelligence: Artificial intelligence can be applied to agricultural data analysis, crop monitoring, yield forecasting, and the identification of potential plant diseases. Machine-learning models can analyse information obtained from sensors, satellite imagery, weather services, and historical agricultural records. These applications may help farmers identify emerging problems and evaluate alternative management strategies. Nevertheless, the accuracy of AI-based recommendations depends on data quality, appropriate model development, local environmental conditions, and expert validation.

Geographic Information Systems: Geographic information systems (GIS) enable the collection, integration, analysis, and visualization of geographically referenced data. In agriculture, GIS can be used to map soil characteristics, agricultural boundaries, irrigation infrastructure, crop distribution, and land-use patterns. Such systems support spatial planning, the identification of areas requiring intervention, and the more efficient management of agricultural resources. Integrating GIS with satellite imagery and field observations can provide a more comprehensive understanding of agricultural conditions. Collectively, these technologies contribute to the development of data-driven farming systems in which decisions are increasingly based on measurable field conditions rather than uniform management practices.

The Role of Digital Technologies in Efficient Water Management: In Uzbekistan, the efficient use of water resources is a particularly important agricultural priority. Irrigated agriculture plays a significant role in agricultural production, while water availability and distribution can affect crop yields, production costs, and rural livelihoods. Digital technologies offer practical tools for monitoring water consumption, assessing soil moisture, and improving irrigation management. For example, soil-moisture sensors can help determine when irrigation is necessary, while automated irrigation systems can regulate water application

according to predefined parameters and field conditions. Satellite observations and digital maps can also support the assessment of crop water requirements, the monitoring of irrigated areas, and the identification of potential water stress. When combined with suitable irrigation infrastructure and sound agricultural practices, these tools can contribute to more efficient water use. However, the adoption of digital irrigation technologies alone does not guarantee water savings. Their effectiveness depends on the accuracy of measurements, the design and maintenance of irrigation systems, farmers' technical skills, and the wider management of water resources. Therefore, integrating digital monitoring with efficient irrigation methods and appropriate water-management policies is essential for sustainable agriculture, particularly in water-scarce regions.

The Economic Benefits of Agricultural Digitalization: Digital technologies can improve the economic performance of agricultural enterprises by supporting better resource allocation, reducing avoidable costs, and improving operational planning. Precision agriculture, for instance, enables farmers to apply fertilizers and other agricultural inputs according to variations in soil properties and crop requirements. Instead of applying the same quantity of fertilizer across an entire field, farmers can use field-specific data to adjust application rates where appropriate. This approach may reduce unnecessary input use, improve nutrient management, and limit the environmental impacts of excessive fertilizer application. Digital platforms can also improve access to agricultural markets by connecting producers with buyers, providing information about market prices, and facilitating product distribution. These services may help farmers identify market opportunities, plan sales, and strengthen their competitiveness. In addition, digital record-keeping and farm-management software can support financial planning, inventory management, production monitoring, and the evaluation of farm performance. Nevertheless, digitalization involves initial investment costs, equipment maintenance, software expenses, connectivity requirements, and staff training. For

small-scale farmers, these costs may represent significant barriers. Consequently, the economic feasibility of each technology should be evaluated in relation to farm size, production type, local conditions, and expected benefits.

Challenges in the Digital Transformation of Agriculture: Despite its considerable potential, agricultural digitalization faces several technical, economic, and institutional challenges. First, reliable Internet connectivity is not equally available in all rural areas. Limited broadband coverage, unstable connections, and inadequate electricity infrastructure can restrict the effective use of digital agricultural services. Second, the cost of sensors, drones, specialized software, and automated equipment may prevent small and medium-sized farms from adopting advanced technologies. Access to financing, technical support, and affordable digital solutions is therefore important. Third, digital literacy remains a significant consideration. Farmers and agricultural specialists need appropriate training to interpret digital information, operate technological equipment, and evaluate the reliability of automated recommendations. Data-related issues also require attention. Inaccurate measurements, incompatible information systems, inadequate data protection, and limited access to locally relevant agricultural datasets can reduce the effectiveness of digital solutions. Addressing these challenges requires investment in rural digital infrastructure, practical training programmes, affordable technology, and cooperation among farmers, universities, research institutions, technology providers, and public authorities. In addition, digital services should be designed to accommodate local languages, agricultural practices, and the technical capabilities of their intended users.

Prospects for Digital Agriculture in Uzbekistan: Uzbekistan has considerable opportunities to expand the use of digital technologies across crop production, horticulture, livestock farming, and agricultural supply chains. One important direction is the development of digital land-management systems,

including the mapping of agricultural areas and the integration of information about soil conditions, irrigation infrastructure, and crop distribution. Such systems can improve agricultural planning and facilitate more informed resource management. Another priority is the expansion of digital water-management solutions. Electronic water measurement, remote monitoring, soil-moisture sensors, and automated irrigation systems could support more efficient irrigation practices when implemented under appropriate technical and institutional conditions.

Digital livestock identification, electronic agricultural marketplaces, product traceability systems, and farm-management applications also offer opportunities to improve productivity and transparency throughout agricultural value chains. Furthermore, mobile applications and online advisory services could help disseminate research findings, weather information, and agronomic recommendations to farmers. Cooperation between universities, agricultural research centres, technology companies, and farming enterprises would be particularly valuable in adapting digital solutions to Uzbekistan's climatic and agricultural conditions. Successful digital transformation, however, requires more than purchasing modern equipment. It should involve the development of digital skills, reliable data infrastructure, effective technical support, and policies that encourage practical innovation. Priority should be given to solutions that are economically feasible, environmentally responsible, and accessible to farmers with different levels of resources.

Conclusion: The Internet and digital technologies are important instruments for modernizing agriculture and improving the efficiency of agricultural production. Through digital information services, precision farming, remote sensing, IoT-enabled devices, artificial intelligence, and geographic information systems, agricultural producers can improve field monitoring, optimize resource use, and make more informed management decisions. These technologies are particularly

relevant in regions where water scarcity, climate variability, and growing food demand create increasing pressure on agricultural systems. In Uzbekistan, the effective adoption of digital agricultural solutions could support more efficient water management, stronger farm competitiveness, improved production planning, and greater resilience to environmental challenges. However, the benefits of digitalization depend on several interconnected factors, including reliable Internet access, appropriate infrastructure, high-quality data, technical training, and the affordability of digital solutions. Therefore, a comprehensive approach is needed to ensure that technological innovation translates into practical and sustainable improvements in agricultural performance. In conclusion, integrating digital technologies into agricultural production should be regarded as a strategic component of sustainable agricultural development. By combining technological innovation with scientific research, farmer education, and effective resource management, Uzbekistan can strengthen its agricultural productivity, protect natural resources, and contribute to long-term food security.

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