

THE DIGITAL ECONOMIC TRANSFORMATION OF AGRICULTURE IN UZBEKISTAN: A REVIEW OF CURRENT RESEARCH

Tulaboyev A.Q., Ablatdinov S.A., Xudoyorova M.M.

Tashkent State University of Economics

ABSTRACT

The agricultural sector is a cornerstone of Uzbekistan's economy, facing challenges such as low productivity, inefficient water use, and vulnerability to climate change. Digital transformation, encompassing technologies like precision farming, IoT, Big Data, AI, and remote sensing, is increasingly recognized as crucial for modernizing the sector, improving productivity, ensuring food security, and promoting sustainable development. This paper reviews scholarly articles and reports analyzing the digital economic transformation in Uzbekistan's agriculture, evaluating the current state of digitalization, government initiatives, implemented technologies, key drivers, prevailing challenges, and potential impacts. Synthesizing diverse perspectives from the sources, it identifies recurring themes such as the strategic importance of government support, the promising potential of specific technologies like remote sensing and drones, and significant barriers including inadequate infrastructure, low digital literacy, and financial constraints for smallholders. While research highlights positive outcomes like increased yields and resource efficiency in pilot projects, it also reveals gaps, particularly in comprehensive quantitative impact assessments and detailed analyses of socio-economic implications. The review underscores the need for sustained, coordinated efforts across policy, infrastructure, education, and finance to realize the full potential of digital agriculture in Uzbekistan and ensure equitable benefits for all stakeholders.

THE DIGITAL ECONOMIC TRANSFORMATION OF AGRICULTURE IN UZBEKISTAN: A REVIEW OF CURRENT RESEARCH, KEY THEMES, AND IMPACTS

The agricultural sector has historically been, and continues to be, a pivotal component of the Republic of Uzbekistan's economy, contributing significantly to both its gross domestic product (GDP) and employment (Ashurov & Khakmirzaev, 2023). However, like many developing nations, Uzbekistan's agriculture grapples with challenges including the need to enhance productivity, improve the efficiency of water resource utilization, and build resilience against the impacts of a changing climate (Ashurov & Khakmirzaev, 2023). In recent years, there has been a growing acknowledgment by the Uzbek government of the transformative potential of digital technologies to address these issues, revolutionize agricultural practices, and ensure national food security (Food and Agriculture Organization of the United Nations, 2023a). This paper aims to provide a comprehensive review and synthesis of scholarly sources and relevant reports concerning the digital economic transformation currently underway within Uzbekistan's agricultural sector. It evaluates the existing research, identifies key themes, highlights research gaps, discusses emerging trends, and provides insights into the anticipated impacts of these technological shifts on agricultural development in the country.

Current State of Digitalization and Government Initiatives

The digitalization of agriculture in Uzbekistan is characterized as being in its early stages, despite a decade of gradual modernization in the sector overall (Ashurov & Khakmirzaev, 2023). Basic digital tools such as mobile phones and computers are widely used by farmers, but the adoption of more advanced technologies, including precision agriculture tools and Internet of Things (IoT) devices, remains limited (Utemuratova, 2025). Nevertheless, positive signs of progress are evident, such as increasing use of geographic information systems (GIS) and remote sensing technologies for land management and crop monitoring (Avilova & Rasulova, 2024). Some larger farms have also begun to implement precision agriculture techniques, demonstrating the potential for broader application (Utemuratova, 2025). Recognizing the imperative for digital transformation, the government of Uzbekistan has launched several strategic initiatives. The "Digital Uzbekistan 2030" strategy, introduced in 2020, includes specific provisions for digitalizing the agricultural sector (Asian Development Bank, 2023). Key initiatives under this national agenda involve the

development of a national agricultural information system, promotion of smart farming technologies through support programs, establishment of innovation centers focused on agricultural technology, and improvement of rural digital infrastructure (Asian Development Bank, 2023). Regulatory reforms are also being pursued to create a more conducive environment for digital innovation, including measures to facilitate technology adoption, protect data privacy, and promote public-private partnerships (Ashurov & Khakmirzaev, 2023). The government views automated farm management systems as a major task today (Zien Journals Publishing, 2023). The Ministry of Agriculture, with support from the Food and Agriculture Organization (FAO) of the United Nations, has been actively involved in projects like "Preparing the grounds for digital transformation of agriculture," which has contributed to the development of a National Digital Agriculture Program (Food and Agriculture Organization of the United Nations, 2023b). Furthermore, the Center for Digitalization of the Agro-Industrial Complex has been established under the Ministry of Agriculture to implement digital technologies, develop software, create a database for the agro-industrial complex, and implement GIS in agriculture (Kalbaev, 2024). A unified state information system for allocating agricultural subsidies is also being created (Kalbaev, 2024).

Key Technologies and Applications

The sources highlight a diverse array of digital technologies applicable to agriculture in Uzbekistan. These include precision farming techniques, Internet of Things (IoT) devices, big data analytics, artificial intelligence (AI), blockchain, GIS, and remote sensing (Zien Journals Publishing, 2023). These technologies hold promise for optimizing resource use, improving decision-making, enhancing supply chain efficiency, and increasing overall productivity (Yusupova, 2023).

Specific technological applications discussed include automatic systems for intelligent agriculture utilizing sensors (wireless, soil moisture), wireless sensor networks, and IoT to monitor environmental parameters, remotely control devices, and automate tasks like weeding and spraying (Kalbaev, 2024). Irrigation management can be significantly improved using sensors and networks for precise water application (Kalbaev, 2024). Remote sensing, involving sensors on the ground, drones, and satellites, is crucial for monitoring crops, assessing biomass and yield, detecting stress, and managing land (Avilova & Rasulova, 2024). Drones, in particular, are noted for their use in aerial photography, crop analysis, quality monitoring, calculating vegetation index, detecting diseases, and optimizing fertilizer and pesticide application, potentially reducing costs and labor (Yusupova, 2023). Big data and AI are seen as vital for timely decisions, harvest forecasting, and developing fertilization schemes (Yusupova, 2023). Blockchain technology is emerging as a tool for traceability in the supply chain (Farmonaut, n.d.).

Examples of specific technologies and platforms being introduced include Farmonaut's satellite-based crop health monitoring system, which utilizes NDVI for assessing plant vigor and an AI-powered advisory system (Jeevn AI) for customized recommendations on irrigation, fertilization, pest management, and yield prediction (Farmonaut, n.d.). This system also incorporates blockchain for traceability and real-time fleet management (Farmonaut, n.d.). Other governmental or supported platforms include Agrosubsidy, CropAgro, a general "Digital Platform for Farmers," the "E-IJARA" land lease system, the Ministry of Agriculture's Geoinformation system, the "Unit agro-platform" for digital interaction, the "Marketplace" trade portal, the "Rubicon" water resource management system, and the ASM single integration platform (Kalbaev, 2024).

Drivers and Opportunities

Several factors drive the digital transformation in Uzbekistan's agriculture and present significant opportunities. Foremost among these is strong government support and clear strategic direction through initiatives like "Digital Uzbekistan 2030" and the Agricultural Development Strategy (Kalbaev, 2024). The country's economic growth and related socio-economic changes, including increasing urbanization and purchasing power, contribute to a more favorable environment for technological adoption (Ministry of Investment, Industry and Trade of the Republic of Uzbekistan, n.d.). Uzbekistan's young and growing population is identified as a primary target audience for digital services, potentially driving higher adoption rates (Ministry of Investment, Industry and Trade of the Republic of Uzbekistan, n.d.).

Opportunities presented by digitalization include substantial increases in agricultural productivity through optimized resource use and higher yields, as demonstrated in pilot projects (Yusupova, 2023). Improved environmental sustainability is a key advantage, with digital technologies enabling more efficient water use, optimized fertilizer and pesticide application, reduced pollution, improved soil health, and better adaptation to climate change (Yusupova,

2023). Enhanced food security is a direct benefit of improved crop planning and reduced losses facilitated by better data and predictive analytics (Yusupova, 2023). Digital platforms can also improve market access and transparency by connecting farmers directly with buyers (KPMG Caucasus and Central Asia, 2023; Kun.uz, 2018). Potential for rural development includes the creation of new job opportunities and bridging the urban-rural digital divide (Food and Agriculture Organization of the United Nations, 2023a). The rational use of land and water resources is a specific focus area enabled by digitalization initiatives (Kalbaev, 2024).

Challenges and Barriers

Despite the promising opportunities and governmental support, the implementation of digital technologies in Uzbekistan's agricultural sector faces considerable challenges. A major barrier is limited infrastructure, particularly in rural areas, which often lack reliable internet connectivity and consistent electricity supply necessary for digital technologies (Utemuratova, 2025). A significant gap exists in digital literacy among farmers, especially older generations and those in remote regions, limiting their ability to effectively utilize new technologies (Leibniz Institute of Agricultural Development in Transition Economies (IAMO), 2023). The high initial costs associated with many digital agricultural technologies are prohibitive for small-scale farmers, who constitute a large portion of the sector (Utemuratova, 2025).

Other challenges include concerns related to data management, ownership, privacy, and security, which arise as digital technologies generate increasing amounts of agricultural data (Utemuratova, 2025). Ensuring compatibility and integration of new digital technologies with traditional farming practices and local knowledge systems is also necessary. The lack of qualified personnel skilled in working with these new technologies, including developers and product specialists, is a limitation (Utemuratova, 2025). Some sources mention insufficient government support and a low level of the regulatory framework as hindering implementation (Utemuratova, 2025), though other sources highlight government initiatives (Ashurov & Khakmirzaev, 2023). The inherent difficulties in adapting to climate change persist, even with monitoring technologies. A lack of practical implementation examples and the rapidly changing nature of digital technologies can also deter adoption. Furthermore, the startup ecosystem report points to a lack of coordinated government approach to digitalization and a tendency for government institutions to develop internal solutions rather than procuring from local startups (Asian Development Bank, 2023). Limited access to external funding, including angel investment and venture capital, is a critical constraint for agritech startups (Asian Development Bank, 2023). Issues with the quality and sector-specificity of incubator and accelerator programs and a shortage of experienced mentors also impede growth (Asian Development Bank, 2023). Bureaucratic regulations and licensing for certain activities can also pose difficulties (Asian Development Bank, 2023). In sectors like cleantech and potentially agritech, factors like lobbying from traditional industries (e.g., chemical fertilizers), government dominance in certain areas (e.g., energy, water), high hardware costs, and low awareness among stakeholders can hinder adoption and investment (Asian Development Bank, 2023).

Impact on Agricultural Development

The implementation of digital technologies holds the potential for profound impacts on Uzbekistan's agricultural development. A primary impact is the significant increase in agricultural productivity through optimized resource allocation and management, leading to higher yields and reduced input costs (Yusupova, 2023). This transformation aims to shift traditional production systems towards modern, productive, and innovative ones (Zien Journals Publishing, 2023). Digitalization is central to achieving water-saving, smart, high-quality, efficient, and environmentally friendly agriculture (Zien Journals Publishing, 2023).

Beyond productivity, digital transformation contributes to improved environmental sustainability by enabling more precise farming techniques that minimize the negative environmental footprint, conserve water resources, and reduce pollution (Yusupova, 2023). Enhanced food security is supported through improved crop planning, monitoring, and forecasting, which can reduce losses and stabilize supply (Yusupova, 2023). Digital platforms facilitate improved market access and transparency, potentially connecting farmers more directly with consumers and reducing intermediary costs (KPMG Caucasus and Central Asia, 2023). On a broader socio-economic level, digitalization has the potential for rural development by creating new job opportunities, improving the standard of living in rural areas, and helping to bridge the urban-rural divide (Food and Agriculture Organization of the United Nations, 2023a). Economic growth is anticipated, with estimates suggesting potential GDP increases from the adoption of technologies like drones (Yusupova, 2023).

Case Studies and Examples

Several pilot projects and initiatives illustrate the practical application and potential benefits of digital agriculture in Uzbekistan. A precision cotton farming project in the Syrdarya region, utilizing GIS, soil sensors, and variable rate application, reportedly resulted in a 15% increase in yield and a 20% reduction in water use (Yusupova, 2023). A digital marketplace mobile application in the Fergana Valley connected farmers directly with buyers, leading to improved market access and potentially higher prices (Yusupova, 2023). In the Tashkent region, a smart greenhouse project employing IoT sensors and automated climate control demonstrated significant improvements in tomato yield, quality, and energy efficiency (Yusupova, 2023). Farmonaut's satellite monitoring project with Global Textile Group in the Fergana region's cotton farming showed substantial yield increases (75-80% over three years), alongside improved water efficiency (20%), reduced fertilizer use (15%), and reduced inspection time (30%) (Farmonaut, n.d.). These limited-scale examples provide valuable insights and serve as potential models for wider implementation (leg.uz, 2023).

Analysis of Research and Gaps

The provided sources collectively offer a valuable overview of the digital transformation landscape in Uzbekistan's agriculture. They consistently identify the critical role of government strategies and initiatives (Asian Development Bank, 2023; Kalbaev, 2024) and highlight the importance of key technologies such as precision farming, remote sensing, and digital platforms (Avilova & Rasulova, 2024; Zien Journals Publishing, 2023). Recurring themes in the challenges section include the foundational issues of infrastructure, digital literacy, and access to finance (Utemuratova, 2025). The potential benefits, such as increased productivity and improved sustainability, are well-documented in multiple sources (Yusupova, 2023). Methodologies employed in the research include analysis of regulatory documents and statistics, comparative analysis, mixed methods, interviews, focus groups, and surveys (Leibniz Institute of Agricultural Development in Transition Economies (IAMO), 2023). The startup ecosystem report provides unique insights from the perspective of agritech startups themselves, shedding light on challenges related to funding, talent, and government engagement (Asian Development Bank, 2023).

Despite these contributions, several research gaps are apparent based on the provided materials. There is a need for more in-depth, comprehensive quantitative studies assessing the actual impact of various digitalization initiatives and technologies across different crops, regions, and farm sizes in Uzbekistan. While pilot projects show promising results (Yusupova, 2023), scaling up impacts requires more rigorous evaluation. Research could also delve deeper into the specific challenges and opportunities for different types of farmers, particularly differentiating between large commercial farms and small family-owned plots, which face unique constraints (Utemuratova, 2025). The socio-economic impacts of digital transformation, beyond aggregate productivity and income increases, warrant further investigation, potentially exploring effects on labor markets, inequality, and rural livelihoods in detail (Food and Agriculture Organization of the United Nations, 2023a). The complexities of data management, ownership, privacy, and security in the agricultural context are mentioned (Utemuratova, 2025) but could benefit from more detailed analysis of specific concerns and regulatory approaches. A critical evaluation of the effectiveness and reach of specific government support programs, digital platforms, and the newly established institutions would also be valuable. Finally, more localized case studies and longitudinal studies tracking the long-term sustainability impacts and adoption trajectories are needed to build a more complete picture.

Emerging Trends

Based on the sources, several emerging trends in Uzbekistan's agricultural digitalization are discernible. There is a strong policy focus on promoting precision farming and smart agriculture technologies, supported by government programs and initiatives (Asian Development Bank, 2023). The increased use of remote sensing, particularly satellite imagery and drones, for monitoring, analysis, and decision support is a significant trend (Avilova & Rasulova, 2024). Integration of AI and Big Data analytics is expected to grow, enhancing predictive capabilities and decision-making (Yusupova, 2023). The development and proliferation of digital platforms for information dissemination, market access, and management are also prominent (Asian Development Bank, 2023). There is growing interest in IoT applications for various aspects of farming, from environmental monitoring to automated systems (Zien Journals Publishing, 2023). Addressing water scarcity through smart irrigation and water resource management systems remains a critical priority, likely driving further digital solutions in this area (Food and Agriculture Organization of the United Nations, 2023a). The government's continued commitment to improving digital infrastructure and fostering digital literacy is a key enabling trend (Asian Development Bank, 2023). Support for the tech startup ecosystem,

including specific agritech startups, is gaining momentum (Asian Development Bank, 2023), coupled with increasing involvement from international organizations and potential for venture capital investment (leg.uz, 2023).

CONCLUSION

The digital economic transformation of the agricultural sector in Uzbekistan is a critical endeavor aimed at modernizing this foundational industry, improving productivity, and addressing key challenges related to resource efficiency, sustainability, and food security. The review of available research and reports highlights a landscape characterized by strong strategic intent from the government, active exploration and implementation of diverse digital technologies, and promising results observed in various pilot projects. Key technologies such as precision farming, remote sensing, AI, and digital platforms are recognized for their potential to optimize agricultural processes and outcomes.

However, the path to widespread digitalization is fraught with significant barriers, notably inadequate rural digital infrastructure, insufficient digital skills among farming communities, and financial constraints that limit technology adoption, particularly for smallholders. Addressing these challenges requires a sustained and coordinated effort involving continued government investment in infrastructure and enabling policies, targeted training and education programs to enhance digital literacy, facilitation of access to appropriate financing mechanisms, and fostering partnerships between the public sector, private technology providers, and research institutions. While existing research provides a valuable overview and identifies core challenges and opportunities, there is a clear need for more in-depth studies, particularly focusing on comprehensive quantitative impact assessments, tailored solutions for diverse farming contexts, and detailed analyses of socio-economic implications. Despite the current limitations, the ongoing initiatives and the growing recognition of the importance of digital agriculture suggest a positive trajectory for the sector's transformation, holding significant promise for enhanced productivity, sustainability, and the well-being of the rural population in Uzbekistan. Realizing this potential hinges on effectively navigating the identified barriers and leveraging the collective strengths of all stakeholders involved.

REFERENCES

1. Ashurov, Z., & Khakmirzaev, N. (2023). *Digital transformation of agricultural sector in Uzbekistan: Current state, advantages and strategies*. *E3S Web of Conferences*, 460(02003). <https://doi.org/10.1051/e3sconf/202346002003>
2. Asian Development Bank. (2023). *Uzbekistan's Ecosystem for Technology Startups*. <https://www.adb.org/publications/uzbekistan-ecosystem-technology-startups>
3. Avilova, N. F., & Rasulova, Z. (2024). *ROLE OF REMOTE SENSING IN AGRICULTURE IN UZBEKISTAN*. *International Multidisciplinary Journal for Research & Development*, 11(09). <https://www.ijmrd.in/index.php/ijmrd/article/view/1856>
4. Farmanaut. (n.d.). *Uzbekistan Satellite Tech Revolutionizes Cotton Farming*. Retrieved from <https://farmanaut.com/blog/precision-agriculture-at-scale-how-satellite-monitoring-is-boosting-cotton-yields-by-80/>
5. Food and Agriculture Organization of the United Nations. (2023a, December 19). *Digital technologies make inroads into rural Uzbekistan and Tajikistan*. *FAO Regional Office for Europe and Central Asia*. <https://www.fao.org/europe/news/2023/digital-technologies-make-inroads-into-rural-uzbekistan-and-tajikistan/en>
6. Food and Agriculture Organization of the United Nations. (2023b, March 6). *Knowledge, innovation and digitalization can transform agriculture in Uzbekistan*. *FAO Regional Office for Europe and Central Asia*. <https://www.fao.org/europe/news/2023/knowledge-innovation-and-digitalization-can-transform-agriculture-in-uzbekistan/en>
7. leg.uz. (2023, December 22). *FAO will continue to work on innovation and digitalization of the agricultural sector in Uzbekistan*. <https://ieg.uz/en/news/fao-will-continue-to-work-on-innovation-and-digitalization-of-the-agricultural-sector-in-uzbekistan>
8. Kalbaev, M. A. (2024). *DIGITAL TRANSFORMATION IN AGRICULTURE IN THE REPUBLIC OF UZBEKISTAN - Ilmiy anjumanlar*. *Ilmiy anjumanlar*, 77-81. <https://doi.org/10.5281/zenodo.14216526>
9. KPMG Caucasus and Central Asia. (2023, August). *E-commerce in Uzbekistan*. KPMG. <https://assets.kpmg.com/content/dam/kpmg/kz/pdf/kz-en-e-commerce-in-uzbekistan-2023.pdf>
10. Kun.uz. (2018, October 18). *Uzbekistan to launch e-commerce site, online information portal for fruit and vegetable exporters*. <https://kun.uz/en/news/2018/10/18/uzbekistan-to-launch-e-commerce-site-online-information-portal-for-fruit-and-vegetable-exporters>
11. Leibniz Institute of Agricultural Development in Transition Economies (IAMO). (2023). *Determinants and impact of farmers' participation in social media groups: Evidence from irrigated areas of Kazakhstan and Uzbekistan* (IAMO

- Discussion Papers No. 201). IDEAS/RePEc. <https://ideas.repec.org/p/zbw/iamodp/201.html>
12. Ministry of Investment, Industry and Trade of the Republic of Uzbekistan. (n.d.). *New Uzbekistan: The Big Country with Big Opportunities* [Brochure].
 13. Utemuratova, A. (2025). PROSPECTS AND BARRIERS OF INFORMATION TECHNOLOGY IMPLEMENTATION IN THE AGRICULTURAL SECTOR OF UZBEKISTAN - *Ilmiy anjumanlar*. *Ilmiy anjumanlar*, 257-262. <https://doi.org/10.5281/zenodo.15516423>
 14. Yusupova, F. E. (2023). *The Impact of the Use of Digital Technologies in Agriculture on the Economy*. *Eurasian Research Bulletin*, 17, 321-338. <https://geniusjournals.org/index.php/erb/article/view/3446>
 15. Zien Journals Publishing. (2023). *Role and Development of Digital Agriculture in Uzbekistan*. *Zien Journals Publishing*. <https://zienjournals.com/index.php/zien/article/view/191/181>