O‘ZBEKISTONDA QISHLOQ XO‘JALIGIDAGI RAQAMLI TRANSFORMATSIYA VA INNOVATSION TEXNOLOGIYALAR

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ANNOTATSIYA

Ushbu maqola O‘zbekistonda qishloq xo‘jaligini boshqarishdagi raqamli texnologiyalarning o‘zgaruvchan ta’sirini o‘rganadi, bu erda qishloq xo‘jaligi sohasiga ilg‘or texnologiyalarni joriy etish orqali barqarorlik, ishlab chiqarish samaradorligi va raqobatbardoshlikni oshirishga qaratilgan. O‘zbekiston qishloq xo‘jaligida yuz berayotgan o‘zgarishlar va yangi chaqiriqlarga qarshi kurashayotgan bir paytda, qishloq xo‘jaligini boshqarishda raqamli transformatsiyani qabul qilish zamonaviy dehqonchilik amaliyotlarining talablariga javob berish uchun muhimdir. Aqlli qishloq xo‘jaligi, aniqlik bilan qishloq xo‘jaligi va qishloq xo‘jaligidagi IoT kabi asosiy texnologiyalar samaradorlikni va qarorlar qabul qilishni yaxshilashdagi roli nuqtai nazaridan o‘rganiladi. Katta ma’lumotlar tahlili va sun’iy intellekt qishloq xo‘jaligini boshqarishda ma’lumotlarga asoslangan tahlillarni ta’minlasa, qishloq xo‘jaligida blokcheyn texnologiyasi shaffoflik va kuzatib borishni oshiradi. Qishloq xo‘jaligida GIS (Geografik axborot tizimi) qo‘llanilishi resurslarni boshqarish va yerlarni optimallashtirishda yordam beradi, bu esa barqaror qishloq xo‘jaligi amaliyotlariga hissa qo‘shadi. Bundan tashqari, tadqiqot raqamli transformatsiyaning qishloq xo‘jaligi ta’minot zanjirlarini optimallashtirish va oziq-ovqat xavfsizligini yaxshilashdagi o‘rnini o‘rganadi. Maqola hukumat tomonidan raqamlashtirishni tezlashtirish va keng qamrovli qabul qilish uchun zarur infratuzilmani yaratishda qo‘llab-quvvatlash zarurligini ta’kidlaydi. Tadqiqot O‘zbekistonda qishloq xo‘jaligi

KALIT SO‘ZLAR

raqamli transformatsiya, aqlli qishloq xo‘jaligi, smart dehqonchilik, qishloq xo‘jaligida IoT, katta ma’lumotlar tahlili, agro-boshqaruvda sun’iy intellekt, qishloq xo‘jaligida blokcheyn, barqaror dehqonchilik

sohasida raqamli davrni to‘liq qabul qilish uchun mavjud bo‘lgan qiyinchiliklarni yengish muhimligini ta’kidlaydi.

АННОТАЦИЯ

В данной статье рассматривается преобразующее влияние цифровых технологий на агро-менеджмент в Узбекистане, уделяя особое внимание интеграции передовых технологий в сельскохозяйственный сектор для повышения устойчивости, продуктивности и конкурентоспособности. В условиях изменения сельскохозяйственных вызовов Узбекистану необходимо внедрение цифровой трансформации в агро-менеджменте для удовлетворения потребностей современных методов ведения сельского хозяйства. Рассматриваются ключевые технологии, такие как умное сельское хозяйство, точное земледелие и IoT в сельском хозяйстве, которые способствуют повышению эффективности и качества принятия решений. Аналитика больших данных и искусственный интеллект в агро-менеджменте обеспечивают аналитические решения на основе данных, а блокчейн в сельском хозяйстве улучшает прозрачность и прослеживаемость. Применение ГИС в сельском хозяйстве способствует управлению ресурсами и оптимизации использования земель, что способствует устойчивым методам ведения сельского хозяйства.

Кроме того, в исследовании анализируется роль цифровой трансформации в оптимизации сельскохозяйственных цепочек поставок и повышении продовольственной безопасности. В статье подчеркивается необходимость государственной поддержки для ускорения цифровизации и создания необходимой инфраструктуры для массового внедрения технологий. Исследование акцентирует внимание

КЛЮЧЕВЫЕ СЛОВА

цифровая трансформация, умное сельское хозяйство, точное земледелие, IoT в сельском хозяйстве, аналитика больших данных, искусственный интеллект в агро-менеджменте, блокчейн в сельском хозяйстве, устойчивое сельское хозяйство

на важности преодоления вызовов для полноценного перехода к цифровой эре в аграрном секторе Узбекистана.

ABSTRACT

This paper examines the transformative impact of digital technologies on agro-management in Uzbekistan, focusing on the integration of advanced technologies in the agricultural sector to enhance sustainability, productivity, and competitiveness. As Uzbekistan faces evolving agricultural challenges, the adoption of Digital Transformation in Agro-Management is crucial to meet the demands of modern farming practices. Key technologies, such as Smart Agriculture, Precision Farming, and IoT in Agriculture, are explored for their role in improving efficiency and decision-making. Big Data Analytics and AI in Agro-Management enable data-driven insights, while Blockchain in Agriculture enhances transparency and traceability. The application of GIS in Agriculture aids in resource management and land optimization, contributing to sustainable farming practices. Furthermore, the study explores the role of digital transformation in optimizing agricultural supply chains and improving food security. The paper highlights the need for government support in accelerating digitalization and establishing the necessary infrastructure for widespread adoption. The research underscores the importance of overcoming challenges to fully embrace the digital era in Uzbekistan's agricultural sector.

KEY WORDS

Digital Transformation, Smart Agriculture, Precision Farming, IoT in Agriculture, Big Data Analytics, AI in Agro-Management, Blockchain in Agriculture, Sustainable Farming

INTRODUCTION

In recent years, Uzbekistan has been making significant strides in various sectors, demonstrating a commitment to progress and innovation. The country has prioritized advancements in economy, education, technology, medicine, tourism, and agriculture through a series of strategic measures and decrees. Under the leadership of President Shavkat Mirziyoyev, Uzbekistan has

embarked on a path of digital transformation, recognizing the necessity of integrating modern technologies into key industries. The designation of 2020 as the "Year of Development of Science and the Digital Economy" underscores the urgent need to enhance educational systems, develop innovative technologies, and empower young professionals to meet contemporary challenges.

One of the most promising areas of digital transformation in Uzbekistan is the integration of digital technologies into land resources, agriculture, and water management. The government has introduced numerous projects aligned with the "Digital Uzbekistan – 2030" strategy, aiming to leverage advanced technical solutions and international expertise to modernize agricultural practices. Collaborations with the European Union and the World Bank have further facilitated the rapid implementation of digitalization efforts. These initiatives have provided farmers and agronomists with access to big data analytics, enabling them to optimize harvesting schedules, manage fertilization schemes, and enhance productivity through real-time monitoring and forecasting.

The digital economy is emerging as a critical driver of Uzbekistan's economic growth. The country boasts a strong intellectual foundation, an advanced telecommunications infrastructure, and an increasing number of high-tech enterprises, all of which contribute to an environment conducive to digital innovation. However, digital transformation remains a global challenge, requiring countries to adopt modernized business models and governance systems. Developed nations have successfully implemented a range of digital tools to enhance efficiency, and Uzbekistan is now following suit to establish a forward-looking economy.

In the context of agriculture, the government's 2022–2026 Development Strategy incorporates international best practices in automated management systems and data-driven decision-making. The modernization of agriculture involves developing automated farm management systems, improving information service technologies, and fostering innovative approaches to resource management. Despite these advancements, challenges remain, particularly in financial literacy and decision-making capabilities among farmers. Many still struggle with financial planning, taxation, and cost forecasting, which can hinder their ability to fully capitalize on digital opportunities.

As agriculture undergoes a transformation, new paradigms are emerging that emphasize sustainability, efficiency, and environmental consciousness.

Concepts such as smart agriculture, water-saving techniques, and precision farming are becoming integral components of Uzbekistan's agricultural strategy. Digital agriculture is now recognized as a crucial tool for achieving these objectives, ensuring that farming practices are modernized and aligned with global trends.

This study aims to analyze the role of digital technologies in Uzbekistan's agricultural sector, comparing its development with that of other well-established economies. It seeks to answer the following key research questions:

- What is the current state of research on agriculture and digital transformation?
- What are the advantages of digitalization in Uzbekistan's agricultural sector?
- What does sustainable agriculture entail in the context of digital transformation?
- What strategies have been implemented in Uzbekistan to develop its agricultural sector?

By addressing these questions, this research contributes to a deeper understanding of Uzbekistan's digital transformation journey, offering insights into the challenges and opportunities within the agricultural sector. The findings will help policymakers, researchers, and industry stakeholders make informed decisions to further integrate digital innovations and promote sustainable agricultural development.

LITERATURE REVIEW

Digitalization in agriculture has been extensively studied from a technical and scientific perspective, with significant focus on technologies such as big data, the Internet of Things (IoT), augmented reality, robotics, sensors, 3D printing, system integration, communication infrastructure, artificial intelligence (AI), digital twins, and blockchain. These innovations enhance productivity and efficiency in farming. However, social science research on the broader implications of digital agriculture remains in its early stages, leading to a fragmented understanding of its societal impact. Recent studies have begun exploring themes related to labor, economic structures, knowledge systems, and ethical considerations, particularly in developing nations like Uzbekistan.

A key concept in this discourse is Agriculture 4.0, which integrates cyber-physical systems into farming operations. Unlike earlier digital approaches, Agriculture 4.0 emphasizes interoperability, automation, and cross-platform coordination. While these advancements boost efficiency, they also pose challenges related to labor dynamics, farmer identity, and skills acquisition. In

Uzbekistan, where agriculture remains a vital economic sector, digitalization is gradually transforming traditional farming practices. Efforts are underway to equip farmers with digital skills, but concerns about data ownership, privacy, and the influence of large agribusinesses highlight the need for regulatory frameworks to ensure equitable access and benefits.

Another critical area of research involves the impact of digitalization on Agricultural Knowledge and Innovation Systems (AKIS). Digital tools are reshaping how agricultural knowledge is generated, shared, and applied, shifting from traditional extension services to data-driven decision-making platforms. In Uzbekistan, the government is integrating modern digital advisory systems to provide real-time insights on weather patterns, soil quality, and crop management. While these advancements offer significant opportunities, ensuring accessibility for smallholder farmers—who often lack financial and technical resources—remains a challenge. Addressing the digital divide is essential to prevent rural farmers from being excluded from the benefits of agricultural modernization.

Uzbekistan's policy framework for digital agriculture reflects the government's commitment to modernization, as outlined in initiatives like the Strategy for the Development of Agriculture (2020-2030) and the Digital Uzbekistan-2030 Strategy. These policies aim to drive digital transformation while ensuring sustainability and productivity. Additionally, the 2021 decree on knowledge and innovation improvement in agriculture underscores the importance of training programs and infrastructure development. Future research should further explore the socio-economic and ethical dimensions of digital agriculture, ensuring that digital transformation fosters inclusive and sustainable agricultural growth, particularly for smallholder farmers.

METHODOLOGY

This research analyzes various national programs, including "Digital Uzbekistan-2030", the National Technological Initiative, and the decree On Measures for the Development of the Digital Economy in the Republic of Uzbekistan. A combination of system analysis and applied mathematics methods was employed to achieve research objectives. Solutions were formulated through comparative, logical, statistical, and system analysis within a general scientific research framework.

The study explores the digitalization of agriculture and the application of advanced technologies in agricultural production, drawing from both domestic and international research. It integrates empirical and theoretical research

methods alongside the economic principles of forming a digital agricultural profile.

A mixed-method approach, incorporating both quantitative and qualitative methodologies, was utilized. Seven large farmers were interviewed using structured research questions to assess the advantages and challenges of digital transformation in agriculture. These semi-structured interviews, conducted in the Kashkadarya region, each lasted approximately five minutes. Additionally, an economic and financial analysis of digital transformation was performed using publicly available state data.

Despite advancements in research methodology, program evaluation and monitoring data often lack utility due to an overreliance on quantitative methods. While surveys provide generalizable results on the presence or absence of impacts, they fail to explain underlying causes. In contrast, qualitative methods uncover the reasons behind observed outcomes, inform survey design, and highlight social and institutional factors that are difficult to quantify. By integrating qualitative insights with quantitative findings, this study presents a more comprehensive and reliable understanding of digital agriculture in Uzbekistan.

To enhance interview quality, the focus group method was employed. These discussions, often considered synonymous with semi-structured interviews, began with defining study objectives and preparing a structured question list. Focus groups play a crucial role in understanding the relationship between individual perceptions and sociocultural contexts, particularly in decision-making related to natural resource management. While widely used in participatory conservation research, their methodological application remains underexplored, with limited best-practice guidelines. The process involved research design, data collection, analysis, and reporting. As a result, four participants successfully launched agro-industrial enterprises, while others were selected based on their agricultural industry involvement. The participant group was diverse, including both men and women from various backgrounds.

Data collection combined semi-structured interviews with farmers and agricultural experts and a quantitative research approach. A short survey targeting individuals aged 18 to 45 captured generational perspectives on digital agriculture. This mixed-method approach facilitated a deeper understanding of agricultural digitalization by incorporating diverse data sources. Data analysis involved cleaning and transforming information to support business decision-making. After gathering materials, interview transcripts, and survey responses, the data was systematically analyzed.

Additional materials, including images of the coding tree and survey results, are provided in the annex. The survey, conducted via social networks (Facebook, Instagram, and Telegram), engaged participants from various professional backgrounds. A total of 15 respondents shared their views on digital agriculture, with many acknowledging its gradual development in Uzbekistan. The coding tree proved instrumental in structuring focus group discussions, fostering engaging and insightful conversations on the topic.

RESULTS AND DISCUSSION

Agriculture has always been the backbone of Uzbekistan's economy, and with the rapid advancement of technology, digital agriculture is emerging as a crucial factor in its development. Farmers in Karshi and other regions of the country have begun recognizing the significance of digital solutions, which are transforming traditional farming methods. One notable example is the adoption of drip irrigation in greenhouses due to water scarcity, leading to improved crop yields and sustainable farming practices. As digitalization continues to reshape the agricultural sector, it is becoming evident that efficiency, resource optimization, and problem-solving in farming depend largely on innovative technologies.

The integration of artificial intelligence (AI), satellite imaging, and drones is playing a transformative role in modern agriculture. These technologies enable farmers to make informed decisions about planting schedules, soil conditions, and pest control. Digital solutions are also instrumental in cost reduction, better planning, and enhanced budgeting, all of which contribute to the sustainability of farming enterprises. However, challenges such as gaps in technical expertise and infrastructure limitations pose significant barriers to widespread adoption. The Internet of Things (IoT) in agriculture, while promising, requires extensive investment in training and infrastructure development to maximize its benefits.

Digital agriculture aligns well with the goals of sustainable farming by improving environmental health while ensuring economic profitability. The adoption of technology-driven solutions allows farmers to make data-driven decisions, leading to more efficient resource management and reduced environmental impact. However, transitioning to sustainable agriculture is a long-term process that requires a balance between ecological preservation and economic viability. Investments in research and education will be critical in equipping farmers with the necessary skills to utilize digital tools effectively.

Recognizing the potential of digital agriculture, the Uzbekistan government, in collaboration with international organizations, has launched a

10-year Agricultural Development Strategy (2020-2030). This initiative focuses on key areas such as food security, agribusiness development, environmental sustainability, and modern governance. To support farmers, a unified state information system is being developed for subsidy allocation, ensuring financial aid reaches those who need it most. Additionally, access to advanced agricultural technologies is being prioritized to enhance productivity and sustainability in the sector.

Despite its numerous benefits, the adoption of digital agriculture in Uzbekistan faces several challenges. High initial costs, resistance to change, and a lack of local technical expertise hinder its widespread implementation. To overcome these obstacles, it is essential to encourage farmers' active participation in developing and deploying digital farming solutions. Expanding university research programs, technology incubation centers, and educational initiatives for young farmers will be crucial in accelerating the digital transformation of agriculture.

In conclusion, digital agriculture presents a promising future for Uzbekistan's farming industry. With continued government support, investment in technology, and education, farmers can harness the power of digital tools to enhance productivity, sustainability, and economic growth. Overcoming current challenges will require collective efforts from policymakers, agricultural experts, and the farming community to ensure a successful digital transformation in the sector.

CONCLUSION

The transition to digital agriculture in Uzbekistan presents significant opportunities to enhance efficiency, sustainability, and competitiveness in the agricultural sector. Government support, infrastructure development, and education are critical for the successful implementation of digital farming practices. Challenges such as high start-up costs, knowledge gaps, and technical limitations must be addressed through strategic investments and policy frameworks.

To accelerate digitalization, Uzbekistan should focus on fostering innovation through public-private partnerships, expanding digital education for farmers, and integrating advanced technologies such as AI, IoT, and big data analytics. The establishment of techno-parks, university incubation centers, and hybrid initiatives combining IT and agronomic expertise can drive the sector's modernization.

While digital agriculture is still in its early stages, its adoption is crucial for sustainable agricultural development. With proper implementation and

government backing, Uzbekistan can leverage digitalization to strengthen food security, improve resource efficiency, and create a resilient agricultural ecosystem for the future.

REFERENCES

1. [FAO] Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, World Food Programmed, The State of Food Insecurity in the World 2015, 2015, Meeting the 2015 international hunger targets: Taking Stock of Uneven Progress, FAO
2. A.-S. Heun, Understanding Technical Terms and Acronyms Used in Precision Agriculture (2010)
3. B.E.-G. Fountas, The Future of Digital Agriculture: Technologies and Opportunities, 22(1). IT Professional, 24-28 (2020)
4. Bobojonov, I., Teuber, R., Hasanov, S., Urutyan, V., & Glauben, T. (2019). Adoption of digital technologies in agriculture: Evidence from survey data in transition countries. Agricultural Economics, 50(4), 413-425.
5. D. Yan e, Research and Analysis about System of Digital Agriculture Based on a Network Platform. Advan ces in Information an d Communication Technology, 274–282 (2011)
6. D. Yane, Research and Analysis about System of Digital Agriculture Based on a Network Platform, In International Conference on Computer and Computing Technologies in Agriculture, pp. 274-282 (2010)
7. Decree of the President of the Republic of Uzbekistan Sh. Mirziyoyev “On the Strategy for the Further Development of the Republic of Uzbekistan” (January 23, 2017).
8. Development strategies of Uzbekistan in 2017–2021, (2017), Uzbekistan, Tashkent.
9. Djanibekov, N., Finger, R., Guta, D. D., Gaur, V., & Mirzabaev, A. (2020). A systematic review of digital technologies for improving agricultural productivity in developing countries. Food and Energy Security, 9(4), e230.
10. Durmanov A.S., Sangirova U.R., Abdurazakova N.M., Abraev N.K., Xoliyorov U.E. Implementation of innovative technologies as a mean of resource saving in greenhouses (through the example of the Republic of Uzbekistan), Proceedings of the 34th International Business Information Management Association Conference - Vision 2020: Sustainable Economic Development and Application of Innovation Management

from Regional expansion to Global Growth, 13-14 November 2019, Madrid, Spain.
11. Durmanov, A.S., Tulaboev A.T., Li, M.R., Maksumkhanova A.M., Saidmurodzoda, M.M. and Khafizov O. (November, 2019). Game theory and its application in agriculture (greenhouse complexes). International Conference on Information Science and Communications Technologies ICISCT 2019, pg.
12. F.N. Sørensen, Conceptual Model of a Future Farm Management Information System, Computers and Electronics in Agriculture, 72(1), 37-47 (2010)
13. Food and Agriculture Organization (FAO). (2021). Digital agriculture in action: FAO's work in Uzbekistan. FAO Regional Office for Europe and Central Asia.
14. Hilorme, T., Tkach, K., Dorenskyi, O., Katerna, O., & Durmanov, A. (2019). Decision making model of introducing energy-saving technologies based on the analytic hierarchy process. Journal of Management Information and Decision Sciences, 22(4), 489-494.
15. J.Y. Cheng, Digital Agriculture–One of Application Domain of Digital Earth. In: Towards Digital Earth — Proceedings of the International Symposium on Digital Earth (1999)
16. Kienzler, K. M., Rudenko, I., Ruzimov, J., Ibragimov, N., & Lamers, J. P. A. (2020). Precision agriculture in irrigated cotton production in Uzbekistan. Precision Agriculture, 21(4), 926-948.
17. Ministry of Agriculture of Uzbekistan. (2020). Strategy for Digital Transformation of Agriculture in Uzbekistan 2020-2030. Government of Uzbekistan.
18. Mirziyoev Sh.M. A comprehensive analysis of the results of socio-economic development of the country in 2016 and a statement by the Cabinet of Ministers of the Republic of Uzbekistan on January 14, 2017, at the session of the Cabinet of Ministers of the Republic of Uzbekistan dedicated to identifying the key priorities and priorities of the economic and social program for the year 2017//, January 16, 2017
19. Mirziyoev Sh.M. We will build a free and prosperous, democratic Uzbekistan with our courageous and generous people. Speech by Mirziyoev at a joint meeting of the Chambers of the Oliy Majlis on the occasion of the inauguration of the President of the Republic of Uzbekistan. December 15, 2016

20. Pugach, I., Yusupov, A., & Berdinazarov, Z. (2021). Digital agriculture in Uzbekistan: Current state, challenges, and prospects. Central Asian Journal of Innovations on Tourism Management and Finance, 2(5), 20-31.
21. Q.Z. Tang, A conception of digital agriculture. International Geoscience and Remote Sensing Symposium (2002)
22. S.B. Narzullaev, Automated farm management system in Uzbekistan. Tashkent pharmaceutical Institute (2021)
23. Sh.M. Mirziyoyev, Speech of the President of the Republic of Uzbekistan to Oliy Majlis. Tashkent (2018)
24. Speech by the President of the Republic of Uzbekistan Shavkat Mirziyoev at the ceremony dedicated to the day of Agriculture // Narodnoe Slovo, 2017. No. 81 (31.817), 2017. - B. 2-3.
25. T.L. Wei, Journal of Anhui Agricultural Science, 36(30), 13458–13460 (2008)
26. Umarov, S. R., Durmanov, A. S., Kilicheva, F.B., Murodov S.M. and Sattorov O.B. (2019). Greenhouse Vegetable Market Development Based on the Supply Chain Strategy in the Republic of Uzbekistan, International Journal of Supply Chain Management (IJSCM), 8(5).
27. UP-5308 (2018). Decree of the President of the Republic of Uzbekistan No. UP-5308 “On the State Programmed on Implementing the Action Strategy for Five Priority Areas of Development of the Republic of Uzbekistan in 2017- 2021 during the “Year of Supporting Active Entrepreneurship, Innovative Ideas and Technologies”, dated 22 January 2018. http://www.ombudsman.uz/ru/press_center
28. Walter, A., Finger, R., Huber, R., & Buchmann, N. (2017). Opinion: Smart farming is key to developing sustainable agriculture. Proceedings of the National Academy of Sciences, 114(24), 6148-6150.
29. World Bank. (2022). Digital CASA - Uzbekistan Project. World Bank Group.
30. X.Z. Ouyang, Review of China Agricultural Science and Technology, 4(3), 76–80. (2001)