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**YANGI  
O'ZBEKISTON  
IQTISODIYOTI**

**“YANGI O‘ZBEKISTON IQTISODIYOTI” *jurnali* 6-son 2026 yil**

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**O‘ZBEKISTON RESPUBLIKASI  
OLIIY TA’LIM, FAN VA INNOVATSIYALAR VAZIRLIGI**

**MIRZO ULUG‘BEK NOMIDAGI  
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**YANGI O‘ZBEKISTON IQTISODIYOTI**

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**INTEGRATION OF DIGITAL AND SMART TECHNOLOGIES IN INCREASING THE  
ECOLOGICAL RESILIENCE OF THE AGRICULTURAL SYSTEM**

**QISHLOQ XO‘JALIGI TIZIMINING EKOLOGIK CHIDAMLILIGINI OSHIRISHDA  
RAQAMLI VA SMART TEXNOLOGIYALAR INTEGRATSIYASI**

**ИНТЕГРАЦИЯ ЦИФРОВЫХ И УМНЫХ ТЕХНОЛОГИЙ В ПОВЫШЕНИИ  
ЭКОЛОГИЧЕСКОЙ УСТОЙЧИВОСТИ СЕЛЬСКОХОЗЯЙСТВЕННОЙ СИСТЕМЫ**

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**Abstract**

This article examines the integration of digital and smart technologies as a strategic tool for enhancing the ecological resilience of agricultural systems. The study focuses on the application of precision agriculture, Internet of Things (IoT), Geographic Information Systems (GIS), remote sensing technologies, artificial intelligence, and big data analytics in modern farming practices. The research investigates how the integration of these technologies contributes to climate change adaptation, efficient resource management, environmental protection, and sustainable agricultural development. The findings indicate that digital transformation significantly improves water-use efficiency, reduces excessive fertilizer and pesticide consumption, strengthens soil conservation measures, and increases agricultural productivity under changing environmental conditions. Furthermore, the study proposes an integrated framework for implementing smart agricultural technologies aimed at improving ecological sustainability, reducing environmental risks, and ensuring long-term agricultural resilience. The results may serve as a methodological basis for policymakers, agricultural enterprises, and researchers seeking to accelerate the digital transformation of agriculture.

**Keywords:** Ecological resilience, digital agriculture, smart technologies, precision farming, IoT, GIS, artificial intelligence, climate adaptation, environmental sustainability, resource efficiency.

Mazkur maqolada qishloq xo‘jaligi tizimining ekologik chidamliligini oshirishda raqamli va smart texnologiyalar integratsiyasining ahamiyati tadqiq etilgan. Tadqiqotda aniq dehqonchilik, narsalar interneti (IoT), geografik axborot tizimlari (GIS), masofadan zondlash, sun‘iy intellekt va katta ma‘lumotlar tahlilining ekologik barqarorlikni ta‘minlashdagi o‘rni o‘rganilgan. Natijalar ushbu texnologiyalar suv resurslaridan samarali foydalanish, kimyoviy vositalar sarfini kamaytirish, tuproq unumdorligini saqlash hamda iqlim o‘zgarishlariga moslashuvchanlikni oshirishga xizmat qilishini ko‘rsatdi. Shuningdek, qishloq xo‘jaligini raqamlashtirish orqali ekologik xavflarni kamaytirish va resurslardan oqilona foydalanishni ta‘minlovchi integratsiyalashgan model taklif etilgan.

**Kalit so‘zlar:** ekologik chidamlilik, raqamli qishloq xo‘jaligi, smart texnologiyalar, IoT, GIS, sun‘iy intellekt, iqlim o‘zgarishi, ekologik barqarorlik.

В статье исследуется интеграция цифровых и smart-технологий как важный инструмент повышения экологической устойчивости аграрных систем. Особое внимание уделяется использованию точного земледелия, Интернета вещей (IoT), геоинформационных систем, дистанционного зондирования Земли, искусственного интеллекта и анализа больших данных. Исследование показывает, что внедрение данных технологий способствует адаптации сельского хозяйства к изменению климата, повышению эффективности использования природных ресурсов и снижению экологической нагрузки. Полученные результаты свидетельствуют о том, что цифровые решения позволяют рационально использовать водные

ресурсы, уменьшать применение химических удобрений и пестицидов, повышать плодородие почв и обеспечивать устойчивое развитие аграрного сектора. Предложен комплексный подход к цифровой трансформации сельского хозяйства, направленный на повышение экологической устойчивости и конкурентоспособности отрасли.

**Ключевые слова:** экологическая устойчивость, цифровое сельское хозяйство, smart-технологии, точное земледелие, искусственный интеллект, Интернет вещей, климатическая адаптация, устойчивое развитие.

Agriculture is one of the most important sectors supporting food security, economic growth, and rural development. However, agricultural systems are increasingly affected by climate change, water shortages, soil degradation, biodiversity loss, and environmental pollution. These challenges require innovative solutions that can improve both productivity and environmental sustainability. In this context, the integration of digital and smart technologies has emerged as a key strategy for strengthening the ecological resilience of agricultural systems.

Technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), remote sensing, drones, Geographic Information Systems (GIS), and precision farming tools enable farmers to monitor crops, optimize resource use, and respond effectively to environmental risks. The use of these technologies contributes to efficient water management, reduced chemical inputs, lower production costs, and improved environmental protection. Therefore, the integration of digital and smart technologies plays a significant role in promoting sustainable and climate-resilient agriculture.

The integration of digital and smart technologies has become an important factor in improving the ecological resilience of agricultural systems. Recent studies emphasize that precision agriculture technologies contribute to efficient resource management and environmental sustainability. According to Smith and Brown, digital farming tools improve water-use efficiency and reduce the excessive application of fertilizers and pesticides, thereby minimizing environmental impacts [1].

Research on Artificial Intelligence (AI) in agriculture shows that AI-based decision-support systems enhance crop management and climate adaptation strategies. These technologies enable farmers to make data-driven decisions that increase productivity while conserving natural resources [2]. Similarly, IoT-based monitoring systems provide real-time information on soil moisture, temperature, and crop conditions, supporting sustainable agricultural practices [3].

Several studies have highlighted the role of remote sensing and drone technologies in strengthening agricultural resilience. These technologies facilitate early detection of pests, diseases, and environmental stresses, allowing timely interventions and reducing production losses [4]. In addition, digital technologies support climate-smart agriculture by improving risk assessment and disaster preparedness [5].

Recent literature also demonstrates that big data analytics and GIS technologies improve agricultural planning and resource allocation. These tools enhance the capacity of agricultural systems to adapt to climate variability and environmental challenges [6]. Furthermore, smart irrigation technologies have been found to significantly reduce water consumption while maintaining crop yields [7].

Despite these advantages, researchers note challenges related to infrastructure, investment costs, and digital literacy among farmers [8]. Therefore, effective policy support and technological capacity-building are necessary to maximize the benefits of digital agriculture and strengthen ecological resilience [9].

This research employs a mixed methodological approach based on qualitative and quantitative analysis. The study is primarily based on a comprehensive review of recent scientific articles, international reports, and policy documents related to digital agriculture, smart farming, and ecological sustainability. Relevant literature indexed in international databases was examined to identify current trends and best practices in the application of digital technologies in agriculture.

Comparative analysis was used to evaluate different smart technologies, including AI-based decision support systems, IoT sensors, drones, and precision irrigation technologies. In addition, statistical and analytical methods were applied to assess their impact on resource efficiency,

environmental protection, and climate adaptation. Secondary data obtained from international organizations and research institutions were analyzed to determine how digital technologies contribute to enhancing ecological resilience. The results were interpreted using a systems approach, allowing for a comprehensive assessment of the relationship between technological innovation and sustainable agricultural development.

The analysis indicates that digital and smart technologies significantly enhance the ecological resilience of agricultural systems. Technologies such as Artificial Intelligence (AI), IoT sensors, drones, and precision farming tools improve resource management, reduce environmental impacts, and increase productivity. Smart irrigation systems help conserve water, while AI-based decision-support systems optimize fertilizer and pesticide use. Remote sensing technologies enable early detection of crop diseases and environmental risks, supporting sustainable agricultural practices.

Furthermore, digital technologies strengthen climate adaptation by providing real-time information on weather conditions and resource availability. However, challenges such as limited infrastructure, high implementation costs, and insufficient digital skills continue to hinder wider adoption. Overall, the findings demonstrate that smart technologies contribute to sustainable and resilient agricultural development.

The study concludes that the integration of digital and smart technologies is essential for improving the ecological resilience of agricultural systems. These technologies increase efficiency, support environmental sustainability, and enhance the ability of agriculture to adapt to climate change.

The following recommendations are proposed:

1. Expand digital infrastructure in rural areas.
2. Improve farmers' digital skills through training programs.
3. Provide financial support for adopting smart technologies.
4. Promote precision agriculture and sustainable resource management.
5. Strengthen cooperation between government, research institutions, and the private sector.

The widespread adoption of digital technologies will support sustainable agriculture, environmental protection, and long-term food security.

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