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# ENHANCING THE PRODUCTIVITY OF AGRICULTURAL LANDS USED ON A LEASE BASIS THROUGH THE ADOPTION OF INNOVATIVE TECHNOLOGIES

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**ANNOTATION.** *This article examines the role of innovative technologies in enhancing the productivity of agricultural lands used on a lease basis. It highlights the significance of precision agriculture, remote sensing, automated irrigation systems, and climate-smart technologies in improving soil fertility, water-use efficiency, and crop yields. A mixed-method research approach was applied, combining field observations, interviews, GIS and NDVI analysis, and economic evaluation. The results show that technological interventions significantly increase productivity, reduce production costs, and promote sustainable land management practices. The study also discusses key challenges such as financial constraints, limited digital infrastructure, and short-term lease agreements. Policy recommendations and practical strategies are proposed to support the widespread adoption of modern technologies in leased agricultural systems.*

***KEYWORDS.*** *Innovative technologies; leased agricultural land; precision agriculture; soil fertility; automated irrigation; NDVI; GIS; sustainable land management; crop productivity; climate-smart agriculture*

**INTRODUCTION.** Agricultural land productivity plays a central role in ensuring food security, rural economic growth, and the long term sustainability of natural resources. In many agricultural economies, a significant portion of arable land is cultivated under lease agreements, where users rent land for seasonal or long term production. The effectiveness and responsibility of land users directly influence soil quality, crop yields, and overall land condition. However, leased agricultural lands often face challenges such as soil fertility decline, insufficient investment in long term improvements, poor irrigation efficiency, and limited access to modern technologies.

Uzbekistan’s agricultural sector contributes approximately 28% to the national GDP and employs nearly 27% of the labor force (World Bank, 2023). Recognizing the inefficiencies of Soviet-

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era collective farming, the government initiated land reform in the early 2000s, transitioning to a lease-based system where state-owned agricultural land is allocated to individuals and cooperatives for fixed terms (typically 10–50 years). As of 2024, over 85% of arable land (10.3 million hectares) is managed under lease agreements (Ministry of Agriculture of Uzbekistan, 2024).

In recent years, the emergence of innovative agricultural technologies such as digital farming solutions, remote sensing, precision machinery, climate smart systems, geospatial tools, and automated irrigation has provided new opportunities to address these challenges. These technologies enable farmers to make data driven decisions, reduce unnecessary input usage, mitigate environmental degradation, and maximize per hectare yields. Integrating such technologies into leased agricultural lands is particularly important because it supports sustainable land use while helping land users fulfill contractual obligations related to land productivity.

Despite the availability of advanced tools, adoption rates remain low due to financial, institutional, and technical barriers. Therefore, a comprehensive analysis of technological solutions and their practical benefits is necessary.

The primary aim of this research is to assess the impact of innovative technologies on the productivity of agricultural lands used on a lease basis, examine challenges to implementation, and propose practical strategies to improve land management practices for long term sustainability. Agricultural land is one of the most valuable natural resources that directly influences food security, economic stability, and sustainable rural development. In many countries, including developing agricultural economies, a significant portion of farmland is used on a lease basis. The productivity of leased agricultural land is often influenced by various factors, such as soil quality, cultivation practices, technological integration, and the responsibilities outlined in lease agreements.

In recent years, the rapid advancement of digital and innovative agricultural technologies has created opportunities for enhancing land productivity, optimizing resource use, and reducing production costs. Technologies such as precision farming, remote sensing, Geographic Information Systems (GIS), drones, automated irrigation systems, and climate smart agriculture practices enable farmers and land users to monitor land conditions accurately and make timely, data driven decisions.

However, despite these advancements, many leased agricultural lands continue to suffer from soil degradation, improper crop rotation, insufficient technological interventions, and limited investment in land improvement. This research investigates how innovative technologies can be applied to improve the fertility and productivity of leased agricultural lands

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and offers practical recommendations for their effective implementation.

The purpose of this study is to analyze the role and impact of innovative technologies in enhancing the productivity of agricultural lands used on a lease basis and to evaluate the economic and environmental benefits associated with adopting modern farming solutions.

**Methods.** This research applies a mixed method analytical framework combining qualitative and quantitative approaches. The study evaluates technological applications in leased agricultural lands by examining soil conditions, productivity metrics, irrigation efficiency, and economic outcomes.

The methodological framework includes literature analysis, field data collection, geospatial monitoring, and statistical modeling. Emphasis is placed on assessing how specific technologies—such as precision farming equipment, satellite monitoring systems, drip irrigation, and digital soil analysis tools—affect productivity indicators and resource management. This study employs a mixed methods research approach, integrating both qualitative and quantitative data to assess the effect of innovative technologies on leased agricultural land productivity.

**Data collection.** Primary and secondary data were collected through the following methods:

- **Field observations** of agricultural activities on leased lands.
- **Interviews** with farmers, agronomists, and landowners involved in lease agreements.
- **Analysis of agricultural reports** from national land management and agricultural agencies.
- **Remote sensing data** collected from satellite imagery to evaluate vegetation health, land use patterns, and soil conditions.

**Data analysis techniques.** The collected data were analyzed using:

- **GIS based spatial analysis** for soil fertility and vegetation index mapping.
- **Normalized difference vegetation index (NDVI)** to assess crop health.
- **Statistical analysis** to compare productivity indicators before and after implementing innovative technologies.
- **Cost benefit analysis** to determine the economic feasibility of technological interventions.

**Study Area.** The study focuses on agricultural regions where land is predominantly leased for seasonal or long term crop cultivation. These areas typically demonstrate varying levels of technological adoption, soil fertility challenges, and diverse farming practices.

**Results.** The findings of the research demonstrate a clear positive correlation between the adoption of innovative agricultural technologies and the productivity of leased agricultural lands. Improvements were recorded in soil fertility, water use efficiency, crop yield, economic returns, and

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environmental sustainability. The study revealed that the implementation of innovative technologies significantly enhances the productivity of leased agricultural lands. The key findings are summarized as follows:

**Improvement in soil fertility and crop growth**

The use of precision farming tools allowed farmers to:

- Apply fertilizers more accurately based on soil nutrient maps.
- Reduce excessive fertilizer usage by **15–25%**, lowering production costs.
- Improve soil fertility indicators due to targeted soil treatment.

Remote sensing data indicated that NDVI values increased by **0.12–0.25 units** in fields where precision agriculture technologies were adopted.

**Water saving and efficient irrigation systems.**

The integration of drip irrigation systems resulted in the following improvements:

- Water savings of up to **40–60%**.
- Increased irrigation accuracy and crop resilience to drought.
- Yield increases of **10–20%** depending on crop type.

Automated irrigation systems further increased water use efficiency and allowed farmers to schedule irrigation based on real time soil moisture readings.

**Economic Benefits for Land Users and Owners**

The cost benefit analysis showed that farmers using innovative technologies experienced:

- An **average income growth of 18–30%** per hectare.
- Reduced reliance on manual labor.
- Higher crop quality and market value.

Farmers operating under lease agreements reported that technological integration enabled them to fulfill land productivity obligations as outlined in lease contracts.

**Environmental impact**

Innovative technologies helped reduce:

- Soil degradation caused by inappropriate farming methods.
- Chemical residue accumulation due to optimized fertilizer use.
- $CO_2$ emissions by minimizing unnecessary machinery operations.

The overall sustainability of leased agricultural lands increased due to improved resource management.

Only 28% of surveyed leaseholders used any form of digital or precision technology. The most adopted tools were mobile advisory services (19%), followed by drip irrigation (12%) and soil testing kits (9%). Larger farms (>20 ha) were three times more likely to adopt multiple technologies than smallholders.

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| Crop | Control yield (t/ha) | Treatment yield (t/ha) | % Increase |
|---|---|---|---|
| Cotton | 2.7 | 3.7 | +37% |
| Wheat | 3.4 | 4.2 | +24% |
| Tomato | 28 | 38 | +36% |

Input cost analysis revealed a 15–25% reduction in water and fertilizer use under technology-integrated practices. Net farm income rose by 22% on average among adopters.

**Discussion.** The results of this study highlight that technological interventions significantly improve land productivity, especially when combined with proper land management practices and supportive institutional frameworks. Technological integration promotes sustainability, strengthens the economic viability of leased agricultural systems, and helps address long standing challenges such as soil degradation and inefficient resource use.

Furthermore, this research emphasizes the need for policy interventions and institutional support to overcome current barriers and ensure widespread technology adoption. Collaboration among government bodies, agricultural extension services, technology providers, and farmers is essential for developing a sustainable agricultural ecosystem. The findings indicate that innovative agricultural technologies can significantly enhance the productivity of leased agricultural lands. These improvements contribute to long term soil fertility, sustainable land use, and economic efficiency. However, several challenges hinder wider adoption of such technologies:

**Financial constraints.** Many small scale tenant farmers lack sufficient financial resources to invest in modern technologies, despite their long term benefits. Subsidies or government support programs may be required to increase adoption rates.

**Limited technical knowledge.** Farmers often lack the technical skills needed to operate GIS tools, drones, and automated systems. Training programs and agricultural extension services play a crucial role in addressing this issue.

**Lease agreement limitations.** Short term lease agreements discourage farmers from investing in long term soil improvement or technology integration. Revising lease policies to encourage longer term agreements may lead to better land management practices.

**Infrastructure barriers.** Rural areas often lack adequate digital connectivity, hindering the adoption of smart farming technologies that rely on real time data.

Despite these limitations, the study demonstrates that the targeted application of technological innovations offers substantial benefits. Integrating soil analysis, satellite monitoring, automated irrigation, and precision agriculture

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creates a synergistic impact that enhances land productivity, especially in leased farmlands.

**Conclusion.** Innovative technologies hold transformative potential for leased agricultural lands in Uzbekistan, offering pathways to higher yields, resource efficiency, and climate resilience. However, their success hinges on complementary institutional reforms particularly in land tenure, credit access, and extension services. A coordinated strategy linking technology providers, leaseholders, and policymakers is essential to unlock this potential. As Uzbekistan advances its 2030 Sustainable Development Strategy, embedding innovation within the leasing framework can catalyze inclusive rural transformation.

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