ECONOMIC ASSESSMENT OF WATER RESOURCE USE IN AGRICULTURE BASED ON SMART TECHNOLOGIES: EVIDENCE FROM UZBEKISTAN

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Abstract. Efficient use of water resources is a critical issue for agricultural sustainability in Uzbekistan. This paper evaluates the economic significance of smart and water-saving irrigation technologies using regional data for 2019–2023. The study analyzes the dynamics of technology adoption, regional distribution, and the economic implications of improved irrigation management. The results indicate that the area equipped with smart technologies reached approximately 1.22 million hectares during the analyzed period, accounting for about 28.4% of irrigated land. Adoption has accelerated significantly since 2021, although regional differences remain substantial. Regions such as Khorezm, Navoi, and Jizzakh demonstrate the highest adoption levels, while Kashkadarya and Karakalpakstan remain below the national average. The findings suggest that smart irrigation technologies can improve the economic productivity of water resources by reducing losses, optimizing irrigation scheduling, and lowering operational costs.

Keywords: smart technologies, irrigation, water-saving technologies, economic efficiency, Uzbekistan, agricultural water use

ЭКОНОМИЧЕСКАЯ ОЦЕНКА ИСПОЛЬЗОВАНИЯ ВОДНЫХ РЕСУРСОВ В СЕЛЬСКОМ ХОЗЯЙСТВЕ НА ОСНОВЕ ИНТЕЛЛЕКТУАЛЬНЫХ ТЕХНОЛОГИЙ: ДАННЫЕ ИЗ УЗБЕКИСТАНА.

Аннотация: Эффективное использование водных ресурсов является критически важным вопросом для устойчивого развития сельского хозяйства в Узбекистане. В данной работе на основе региональных данных за 2019–2023 годы оценивается экономическое значение интеллектуальных и водосберегающих технологий орошения. В исследовании анализируется динамика внедрения технологий, региональное распределение и экономические последствия улучшения управления орошением. Результаты показывают, что площадь, оснащенная интеллектуальными технологиями, за анализируемый период достигла примерно 1,22 млн гектаров, что составляет около 28,4% орошаемых земель. Внедрение значительно ускорилось с 2021 года, хотя региональные различия остаются существенными. Регионы Хорезм, Навои и Джизак демонстрируют самые высокие уровни внедрения, в то время как Кашкадарья и Каракалпакстан остаются ниже среднего показателя по стране. Результаты показывают, что интеллектуальные технологии орошения могут повысить экономическую продуктивность водных ресурсов за счет сокращения потерь, оптимизации графика орошения и снижения эксплуатационных расходов.

Ключевые слова: интеллектуальные технологии, орошение, водосберегающие технологии, экономическая эффективность, Узбекистан, водопользование в сельском хозяйстве

QISHLOQ XO'JALIGIDA SUV RESURSLARIDAN FOYDALANISHNI AQLLI TEXNOLOGIYALAR ASOSIDA IQTISODIY BAHOLASH: O'ZBEKISTONDAN OLINGAN DALILLAR

Annotatsiya: Suv resurslaridan samarali foydalanish O'zbekistonda qishloq xo'jaligi barqarorligi uchun juda muhim masala hisoblanadi. Ushbu maqolada 2019–2023 yillardagi mintaqaviy ma'lumotlardan foydalangan holda aqlli va suvni tejaydigan sug'orish texnologiyalarining iqtisodiy ahamiyati baholanadi. Tadqiqotda texnologiyalarni joriy etish dinamikasi, mintaqaviy taqsimot va sug'orishni boshqarishni yaxshilashning iqtisodiy oqibatlari tahlil qilinadi. Natijalar shuni ko'rsatadiki, tahlil qilingan davrda aqlli texnologiyalar bilan jihozlangan maydon taxminan 1,22 million gektarga yetdi, bu sug'oriladigan yerlarning taxminan 28,4% ni tashkil qiladi. 2021 yildan beri joriy etish sezilarli darajada tezlashdi, ammo mintaqaviy farqlar sezilarli darajada saqlanib qolmoqda. Xorazm, Navoiy va Jizzax kabi mintaqalar eng yuqori joriy etish darajasini ko'rsatmoqda, Qashqadaryo va Qoraqalpog'iston esa milliy o'rtacha ko'rsatkichdan pastligicha qolmoqda. Tadqiqot natijalari shuni ko'rsatadiki, aqlli sug'orish texnologiyalari yo'qotishlarni kamaytirish, sug'orish jadvalini optimallashtirish va operatsion xarajatlarni kamaytirish orqali suv resurslarining iqtisodiy unumdorligini oshirishi mumkin.

Kalit so'zlar: aqlli texnologiyalar, sug'orish, suvni tejaydigan texnologiyalar, iqtisodiy samaradorlik, O'zbekiston, qishloq xo'jaligida suvdan foydalanish

1. Introduction

Water resources play a central role in Uzbekistan’s agricultural sector. Agriculture accounts for approximately 90% of the country’s water consumption, making efficient water management essential for sustainable economic development. However, a large share of irrigation infrastructure remains outdated, leading to significant water losses and high operational costs.

Recent national strategies have emphasized modernization of irrigation systems and the introduction of digital and smart technologies. The Government of Uzbekistan adopted the Water Sector Development Concept for 2020–2030, which prioritizes improved efficiency in water use and wider adoption of water-saving technologies. Financial incentives have also been introduced to encourage farmers to adopt modern irrigation methods. For example, subsidies are provided for land equipped with water-saving irrigation systems.

Smart irrigation technologies such as drip irrigation, sprinkler systems, and digital water management tools allow farmers to control irrigation more precisely and reduce unnecessary water use. These technologies also improve crop productivity and reduce energy costs associated with pumping water.

The objective of this paper is to assess the economic importance of smart irrigation technologies in Uzbekistan’s agriculture. The study focuses on analyzing adoption trends and regional distribution while discussing their potential economic implications for water resource management.

2. Results and discussion

The national trend is clear. The total area reported under smart technologies increased from 35.7 thousand hectares in 2019 to 49.5 thousand hectares in 2020, then rose sharply to 433.0 thousand hectares in 2021. Although the annual total moderated after that, it remained high at 354.7 thousand hectares in 2022 and 348.9 thousand hectares in 2023. Over the five-year period, the

cumulative reported area reached about 1.22 million hectares. This pattern suggests a structural scaling-up of smart irrigation after 2020 rather than isolated pilot adoption.

At the same time, adoption is highly uneven across regions. Based on the uploaded dataset, the national cumulative adoption shares equals 28.4% of irrigated land. Yet regional values range from 15.9% in Kashkadarya and 21.7% in Karakalpakstan to 53.0% in Khorezm. Such differences matter economically because the benefits of better irrigation control are not distributed evenly across the country.

Table 1. Top five regions by adoption share in the uploaded dataset.

Region	Irrigated land (ha)	Smart-tech area (ha)	Adoption share (%)
Khorezm	266,000	141,010	53.0
Navoi	123,000	49,488	40.2
Jizzakh	300,000	111,080	37.0
Andijan	265,000	93,296	35.2
Bukhara	275,000	93,980	34.2

Source: Author’s calculations based on the uploaded regional dataset for 2019–2023.

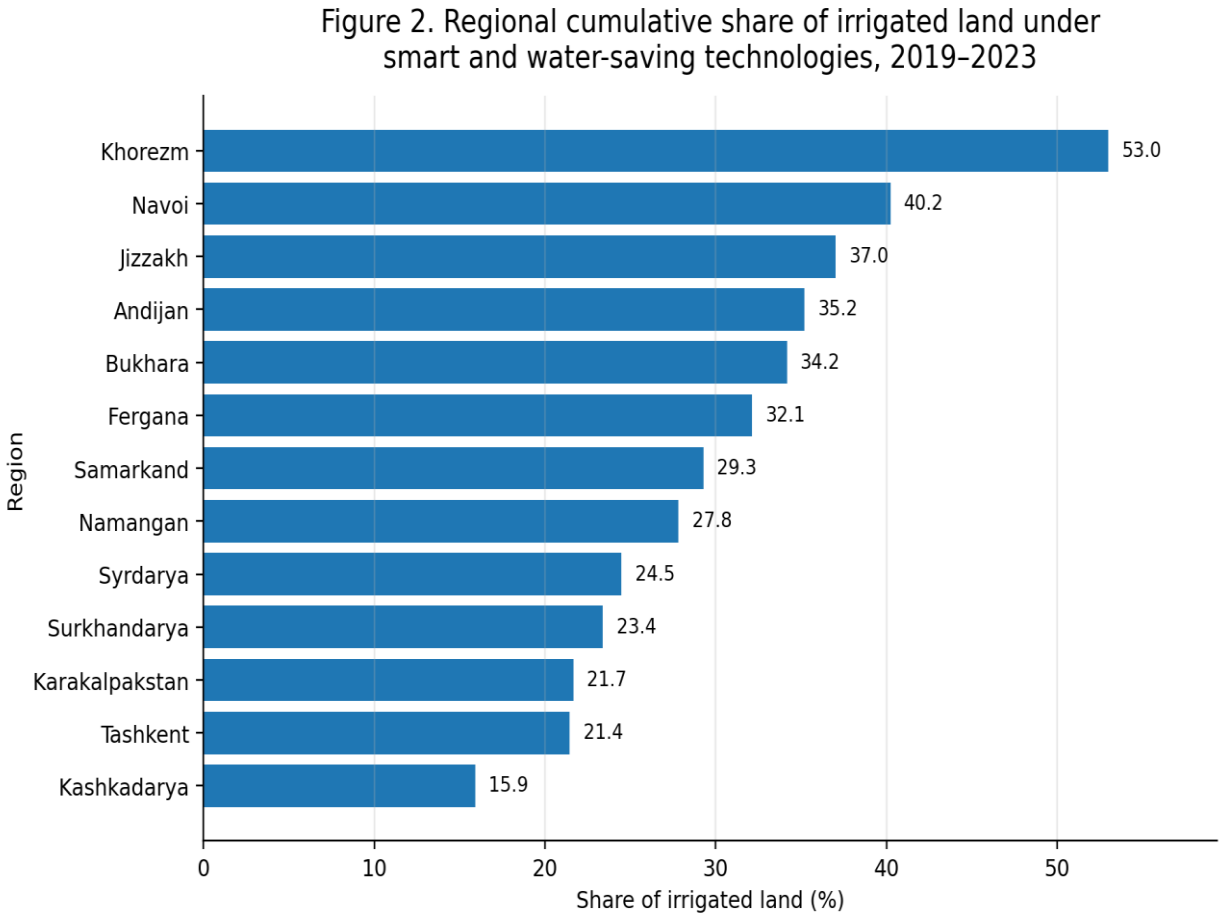

Figure 2. Regional cumulative share of irrigated land under smart and water-saving technologies, 2019–2023 (%).

Source: Author’s calculations based on the uploaded regional dataset for 2019–2023.

The regional ranking places Khorezm first, followed by Navoi, Jizzakh, Andijan and Bukhara. Economically, these regions can be interpreted as the current frontier of water-saving modernization in the dataset. Higher coverage of smart systems should improve the return on each cubic meter delivered to farms by reducing over-irrigation and by improving the precision of application. This is especially relevant in Uzbekistan because irrigation reliability, pumping intensity and energy use are tightly connected.

The composition of technologies also matters. The dataset shows that laser land leveling and drip irrigation account for the largest cumulative areas over 2019–2023, followed by sprinkler and flexible-pipe systems. This mix is economically meaningful: drip irrigation is associated with targeted water delivery, while laser leveling can reduce uneven distribution and excess losses in field application. In other words, the economic value of smart technologies comes not only from “saving water” in a narrow sense, but from reorganizing the production process around more precise, controllable, and potentially lower-cost irrigation.

However, the results should be interpreted carefully. The sharp increase after 2020 may reflect both real expansion and improved reporting or measurement. More importantly, this paper cannot estimate exact net present value, internal rate of return, or crop-specific profit effects because the underlying dataset lacks investment, maintenance, water-use and yield series at farm level. For a longer thesis, these variables should be added to build a full cost-benefit model. For a conference paper, the present evidence is sufficient to demonstrate strong economic relevance and to identify where deeper evaluation should be targeted.

4. Conclusion

The evidence from Uzbekistan’s regional data for 2019–2023 supports the conclusion that smart and water-saving irrigation technologies are economically important instruments for improving agricultural water use. Their significance lies in increasing water-use efficiency under conditions of scarcity, reducing operational burdens associated with pumping and field-level inefficiency, and creating a basis for more productive and resilient irrigated agriculture. The data set shows that adoption has expanded rapidly but unevenly, which implies that future policy should combine continued financial incentives with stronger technical support in lagging regions. For subsequent research, the best next step is to connect regional adoption data with farm-level information on water consumption, yields, energy use and installation costs to estimate direct monetary returns more precisely.

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