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THE ROLE OF RESOURCE-SAVING TECHNOLOGIES IN REDUCING OPERATIONAL COSTS AND ENHANCING SOLVENCY IN THE AGRO-INDUSTRIAL SECTOR OF UZBEKISTAN

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Abstract: Uzbekistan is the country, where agriculture plays a crucial role in the economy, contributing significantly to GDP and providing employment, especially in rural areas. This research paper investigates the impact of resource-saving technologies on operational costs and financial solvency within Uzbekistan's agro-industrial sector. However, the several issues need to be studies and addressed in the sector, as it faces challenges such as water scarcity, rising input costs, and global market volatility. Findings indicate that these technologies can yield substantial savings in water, labor, fertilizers, and energy, thus it can improve profitability and solvency for agricultural enterprises. Additionally, the need for government support and infrastructure development to overcome barriers to technology adoption and achieve sustainable agricultural practices are also discussed within the article.

Key words: Agro-industry, solvency, operational costs, ROE, export, GDP, drip irrigation, laser land leveling, Sprinkler irrigation, water productivity, fertilizer, SAFA, FAO.

Introduction

In the economy of Uzbekistan, agriculture accounts for the large portion of the national economy and its growth. The agro-industrial sector significantly contributes to the country's GDP (gross domestic product), moreover, the sector assists in mitigating the unemployment and poverty issues, providing substantial employment opportunities, particularly in rural areas. Additionally, it surely is one of the most important parts that generate vital export revenues, as also stated by the World Bank.[1] Apart from its economic value, agro-industry is a tool to ensure food security for the nation's population and support the livelihoods of its citizens.[2] However, there are some issues that need to be addressed, such as the need to meet the food demands of a growing population while simultaneously addressing environmental sustainability concerns.

These challenges are related. Reduced water supply due to climate change, ineffective irrigation, and local water disputes causes soil erosion and salinization. At the same time, agricultural businesses are under pressure from growing labor, fertilizer, energy, and water prices. Furthermore, the profitability of the sector is further threatened by the volatility of global commodity prices. Thus, analyzing the solvency of farms and companies in the agriculture industry, the capacity of agricultural enterprises to fulfill long-term financial commitments is essential regarding the mentioned problems. Resilience, investment attractiveness, and the ability to endure environmental and economic shocks are all guaranteed by maintaining solvency. This article examines the ways in which resource-saving technology might lower operating expenses and promote the agro-industrial sector's financial stability in Uzbekistan so that application of these technologies contributes to boosting solvency, increasing efficiency, and guaranteeing agriculture's sustainable future.

Literature Review

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The agro-industrial sector forms a critical pillar of Uzbekistan's economy. In 2020, agriculture alone accounted for approximately 25 percent of the nation's gross domestic product (39), a figure that remained significant at 23 percent in 2023.

Tayirov, O., Karimov, I. V., Toshmamatov, A., and Shomirzayev, S. (2024) have analyzed the rational use of water resources in agriculture, and their study highlights the urgent need for Uzbekistan to improve water management practices in the agricultural sector, addressing economic and governance barriers, and implementing community-based systems to protect the system.[1] The integration of contemporary technology with local participation has been demonstrated in recent pilot projects to improve system sustainability and resource efficiency.

According to Gerasymchuk (2017), the production of a single calorie of food frequently requires up to 10 calories of energy, making agriculture one of the most resource-intensive businesses. This inefficiency is not specific to poor countries; for instance, increased automation and chemical use in the US has resulted in a tenfold increase in energy use for every doubling of agricultural output. More specifically, the typical American farmer uses over 40 billion kilowatt-hours of power, 19 million tons of mineral fertilizers, and one million hectoliters of oil per year.[2] These results highlight how vital it is for agriculture to use more energy-efficient technology in order to lower input costs and increase sustainability.

The study of Jo‘rayev, F. and Normurolovich, S. (2024) indicates that establishing minimal permitted expenditures, setting up innovation centers, and guaranteeing a varied economic structure are all viable strategies for the rehabilitation and expansion of agricultural industries. To establish an agricultural cluster, these hubs are essential, as are creative opportunities and a diverse economic structure.[3] The authors also emphasize the importance of establishing protected status in the budget for financing and implementing innovations, and ensuring the creation of innovation centers to support the development and growth of the agricultural sector.

The analysis conducted by Eshov, M., Amirov, L., and Askarova, M. (2021) indicate that although Uzbekistan protects the land rights of farmers, studies show that important agricultural projects continue to get insufficient support. Modernizing the industry, increasing export potential, and improving budget efficiency are all regarded as crucial measures in increasing competitiveness.[4] The industry plays a crucial role in rural employment and national food security, making these reforms especially crucial. With assistance from foreign partners, the National Agricultural Development Strategy (2019–2030) is anticipated to direct this transition.

Methodology

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[1] Tayirov, O., Karimov, I. V., Toshmamatov, A., & Shomirzayev, S. (2024). Rational Use of Water Resources in Agriculture (In the Case of Uzbekistan). *International Journal of Business Diplomacy and Economy*, *3*(5), 142-146.

[2] Gerasymchuk, N. (2017). Specifics of development and approbation of resource saving strategy in agro-industrial complex. *Технологический аудит и резервы производства*, *5*(5 (37)), 13-20.

[3] Jo‘rayev, F. D. S., & Normurolovich, S. S. (2024). Agrosanoat klasterlari o'sish omili sifatida mintaqaning raqobatbardoshligi baholash. *Prospects and main trends in modern science*, *2*(16), 46-52.

[4] Eshov, M., Amirov, L., & Askarova, M. (2021). Development of the agricultural sector and its importance in Uzbekistan. In *E3S Web of Conferences* (Vol. 244, p. 03014). EDP Sciences.

This study adopts a mixed-methods approach and applies both qualitative and quantitative analysis to examine how resource-saving technologies affect operational costs and solvency in Uzbekistan's agro-industrial sector. The literature review draws on academic research, policy documents, and reports from international to establish a theoretical framework and identify knowledge gaps relevant to Uzbekistan.

Selected agricultural businesses and geographical areas that have integrated technology such as laser land leveling, precision agriculture, and drip irrigation are the subject of case studies. These were selected to represent variations in farm size, crop variety, and location. The examination looks at how the technologies affect financial metrics including debt levels and profitability along with operating expenses. Secondary data from sources including the Uzbek State Committee on Statistics, FAO, and multilateral development banks supports the analysis of sectoral performance and technology adoption trends. The analysis is constrained by the availability of comprehensive farm-level financial data as well as the data sources' inconsistent regional and temporal coverage.

Results and Discussion

Key performance metrics of irrigation management and planning, including the area of irrigated crops, the adequacy of irrigation service, water consumption, water productivity, and irrigation efficiency, were analyzed geographically and temporally in a multi-year remote sensing-based I&D performance assessment for Uzbekistan by the World Bank.

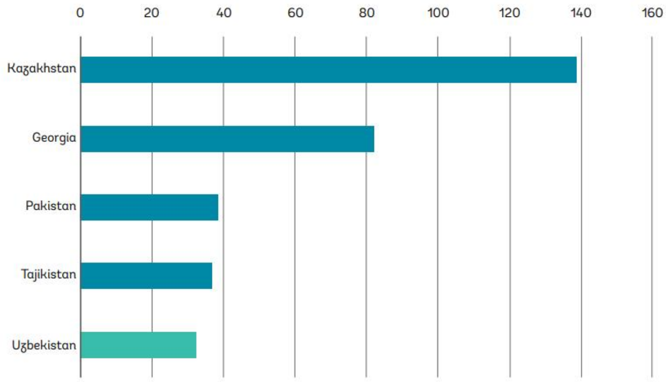

Figure 1. Total Annual Capital Expenditure per Hectare (USD/hectare), Selected Countries in Central Asia

A large amount of money spent on O&M takes money away from capital projects to upgrade and repair the nation's irrigation infrastructure. Comparing Uzbekistan to its neighbors, the country spends less on I&D, namely Irrigation and Drainage (Figure 1). Looking at average capital expenditures from 2015 to 2019, for instance, Kazakhstan's capital expenditures per acre are around four times more than Uzbekistan's.

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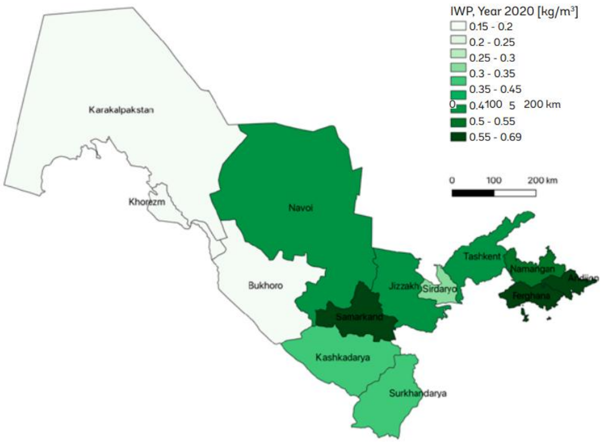

Figure 2. . Irrigation Water Productivity According to Regions, 2020[5]

While irrigation water productivity level in most areas falls below of global standards, there was a noticeable upward trend between 2016 and 2020, and several oblasts, including Andijan, Ferghana, and Samarkand, had average system-level irrigation efficiency between 55 and 60 percent. Additionally, regions experiencing water stress conditions due to inadequate irrigation water are identified by the remote-sensing study. According to Figure 2, water deficits are higher in arid regions of northern and western Uzbekistan, indicating greater irrigation water demand. Cotton in Samarkand Oblast has the lowest water deficit values, indicating issues with water delivery to meet crop water demand.
The adoption of resource-saving technologies in Uzbekistan's agro-industrial sector is showing 0070romising trends, directly influencing operational costs and enhancing financial solvency.

a) Adoption rates of key technologies
The Uzbek government has actively promoted the adoption of water-efficient irrigation technologies. According to the Food and Agriculture Organization of the United Nations (FAO) In Uzbekistan and Turkmenistan, there is a critical level of stress on water resources.[6]
Experts assess the level of water resource stress in Uzbekistan and Turkmenistan as critical (exceeding 100 percent).
The volume of water used by these countries amounts to 169 percent and 144 percent of their available water reserves, respectively. As of 2023, drip irrigation has been implemented on over 200,000 hectares, with ambitious plans to expand this to 4.3 million hectares by 2030.[7]
Sprinkler irrigation covers around 55,000 hectares, and another technology, laser land leveling is also receiving significant government support.[8] Precision agriculture is emerging, primarily on larger farms, while conservation tillage is also gaining traction.

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[5] Uzbekistan - Policy Perspectives for Irrigation and Drainage Sector Reform - World Bank Documents and Reports, https://documents1.worldbank.org/curated/en/099022824155511451/pdf/P1732501ad71e00301b2fa1dc0dd0e51758.pdf
[6] https://news.un.org/ru/story/2021/08/1408882
[7] Shavazov, K., Khojibekova, S., Mukimov, B., Umirov, A., & Kadirova, S. (2025). State and development of farms in Uzbekistan as a basis for food security. In *BIO Web of Conferences* (Vol. 161, p. 00027). EDP Sciences.
[8] Uzbekistan Takes Bold Steps to Address Water Scarcity, https://uzbekistan.org/uzbekistan-takes-bold-steps-to-address-water-scarcity/4551/

Drip Irrigation
Up to 40% less water is used when drip irrigation is used to distribute water straight to plant roots. Farmers in Uzbekistan receive subsidies that cover up to 50% of system expenses and are granted a five-year land tax exemption. However, small farms' adoption is constrained by the large initial expenditure.
Sprinkler Irrigation
Sprinkler systems can improve irrigation efficiency because the system simulates rainfall, but adoption in Uzbekistan is lower due to equipment costs and energy needs. They are mainly used in larger farms or pilot projects which aim to modernize irrigation.
Laser Land Leveling
This technique levels fields using laser-guided equipment, saving 15–20% of water and increasing yields by up to 7 centners/ha. In general, it is gaining popularity with government support, equipment cost and required expertise remain barriers for smaller farms.

b) Impact on Operational Costs: A quantitative perspective:
Nowadays, the financial benefits of adopting resource-saving technologies are becoming evident and being analyzed in application.

- Water Savings: Drip irrigation can reduce water usage by 20-60% compared to traditional methods.[9] Some findings suggest that drip irrigation saves up to 40–55% of water per 1 hectare of land by type of crop, 1.5–2 times reduction of labor costs, 35–40% It was found that the saving of mineral fertilizers will increase the yield of cotton by 0.8–1.0 t·ha–1, as studied in Bukhara region.[10] As a hypothetical example, irrigating 1 hectare of cotton traditionally might require 10,000 m^3 of water, while drip irrigation could lower this to 4,000-8,000 m^3, so the result shows substantial cost reductions on water tariffs and energy for pumping. Laser land leveling contributes to a 20-30% reduction in water use.
- Fertilizer Savings: Department of Water-Saving Scientific and Innovative Technologies of the Ministry of Water Resources of the country informs targeted fertilizer application through drip irrigation can lead to savings of 25-35%, and potentially up to 50%.[11]

P recision agriculture has shown a 15% reduction in fertilizer use in some cases.

- Energy Savings: Optimized irrigation, particularly drip irrigation, can significantly reduce electricity consumption for pumping. Studies in the Karshi Steppe suggest potential savings of 259 GWh of electricity.[12] So, optimized irrigation, particularly drip irrigation, can significantly reduce electricity consumption for pumping
- Labor Savings: Technologies like drip irrigation reduce the need for manual watering, and laser land leveling can automate land preparation, which leads to the potential reduction in labor cost.

[9] Otabek, B. (2019). Agricultural production costs, product cost and ways to reduce it in Uzbekistan. *Science Review*, (4 (21)), 25-28.
[10] Efficiency of drip irrigation technology of cotton in the saline soils of Bukhara oasis M.Kh. Khamidov1 , U.A. Juraev2, X
[11] Uzbekistan seeks to introduce new technologies for irrigation of agricultural lands, https://cabar.asia/en/uzbekistan-seeks-to-introduce-new-technologies-for-irrigation-of-agricultural-lands
[12] Djumaboev, K., Yuldashev, T., Holmatov, B., & Gafurov, Z. (2019). Assessing Water Use, Energy Use And Carbon Emissions In Lift-Irrigated Areas: A Case Study From Karshi Steppe In Uzbekistan. *Irrigation and Drainage*, *68*(3), 409-419.

Table 1. Potential Cost Savings from Resource-Saving Technologies

Technology	Input saved	Estimated Saving	Note
Drip Irrigation	Water	20-60%	High water savings potential.
Drip Irrigation	Fertilizer	25-50%	Substantial nutrient efficiency gain.
Drip Irrigation	Energy	Significant	potentially large
Laser Land Leveling	Water	20-30%	Moderate, consistent water savings.
Precision Agriculture	Fertilizer	Up to 15%	Modest input reduction.

c) International Frameworks and Uzbekistan

Several international frameworks emphasize sustainable agriculture and responsible investment, aligning with Uzbekistan's efforts:

- FAO's Sustainability Assessment of Food and Agriculture systems (SAFA): Provides a comprehensive framework for assessing environmental integrity, social well-being, economic resilience, and good governance in agricultural systems.
- Principles for Responsible Investment in Agriculture and Food Systems (CFS-RAI): Offer guidance for investors to contribute to sustainable development, enhance food security and nutrition, and respect human rights in their agricultural investments.
- Global Reporting Initiative (GRI) Sector Standard for Agriculture, Aquaculture and Fishing: Aims to increase the completeness and comparability of sustainability information for organizations in these sectors.

Taking into account Uzbekistan's "Strategy for Transition to Green Economy" [13]and its Nationally Determined Contributions (NDCs) under the Paris Agreement demonstrate a commitment to these international goals by promoting resource-saving technologies and sustainable practices.

d) Formulas and Calculations

- **Water Saving Calculation (Example):**
  - Traditional Water Use = 10,000 m³/ha
  - Drip Irrigation Water Use = 6,000 m³/ha (40% reduction)
  - Water Saved = 10,000 - 6,000 = 4,000 m³/ha
- **Fertilizer Saving Calculation (Example):**
  - Traditional Fertilizer Use = 100 kg/ha
  - Precision Agriculture Fertilizer Use = 85 kg/ha (15% reduction)
  - Fertilizer Saved = 100 - 85 = 15 kg/ha
- **Return on Investment (ROI)** (Simplified):

ROI = (Net Profit from Investment - Cost of Investment) / Cost of Investment

[13] Environment and Climate Action | United Nations Development Programme, https://www.undp.org/uzbekistan/environment-and-climate-action

Based on the case study, the ROI for drip irrigation in cotton over five years can be estimated in application with a detailed year-by-year calculation.

Table 2. Uzbekistan: Economic costs and benefits of drip irrigation adoption[14]

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Benefits ('000 Soums/ha): **	**12,375.3**	**11,250.2**	**10,227.5**	**9,297.7**	**8,452.6**	**51,602.9**
Fuel savings	413.3	375.7	341.5	310.5	282.3	1,723.2
Mechanization	405.0	368.2	334.7	304.3	276.6	1,688.8
Fertilizers	933.0	848.2	771.1	701.0	637.3	3,890.5
Labor savings	-149.2	-135.7	-123.3	-112.1	-101.9	-622.2
Yield increase	6,825.0	6,204.5	5,640.5	5,127.7	4,661.6	28,459.3
Income from improved watering of other crops*	4,000.0	3,636.4	3,305.8	3,005.3	2,732.1	16,679.5
Costs ('000 Soums/ha):	**9,611.7**	**1,435.3**	**673.7**	**136.3**	**109.3**	**11,966.3**
Matching grant	8,000.0					8,000.0
Interest rate subsidy	1,451.7	1,289.8	541.5	16.1		3,299.1
Land tax exemption	160.0	145.5	132.2	120.2	109.3	667.2
Net gain for cotton ('000 Soums/ha)	**-1,184.6**	**6,225.6**	**6,290.8**	**6,195.1**	**5,646.6**	**23,173.3**
Net gain for cotton and other crops ('000 Soums/ha)	**2,815.4**	**9,862.0**	**9,596.6**	**9,200.4**	**8,378.7**	**39,852.8**

Table 35 shows that, in contrast to the program's total public investment of 12 million Soums over five years, the nation's net economic gains per acre may potentially reach 23 million Soums. An average increase of 1.5 tons per hectare in cotton output is responsible for almost 80% of these advantages. The net benefit is still significant at 14 million Soums per hectare, even though the yield gain is just 1.0 ton per hectare. As a result, it is predicted that the 57,000 hectares that are now under drip irrigation would offer net economic benefits that range from 792 billion Soums (with a yield increase of 1.0 tons/ha) to 1.33 trillion Soums (with a yield increase of 1.5 tons/ha). When the water savings from irrigating other crops are taken into account, these advantages are further increased. For example, Table 35 shows that irrigating an extra 0.25 hectares of tomatoes might boost net profits by 40 million Soums.

Conclusion

Despite the obvious benefits of resource-saving technology, there are still several barriers to their general adoption, chief among them being high upfront costs, a lack of farmer awareness, and inadequate infrastructure. Subsidies, tax breaks, and awareness initiatives are some of the ways the government is actively assisting this shift, creating genuine prospects for future expansion. One of the most important things Uzbekistan's agriculture industry can do to reduce production costs and increase financial stability is to use these technology. Data and examples from the real world demonstrate that these improvements may drastically cut down on labor, energy, fertilizer, and water usage, which will increase earnings.

The long-term benefits of implementing such methods are demonstrated by these initiatives, which also help global sustainability goals. Building a sustainable and prosperous future for Uzbekistan's agriculture will require continued government assistance in the form of infrastructure development, research, and farmer training in order to fully realize their potential.

[14] documents1.worldbank.org, https://documents1.worldbank.org/curated/en/381251635752865696/pdf/Uzbekistan-Second-Agricultural-Public-Expenditure-Review.pdf

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