WAYS TO INCREASE THE ECONOMIC EFFICIENCY OF GRAIN PRODUCTION THROUGH THE USE OF INNOVATIVE TECHNOLOGIES IN AGRICULTURE

Dilmurodov Lochinbek Utkir ugli
Tashkent State Agrarian University Field of Digital Economy 2nd year master's student
Email: dilmurodovlochin01@gmail.com
DOI:https://doi.org/10.5281/zenodo.23089829

Abstract. This thesis examines practical ways to increase the economic efficiency of grain production in Uzbekistan through innovative agricultural technologies. The analysis combines official national statistics, recent scientific evidence on wheat productivity, and Uzbekistan's agricultural policy framework. According to the National Statistics Committee, total grain and leguminous crop production reached 10.112 million tonnes in 2025, 13% higher than in 2024. Official historical data also show that grain production increased from 7.663 million tonnes in 2020 to 8.947 million tonnes in 2024, while wheat output rose from 6.165 million to 6.729 million tonnes over the same period. The thesis argues that economic efficiency should be improved not simply by maximizing output, but by increasing yield and quality per unit of land, water, energy, fertilizer, machinery time and working capital. Policy measures under the Agriculture Development Strategy 2020–2030, the Smart Agriculture digitalization strategy and Presidential Decree No. PF-130 of 12 August 2025 provide an institutional basis for accelerating this transition.

Keywords: grain production; wheat; economic efficiency; innovative technologies; precision agriculture; water-saving irrigation; digital agriculture; conservation agriculture; productivity; Uzbekistan.

Introduction

Grain production is a strategically important component of food security and agricultural development in Uzbekistan. Wheat, in particular, occupies a central position in the national food system and in irrigated crop rotations. The economic efficiency of grain production is therefore important not only for individual farms but also for price stability, rural incomes, efficient use of scarce water and land resources, and the resilience of the national food system.

The current challenge is changing from a simple increase in gross output to an increase in resource productivity. Uzbekistan's agriculture operates under water scarcity, rising energy costs, climate variability, soil salinity in a number of regions, and significant differences in farm-level management quality. Under these conditions, additional production obtained through excessive water, fertilizer or fuel use may not be economically efficient. Innovative technologies are valuable when they reduce the cost of producing one tonne of grain, raise marketable yield, stabilize production risks, or improve the timing and quality of farm decisions.

Official statistics demonstrate the scale and recent growth of the sector. Total grain production in all categories of farms increased from 7.663 million tonnes in 2020 to 8.947 million tonnes in 2024, an increase of approximately 16.8%. Wheat production increased from 6.165 million tonnes to 6.729 million tonnes, or about 9.1%, during the same period. Preliminary official data for 2025 report 10.112 million tonnes of grain and leguminous crops, 13% above 2024. These figures show strong production dynamics, but they do not by themselves indicate whether every additional tonne was produced at minimum economic and environmental cost.

The purpose of this thesis is to identify the main technological and organizational directions through which innovative agricultural technologies can increase the economic efficiency of grain production in Uzbekistan. The focus is on precision and digital agriculture, water-saving technologies, improved seed and variety selection, conservation agriculture, optimized fertilizer use, mechanization and data-based farm management.

© 2026 International Conference on Artificial Intelligence and Applications . All Rights Reserved.

Main Part

Current production trends and the economic-efficiency problem

The National Statistics Committee reports that Uzbekistan produced 8.947 million tonnes of grain crops in 2024, compared with 8.510 million tonnes in 2023 and 8.036 million tonnes in 2022. Wheat accounted for 6.729 million tonnes in 2024. In 2025, preliminary production of grain and leguminous crops reached 10.112 million tonnes. At the regional level, the largest reported 2025 volumes included Fergana Region with 1.147 million tonnes, Samarkand Region with 1.016 million tonnes and Kashkadarya Region with 0.955 million tonnes. The regional variation confirms the importance of local agro-climatic conditions, irrigation access, crop management and technology adoption.

Recent research provides a more direct indication of the productivity reserve. Devkota and co-authors estimate that wheat productivity in Uzbekistan reached about 4.55 t/ha in 2023 but identify a yield gap of approximately 3.25 t/ha. Their analysis indicates that achieving a substantially higher national wheat yield requires coordinated improvements in irrigation, fertilizer management, varieties and sowing time. The same research reports that conservation agriculture can increase wheat yield by about 26% relative to conventional tillage in relevant salt-affected dryland conditions, while newer high-yielding and stress-tolerant varieties can raise productivity by up to 22% under the studied conditions. These are agronomic effects rather than guaranteed farm profits, but they reveal a significant economic opportunity if additional output exceeds the cost of adoption.

Economic efficiency can be expressed through several complementary indicators: yield per hectare, production cost per tonne, gross margin per hectare, profitability, water productivity, fertilizer-use efficiency, fuel use per hectare and labor productivity. An innovation should therefore be evaluated by its effect on the whole cost-and-return structure. For example, a technology that raises yield by 8% but raises total production cost by 20% may be unattractive, while a technology that keeps yield stable and reduces fuel and water use can improve profitability.

Table 1. Selected grain-production indicators in Uzbekistan. Source: National Statistics Committee (SIAT).

Indicator	2020	2024	Change, 2020–2024
Total grain production, thousand tonnes	7,662.6	8,946.9	+16.8%
Wheat production, thousand tonnes	6,165.4	6,729.4	+9.1%

Precision agriculture and digital monitoring

Precision agriculture can improve grain profitability by applying inputs according to spatial and temporal need rather than using uniform rates across heterogeneous fields. Satellite imagery, geographic information systems, soil maps, yield maps, field sensors and drone observations can identify zones with different moisture, salinity, nutrient status or crop vigor. The economic mechanism is straightforward: unnecessary fertilizer, water and pesticide applications can be reduced in low-response areas, while yield-limiting zones can receive timely treatment.

For grain farms, the highest-value digital applications are likely to be field mapping, crop-condition monitoring, irrigation scheduling, weather-based disease risk alerts and digital recording of input use. These tools also improve management accounting because farmers can compare actual costs and yields by field. Digitalization is particularly useful for large farms where visual inspection alone is costly and slow.

Uzbekistan's policy framework increasingly supports this direction. Cabinet of Ministers Resolution No. 794 of 17 December 2020 on digitalization of the agro-industrial complex identifies digital and geoinformation technologies for agricultural land, computerized water management,

© 2026 International Conference on Artificial Intelligence and Applications . All Rights Reserved.

automated technologies and training for "smart agriculture" as long-term directions. More recently, Presidential Decree No. PF-130 of 12 August 2025 set the goal of digitalizing sowing and irrigation processes on more than 4 million hectares of agricultural land and expanding services using unmanned aerial vehicles. This creates a direct institutional basis for applying remote sensing and digital monitoring to grain production.

Water-saving irrigation and water productivity

Water is one of the most important economic constraints in Uzbekistan's grain production. The Agriculture Development Strategy for 2020–2030, approved by Presidential Decree No. PF-5853 of 23 October 2019, includes a target to reduce water use per irrigated hectare by 20% by 2030 and calls for support for water-saving technologies. This policy is economically important because irrigation has both direct water-delivery costs and indirect energy costs.

The World Bank reports that about 2.4 million hectares, or 56% of Uzbekistan's irrigated agricultural land, depend on pumping, while approximately 1,700 irrigation pumping stations consume around 7.2 billion kWh of electricity annually. Consequently, water-saving and energy-efficient irrigation can affect grain profitability through both water productivity and energy expenditure. Field-level irrigation scheduling, soil-moisture monitoring, laser land leveling where appropriate, improved canal management and efficient irrigation methods can reduce avoidable losses.

Recent wheat research for Uzbekistan also identifies irrigation as one of the principal determinants of the yield gap. The economic priority is therefore not simply "less water," but more grain per cubic meter of water. Farms should evaluate irrigation technology using additional yield, water saved, energy saved, capital cost and equipment life. Subsidy or credit mechanisms are most effective when they reward verified resource savings rather than equipment purchase alone.

Conservation agriculture, improved varieties and optimized inputs

Conservation agriculture offers another route to lower unit costs. Reduced tillage and No-Till systems can decrease machinery passes, fuel use, labor requirements and field-preparation time while helping retain soil moisture. FAO-supported regional work has reported increases in water-use efficiency of 21–30% where conservation-agriculture principles were applied, and a maximum grain yield of 7.51 t/ha was recorded in Uzbekistan in the cited regional project. More recent Uzbekistan-specific research reports a 26% wheat-yield advantage from conservation agriculture over conventional tillage under studied salt-affected dryland conditions. These results support wider farm-level economic trials, although performance should be evaluated by soil type, rotation and machinery availability.

Improved varieties and quality seed are equally important because they influence the productivity of all other inputs. Stress-tolerant and high-yielding varieties can improve the return to irrigation and fertilizer under heat, salinity or water stress. Devkota et al. identify variety selection, sowing date, irrigation and nitrogen management as major determinants of wheat yield. Their analysis suggests that delayed sowing can cause measurable yield penalties, demonstrating that timeliness itself is an economic variable.

Precision nutrient management should replace blanket fertilizer recommendations where data are available. Soil testing, crop diagnostics and field history can be used to select rates and timing. The objective is to maximize marginal return: fertilizer should be applied until the expected value of additional grain no longer exceeds the marginal fertilizer and application cost. Mobile soil laboratories, digital recommendations and variable-rate technologies can strengthen this approach.

Policy reforms and conditions for profitable innovation

Technological innovation works best when supported by market and institutional reform. Presidential Decree No. PF-5853 approved the Agriculture Development Strategy for 2020–2030 and emphasizes food security, resource-saving technologies, investment, market mechanisms, information and communication technologies, science and human-capital development. The Strategy also envisages expansion of water-saving irrigation and gradual reduction of direct state participation in cotton and grain production. This is important because farm-level economic incentives influence whether producers adopt innovations that reduce cost or improve quality.

© 2026 International Conference on Artificial Intelligence and Applications . All Rights Reserved.

Presidential Decree No. PF-130 of 2025 further accelerates modern technology adoption by linking digital agriculture with rational land and water use, accurate production data, interactive services and unmanned aerial systems. The economic effect of such policy will depend on affordability and farmer access. Small and medium farms may need shared drone services, machinery-service centers, leasing, concessional innovation credit, extension services and digital platforms rather than purchasing expensive equipment individually.

Table 2. Main innovative directions and their economic mechanisms in grain production.

Innovation	Economic mechanism	Expected efficiency effect	Key condition
Precision agriculture and GIS	Target inputs by field condition	Lower input cost per tonne; better yield stability	Reliable field data and advisory skills
Digital crop/drone monitoring	Earlier detection of stress and crop problems	Lower scouting cost and avoidable yield loss	Affordable service model and trained operators
Water-saving irrigation	Reduce water and pumping-energy use	Higher water productivity and lower energy cost	Correct scheduling and infrastructure
No-Till / reduced tillage	Fewer machinery passes and better moisture retention	Lower fuel/labor cost; possible yield gains	Suitable soils, rotation and machinery
Improved varieties and quality seed	Higher genetic yield and stress tolerance	Higher output and lower production risk	Locally adapted certified seed
Precision fertilizer management	Apply nutrients according to crop/soil need	Higher fertilizer-use efficiency and gross margin	Soil testing and economic thresholds

The most efficient policy model is therefore technology-neutral and results-oriented. Support should prioritize verified reductions in water, fuel and input costs; improvements in yield stability and quality; and measurable increases in farm profitability. Demonstration plots and independent cost-benefit assessment can reduce the risk of adopting expensive technologies that are unsuitable for local conditions.

Conclusion

Uzbekistan has achieved significant growth in grain output: official data show an increase from 7.663 million tonnes in 2020 to 8.947 million tonnes in 2024, followed by preliminary production of 10.112 million tonnes of grain and leguminous crops in 2025. Nevertheless, recent scientific evidence indicates that a substantial wheat yield gap remains. This means that future growth can increasingly come from better management of existing land, water and inputs rather than from extensive expansion.

The most promising ways to increase economic efficiency are the combined use of precision agriculture, digital and drone monitoring, water-saving irrigation, conservation tillage, improved varieties, timely sowing and site-specific nutrient management. Their economic value should be assessed through cost per tonne, gross margin, profitability, water productivity, fuel use and yield stability, not through yield alone.

Uzbekistan's Agriculture Development Strategy 2020–2030, the Smart Agriculture digitalization framework and Presidential Decree No. PF-130 of 2025 provide a supportive policy basis. To convert these policies into farm income, it is recommended to expand demonstration farms, shared digital and machinery services, applied extension, affordable innovation finance, soil and water diagnostics, and independent cost-benefit monitoring. The central principle should be to produce each tonne of grain

© 2026 International Conference on Artificial Intelligence and Applications . All Rights Reserved.

with fewer scarce resources and lower avoidable cost while maintaining soil fertility and long-term resilience.

References

1. National Statistics Committee of the Republic of Uzbekistan. (2026). Production of grain crops – total in all categories of farms. SIAT official statistics database.
2. National Statistics Committee of the Republic of Uzbekistan. (2026). Wheat production in all categories of farms. SIAT official statistics database.
3. National Statistics Committee of the Republic of Uzbekistan. (2026, February 25). The volume of grain production in 2025 exceeded 10.1 million tons.
4. Devkota, K. P., Devkota Wasti, M. K., Boboev, H., Juraev, D., Dilmurodov, S., & Sharma, R. C. (2025). Data-Driven Agronomic Solutions to Close Wheat Yield Gaps and Achieve Self-Sufficiency in Uzbekistan. Agricultural Systems, 225, 104291. https://doi.org/10.1016/j.agsy.2025.104291
5. Food and Agriculture Organization of the United Nations (FAO). Conservation agriculture and resource conserving technologies for irrigated areas in Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan. FAO and Türkiye Partnership.
6. World Bank. (2025, May 21). Uzbekistan to Modernize Its Irrigation Infrastructure with World Bank Support.
7. President of the Republic of Uzbekistan. (2019). Decree No. PF-5853 of 23 October 2019, On approval of the Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020–2030. National Database of Legislation (LexUZ).
8. Cabinet of Ministers of the Republic of Uzbekistan. (2020). Resolution No. 794 of 17 December 2020, On measures to develop the digitalization system in the agro-industrial complex and agriculture. National Database of Legislation (LexUZ).
9. President of the Republic of Uzbekistan. (2025). Decree No. PF-130 of 12 August 2025, On measures to increase efficiency through further acceleration of the introduction of modern technologies in agriculture. National Database of Legislation (LexUZ).

© 2026 International Conference on Artificial Intelligence and Applications . All Rights Reserved.