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DEVELOPMENT AND IMPROVEMENT OF INNOVATIONS IN AGRICULT

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Abstract. The article explores strategies for enhancing the implementation of nnovations in agriculture. Due to the rapid growth of Uzbekistan's agricultural sector and the launch of promising development projects, there is a growing need to adopt modern machinery, equipment, technologies, and expertise across emerging agricultural fields. This includes organizing efficient and innovation-driven operations and ensuring that innovation efforts are properly directed.

The issue has been widely addressed in scientific literature through journal articles and monographs. The increasing interest from both society and the scientific community reflects the recognition of innovation's vital role, particularly during the transition to a market-based economy.

To address this topic, several objectives were achieved: the concepts of innovation and innovative activity were examined; the nature and distinctive aspects of innovation in agriculture were identified; an assessment of the current state of Uzbekistan's agricultural sector was conducted; the progress of innovation initiatives in the country was analyzed; and mechanisms to strengthen innovation in agriculture were proposed.

1. Introduction

The development of our country's economy is closely linked to the agricultural sector, which plays a vital role in providing food for the population and raw materials for industry. To ensure the sustainable growth of agriculture in Uzbekistan, it is essential to implement consistent economic reforms, make effective use of investments, labor, technology, and innovations, and leverage available resources to increase the sector's economic efficiency.

Currently, as part of the nation's economic reforms, various legal, organizational, and economic initiatives are being introduced to support the sustainable development of small agricultural enterprises. The "Agricultural Development Strategy of the Republic of Uzbekistan for 2020–2030" emphasizes support for entrepreneurship and diversification within the sector.

Additionally, the "new Uzbekistan development strategy for 2022–2026" outlines key goals, including science-based intensive farming, improved soil fertility, enhanced agricultural services through innovation, a 1.5-fold increase in agro-industrial production, the development of agro-logistics centers and laboratories, the implementation of a national seed and seedling program, and the establishment of an international agricultural university to strengthen the link between science and practice.

Globally, leading countries are transitioning to innovation-driven models in the agro-industrial complex. This model focuses on integrating science and technology with agricultural production to improve efficiency. In Uzbekistan, the advancement of innovation is central to increasing productivity and employment in agriculture. It supports better product quality, reduced labor and material costs, higher labor efficiency, and improved production organization.

In the era of digitalization, innovation becomes a critical driver of agricultural growth and efficiency. The national innovation strategy aims to develop and adopt new technologies, enabling a shift to modern production systems and enhancing the competitiveness of agricultural

enterprises in both local and international markets. Innovation encompasses not only technology but also economic, organizational, and social advancements

To successfully develop the agricultural sector, Uzbekistan must adopt modern machinery, tools, technologies, and innovative approaches. Attracting foreign investment by capitalizing on innovation potential is a key priority[1-2].

This requires defining innovation policy directions aligned with current economic needs, implementing innovation-driven projects, and establishing a market for innovative products. Achieving these goals will also depend on training specialists with strong knowledge of scientific and organizational principles of innovation [1-4].

Modernizing agricultural production infrastructure, increasing crop and livestock productivity, and boosting innovation to ensure global competitiveness are crucial. However, challenges remain in integrating innovation into the sector, especially due to inconsistencies in reforms, farming development, and cooperative expansion [1-3].

Therefore, it is essential to develop scientifically grounded mechanisms for introducing innovation, establishing new organizational and management practices, and identifying the most effective strategies for implementation.

2. Discussion

The rapid advancement of Uzbekistan's agricultural sector involves integrating modern machinery, equipment, technologies, and expertise into emerging areas of agriculture through the implementation of forward-looking development projects. A key objective is to establish effective and well-structured innovation-driven activities. However, fully utilizing innovative potential and attracting foreign investment remains a significant challenge.

To address this at the level of agricultural enterprises and sectors, it is essential to define innovation policy directions that align with current economic development needs, launch innovative projects, and develop a functioning market for innovative products. Achieving these goals also requires training qualified personnel with a strong understanding of the scientific and organizational principles of innovation.

Implementing this task within the agricultural sector and economic entities requires identifying the key directions of innovation policy aligned with contemporary economic development demands. This involves executing innovative projects and establishing a market for innovative products. To achieve these goals, it is essential to train professionals equipped with comprehensive knowledge of the scientific principles and organizational structures that drive innovation.

Innovation emerges from efforts to leverage modern technologies, knowledge, and advanced methods to develop new products that offer fresh capabilities with market potential or address the negative impacts of harmful processes. It represents a culmination of scientific and technological progress, delivering value across economic, social, and environmental dimensions. Innovation activity serves as a comprehensive system integrating innovative outcomes, cutting-edge products, advanced workforce training, and more. Among these, referential innovation activity stands out as a particularly significant aspect of innovation efforts.

Key areas for the advancement and modernization of agriculture focus on enhancing production through the application of scientific and technological progress, as well as research and development in the agro-industrial sector. Innovation in this context refers to a systematic process that brings about qualitative changes in products, tools, equipment, technologies, and methods of production and management, with the primary aim of boosting competitiveness and production efficiency.

A review of innovation types highlights several that are especially prevalent in agriculture, including:

Implementation of technologically advanced equipment and agro-industrial technologies;

Adoption of new marketing strategies and tools;

Improvement of management systems and workplace organization.

Cotton farming stands out as the most commercially significant agricultural sector in Uzbekistan. The industry benefits from the use of modern machinery and technologies, a well-established infrastructure for producing technical resources, the development of new agro-technological methods, and substantial scientific expertise in cotton breeding and seed production. This, along with the presence of experienced professionals, positions Uzbekistan as one of the leading cotton-producing countries in the world.

The cotton sector plays a crucial role in the overall growth of the agricultural economy. Cotton farmers today earn substantial incomes from their work, invest in expanding production, and develop entrepreneurial competencies. The increase in agricultural output is largely driven by intensive farming practices aimed at boosting crop yields

Table 1 presents the changes in the area of agricultural crops over time. According to the data, the land devoted to grain crops decreased from 1,689.4 thousand hectares in 2019 to 1,578.3 thousand hectares in 2022. In contrast, the area for vegetable cultivation grew from 206.2 thousand hectares in 2019 to 220.0 thousand hectares in 2022. Similarly, the land allocated for potatoes increased from 84.6 thousand hectares in 2019 to 89.6 thousand hectares in 2022. Overall, the total agricultural crop area contracted from 3,705.7 thousand hectares in 2019 to 3,397.4 thousand hectares by 2022. Despite this reduction in arable land, agricultural production levels remained unaffected. This stability is primarily attributed to the intensive development of agriculture, particularly through improved crop yields [1-4].

Table 1. Dynamics of changes in the area of agricultural arable land in the republic (thousand hectares) [12].

No	Indicators	2019 year	2020 year	2021 year	2022 year
1	Total sown area	3705.7	3475.5	3395.0	3397.4
	Including:				
2	Wheat	1689.4	1655.6	1644.2	1578.3
3	Potato	84.6	78.5	85.8	89.6
4	Vegetable	206.2	189.4	218.0	220.0
5	Polycultures	58.7	53.8	52.5	53.4
6	Cotton	1264.1	1203.2	1109.3	1150.6

Table 2 shows the dynamics of agricultural production in the republic. As can be seen from the table, over the past 20 years, the gross harvest of the main types of agricultural crops has had a constant growth rate. In particular, in 2022, compared to 2019, grains will increase from 8117.5 thousand tons to 7437.8 thousand tons, vegetables from 11434.6 thousand tons to 10215.1 thousand tons, potatoes from 3015.6 thousand . tons to 3089.2 thousand tons, sugar products from 2094.8 thousand tons to 2068 7. thousand tons, fruits increased from 3076.3 thousand tons to 2752.7 thousand tons, grapes from 1747.9 thousand. . tons to 1749.9 thousand tons [1-5].

Table 2. Dynamics of agricultural production in the republic (thousand tons) [12].

No	Indicators	2019 year	2020 year	2021 year	2022 year
1.	Don	8117.5	7289.5	6554.5	7438.8
2.	Cotton	2901.2	2854.9	2286.6	2692.7
3.	Potato	3015.6	2794.7	2913.9	3099.2
4.	Vegetable	11434.6	10239.9	9761.3	10216.1
5.	Policy max.	2094.8	2031.0	1837.0	2068.7
6.	Fruits	3076.3	2614.9	2706.2	2752.7
7.	Grape	1747.9	1748.9	1749.9	1759.9

To enhance the efficiency of agricultural production, it is essential to minimize production constraints and network costs while optimizing workflow processes. This requires the mechanization of advanced modern production, procurement, and storage methods within enterprises. Additionally, it is important to maximize the effective use of fixed assets, implement innovative technologies, and establish both material and moral incentives to motivate workers.

During periods of stable water supply in Uzbekistan, it is recommended to maintain cotton cultivation within an area of 95-100 thousand hectares. This figure represents 25-30% of the total sown area during favorable water conditions and allows for the implementation of a scientifically grounded crop rotation system, particularly benefiting agricultural practices in the Republic of Karakalpakstan. However, unplanned cotton planting or cultivating cotton in low-yield areas with high soil salinity can lead to substantial financial losses for cotton growers. These losses should be regarded as a negative impact on the overall economy of the republic.

Introducing resource-saving innovative technologies on a large scale is crucial for our country's progress. The development of cotton growing in the republic serves as a prime example of the benefits such innovations bring. Specifically, the use of the specialized product "Humimax-double strength" in cotton cultivation significantly increases the proportion of raw materials classified as first-grade quality, averaging 85-90 percent. This improvement directly translates into additional income for farmers. Experiments confirm the positive influence of this product on cotton growth and development. Observations reveal that the cotton stems in treated fields reached a length of 54.3 cm, which is 1.5 times greater compared to untreated fields. Moreover, the 8.3 cm growth advantage in Humimax-treated fields was found to be 3.3 times higher than in control plots.

The number of bolls, buds, and fully developed bolls in the control field was noticeably lower compared to other cotton fields. For instance, on August 1, the number of bolls per cotton plant in the control field was 5.5. In contrast, in the field where Humimax was applied at a rate of 0.3 l/ha, this figure increased to 6.5. By September 1, the control field showed 6.6 bolls per plant, whereas the field treated with Humimax recorded 8.0 bolls. Additionally, it was observed that the highest number of opened bolls—16.2% more than in the control—was seen in areas where Humimax fertilizer was applied at a rate of 0.3 l/ha. In these same treated fields, the average weight of raw cotton per boll reached 5.98 grams, marking a 4.7% increase (or 0.27 grams) compared to the cotton bolls in the control plots.

Based on the experimental results, it was determined that a decrease in the application rate of the drug Humimax leads to a proportional reduction in the weight of cotton raw material per bag. Calculations indicate that fields treated with Humimax yielded, on average, 2.2–4.2 c/ha more than the untreated control fields. The highest yield, recorded at 34.4 t/ha, was achieved when Humimax was applied at a rate of 0.3 l/ha during the budding and flowering stages of cotton growth. Additionally, the relative tensile strength of 3-fiber improved, with the weight of 1000 seeds increasing by 0.5–1.0 gk/tex. The experimental data also highlight the high economic efficiency of Humimax. Its application to 1 hectare resulted in an additional yield of 3.68 t/ha

across the cotton area. Further analysis showed that the enhanced variant, "Humimax-Double Strength," not only increased overall yield but also improved the proportion of first-grade material in the cotton raw composition, raised the average quality rating, and boosted profitability levels.

Table 3. Effect of the stimulant Humimax on cotton yield [12].

Experience Options	Bag weight, g	Cotton yield, tons/ha	Besides	
			c/ha	%
Control	4.0	28.7	-	-
Urea suspension 5+7 kg/ha	4.0	29.8	0.6	102.2
Humimax 0.8 l/t	4.3	32.2	3.5	112.6
Humimax 0.8 l/t, 3+0.3 l/ha	4.4	33.3	4.6	116.6
Humimax 1.0 l/t	4.3	32.6	3.9	114.1
Humimax 1.0 l/t0.3+0.3 l/ha	4.3	32.2	4.7	117.0

Based on Table 4, the yield with the application of the drug Humimax-double strength reached 29 centners per hectare, an increase of 4 centners compared to the untreated state (25 centners/ha) and 3 centners higher than with suspension treatment alone (26 centners/ha). When combined with a Humimax + suspension treatment, the yield rose by 2 centners, reaching 27 centners per hectare. This boost in productivity resulted in higher profits and improved overall profitability. Specifically, the profitability rate with Humimax-double strength treatment was 34 percent, reflecting a 13-point increase compared to the profitability rate observed in untreated cotton cultivation.

Table 4. Economic efficiency of cotton processing with Humimax[12].

	Economic indicators	Control	Treatment with suspension	Treatment with Humimax +	Humimax + suspense
1	Performance	25	26	29	27
2	Income from product sales, thousand soums	30000	31300	34900	32400
3	Total production costs, thousand.	24900	24200	25960	26000
4	Benefit	5200	7100	8940	6400
5	Profitability	21	29	34	24

Enhancing the management of innovation in agriculture supports the technical, technological, organizational, and economic modernization of the sector. Comparative analysis shows that overall efficiency results from the combined impact of these factors, enabling higher profits with reduced costs.

In Uzbekistan, technological advancements are being made in the use of drip irrigation systems. This method not only conserves water but also boosts land productivity, minimizes environmental pollution, significantly reduces wastewater discharge, improves water quality in natural sources, and contributes to environmental protection.

To improve the efficiency of cotton cultivation in agricultural enterprises across the country, several key measures are necessary:

Choose seed varieties that are appropriate for the fertility level of the soil.

Ensure proper management of irrigation and land reclamation practices.

Strengthen financial and economic support systems for cotton producers.

Improve collaboration between agricultural enterprises and training or service organizations.

Establish mechanisms to ensure that farms fully comply with contractual obligations.

Maintain a balanced cotton-grain-alfalfa crop rotation system in farms and small businesses; follow agronomic and agrochemical practices in line with scientific guidance and proven field experience; and ensure timely and effective irrigation.

Adhere to regulatory standards to combat cotton diseases and pests. The use of herbicides and other pest control chemicals is advised to slow pest development. Early harvesting—prior to the rainy season and within a short timeframe—is also recommended. Manual harvesting should be strictly monitored for contamination, with incentive bonuses provided for clean harvests.

In addition, it is recommended to apply 10 tons of locally sourced fertilizer per hectare during the harvest period, level the land, and prepare it for fall planting. These steps are crucial for achieving a strong and healthy cotton yield.

3. Conclusions

One of the key drivers of increased agricultural output and productivity is the adoption and widespread use of innovative practices. Experience has shown that innovation plays a crucial role in enhancing product quality, reducing labor and material costs, boosting labor efficiency, streamlining production, and improving overall industrial performance. Advancing innovation is essential to improving the socio-economic conditions of the agricultural sector in the country.

Priority areas for introducing innovation in agriculture include:

Enhancing the ecological state of irrigated lands and adopting water-saving irrigation technologies;

Advancing modern techniques for maintaining and boosting soil fertility;

Developing resource-efficient technologies to achieve higher yields and better-quality crops;

Breeding new cotton and grain varieties that are early-maturing, high-yielding, disease- and pest-resistant, and well-adapted to various soil and climate conditions, along with improving the primary seed production system;

Introducing agrotechnical practices tailored to cultivate new, acclimated, and promising crop varieties;

Making effective use of locally available raw materials and resources;

Implementing integrated plant protection methods;

Designing and deploying new agricultural equipment.

In today's era of scientific and technological advancement, creating and integrating innovations into the operations of agricultural enterprises remains a top priority. To further enhance this system, the following recommendations are proposed:

Apply innovative approaches to effectively utilize products, technologies, equipment, and other resources developed within agricultural enterprises;

Encourage and support innovative initiatives to promote the financial sustainability of newly established agricultural businesses.

Provide these enterprises with innovative ideas for the growth of agricultural processing industries.

Continuously invest in improving employee skills and integrate innovative thinking into training programs;

Study and adopt best practices from developed countries in organizing innovation in agriculture.

Strengthen systems for in-depth analysis of agricultural enterprise operations, ensuring proper implementation and regulation of innovation practices.

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