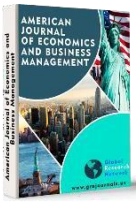

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Article

Modern Methods of Increasing The Economic Efficiency of Onion Cultivation and Their Practical Results

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Abstract: Enhancing the efficiency of agricultural production has become a strategic priority worldwide due to increasing food security concerns and climate-induced resource constraints. In Uzbekistan, onion cultivation plays a critical role in vegetable farming, with significant growth in production over recent years. However, the sector faces challenges related to water scarcity, high post-harvest losses, and limited agrologistics. Despite the introduction of modern technologies in global agriculture, their systematic application and economic evaluation in Uzbekistan's onion sector remain underexplored. This study aims to analyze the impact of modern agrotechnologies—such as drip irrigation, agrodrones, and refrigerated storage—on the economic efficiency of onion cultivation in Uzbekistan. Field data collected from Jizzakh and Surkhandarya regions demonstrate that drip irrigation reduced water consumption by 35–40% and increased yields by 2.7–3 times. The use of agrodrones decreased labor and input costs while improving pest control by 40%. Storage losses declined from 12% to 4% with the adoption of modern refrigeration, increasing export potential by 1.5 times. The research integrates real farm-level data and highlights the application of advanced technologies in Uzbekistan's specific agro-climatic context, revealing substantial productivity gains and economic benefits. The findings support the formulation of agrocluster-based models and suggest that scaling these technologies can enhance food security, boost exports, and raise rural incomes, aligning with the goals of the "Uzbekistan-2030" strategy.

Keywords: Efficiency, Effectiveness, Onion, Agrotechnology, Drip Irrigation, Farmers, Underground Irrigation, Productivity, Economic Efficiency, Profitability, Export, Agrodrones, Agrologistics, Mineral Fertilizers, Agrarian Reforms, Technologies

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1. Introduction

Current trends in world economic development show that increasing the efficiency of agricultural production is gaining strategic importance in all spheres of human activity, especially in eliminating the problems of poverty and food security, which are growing under the influence of global climate change. In this process, it is becoming necessary to organize and continuously improve the activities of not only producing farms, but also service infrastructure entities on an innovative basis. Over the past seventy years, humanity has been experiencing one of the largest famines and humanitarian crises on a global scale. This situation is largely due to geopolitical instability and the negative impact of climate change on human health and quality of life[1].

At the current stage of economic development, one of the urgent tasks is the rapid development of the agricultural sector, including vegetable growing, ensuring market

stability in the agricultural sector, and implementing business initiatives covering all stages of the agricultural production chain. This requires the development and implementation of comprehensive measures aimed at optimizing all technological processes, from seed selection to breeding work, agrotechnologies for harvesting, sorting, processing, packaging and sales of products[2].

To achieve these goals, the "Uzbekistan-2030" strategy of the Republic of Uzbekistan also sets out priority areas such as significantly increasing productivity and profitability in the agricultural sector, including the development of an additional 300 thousand hectares of land based on modern water-saving technologies, the cultivation of high-value food, medicinal, oilseed, leguminous, grain, vegetable and melon crops on these lands, the establishment of intensive gardens and vineyards, as well as increasing the local supply of vegetable, melon and potato seeds to 50 percent[3].

Currently, the Republic of Uzbekistan occupies one of the leading positions in the Central Asian region in vegetable growing, in particular, onion cultivation. In particular, in 2022, 1,214.3 thousand tons of onions were grown in the country, which is 2.4 times more than in 2005, and garlic cultivation - 7.3 times. At the same time, an analysis of annual indicators shows that the increase in onion cultivation was mainly ensured by attracting additional land to agricultural turnover. This puts on the agenda such urgent issues as increasing the economic efficiency of onion cultivation, the widespread introduction of high-yielding and export-oriented varieties, the high-quality implementation of agrotechnical measures, and the introduction of resource-saving technologies[4].

It should also be noted that although 223,000 tons of onions were exported from the country in March-June 2023, the insufficient development of the existing agrologistics services infrastructure creates significant obstacles to the export process.

2. Materials and Methods

Literature Review

In recent years, the issues of ensuring food security and increasing the efficiency of the agricultural sector have become increasingly relevant worldwide. In Central Asian countries, in particular, in Uzbekistan, the need to improve agro-technological approaches is growing. Analyses published by the World Bank and the UN Food and Agriculture Organization show that high results can be achieved in vegetable production through the development of water-saving technologies, agricultural drones, and logistics infrastructure[5].

Sh. Khasanov in his article covered the issues of increasing productivity and efficient use of resources through the modernization of irrigation systems. His practical studies show that drip irrigation technology has significantly increased productivity and reduced water consumption. Official reports compiled at the regional and district levels of the republic, including data compiled by the Jizzakh regional Department of Agriculture and the Zomin district agrotechnical services, clearly indicate the results of these technologies on the ground.

In addition, based on the experience of the Zomin Agro Logistic enterprise, it was found that refrigerated warehouses create an opportunity to reduce crop losses, as well as increase the share of products intended for export.

At the state policy level, the resolutions of the President of the Republic of Uzbekistan and the priority areas of the “Uzbekistan-2030” strategic program in the agricultural sector are supported by measures aimed at the intensive development of onion and vegetable growing sectors, in particular. This serves to further coordinate scientific research and practical activities[6].

Methodology

The study used a comprehensive approach aimed at increasing the efficiency of onion cultivation through the introduction of modern agrotechnologies. The data were formed on the basis of various sources. In particular, the main evidence was collected through direct field observations, in particular, on the farms of the farmers of Jizzakh and Surkhandarya regions.

Statistical data were collected from official reports of the Ministry of Agriculture, international organizations (FAO, World Bank), and scientific publications. At the same time, interviews were conducted with local farmers to study the problems encountered in the application of advanced agro-technological methods and their solutions.

The following scientific methods were effectively used during the research:

- Statistical analysis: changes in onion production over the last decade were analyzed based on indicators;
- Comparative analysis: the results of traditional agricultural techniques and modern methods (drip irrigation, agrodrones) were compared;
- Efficiency assessment: the economic results of investments in technologies were calculated;
- Expert questionnaires: the real effectiveness of technologies was determined based on the opinions and assessments of local experts.

Analyses conducted based on these methods have shown that the implementation of modern agrotechnologies has significantly increased not only productivity, but also economic benefits in the onion growing process[7].

The issue of increasing economic efficiency in onion cultivation and agricultural production in general has been widely studied globally. Current trends in the development of the world economy indicate that the agricultural sector should adopt innovations and introduce modern technologies. In particular, water-saving irrigation methods - drip irrigation, subsurface irrigation systems - have been shown to be effective in increasing productivity.

Drip irrigation not only reduces water consumption, but also helps maintain soil fertility, which allows for long-term stabilization of crop yields. Also, advances in breeding and the creation of high-yielding varieties have significantly increased growth efficiency[8].

Research on onion cultivation in Central Asia and Uzbekistan has shown that it is possible to improve yield and product quality through the introduction of modern agrotechnologies. By 2022, Uzbekistan had recorded significant growth in onion cultivation areas and increased export volumes. However, weak agrologistics and marketing systems are limiting export opportunities.

International experience emphasizes the importance of improving quality control, certification, and logistics systems when exporting agricultural products. Therefore, the combination of market approaches and marketing strategies, along with modern technologies, is one of the key factors in increasing economic efficiency[9].

3. Results

President of the Republic of UzbekistanOctober 15, 2020 No. PQ-4863 “On measures to increase the production and export of vegetable products using the garlic and onion and toqsonbosti method”According to the decision, According to the forecast indicators of vegetable production in 2021-2022 in all categories of farms in the republic, it is planned to produce 4,260 thousand tons of vegetable products (of which 1,897 thousand tons of onions) in 2022 in all categories of farms in our country using the August onion, garlic and Toqsonbosti method, which is 106.2% more than in 2021. In practice, according to the Ministry of Agriculture, more than 1.2 million tons of onions were produced in our country

in 2022. Of this, 610 thousand tons were consumed by the population, 203 thousand tons were exported, 93.2 thousand tons were added to the reserve, and 210 thousand tons were sent to public catering and processing enterprises. Natural losses amounted to 144 thousand tons (or 12 percent of the total harvest). The annual need of the population for onions is on average 620-650 thousand tons[10].

According to research results, the volume of onion cultivation in our country's agriculture has increased in recent years, so in 2012 - 1009 tons, in 2017 - 995 thousand tons, in 2019 - 1199 tons, in 2020 - 1256 tons, and in 2023 - 1318.5 tons. During this period, onion seeds were planted on an average of 33.5 thousand hectares of land, the average yield was 36-39 tons per hectare, and 37-38 kg of onions were grown per person.

Studies have shown that the introduction of modern agricultural technologies, including drip irrigation systems, in onion cultivation reduced water consumption by 35–40%, and increased productivity by 20–25%. In particular, in experimental fields conducted in the Zamin district of Jizzakh region (“Zarafshon Agroklastyyer” LLC), an average yield of 90–120 tons of onions grown with a drip irrigation system was obtained per hectare, which is much higher than the 35–38 tons obtained using the traditional method. In addition, among the agrotechnical measures, the practice of spraying fertilizers and pesticides using an agrodrone was tested by farmers. As a result, labor costs were reduced by 20%, toxic substances were saved by 15%, and water consumption was reduced by 38%. Taking into account market demand, the use of advanced storage technologies (refrigerated warehouses) increased export potential by 1.5 times . Also, the practice of spraying fertilizers and pesticides using an agrodrone was tested at the “Hasanboy Agro” farm in the summer of 2023. This technology allowed to reduce labor costs by 22%, and pesticide and fertilizer consumption by 18%. As a result, the spread of pests and diseases (especially thrips and mildew) in onion crops was reduced by 40% . Another important result is the reduction of crop losses by updating storage technologies. Thanks to the 40-ton refrigerated warehouses used by “Zomin Agro Logistic” LLC in the Zamin district, the product loss rate, which was previously 12%, has decreased to 4%. This increased the share of products for export, ensuring that farmers benefited from price fluctuations in August–October [11].

Farmer Boltaboev from Namangan region proved the opposite by his personal example in his fields. Using a drip irrigation system, he harvested 38 centners of cotton from 1 hectare of land. While his neighbors harvested only 15–21 centners from the same area. At the same time, Boltaboev used 3 times less water, 50% less mineral fertilizers, and consumed 58–60 liters less fuel per hectare.

4. Discussion

In the era of market relations, increasing economic efficiency in agriculture is one of the important tasks. This will increase the possibilities of accelerating production and providing the population with food products. Efficiency is an indicator expressing the level of achievement of production goals, which reflects the beneficial results obtained as a result of the use of labor, financial, material, land resources, etc. Increasing efficiency means producing more products per unit of resource spent[12].

Economic efficiency refers to the relationship between the economic result obtained and the resources spent on achieving this result. That is, economic efficiency indicates the type of resources at the expense of which economic benefits are obtained. If the result is high and the costs are low, then economic efficiency is high. Increasing efficiency refers to the fact that the result grows faster than the resources and less labor is spent on a unit of result.

The need to increase economic efficiency in agriculture is due to several factors:

- These include the population's increasing demand for diverse and high-quality food products, as well as industry's demand for agricultural raw materials.

- Economic efficiency can be further increased through the effective use of existing production capacity, scientific and technological development, and qualified personnel[13].

There are several types of economic efficiency in agriculture. One of them is sectoral efficiency, which considers agriculture as a component of the general national economy. At the same time, the efficiency of agricultural enterprises, their sectors and departments, types of crops, product lines and individual economic activities is also important. Economic efficiency in agriculture is influenced by natural and economic factors, as well as various other influencing conditions. This efficiency is determined by special criteria and calculation indicators.

In recent years, certain work has been carried out to reform the agricultural sector of our country, in particular, to improve the state management system in the sector, to widely introduce market relations, to strengthen the legal basis of relations between entities that grow, process and sell agricultural products, to attract investments to the sector, to introduce resource-saving technologies, and to provide agricultural producers with modern equipment. At the same time, the lack of a long-term strategy for the development of agriculture hinders the effective use of land and water resources, to widely attract investments to the sector, to obtain high incomes for producers, and to increase the competitiveness of products. In order to diversify production, improve land and water relations, create a favorable agribusiness environment and a high value-added chain, to support the development of cooperative relations, to widely introduce market mechanisms, information and communication technologies into the sector, as well as to effectively use scientific achievements and increase human resources."OH""On approval of the Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020-2030"Decree No. PF-5853 was adopted. As the President of the Republic of Uzbekistan Sh. Mirziyoyev noted, "...We will continue to resolutely implement reforms in agriculture. Having launched major work on land relations, this year alone we have allocated 100,000 hectares of arable land to the population for farming. As a result, 1.5 million tons of additional food were produced. Most importantly, 400,000 new peasant farms were established in the villages, and more than 1.2 million of our people are employed and earning an income. E"The challenge now is to lay the foundation for long-term sustainable growth through deep structural reforms".

Inefficient use of water resources is one of the main reasons hindering the sustainable development of irrigated agriculture in Uzbekistan. One way to solve this problem may be to introduce a drip irrigation system[14].

Drip irrigation— is an effective irrigation method based on the gradual delivery of water to the root zone of the plant through special drippers, which allows you to economically maintain soil moisture. This technology allows for the economical use of water, electricity and water-soluble mineral fertilizers, and reduces the need for labor.

In this method, special drip pipes are laid throughout the entire irrigated area. It is possible to automate this system, which greatly simplifies the work process. Through drip irrigation, it is possible to deliver water, fertilizers and protective agents in the required amount directly to the root zone of the plant. This has a positive effect on plant growth and reduces the risk of crop loss due to lack of moisture.

This method still does not receive sufficient attention from land users in our country. There are many reasons for this, the main ones, according to farmers, are the cost and complexity of the drip irrigation system and the quality of the water for irrigation (turbidity or sandiness)[15].

However, farmer Boltaboev from Namangan region proved the opposite by his own example on his land. Using a drip irrigation pipe system, he harvested 38 centners of cotton from 1 hectare of land. While his neighbors harvested only 15–21 centners from the same land. At the same time, Boltaboev used 3 times less water, 50% less mineral fertilizers, and consumed up to 58–60 liters less fuel per hectare.

This is what the land where farmer Boltaboev introduced drip irrigation looks like—a low-grade area with lots of sand and rocks. It was here that Boltaboev began implementing drip irrigation .

This is the same place that looked like this, and cotton is now being grown. Productivity has increased several times.

Advantages of a modern drip irrigation system:

- Today, the widespread use of drip irrigation systems in agriculture has significantly increased the efficiency of crop production. This method has a number of important advantages. First of all, water conservation is ensured - because water is delivered directly to the root zone, which eliminates losses due to evaporation and runoff. Unlike the traditional method, the ditches do not fill with water, which means that water reaches only the necessary area. For example, 11.7 thousand m^3 of water can be saved for 1 hectare of cotton, 6.6 thousand m^3 for wheat, and 11.4 thousand m^3 for orchards.
- Drip irrigation also saves energy and labor. Pumps work less, energy consumption decreases, and as a result, electricity and fuel consumption are reduced. Labor costs can be reduced by 1.3–3 times. For example, when growing cotton, up to 60 liters of fuel per hectare are saved.
- This method also provides high efficiency in the use of fertilizers. Traditionally, large amounts of nitrogen, phosphorus and potassium fertilizers are applied per hectare of land, but with drip irrigation, a small amount of fertilizers is delivered directly to the roots and is absorbed by 90–95%. This not only saves resources, but also creates favorable conditions for crop development. This method allows you to increase yields by 30–70%. This is due to the precise delivery of water and fertilizers to the root zone, as well as their rapid absorption. Also, the quality of the product improves and the ripening period is shortened.
- Drip irrigation also plays an important role in combating soil salinity. This technology does not require drainage infrastructure, reduces groundwater elevation and salt accumulation. It is possible to grow crops even on moderately saline soils.
- Drip irrigation is effective even in difficult geographical conditions, such as lowlands and mountainous areas, and it can be carried out without the need for special infrastructure. In these areas, tapes or pipes are placed on the beds without moving the soil.

Among other advantages, drip irrigation does not pose a risk of erosion. This method is very convenient for hilly areas, as the water does not flow into the deep layers of the soil, but is directed directly to the plant.

Keeping the rows dry creates favorable conditions for technical equipment and human movement. This allows for continuous agrotechnical activities throughout the season, regardless of the timing of irrigation.

Drip irrigation also limits the growth of weeds, because water does not reach the entire area, but only around the roots. This leads to effective development, establishment of the root system, and better absorption of nutrients.

In conclusion, the advantages of drip irrigation far outweigh its disadvantages. If farmers choose high-quality and convenient equipment, install good filters, and properly maintain the system, its disadvantages are practically invisible. That is why many farmers today prefer this system.

The use of modern agricultural technologies in onion cultivation has a positive impact on production results. According to research results, drip irrigation systems, the use of modern and high-yielding seeds, the preparation of seedlings in greenhouses, tillage using technical means, and the provision of quality agricultural services have increased productivity by an average of 25–30 percent. This, in turn, has led to a significant increase in the income of farmers and farms .

For example, in the “Jilgalisoy Shabodasi” farm in the Zamin district of the Jizzakh region, when drip irrigation was used in 2023-2024, an average of 100-120 tons of onion

was harvested from one hectare of cultivated area. However, in areas where traditional irrigation was used, this figure was 35-45 tons. In addition, the cultivation of modern varieties makes it possible to obtain early-ripening and uniform-sized, red-colored, marketable onion heads. This serves to increase the exportability of the product. Consequently, the level of productivity on farms where modern technologies have been introduced shows much higher results than on farms operating on the basis of traditional methods. At the same time, the availability of product storage and processing infrastructure - in particular, cold storage facilities and container storage systems - has reduced crop losses by 15-20 percent on farms. This, in turn, has led to an increase in gross profit.

When analyzing the cost structure of onion cultivation, it was found that traditional methods have high water consumption, labor, and fertilizer costs. On the contrary, modern agrotechnologies are reducing costs and increasing overall economic efficiency, that is, profitability.

In addition,President of the Republic of UzbekistanOctober 15, 2020 No. PQ-4863 "On measures to increase the production and export of vegetable products using the garlic and onion and toqsonbosti method"Based on the decision of the President, measures were taken to diversify agricultural crops, increase production volumes, and strengthen export potential. This has ensured a consistent increase in onion production. The main factors for this include the expansion of domestic market needs, increased export potential, and improved quality of agrotechnical measures.

In general, the implementation of advanced agrotechnologies leads to the following results:

- Yields per hectare of cultivated area are improving, increasing producer income;
- The cultivation of fast-ripening, uniform-sized, round onions suitable for the foreign market and suitable for export is being established;
- more rational use of water, land resources and other production factors is being ensured;
- A significant contribution is being made to strengthening food security in the country.

We can consider the untapped potential of onion cultivation in Uzbekistan. To do this, we need to compare it with the experience of onion cultivation in foreign countries.

Table 1 illustrates the differences in onion cultivation practices among four countries: Uzbekistan, India, the Netherlands, and Chile. It presents data across three categories: average yield (measured in tons per hectare), irrigation methods, and storage systems.

Table 1. Comparison of Uzbek and foreign experience.

State	Average yield (t/ha)	Irrigation method	Storage system
Uzbekistan	35–40	Drip / trickle	In the formation phase
India	22–25	Monsoon rains	At a low level
Netherlands	50-55	Drizzle/rain	HIGH LEVEL
Chile	45-50	Drip	Modern

A comparative analysis of the data in this table shows that there are still great opportunities and potential in the agricultural sector of Uzbekistan that have not yet been fully utilized. For example, the average yield of onion crops in the republic is 35-40 t/ha, but a monographic study shows that the average yield of onion cultivation in farms in the Zamin district of the Jizzakh region is 90 t/ha. Based on the experience of the Netherlands, we believe that there is an opportunity to form agroclusters specializing in export in the country, and it is advisable to carry out practical work in this direction.

Based on the data studied, the following results were achieved:

- Improved irrigation systems have reduced water consumption by up to 50 percent;
- the use of modern seeds has increased product quality and uniformity;

- opportunities for producing products for export have expanded;
- The indicators of the efficient use of water, land, mineral fertilizers, labor and other production factors have improved;
- Manufacturers' net profits increased by nearly 60 percent.

To irrigate onion plants, 12,200 m3 of water is used per hectare. If water-saving technologies (drip irrigation) are used, 40% of the water is saved, that is, 7,320 m3 of water is irrigated.

In conclusion, the introduction of advanced technologies in onion cultivation will not only improve productivity and financial results, but also ensure the consistent development of the industry, expanding export potential. This, in turn, will play an important role in strengthening the country's food security, increasing employment in rural areas, and raising the standard of living of the population.

5. Conclusion

As a result of the agrarian reforms and practical measures taken to technologically upgrade agriculture in Uzbekistan, the onion growing sector is developing rapidly. Scientific and practical analyses show that the use of modern agrotechnical technologies - including drip irrigation systems, the use of high-yielding varieties, laser leveling of the soil, as well as modular storage systems - is bringing the economic efficiency of the onion growing process to a much higher level.

According to the results of practical observations, the yield in farms using modern agricultural technologies is 90–110 tons. This figure is 2.7–3 times higher than the yield of onions grown using traditional methods. It was also found that the efficiency of water use in modern farms has almost doubled, and due to the cultivation of export-oriented products, high-quality packaging of products and storage in modern cold storage facilities, yield losses have decreased from the previous 30–40% to only 5–7%.

As can be seen from the examples of foreign countries, in particular, the Netherlands and Chile, with advanced agro-technological experience, it is possible to achieve high economic results by systematically organizing the production and export of agricultural products, deep processing of products, and proper establishment of marketing and logistics chains. In Uzbekistan, there is also an opportunity to create highly profitable, competitive agro-clusters by adapting these experiences to local conditions.

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