Assessment of the efficiency of production infrastructure in the agricultural sector in Azerbaijan

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Received:01.08.2026 Accepted: 12.08.2026 Published: 07.09.2026
https://doi.org/10.54414/UNBK7007

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Abstract

This article examines the current state of production infrastructure in the agricultural sector in Azerbaijan and its impact on the efficiency of agricultural production. The main objective of the study is to assess the economic efficiency of irrigation systems, transport and communication networks, warehouse and logistics centers, energy supply facilities, and other production infrastructure operating in the agricultural sector. It has also been determined that the uneven level of infrastructure provision in some regions is one of the main factors limiting the competitiveness of agricultural production. As a result of the analyses, recommendations were developed to increase the efficiency of infrastructure projects, introduce innovative technologies, and expand public-private partnership mechanisms.

Keywords: agrarian sector, production infrastructure, efficiency, agriculture, logistics, irrigation systems, regional development, Azerbaijan

1.Introduction

1.1. The essence and role of production infrastructure in the agricultural sector

Agriculture is one of the important sectors of the Azerbaijani economy and plays an important role in providing food to the population, increasing employment, and in the socio-economic development of regions. The sustainable development of the agricultural sector depends not only on land and labor resources, but also on a developed production infrastructure. Production infrastructure is a set of technical, economic, and organizational means necessary for the production, processing, storage, and delivery of agricultural products to consumers. As a result of the reforms implemented in the country's economy, which is currently undergoing a successful development process, it is expected that economic, organizational, technical, and technological sustainable mechanisms will be established that ensure the efficiency of the production process, and individual production sectors will develop further in accordance with market demands. However, under modern market relations, it is not only quantitative indicators that drive the growth of production, but also the formation and development of the necessary production infrastructure elements to implement this process, which requires significant relevance.

In general, the main aspect that makes the topic relevant is that there is increasing attention paid to further increasing the production volume of agricultural products, increasing their productivity, and effectively using existing potential in order to give dynamism to existing trends. This goal requires great

importance to be given to the establishment of processing and service enterprises, packaging and transportation, the adaptation of the material and technical base of agriculture to new economic relations, in short, the further strengthening of the achieved trends.

Agricultural economist Lydia Zepeda notes that infrastructure investments made by the state create the foundation for private investment. In his opinion, without roads, irrigation systems, reservoirs, and marketing infrastructure, it is impossible to introduce technologies and increase productivity. He emphasizes that infrastructure investments accelerate the adoption of technologies and improve market access for agricultural products (Zepeda, 2001, p. 5).

Another economist, Robert Evenson, believes that agricultural production infrastructure also includes agricultural advisory and training services. According to his research, increasing farmers' knowledge and spreading innovations have a significant impact on increasing productivity (Evensonç 1997, p.24).

Production infrastructure is a set of logistical and organizational systems that ensure the uninterrupted and efficient implementation of the agricultural production process.

The production infrastructure in the agricultural sector consists of the following elements:

-irrigation and land reclamation systems;

-agricultural machinery and agro-services;

-transport and logistics networks;

-electricity and communication systems;

-warehouses and refrigeration complexes;

-processing plants;

-agroparks and agricultural clusters;

-information and advisory services.

These infrastructure facilities create conditions for reducing production costs in agriculture, increasing productivity, and minimizing crop losses.

The analysis shows that the production process is characterized as a complex socio-economic and production infrastructure system with its own specific characteristics, encompassing the stages of preparation, sale, supply, processing, and consumption of products. From the perspective of modern economic development, the concept of infrastructure has a deeper and more comprehensive content. However, the issues of using infrastructure factors in the market economy system are at the stage of formation in some areas in terms of efficiency. Although the implementation of economic reforms in the agrarian sector of the country's economy and the application of foreign experiences have led to some economic growth, there are sometimes also cases of tension. The poor development of individual infrastructure elements in the agricultural sector also has a negative impact on overall development.

To overcome this deficiency, it is essential to formalize and develop the production and market infrastructure in a comprehensive manner. First of all, infrastructure, as a complex component of production sectors, acts as a subsystem serving the main production. Of course, the final results of the economy depend not only on the level of development of these sectors. It also depends on the level of development of other regions serving the agricultural sector. At this time, the development of both production infrastructures that ensure large-scale production, transportation, supply and processing of agricultural and food products, as well as infrastructure elements that create conditions for the efficient use of these products, emerges as an equally important matter.

It must be admitted that the agricultural sector in our country lags somewhat behind other sectors of the economy in terms of infrastructure provision. The level of service of the existing infrastructure entities here does not yet meet the necessary market requirements. In the agrarian economy, especially in the production process, it is very important for economic entities operating in the agricultural sector to have sufficient access to various machinery, equipment and facilities, pest control products, water supply, warehouses for the purchase and storage of products, modern and convenient roads, and numerous other factors. The weak development of farm communication services in some farms is also a factor slowing down the development of this sector. The gradual resolution of all these problems is a necessary challenge.

However, a number of problems remain:

- limited water resources;

- the presence of outdated irrigation networks;

- differences in infrastructure provision across regions;

- poor development of storage and logistics capabilities in some regions;

- limited access of small farmers to modern technologies.

The efficiency of irrigation systems in particular is critical for agricultural production. In Azerbaijan, 85–90% of crop production is grown on irrigated land, and the quality of water supply directly affects productivity.

In recent years, state programs implemented in Azerbaijan to develop the agricultural sector, the creation of agroparks, the renovation of land reclamation and irrigation systems, and the establishment of logistics centers have had a positive impact on the development of production infrastructure (State Program, 2026). However, assessing and improving the efficiency of existing infrastructure remains a pressing issue.

2. Evaluation of the efficiency of production infrastructure.

The assessment of infrastructure efficiency is based on several economic and technical indicators. If the productivity indicator increases the volume of output per hectare as a result of infrastructure development, this indicates its efficiency (Mustafaeva, Gambarova, & Abbasova, 2024). Resource utilization level: The economic use of water, energy, fuel, and labor resources is one of the main indicators of the effective functioning of infrastructure. Reducing product losses: Modern storage and refrigeration systems reduce product losses, increasing overall profitability.

Logistics costs, transportation, and road infrastructure have a direct impact on product transportation costs. A decrease in costs indicates an increase in efficiency.

The profitability level, the ratio of profit from production to production costs, determines the economic efficiency of the infrastructure.

The efficiency of using production potential in the agricultural sector should be assessed based on the interaction of land, labor, and technical resources. (Amrahov, 2020, p. 45).

The development of production infrastructure in the agricultural sector in Azerbaijan has had a positive impact on the increase in the production volume of agricultural products.

Table 1. Efficiency of production infrastructure in the agricultural sector

Criterion	Evaluation indicator
productivity	volume of product obtained per hectare
resource efficiency	water, energy, and labor consumption
logistics costs	product transportation and storage costs
level of loss	crop loss and waste volume

profitability	profitability index
market access	product sales speed and export opportunities
level of innovation	application of digital technologies

(Source: prepared by the author.)

It would be advisable to implement the following measures to increase efficiency:

-expansion of drip and sprinkler irrigation technologies;

-increasing the number of agroparks and logistics centers;

-development of cold storage networks;

-application of digital agriculture and smart management systems;

-improving farmers' access to technical and financial resources;

-development of the processing industry and expansion of the added value chain.

By examining the effectiveness of the application of information and communication technologies in the agricultural sector, it is shown that the development of digital infrastructure facilitates farmers' access to information, improves the decision-making process, and makes production management more effective. (Bedirzade, 2021, p. 22).

Although the efficiency of agricultural production infrastructure in Azerbaijan has increased significantly in recent years, there is potential for further development, especially in the areas of irrigation, logistics, and digitalization. Modernization of infrastructure creates conditions for increasing agricultural productivity, reducing production costs, expanding export opportunities, and strengthening the country's food security (Məmmədov, 2025).

Theodore Schultz and Zvi Griliches emphasized the role of education, research, and innovation infrastructure when explaining productivity growth in agriculture. Schultz believed that farmers' education and skills directly affected production efficiency. Griliches has shown that investments in agricultural research and advisory services are an important factor in increasing productivity (Chang & Zepeda, 2001). p. 35).

Assessing the efficiency of production infrastructures in the agricultural sector involves determining the impact of the material and technical base used in agriculture, irrigation systems, transport and logistics networks, warehousing, agroparks, and other infrastructure elements on production results. Efficiency assessment allows us to determine the economic results of investments in these facilities and their impact on productivity and profitability.

Thus, economic efficiency is determined by the ratio of funds invested in infrastructure facilities to the results achieved. The following indicators are used here:

-productivity growth rate;

-reduction in production costs;

-reduction in product cost;

-increase in profits and profitability;

-investment payback period (Amrahov et al.,2022)

For example, the implementation of a modern drip irrigation system can reduce water consumption by 30–50% and labor costs by 20–30%, which increases the economic efficiency of production.

Technical efficiency characterizes the ability to produce maximum output using available resources. Technical efficiency evaluation indicators:

-Production per hectare;

-Technical load factor;

-Efficiency factor of irrigation systems;

-Utilization level of storage facilities;

-Technical equipment service life.

Among foreign scholars, Farrell evaluated technical efficiency as the proximity to the maximum level of production that can be achieved with existing resources. The development of agricultural infrastructure also affects social well-being in rural areas. The main indicators include the following:

-number of new jobs;

-increase in rural incomes;

-reduction in rural-urban migration;

-increase in employment levels;

-improvement in living conditions.

For example, the creation of agroparks creates the conditions for the creation of hundreds of permanent and seasonal jobs. One of the important features of modern agricultural infrastructure is environmental sustainability. The evaluation indicators:

-water saving level;

-reduction of soil salinization;

-reduction of energy consumption;

-reduction of waste;

-protection of soil fertility.

In this regard, drip irrigation systems and energy-saving technologies have the highest environmental efficiency indicators.

3. Current status of agricultural production infrastructure in Azerbaijan

The reforms carried out in the agrarian sector during the period of independence gave impetus to the development of agriculture. The state has adopted a number of programs to support the agricultural sector. Agroparks operating in the country allow for the application of modern technologies in agriculture. Production, processing, packaging, and logistics services in agroparks are organized as a single system.

Important projects have been implemented to develop irrigation systems. As a result of the construction of new reservoirs and the reconstruction of existing land reclamation networks, water supply to thousands of hectares of land has been improved. In addition, the renovation of rural roads and the expansion of logistics infrastructure have enabled faster delivery of products to markets.

Table 2. Main indicators of agricultural infrastructure (as of the end of 2023)

Indicators	Numbers
Irrigated agricultural lands	approximately 1.45 million ha
Length of collector-drainage network	More than 31 thousand km
Main and inter-farm canals	More than 52 thousand km
Number of reservoirs	More than 140
Total capacity of grain storage facilities	More than 1.8 million tons
Cold storage capacity	About 500 thousand tons
Number of agroparks	More than 50

Number of tractors in agricultural machinery parks	About 35 thousand pieces
Number of combines	More than 2 thousand 500

(Source: Statistical compilation "Agriculture of Azerbaijan".)

These indicators indicate that the material and technical base of agricultural production in the country has been expanded in recent years. In particular, irrigation systems, storage facilities, and agroparks are considered key elements of agricultural production infrastructure (Azərbaycanın kənd təsərrüfatı, 2024).

Modernization of production infrastructure in the agricultural sector of Azerbaijan has been one of the main directions of state policy in recent years. Expanding irrigation systems, creating agroparks, strengthening technical support, and developing warehousing serve to increase productivity in agriculture.

Let us try to provide an analysis of the current state of agricultural production infrastructure in Azerbaijan.

1. Irrigation infrastructure. Since Azerbaijan's agriculture operates mainly in arid climates, irrigation infrastructure is a key element of agricultural production. Approximately 1.4–1.5 million hectares of agricultural land are irrigated in the country. In recent years, the application of modern irrigation systems such as drip and sprinkler irrigation has expanded. For example, advanced irrigation systems were installed on 26,000 hectares (73%) of the 35,700 hectares of irrigated area used in agroparks in 2024. The breadth of the irrigation network is an important advantage for the country's food security. However, in some regions, water losses and outdated canals still negatively affect productivity.

2. Agroparks and production complexes. Agroparks in Azerbaijan have become a key component of the industrial-based development model of agriculture. In general, in agroparks in 2024:

1. 42.5 thousand hectares of land were brought into crop rotation;

2. 34.1 thousand tons of wheat;

3. 25.5 thousand tons of barley;

4. 91.8 thousand tons of corn;

5. 49.7 thousand tons of sugar beet were produced;

6. The value of total agricultural products amounted to 150 million manats.

Agroparks play an important role in implementing modern technologies, increasing productivity, and increasing export potential (Niftiyev & Ibadoghlu, 2023).

3. Technical support. According to the State Statistics Committee, thousands of tractors, combine harvesters, and other equipment are used in agriculture. The state is improving the provision of machinery to farmers through preferential leasing mechanisms. The fleet of agricultural machinery is updated and expanded every year. Although the provision of machinery has improved compared to previous years, access to machinery is still limited in some small farms.

4. Storage and logistics infrastructure. A network of cold storage and grain warehouses has been formed in the country for the storage of fruit and vegetable products. These facilities allow for reduced crop losses, mitigate seasonal price volatility, and expand export opportunities. New logistics centers and warehouse complexes have been created within the framework of state programs.

Increased storage capacity allows for uninterrupted product delivery to the market, but in some regions, the availability of logistics services is not fully ensured.

Thus, the agricultural production infrastructure in Azerbaijan has developed significantly over the last decade. Modernization of irrigation systems, creation of agroparks, modernization of agricultural machinery, and construction of logistics facilities have increased the competitiveness of the agricultural

sector. However, efficient use of water resources, reducing regional infrastructure disparities, and improving technical support for small farmers remain key priorities for future development (Atashov, 2017).

4. Conclusion

It would be advisable to implement the proposed measures to increase the efficiency of production infrastructure in the agricultural sector in Azerbaijan. These measures include the following:

-Expanding the application of water-saving technologies;

-Implementation of new land reclamation projects;

-Increasing the number of agroparks;

-Strengthening state support for farmers;

-Development of digital agricultural systems;

-Stimulating the application of innovative technologies in agriculture.

The development of production infrastructure in the agricultural sector in Azerbaijan plays an important role in the modernization of agriculture. As a result of state programs implemented in recent years, irrigation systems, agroparks, logistics centers, and rural roads have developed significantly. These measures have created conditions for increasing productivity, reducing production costs, and increasing the competitiveness of agricultural products. However, problems such as limited water resources, regional differences, and the obsolescence of some infrastructure facilities still remain. In the future, the introduction of innovative technologies, expansion of digitalization, and strengthening of state support will allow for further increasing the efficiency of production infrastructures in the agricultural sector.

Author Contributions

The sole author is responsible for conceptualizing, collecting, and analyzing data, and writing and editing the manuscript

Conflict of Interest

The authors declare no conflicts of interest.

Funding

This study received no external funding.

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