1. ЕКОНОМІКА

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IMPACT OF THE APPLICATION DIGITAL TECHNOLOGIES IN AGRICULTURE ON SUBSIDIZATION AND PRODUCTION MECHANISMS

In recent years, the use of digital technologies in agriculture has had a significant impact both on the production process itself and on subsidy mechanisms. These technologies enable farmers to manage production more accurately, efficiently, and conveniently. For example, through soil fertility sensors, weather monitoring systems, and automated irrigation, farmers can achieve higher yields at lower costs. At the same time, product quality improves and the irrational use of natural resources is reduced. Digital technologies also ensure a fairer and more transparent distribution of state subsidies. Farmers' activities are monitored through electronic systems, and the amount of subsidies is determined based on actual production indicators. Such an approach creates conditions for the efficient use of public funds and helps prevent the spread of false information.

Keywords: *agriculture, subsidization, digital technologies, production mechanisms, subsidy mechanisms.*

Formulation of the problem. Agriculture is a very important aspect of society and the economy, as it provides people with food, jobs and other resources. These are some of the most basic needs of people. It does more than just grow crops; it also provides people with healthy and balanced food, strengthens the national economy, creates jobs and provides raw materials for agriculture-related companies. However, this industry has faced many challenges in the past few years, such as changes in global markets, economic crises, climate change, drought, urbanization, land fragmentation and lack of agricultural education. As the population grows rapidly and natural resources are depleted, the industry has new challenges. In this case, technology, especially digital technologies, has a huge impact on how sustainable and productive agriculture can be. Digital technologies are opening up new opportunities in agriculture with Industry 4.0 and digitalization. For example, they help plan crops, detect diseases, predict weather, analyze soil and manage irrigation. Studies in Australia, the US and China show that farms using digital technologies can increase production by 20–30%, reduce insurance risks and increase their chances of receiving subsidies.

Digitalization is the main driving force for the development of agricultural production. The use of modern digital products will automate labor-intensive processes, while improving planning and management. Automated crop rotation planning, field digitization, and optimization of product sales timing play a key role. The digitalization of the agro-industrial complex includes a number of innovative technologies. One of the most promising areas is the use of drones for monitoring arable land. Specialized unmanned aerial vehicles are equipped with high-precision cameras and sensors that collect information about the condition, growth, and health of plants. Digitalization and automation of agricultural processes are an essential part of the agricultural development strategy. An important aspect of digitalization in the agro-industrial complex is the use of GPS monitoring systems. With the help of satellite navigation technologies, farmers can more accurately and efficiently use tractors and other agricultural machinery, optimize product delivery routes, and control the movement of livestock. An integral part of digitalization in the agro-industrial complex is the creation of automation and intelligent management systems. The use of modern technologies allows for the automation of data collection and analysis, animal feed management, crop

protection and processing. This allows farmers to optimize costs, increase profitability and reduce their environmental impact. In addition, some banks are contributing to the development of digitalization in the agro-industrial complex by introducing their own technologies.

Analysis of recent research and publications. In the modern world, using digital technologies and AI solutions in farming is one of the most important ways to make farming more efficient. At the state level in the Republic of Azerbaijan, this process is backed by strategic documents and institutional mechanisms. The State Statistical Committee of the Republic of Azerbaijan says that the agricultural, forestry, and fisheries sectors make up a large part of the country's non-oil economy. It is especially important to use digital solutions to boost productivity in these areas [1]. The Ministry of Agriculture's "digital agriculture" approach involves using information and communication technologies in farming and giving farmers more options when making decisions [2]. Satellite technologies and mobile apps are also very important in this area. The "Farmer" app from Azercosmos makes it easy to get agricultural data quickly and keep an eye on fields [3]. The use of digital technologies in agriculture is also seen in the rules and laws that govern the industry. The Law of the Republic of Azerbaijan "On the Application of Digital Technologies in Agriculture" lays the groundwork for this process and makes sure that new ideas will last over time [4]. International experience demonstrates that satellite-based platforms and artificial intelligence algorithms yield significant outcomes in predicting productivity and optimizing land and water resources. The Farmonaut platform, for instance, uses satellite data to check on the health of plants and find risks early on [5]. Research in the United States indicates that state endorsement of precision agricultural technologies enhances innovation capacity and improves the efficiency of research and development expenditures [6]. A lot of scientific papers look at how artificial intelligence can be used in farming. Liakos and his co-authors stress how important AI technologies are for automation, crop monitoring, and decision support systems [7]. Ozguven points out that new technologies in farming change the way things are made and make knowledge-intensive methods more important [8]. Other researchers are looking into how AI could help close the digital divide and make sure everyone has access to technology [9]. Market studies show that agricultural technologies based on AI are growing quickly all over the world. Precedence Research says that this market will grow a lot between 2024 and 2034 [10]. The Chinese experience shows that subsidies are a key factor in getting AI technologies to rural areas [11]. Statista data shows how AI is used in farming in the US and around the world [12; 13]. In these processes, interactive geographic information systems like WebGIS improve monitoring and mapping, making it possible to make decisions based on science [14].

Purpose of the topic. The purpose of the study is to examine the impact of the application of digital technologies in agriculture on subsidization and production mechanisms in the case of Azerbaijan.

Presentation of the main research material. Agriculture is one of the most important areas of activity where the necessary and basic needs necessary for human survival are met. Agricultural products consisting of crop and livestock farming; It has important social and economic effects such as healthy and balanced nutrition of people, increasing national income and employment, providing raw materials for agriculture-based industries, contributing to development through foreign trade, and increasing foreign exchange earnings. The agricultural sector has suffered in recent years from negative factors such as global market fluctuations, economic crises, global warming causing drought and climate change, animal diseases, and the use of agricultural products other than food production. because biofuels are affected by fragmented agricultural lands and lack of education. In addition, natural resources such as agricultural land and water per capita are decreasing as a result of the rapid increase in the world population and increasing urbanization, resulting in a decrease in agricultural areas [5]. The applications of digital technologies are expected to be among the most important agricultural research topics today and in the near future due to their potential to facilitate agricultural processes and develop alternative solutions to problems that are waiting to be solved or improved. The use of digital technologies in many areas of agriculture is widely used in crop production planning, plant classification, yield assessment, detection of plant diseases, pests and weeds, route determination and application decisions in agricultural robots, and similar areas.

Digital technologies are of great importance in agricultural production and resource planning. In particular, it is predicted that energy costs will decrease. Increased production means increased supply and, as a result, lower product prices.

The following tools are the main technologies used in the digitalization of agriculture:

- Internet of Things (IoT) technology;
- Drone technology;
- LIDAR technology;
- Controlling the aggregate with GPS system technology;
- GNSS, GIS technology;
- VRT Variable rate technology;
- Application of agrobots to agriculture.

The use of digital technologies in the agricultural sector of Azerbaijan.

Digital technologies are swiftly transforming the operations of individuals, enterprises, and governments, impacting entire food systems and all participants, while concurrently delivering substantial advantages to agriculture by reducing data, transaction, and control costs. Digital technologies significantly contribute to the attainment of the 2030 Agenda for Sustainable Development but, they also present economic, social, and ethical issues, particularly with privacy, security, and their effects on enterprises, jobs, and markets. The equity and efficiency of global agri-food systems can significantly improve through digital technologies; thus, a coordinated and inclusive promotion

of new practices, along with a balanced policy framework, is essential to mitigate risks and guarantee that "no one is left behind." The "Electronic Agricultural Information System" has been implemented in our republic to expedite the adoption of digital technologies, enhance transparency in farmers' subsidy policies, augment production volumes, and bolster their competitiveness [2].

The "Electronic Agricultural Information System" (EKTIS) is a cohesive framework that encapsulates the core operational tenets of the Ministry of Agriculture of the Republic of Azerbaijan, including proximity to farmers, transparent and efficient management, and the implementation of innovation. It extensively facilitates integration with both internal and external systems, thereby establishing a foundation for the development of an agricultural chain. EKTIS encompasses the development of modules that address all business operations of farmers and agricultural goods, from inception to completion, with an emphasis on openness and efficiency [4]. EKTIS encompasses all facets of agriculture while facilitating the expansion of integration opportunities with both internal and external systems. It ensures logical coherence among all agricultural processes, enables process completion, conducts analyses, implements contemporary technical solutions, and provides forecasts grounded in precise data. EKTIS possesses the capability to institute control mechanisms that guarantee the effective execution and advancement of agricultural operations, together with the capacity to monitor these processes in real time. EKTIS possesses the ability to provide analytical reports and produce models that facilitate decision-making and underpin future development planning, in addition to collecting and producing "Big Data", which is essential in the contemporary environment [4].

The fundamental operational concepts of EKTIS are as follows:

- Facilitating accessibility for farmers;
- Implementing transparent and efficient governance;
- Utilizing innovative practices;
- The objectives of EKTIS are as follows:
- Enhancing transparency and efficiency in governmental support for the agricultural sector;
- Providing innovative assistance for the execution of state policy across all agricultural domains;
- Ensuring the management and optimal utilization of agricultural lands and other natural resources;
- Facilitating food and nutrition security;
- Augmenting the income of agricultural producers;
- Improving the efficacy of information and advisory services;
- Establishing a foundation for the delivery of e-government services;

The structural mechanisms of EKTIS are as follows:

- EKTIS encompasses the primary electronic registers pertinent to the delivery of electronic services;
- Data input;
- Facilitating electronic communication between farmers and the Ministry of Agriculture;
- Acquisition of electronic services;
- Complimentary access to the system for agricultural entities;
- Monitoring and management of processes by local government and ministry personnel;
- Integrated information in EKTIS, sourcing data from systems (excluding information whose acquisition is legally restricted);
- Provision of additional services;

The electronic services encompassed within EKTIS are enumerated below:

- Registration of seed and seedling producers;
- Issuance of seed subsidies;
- Issuance of certificates verifying the variety and sowing qualities of seeds.
- Implementing agronomy in seed and seedling cultivation;
- Distribution of bee subsidies;
- Distribution of sowing subsidies;
- Distribution of animal subsidies;
- Distribution of silkworm subsidies;
- Distribution of crop subsidies [4].

Additionally, software has been created and released to grant farmers oversight of their farms. Additional information is shown below:

Farmer Application

The Farmer App, offered by Azercosmos, is a digital platform that enhances agricultural output via satellite imagery and sophisticated analytics. This application oversees agricultural operations by examining satellite imagery to deliver critical data on parameters such as NDVI, NDWI, NDRE, and temperature. The application notifies farmers of crop development phases and offers recommendations for enhancing agricultural practices. This program minimizes expenses by improving resource utilization and provides farmers with timely alerts regarding weather fluctuations [3].

Collaboration between Azercosmos and Agro Dairy

Under the partnership agreement established between Azercosmos and Agro Dairy, a prominent agricultural enterprise in Azerbaijan, agricultural field monitoring will be conducted via satellite imagery. This collaboration will facilitate the monitoring of field development status, forecasting production, and promptly identifying changes in fields.az.

WebGIS application

Azerkosmos' WebGIS software enables users to view and manage geographical data using web browsers. This technology enables simultaneous cooperation and data interchange, permitting numerous people to evaluate geographic data concurrently. WebGIS software is utilized in urban planning, cadastre, agriculture, environmental science, ecology, emergency management, and various other domains, offering critical information for decision-making [14].

This study is based on a qualitative approach and aims to assess the impact of digital technologies on subsidy policies in agriculture. The study mainly used secondary sources, namely international statistical data and

existing scientific research. The experience of countries such as China, the USA and Azerbaijan was analyzed comparatively. The data will be mainly used in official reports, scientific journals et al.

The use of artificial intelligence in agriculture in 2019 is quite extensive. Statistical data on types of agriculture are recorded in the graph. In agriculture, more than 60% of the market share was common to farming.

The AIin agriculture market is estimated to be worth USD 1.1 billion in 2019 and will exceed USD 3.8 billion by 2025 [9].

Artificial intelligence technologies are used in various areas of agricultural production; their increasing use is often associated with the robotization of the industry. In robotics, AI technologies are used to recognize patterns, spatial orientation, and process large amounts of incoming data. You can also note AI technologies related to the navigation of agricultural machinery, which includes various thrusters and navigators. The following prerequisites for the use of AI technologies in agriculture can be identified:

• Increasing the volume and improving the quality of data on the status of the production process;

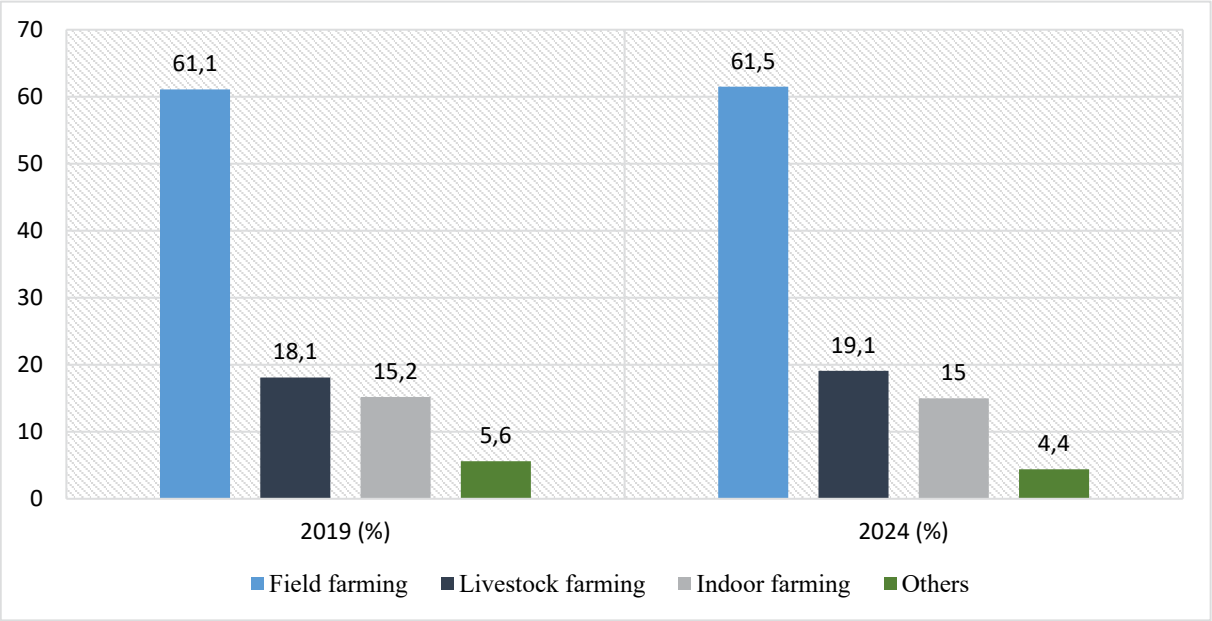

Fig. 1. Global market shares of artificial intelligence in agriculture in 2019 and 2024

Source: [9]

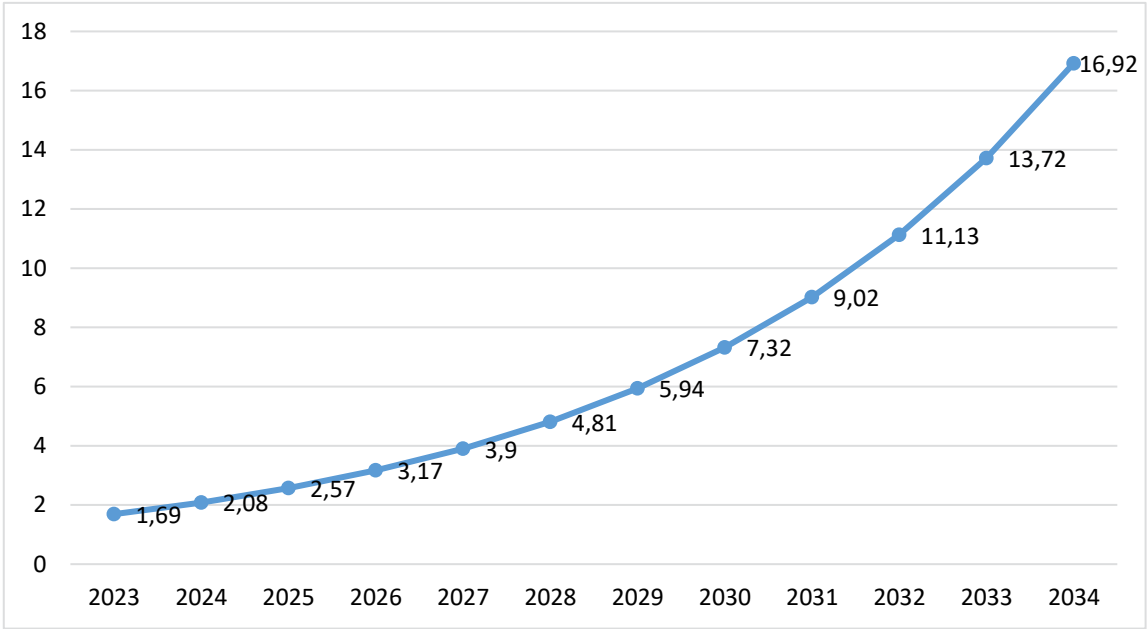

Fig. 2. Global market share of agriculture with artificial intelligence 2022–2032, USD billion

Source: Prepared by the author himself based on Precedence research [10]

• The need to increase production efficiency by reducing the amount of consumables used and increasing labor productivity;

• The increasing complexity of the production process and the need to improve the accuracy of forecasts.

We can highlight the main directions for the development and use of AI technologies in agriculture. Thus, these technologies are often used to predict crop yields depending on various factors. For example, Australian scientists accurately predict coffee yields based on environmental, climate, and soil conditions. Other studies have shown machine learning systems predict cherry yields at harvest, map citrus yields, predict wheat yields, and predict rice developmental stages [8].

This study assessed the application of artificial intelligence in agriculture and its impact on subsidy policy based on empirical indicators. The study mainly analyzed international statistics and trends covering the years 2019–2025 and 2022–2032. In 2019, the global market volume of artificial intelligence technologies in agriculture amounted to 1.1 billion US dollars. According to forecasts, this figure will exceed 3.8 billion US dollars in 2025 [13]. This growth is explained by the expansion of the application areas of artificial intelligence technologies in agriculture. Accordingly, 63 percent of the application areas belong to crop production, 20 percent to animal husbandry, and 17 percent to processing and supply chains. According to studies conducted in Australia, annual income on farms where artificial intelligence technologies are applied increased by 27 percent, while at the same time, loss payments in agricultural insurance decreased by 21 percent. In the US, 37 percent of farmers using AI-based insurance models have switched to preferential insurance packages. The subsidy support provided to these farmers has increased by an average of 12 percent. In China, subsidy rates for farmers using AI have been increased from 0.7 percent to 1.4 percent. This approach aims to stimulate farmers' transition to AI technologies. At the same time, productivity in farms where AI technology is applied has increased by 15–22 %, and the probability of these farms receiving subsidies has been 1.8 times higher than in traditional farms. In this study, a conceptual model reflecting the "Artificial intelligence agriculture insurance subsidy" relationships developed by the author is presented and a comparative analysis is conducted with international experience. The model shows that the application of AI technologies increases farmers' resilience to risk and creates conditions for a more targeted distribution of state subsidies [11].

Artificial intelligence in agriculture increases productivity and helps distribute subsidies more equitably. This increases farmers' income and saves resources. However, the high cost of the technology and the lack of internet are holding some back. The digital divide creates difficulties for small farmers. Government support and new insurance models create opportunities in this area. But technical problems and political changes may slow this development [6].

Table 1

AI technologies,digital technology and subsidies in agriculture in China, Azerbaijan and the US by 2025

Country	2024-2025
China	AI market size forecast for 2025: $232.15 million
	Digitalization plan covering 2024–2028 is active – productivity and food security are targeted
	State subsidies of up to 30% for the transition to AI technologies (Zhejiang example)
Azerbaijan	2024 data: 362.5 million manat subsidies to 380,704 farmers (expected to continue in 2025)
	Crop monitoring and digital agricultural measures are implemented on the Farmonaut platform
	Subsidies are calculated based on the crop coefficient (e.g. wheat 1.1, rice 1.8)
USA	AI market size forecast for 2025: $705.74 million
	USDA allocated $1.4 million to the DSFAS program in 2024 – implementation continues in 2025
	Soil and crop monitoring for farmers, artificial intelligence-based fertilization systems are expanding

Source: [11,12] prepared by the author himself

Table 2

SWOT analysis of the application of digital technology in the agricultural subsidy system

Strengths	Weaknesses
15–27% increase in productivity Risk forecasting and management More targeted and fair distribution of subsidies More efficient use of resources Reducing environmental impacts (in terms of energy and carbon emissions)	Infrastructure shortage (internet and technology problems in rural areas) Low level of technical knowledge and digital skills among farmers High initial financial cost of SI technologies Increasing digital inequality (difference between large and small farmers)
Opportunities	**Threats**
Development of smart insurance and data-based subsidy models Digitalization-based state support programs Integration of international experience into local policy (examples of China, USA) Subsidy reforms with smart policy tools Making more sustainable decisions with data analysis	Additional technical and financial costs put pressure on the subsidy system Farmers become dependent on SI Data privacy and security at risk Political and institutional changes slow down SI plans

Source: [7]

From 2010 to 2024, looking at statistical data shows that using digital technologies in farming has helped both production and subsidy systems. Profit grew by about 941%, from 32.4 million manat in 2010 to 337.6 million manat in 2024. During the same time period, losses went up from 4.7 million manat to 24.7 million manat, but the growth rate was not as high as that of profits. From 2010 to 2024, total profit went up by about 11.3 times. Sales went up by 623%, from 188.6 million manat to 1.36 billion manat. This shows that digital sales and control systems work. Profits in the crop sector went up from 8.9 million manat to 168.6 million manat, which is about 19 times more. In livestock farming, this number went up from 13 million manat to 149 million manat, which is 10.4 times more. These numbers show that digital technologies have made people work harder, made subsidies go to the right people, and made market relationships stronger. Taking into account how quickly digitalization is happening, experts say that profits will reach about 370 million manat in 2026 and 410 million manat in 2027. This change shows that digital technologies are still being used effectively in Azerbaijani agriculture [1].

The table shows that between 2010 and 2024, agricultural production in all of Azerbaijan's economic regions grew a lot. For instance, the total increase in Baku went up by about 8.4 times (from 20700.9 to 176785.1) from 2010 to now. The rise was about 6.8 times in the Absheron-Khizi economic region and 4.9 times in the Karabakh economic region. The Karabakh, Gazakh-Tovuz, and Central Aran regions have the most dynamic changes. This is because land is being

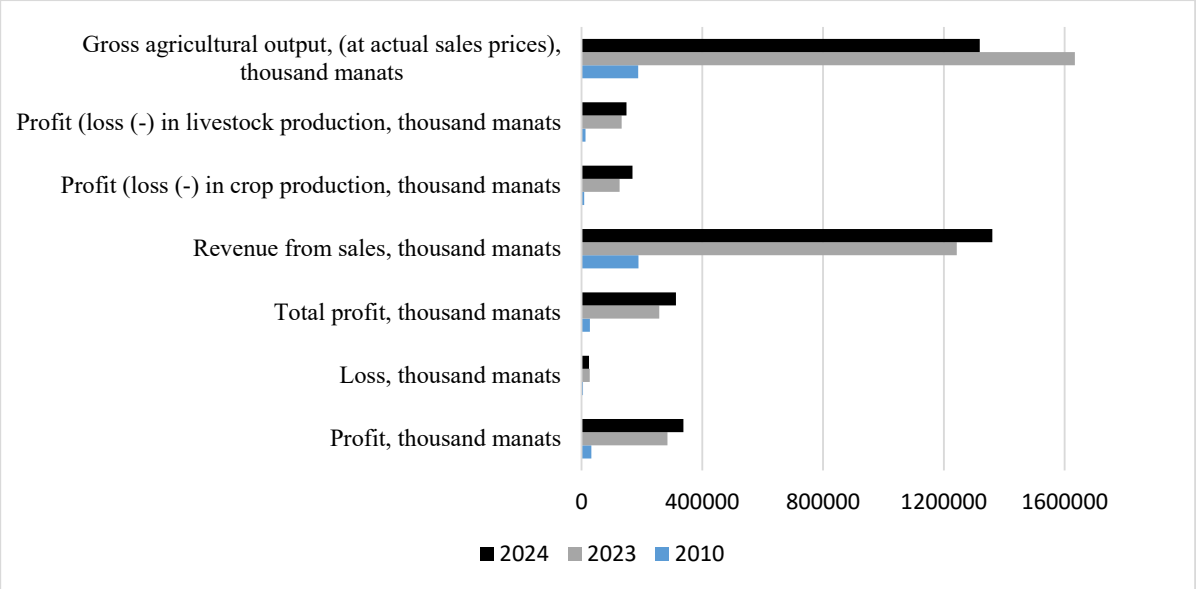

Fig. 3. Main economic indicators of agricultural enterprises

Source: [1]

Table 3

Gross agricultural product, at actual prices, thousand manats

	2010	2023	2024
	Total		
Baku city	20700.9	162339.0	176785.1
Nakhchivan Autonomous Republic	246122.7	358429.4	382206.2
Absheron-Khizi economic region	71337.9	463539.1	488142.4
Mountainous Shirvan economic region	158690.2	537271.8	549811.2
Ganja-Dashkan economic region	156500.8	429195.1	449358.7
Karabakh economic region	297594.2	1255407.4	1460495.5
Gazakh-Tovuz economic region	558098.7	1616795.1	1689424.5
Guba-Khachmaz economic region	395361.6	1274850.9	1324837.5
Lankaran economic region	385106.3	1110331.4	1083620.9
Central Aran economic region	417460.7	1215415.6	1313020.5
Mil-Mugan economic region	321404.3	1128252.8	1203420.1
Sheki-Zagatala economic region	353259.9	884285.8	953879.4
Eastern Zangezur economic region	32874.6	145689.3	168991.6
Shirvan-Salyan economic region	219489.1	827085.7	885429.6
Other (weight increase)*	243714.0	801724.6	865748.9

Source: [1]

restored and state support systems are being strengthened. The increase is fairly stable in the Lankaran and Mil-Mugan areas, at about 2.8 to 3 times. Using digital technologies makes subsidy processes more open and efficient. Electronic subsidy platforms and drone control systems help make the best use of resources and boost productivity. The results from 2024 show that farms that use digital systems in agriculture are 5–7% more productive. Predictions say that overall agricultural indicators will go up by about 8% in 2026 and by another 10% in 2027. This trend shows that using digital technologies more widely will make both subsidization and production systems more sustainable and narrow the gaps between regions [1].

Conclusion. This study examines the economic and institutional implications of digital technologies in the management of subsidies in agriculture, highlighting their importance in increasing productivity and reducing risks. According to the results of the study, on farms equipped with artificial intelligence technologies, productivity increases by 15–27%, insurance premiums are reduced, and subsidies are distributed more equitably. The experience of countries such as the United States and China shows that the introduction of digital technologies significantly increases the efficiency and sustainability of agriculture. However, limitations such as weak technological infrastructure, lack of digital skills, and high costs hinder the widespread deployment of this technology. Therefore, it is important for governments to create subsidy and insurance mechanisms that encourage the introduction of artificial intelligence.

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ВПЛИВ ЗАСТОСУВАННЯ ЦИФРОВИХ ТЕХНОЛОГІЙ У СІЛЬСЬКОМУ ГОСПОДАРСТВІ НА МЕХАНІЗМИ СУБСИДУВАННЯ ТА ВИРОБНИЦТВА

Останніми роками застосування цифрових технологій у сільському господарстві справило значний вплив як на процес виробництва сільськогосподарської продукції, так і на механізми субсидування. Ці технології дають змогу фермерам більш точно, ефективно та зручно управляти виробничим процесом. Наприклад, завдяки датчикам вимірювання родючості ґрунту, системам моніторингу погоди та автоматизованим зрошувальним пристроям фермери можуть отримувати більші обсяги продукції з меншими витратами. Водночас підвищується якість продукції та зменшуються втрати природних ресурсів. Цифрові технології також забезпечують більш справедливий і прозорий розподіл державних субсидій. Діяльність фермерів контролюється за допомогою електронних систем, а розмір субсидій визначається на основі реальних показників виробництва. Такий підхід створює умови для ефективного використання державних коштів і запобігання поширенню неправдивої інформації. Цифрові платформи (зокрема фермерські застосунки) надають фермерам оперативну інформацію про агротехнологічні інновації, ринкові ціни та прогнози погоди. Завдяки цій інформації фермери ухвалюють більш обґрунтовані рішення, знижують ризики та підвищують свої доходи. Онлайн-системи подання заявок спрощують процес отримання субсидій і запобігають втраті часу. У дослідженні розглядається застосування цифрових технологій у сільському господарстві Азербайджану, а також процес субсидування цих технологій, їхній вплив на виробничі механізми та управління цими механізмами. Основною метою дослідження є вивчення

того, як цифрові технології сприяють підвищенню продуктивності, зниженню ризиків і більш ефективному розподілу систем субсидування. У межах дослідження було порівняно дані міжнародної статистики за період 2019–2032 років та дані таких країн, як Китай, Сполучені Штати Америки та Азербайджан. Результати показують, що фермери, які використовують цифрові технології, підвищують свою продуктивність на 15–27 відсотків, стають більш стійкими до ризиків і отримують більше субсидій. Дослідження, проведені у США та Китаї, підтверджують, що фермери, які застосовують ці технології, отримують більшу державну підтримку та переходять до більш прибуткових страхових систем. Крім того, ці технології зменшують негативний вплив на довкілля та сприяють більш ефективному використанню енергії. Водночас існують і певні труднощі. Зокрема, обмежений доступ до інтернету та недостатній рівень технічних знань заважають деяким фермерам повною мірою скористатися цими можливостями. Дослідження показує, що інтеграція цифрових технологій у систему субсидування може створити умови для більш прозорого та ефективного управління сільським господарством.

Ключові слова: *сільське господарство, субсидійна політика, цифрові технології, виробничі механізми, механізми субсидування.*

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