Financial Instruments that Ensure Food Market Sustainability

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Abstract

The aim of the research was to study financial instruments ensuring the food market sustainability in the face of economic and environmental challenges. The research employed the following methods: SWOT analysis, econometric, correlation, and regression analysis. The analysis of investment in agricultural technologies showed a significant increase in interest in innovations, in particular in response to global challenges, such as climate change. In particular, the use of IoT in agriculture has contributed to an increase in the yield of major crops such as wheat, corn, and soybeans. The study found that the use of financial instruments, such as grants, technical assistance, loan guarantees and equity investments, effectively reduces financial risks. A promising direction for further research is to study in more detail the effectiveness of the use of mixed financial instruments for the sustainable development of the agricultural sector.

Keywords: agricultural finance, financial instruments, credit guarantees, food security, market sustainability, agricultural technology.

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Introduction

Food security is one of the main strategic goals pursued by governments around the world. In the current economic instability, climate change, crises, and political upheavals, the food market is becoming sensitive to any external and internal influences. At the same time, the stability of this market directly depends on the effective use of financial instruments that minimize the risks associated with fluctuations in food prices. They also help to respond to changes in supply and demand and the external economic situation. According to the Food and Agriculture Organization of the United Nations (FAO), more than 735 million people in the world faced hunger problems in 2023. This is 122 million more than in 2019, and mainly due to economic crises, conflicts, and climate change. Global food losses caused by market instability and logistical difficulties are estimated at $400 billion annually. The presented data emphasize the relevance of research into financial mechanisms that can help to stabilize food markets and reduce the risks of food shortages.

The study is of particular importance because of the need to ensure access to food for all population groups, especially during economic crisis or in the event of natural disasters. Such instruments as state subsidies, support for agricultural investment, and agricultural risk insurance play an important role in stabilizing the market. Besides, the creation of favourable conditions for the development of financial mechanisms supports agriculture and food infrastructure. The researchers actively study financial mechanisms and models for supporting food security in the context of economic globalization. In particular, Humeniuk et al. (2021a) emphasize the importance of an integrated approach to financing the food sector and improving the conditions for sustainable agricultural development. Wattel et al. (2023) consider the possibilities of public investment for the development of infrastructure and ensuring the availability of food in view of climate change and global economic shocks.

In this context, Deng et al. (2023) and Shelenko et al. (2023) propose a mechanism for public management of the agricultural sector. It is based on the principles of agrarian protectionism, program-targeted regulation, self-financing, and efficient resource use. It is worth noting that the current situation requires states and international organizations not only to develop financial support instruments, but also to effectively implement them to ensure the stability of food markets. Increasing the role of financial instruments in the development of food security is extremely important in the context of strategic planning of agricultural policy (EU, 2021-2027). This requires taking into account the peculiarities of domestic and external food

markets and ways to minimize socio-economic consequences in crisis situations.

The aim of the research is to assess financial instruments that ensure food market sustainability in the face of economic and environmental challenges. The aim was achieved through the fulfilment of the following research objectives:

1. Identify the main financial instruments used to ensure food market sustainability.
2. Analyse the effectiveness of the application of financial mechanisms.
3. Develop proposals for improving financial instruments in the context of global and local economic challenges.

The novelty of this study is the integrated approach to assessing the effectiveness of financial instruments used to ensure food security during global crises. It is expected that the results of the study will identify the most effective financial mechanisms to support food security. They will contribute to the development of recommendations for their adaptation and implementation in the face of economic instability and climate change, as well as increasing the effectiveness of state support policies for the agricultural sector.

Literature Review

The studies deal with various financial mechanisms that contribute to market stability, including government subsidies, investment, agricultural insurance, international financing, and strategic financial management. According to the research data, government subsidies and investment in agriculture are key tools for ensuring food market stability. Ashiq et al. (2023) emphasize the importance of creating an effective system of agricultural financing through subsidies that contribute to reducing production costs and increasing the availability of agricultural products. Cao et al. (2020) emphasize that government financing should be aimed not only at supporting production, but also at developing agricultural infrastructure, including logistics systems, storage, and processing of products.

However, there are a number of shortcomings in earlier studies. In particular, most studies focus on the positive impact of subsidies, but do not sufficiently analyse their long-term consequences, such as the possible creation of dependence of agricultural enterprises on state support. Furthermore, not all studies take into account the effectiveness of subsidies in different economic contexts. Some authors, such as Ostapenko (2021), argue that excessive funding can distort the market. At the same time, others,

in particular Hua et al. (2024), note that small and medium-sized enterprises (SMEs) in agriculture have limited opportunities for development without state support. Agricultural insurance is another important financial instrument. Guo et al. (2024) note that agricultural insurance becomes necessary to reduce the risks associated with crop losses in the context of global climate change and natural disasters. Moldavan et al. (2023) emphasize that stable insurance mechanisms reduce financial pressure on farmers and stimulate investment in agriculture.

However, the studies do not sufficiently address the issue of the accessibility of insurance programmes for small and medium-sized farms. They are often unable to use these instruments due to high insurance premiums or difficult conditions for obtaining compensation. According to Tahiri-Jouti (2022), only 30% of small farmers have access to agricultural insurance due to high costs. At the same time, Giannetti et al. (2023) suggest alternative approaches, such as microinsurance and cooperative insurance models, that can increase the accessibility of this financial instrument.

International financial organizations, such as the World Bank and the International Monetary Fund, actively support the financing of agricultural initiatives. Agrawal et al. (2023) note that these organizations play an important role in financing agricultural infrastructure projects, including the development of water supply, irrigation systems, and crop storage. Ahmed et al. (2024) emphasize the importance of green bonds in supporting sustainable agriculture.

Despite the positive effect, it is important to note that international financial programmes are not always effectively adapted to local economic and environmental conditions. In many cases, projects are implemented taking into account global priorities, but do not take into account the specifics of regional development. For example, Mustafa et al. (2023) argue that World Bank financing is often directed at large-scale infrastructure projects that may not take into account the needs of small farmers in specific countries.

Strategic financial management also plays an important role. Alharbi et al. (2023) analyse successful approaches to financing the agricultural sector, including diversifying sources of financing, using innovative financial instruments, and developing partnerships with international organizations. Shi and Yang (2025) and Bazaluk et al. (2020) argue that countries that actively use strategic financial approaches have more sustainable food markets.

However, there is a lack of studies in the literature that analyse the long-term effectiveness of strategic financial decisions in the context of global economic and environmental crises. The study of Abhilash et al. (2023)

shows that strategic financial management can increase resource efficiency. In many countries it is not sufficiently implemented because of weak institutional capacity and insufficient level of digitalization. The analysis of studies shows that financial instruments, in particular state subsidies, agricultural insurance, international investment, and strategic financial management, are the main mechanisms for ensuring the food market sustainability. However, there are a number of gaps in previous research, in particular insufficient attention to the long-term effects of financial measures. There is also a lack of research on adapting international financing to regional conditions and developing affordable insurance mechanisms for small agricultural enterprises. Therefore, research should be continued on improving existing financial instruments and adapting them to changes in the global economy and natural conditions. Besides, it is necessary to develop new innovative financial mechanisms for the sustainable development of the agricultural sector.

Methods

Research Design

The study of financial instruments for ensuring food market sustainability consisted of several stages:

1. Review of academic literature. The analysis of studies on the use of financial instruments in ensuring food security and food market stability.
2. Empirical research. Analysis of statistical data. Study of official statistical sources, such as the World Bank, UN, FAO in order to assess the dynamics of the global market of financial instruments and their impact on the food market. SWOT analysis. Assessment of the strengths and weaknesses of financial instruments, as well as opportunities and threats affecting the agricultural sector.
3. Providing practical recommendations. Development of proposals for improving mechanisms for state support for the agricultural sector and attracting international investment.

Sampling

The study covered the period 2019-2023, which allowed us to assess the impact of global economic changes and technological developments on financial instruments in the food market. The data were obtained from official sources, in particular, FAO, which provides information on global

production of major agricultural crops and the level of use of organic fertilizers. The World Bank contains data on the volume of investment in agricultural technologies and financing of agrofood systems. Eurostat covers subsidies for renewable energy in the agricultural sector and the implementation of environmental standards. Furthermore, World Resources Institute (WRI) analytical reports (2021) on payments for ecosystem services and agricultural land restoring activities were used. FAO – United Nations Development Programme (UNDP) – the United Nations Environment Programme (UNEP) studies were also taken into account (2021), which assess the effectiveness of reoriented support for the agro-food sector. The analysis covered financial instruments, including grants, technical assistance, loan guarantees, equity investment and funds that ensure the development of infrastructure and the availability of credit resources. Support for innovations in precision agriculture and the application of IoT in the agricultural sector was also considered.

Methods

The study was based on a combination of quantitative and qualitative methods. Statistical data analysis. Official data were used to analyse the dynamics of financial instruments in agriculture and their impact on food security. *Correlation and regression analyses* were used to determine the relationships between investments in agriculture, the use of innovative technologies, and production efficiency. Correlation analysis was used to identify the degree of dependence between investment indicators and the yield of major agricultural crops, while regression analysis was used to build models for predicting the impact of financial instruments on long-term incomes of the agricultural sector. *SWOT analysis* covered the assessment of internal and external factors affecting the effectiveness of financial instruments in ensuring the sustainability of the food market. The strengths of such instruments as state grants and subsidies for farmers, which provide access to credit resources and reduce risks for producers, as well as programmes supporting innovative technologies, in particular green bonds, were assessed.

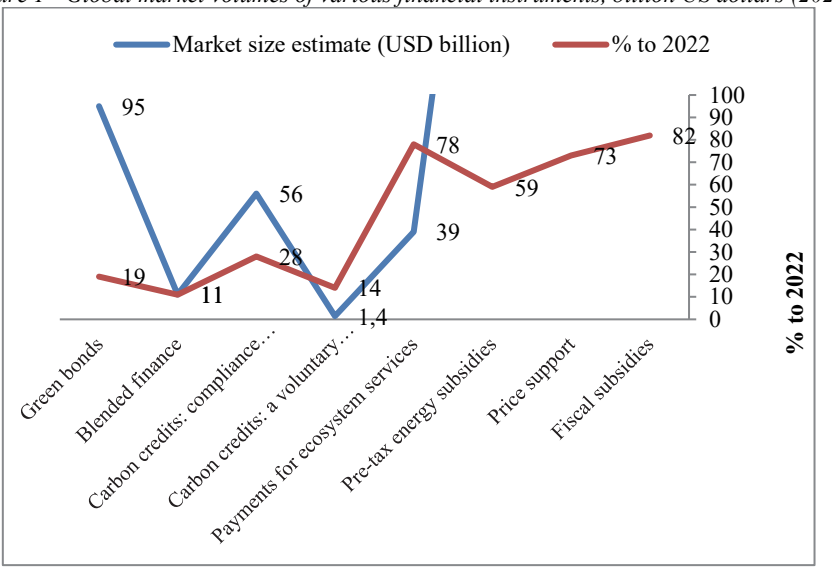
At the same time, weaknesses were identified, such as high collateral requirements for loans, which limit access to finance for small and medium-sized farms. The instability of financial instruments in periods of economic and political uncertainty was also noted. The opportunities associated with the development of digital financial instruments, such as crowdfunding platforms, were considered, as well as the growing potential of international investment in sustainable development of the agricultural sector. However,

the threats that arise in the event of changes in international trade agreements or political decisions that may reduce access to external financial resources were also assessed. The impact of natural disasters and climate change, which threaten the stability of agricultural production, was also taken into account.

Results

It is important to note the scale of the global market for various financial and policy mechanisms in the discussion of agro-food support instruments and their impact on the sustainability of food markets. Figure 1 shows the estimated annual turnover of various instruments used to support and develop the agricultural sector at the global level. The market size of financial instruments that impact environmental and energy initiatives ranges from large amounts to much smaller ones. Green bonds account for $ 95 billion, the carbon credit market (Emission Trading Systems, ETS compliance markets) for USD 56 billion. Voluntary carbon credits account for $ 1.4 billion, and payments for ecosystem services for $ 39 billion. Traditional energy subsidies for $ 296 billion, price supports for $ 294 billion, and fiscal subsidies for $ 245 billion (Figure 1).

Figure 1 - Global market volumes of various financial instruments, billion US dollars (2024)



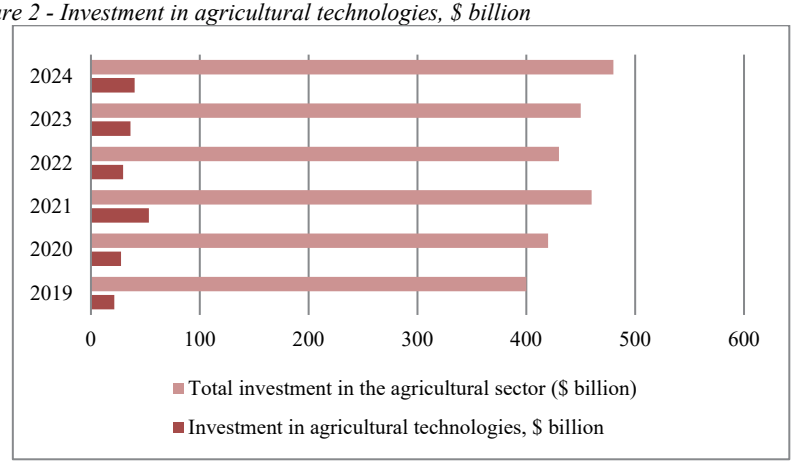
Source: developed by the authors based on FAO (2021), UNCTAD (2022), World Bank (2024), USDA (2024)

The data analysis indicates a great potential for change in the sustainable finance market. However, there are significant financial barriers that require rethinking and adapting policies to achieve true sustainability and reduce environmental impact. The analysis of investment in agricultural technologies during 2019-2024 reveals several key trends. In 2019, investment amounted to 21.5 billion US dollars, and the following year they increased to $ 27.7 billion. This indicates an increased interest in innovation in the agricultural sector, likely due to the need to adapt to new economic realities and changes in food demand.

However, 2021 experienced the largest leap in investment, when they reached $ 53.2 billion. A significant increase of 92% compared to the previous year can be explained not only by the high pace of development of agricultural technologies, but also by global challenges such as climate change and the pandemic. They stimulated the need for modernization and increased production efficiency.

In 2022, investments decreased to $29.6 billion, a 23.6% decrease compared to the previous year. This may be determined by the market adjustment after the high growth rates in 2021, as well as economic challenges that reduced the attractiveness of such large investments. At the same time, growth is expected to resume in 2023 to $36.4 billion, an increase of $6.8 billion compared to 2022. The investment is expected to reach $40.2 billion in 2024, indicating further growth and renewed confidence in the agricultural sector. This confirms that investment in agriculture continues to be important and the industry has significant potential for development, provided that economic and political conditions are stable.

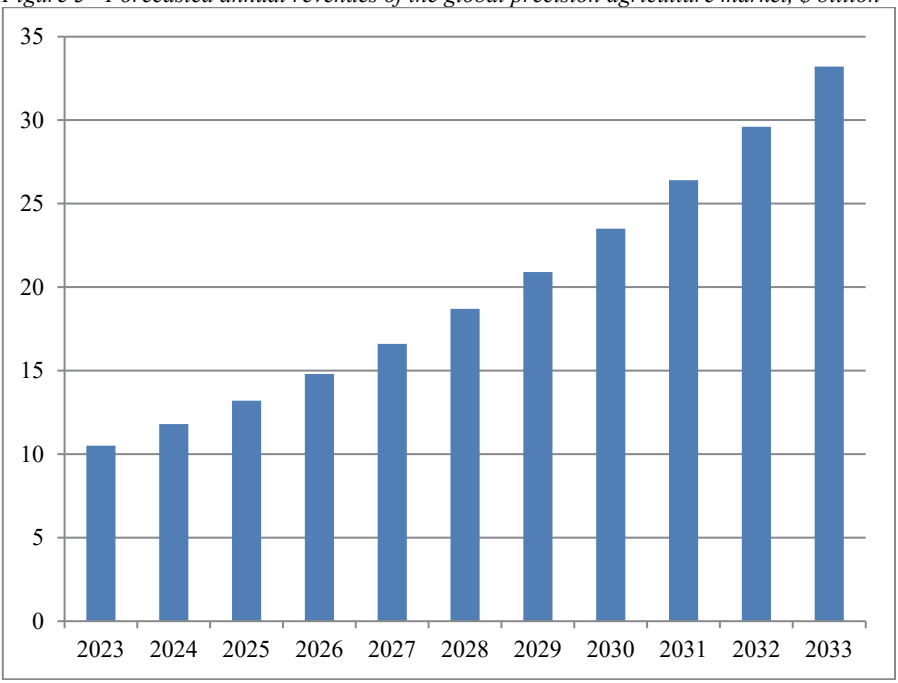
Figure 2 - Investment in agricultural technologies, $ billion



Source: developed by the authors based on FAO (2021), UNCTAD (2022), World Bank (2024), USDA (2024)

In general, the dynamics of investment in agricultural technologies reflect global trends in the agricultural sector, where periods of high growth alternate with adjustments. This indicates market instability, while indicating great opportunities for innovation and development in the future. Forecasted revenues for the coming years demonstrate steady growth, which confirms the positive dynamics of economic activity. In particular, revenues has gradually increased from 2023, reaching $ 33.2 billion by 2033. This indicates the stable development of the agricultural sector and the potential to achieve financial goals, in particular within the scope of sustainable development (Figure 3).

Figure 3 - Forecasted annual revenues of the global precision agriculture market, $ billion



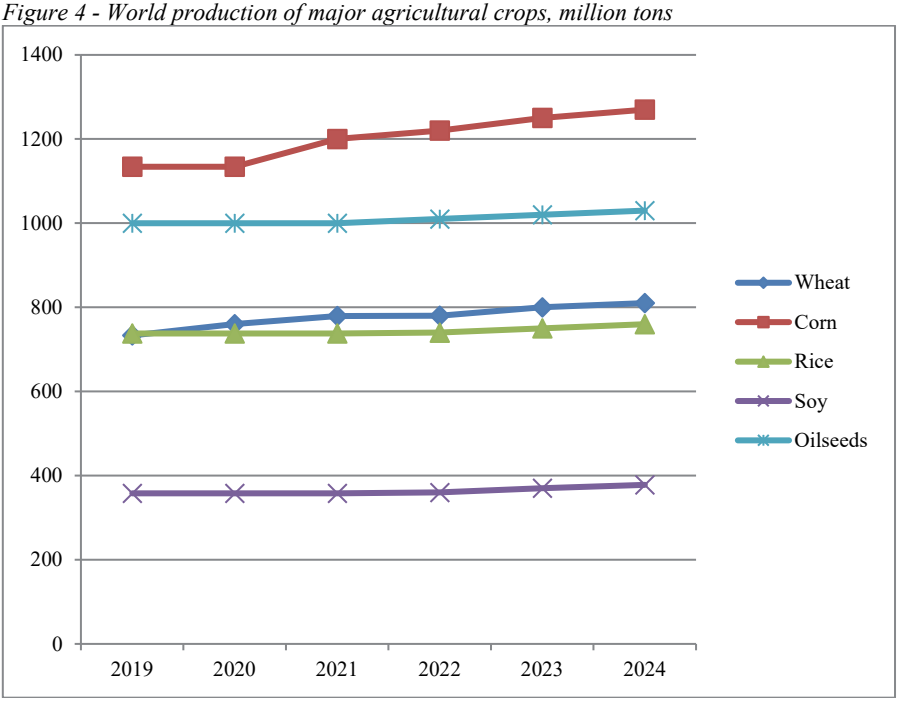
Source: developed by the authors based on FAO (2021), UNCTAD (2022), World Bank (2024), USDA (2024)

The growing income and financial instruments aimed at sustainable development can also be correlated with trends in the agricultural crop market. During 2019-2024, there has been a steady increase in the yield of major agricultural crops, such as wheat, corn, rice, soybeans, and oilseeds. In particular, the yield of wheat during this period increased by 10.5% (from 733.5 to 810), corn – by 11.9% (from 1134 to 1270), rice – by 1.6% (from 738 to 760), soybeans – by 5.6% (from 358 to 378), and oilseeds – by 3%

(from 1000 to 1030). This indicates an increase in production efficiency and potential for development of the agricultural sector (Figure 4).

In the context of projected revenues, which are steadily growing to $33.2 billion by 2033, these data give grounds to conclude that the agricultural sector will play an important role in ensuring economic stability and development. The growth in agricultural crop production is in line with the general trends of income growth, which also highlights the importance of sustainable development and adaptation to global changes in the agribusiness.

Figure 4 - World production of major agricultural crops, million tons



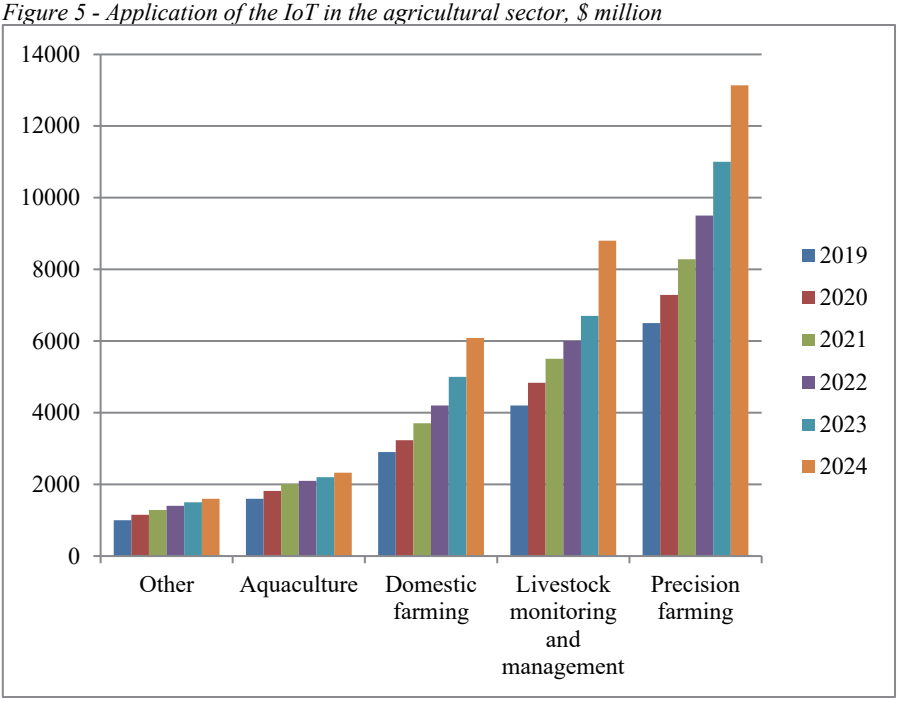
Source: developed by the authors based on World Bank (2024)

The analysis of the trends in crop yield growth shows a clear correlation between increasing efficiency of agricultural production and the use of technologies such as IoT. Over the period 2019-2024, the increase in the yield of wheat, corn, rice, soybeans and oilseeds demonstrates the sustainability and gradual development of the agricultural sector. This, in turn, contributes to an increase in economic activity and income in this area. The increased use of IoT in the agricultural sector also reflects the ability to adapt to global changes and challenges, in particular climate change and

resource constraints. The continuous implementation of the latest technologies and investment in sustainable development make the agricultural sector more efficient and able to provide stable income growth, as well as adapt to changing market conditions (Figure 5).

Considering that the income of the agricultural sector is projected to grow to $ 33.2 billion by 2033, it is obvious that IoT will become one of the main driving forces of this development. The use of IoT in agriculture, as well as through investment in innovative technologies will enable the agricultural sector to increase production, but also to reduce the negative impact on the environment, which in turn will strengthen the resilience of the food market and contribute to sustainable development.

Figure 5 - Application of the IoT in the agricultural sector, $ million

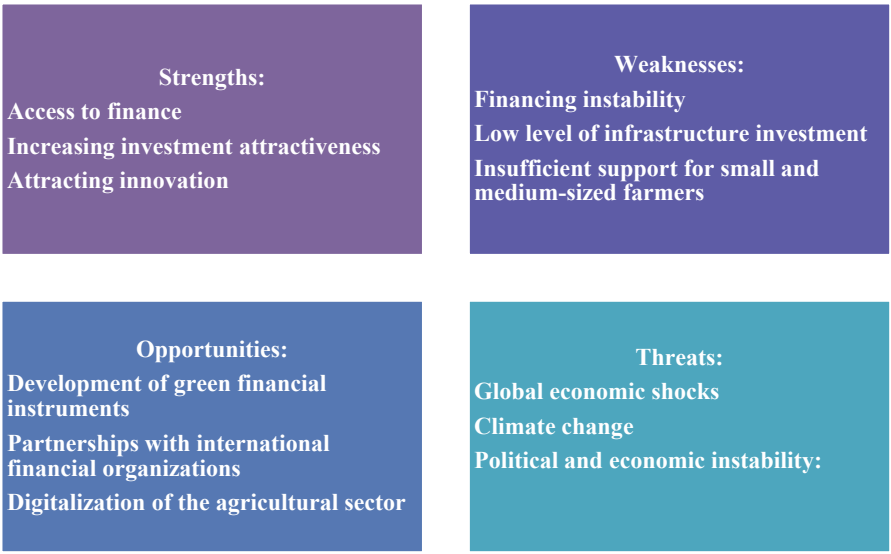


Source: developed by the authors based on World Bank (2024), USDA (2024)

SWOT analysis of financial instruments (Figure 6) in the agricultural sector shows that state support, loans and investment contribute to its development, and green bonds increase investment attractiveness. However, the instability of financing and the low level of infrastructure investment limit the efficiency of the sector, especially for small farmers. At the same time, the development of green financial instrument, digitalization and

international financial opportunities create prospects for growth. However, there are still such threats as global economic crises, climate change, and political instability. Sustainable development requires stable financing, innovative technologies, and effective regulation.

Figure 6 - SWOT analysis of the effectiveness of financial instruments in the agricultural sector



Source: developed by the authors

The improvement of financial instruments in the agricultural sector requires focusing on infrastructure development, support for small and medium-sized farmers, as well as the introduction of innovative financial instruments, such as green bonds and specialized investment funds. It is also important to expand international cooperation to attract external financial resources and develop new technologies. Adapting financial programmes to climate and economic changes will contribute to the creation of sustainable and environmentally friendly agricultural production, which will ensure the long-term stability of the sector.

Discussion

The results of the study of financial instruments for ensuring food market sustainability confirm the conclusions of a number of other authors. In

particular, the importance of blended financing, which includes grants, technical assistance, loan guarantees, investment in capital and funds, is emphasized. The outlined approaches actively support the agricultural sector, which is consistent with the perspective of Varnalii (2020). He emphasizes the need for state subsidies to reduce production costs and increase the availability of agricultural products. The study confirms that state subsidies contribute to the stability of the food market. However, their effectiveness directly depends on their intended use, which is also emphasized by Giannetti et al. (2023), focusing on the importance of developing the infrastructure of the agricultural sector. Studies by international financial organizations confirm that the stable insurance mechanisms reduces financial pressure on farmers and stimulates investment in agriculture. This is consistent with the opinion of Hua et al. (2024), who note the role of international financial institutions in creating financing programmes aimed at ensuring food security. Strategic financial management, which includes diversifying funding sources and developing partnerships with international organizations, is an important element in ensuring food market stability. This is also confirmed by the study of Sumets et al. (2022).

The use of innovative financial instruments, such as green bonds, can significantly support the sustainable development of the agricultural sector. This is also confirmed by the studies of Shi and Yang (2025) and Shpykuliak et al. (2022). They emphasize the importance of combining traditional financial instruments with new mechanisms, such as socially responsible investment (SRI). This not only stabilizes the market, but also ensures environmental responsibility. The role of adapting financial mechanisms to global economic changes is also important, which is confirmed by the research of Ostapenko (2021). These instruments allow countries to respond more quickly to the challenges associated with climate change and economic instability. Attracting investment in agricultural infrastructure is another important aspect that increases the efficiency of agricultural production. The research of Humeniuk et al. (2021b), as well as Chen and Bian (2023) emphasize that the development of facilities such as roads, warehouses, and irrigation systems is critical to ensuring access to finance and increasing agricultural productivity.

The study of the role of public investment in supporting SMEs in the agricultural sector, in particular through flexible financial mechanisms, which is emphasized by Ivashkiv et al. (2020), contributes to ensuring food security, as these enterprises are important suppliers of food in local markets. The findings of Tsimoshynska et al. (2021) on the importance of flexible financial mechanisms also confirm these results.

A comparison of traditional and refocused approaches to supporting the agri-food sector revealed that traditional mechanisms, in particular export subsidies, can distort market signals. Instead, refocused approaches emphasize sustainable development and environmental standards. This statement is consistent with the recommendations of international organizations such as FAO, which suggest focusing on the environmental efficiency of production.

The study confirms the importance of financial instruments for ensuring food market sustainability. However, it reveals the need for further research and improvement of existing mechanisms, adapting them to changes in the global economy and natural conditions. Such an approach will ensure stable development of the agricultural sector and food security in the face of current challenges.

The practical application of the obtained results is to optimize the financing of the agricultural sector by increasing the role of state subsidies, investment in green financial instruments and the development of agricultural infrastructure. This will ensure not only the stability of financing, but also the sustainable development of the agricultural sector. The integration of environmental standards and flexible financial mechanisms for small businesses will allow an effective response to modern economic and environmental challenges.

The limitations of the conducted research: the analysis was conducted based on data available for 2019-2024, which may not take into account long-term changes in the financial or economic situation.

The recommendations based on the research can be aimed at improving financial mechanisms, increasing the efficiency of the agricultural sector, and ensuring the stability of the food market. In particular, expanding access to agricultural insurance can significantly reduce farmers' financial risks associated with natural disasters and unpredictable climate changes. It is important to develop insurance programmes that support small and medium-sized producers, in particular through state guarantees or subsidies.

Conclusions

The study found that blended finance, which includes grants, technical assistance, loan guarantees, and equity investments, is a key tool for ensuring food market sustainability. These financial mechanisms reduce costs,

improve project quality and reduce financial risks, which helps to attract investment in sustainable agricultural development.

The analysis of investment in agricultural technologies showed a growing interest in innovation, particularly in the face of global challenges such as climate change. In 2019, investment in agricultural technologies amounted to $ 21.5 billion, and they reached $ 40.2 billion in 2024, which indicates significant potential for development in the agricultural sector, provided that economic and political conditions are stable. The introduction of technologies such as IoT also plays an important role in increasing production efficiency. According to the results, the implementation of IoT in agriculture ensures an increase in the yield of major crops such as wheat (growth by 10.5% from 733.5 to 810 million tons), corn (growth by 11.9% from 1,134 to 1,270 million tons) and soybeans (growth by 5.6% from 358 to 378 million tons) for 2019-2024.

It is important to develop infrastructure, support small and medium-sized farms, and adapt financial programmes to new realities in order to improve financial instruments in the agricultural sector.

The practical value of the study is the developed recommendations for optimizing financing for sustainable development of the food market, in particular through the use of blended financial instruments. The results of the study may be useful for government agencies, financial institutions, and agricultural enterprises in developing policies and programmes to ensure food security and food market sustainability.

Prospects for further research include an in-depth analysis of the effectiveness of using blended financial instruments for sustainable development of the agricultural sector. In particular, this is a study of the impact of new technologies, such as AI and blockchain, on increasing transparency and reducing costs in agriculture.

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