

Analysis of investment and innovation support for the agricultural sector of Ukraine

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Abstract. The definition of innovation and investment support for developing the agricultural sector is clarified. The dynamics of capital investments in Ukraine's agriculture, forestry, and fisheries and their share in the total structure of capital investments are analyzed. The share of capital investments in Ukraine's agriculture, forestry, and fisheries in terms of sources of financing are highlighted, and the aspects of bank lending to the agricultural sector are singled out. The dynamics of direct investment in Ukraine are covered, and it was established that growth in capital investment in agriculture, forestry, and fisheries was observed in 2021 and 2013-2018. The basic components of investment support for the development of the agricultural sector, such as private capital, state investments, international investments, and credit resources, are identified. Their advantages and disadvantages are characterized. Ukraine's global innovation index (GII) for 2013-2023 and its components are studied. It was established that in 2022, Ukraine took the 57th position (49th in 2021) and 2023 – 55th in the GII ranking. The factors influencing the rating of Ukraine in the world ranking of economies according to the GII are identified. A correlation analysis between the GII and its sub-indices is carried out. A close connection between GII and "Knowledge and technology outputs" has been established. A linear functional relationship is formed between GII and "Knowledge and technology outputs" as subindex.

1 Introduction

For several millennia the agricultural sector has traditionally been considered strategically significant for Ukraine. It is the agricultural sector that constitutes a priority component of the country's economy, and investment resources are now extremely important for the development of the national economy as a whole.

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In the current economic environment the competitiveness of this sector will be ensured only by investing significant financial resources. This, in turn, will create a number of jobs. The lives of millions of people depend on the efficiency of the agricultural sector of the economy. The lack of investments endangers the further development of the agricultural sector, and therefore the lives of millions of people. However, it is worth noting that the development of agriculture in Ukraine in recent years has been accompanied by new challenges [1]. Investments are supposed to be all types of property and intellectual property invested in business and other activities that generate profit and/or achieve social and environmental effects [2]. According to the Tax Code of Ukraine investments are business transactions that involve the acquisition of fixed assets, intangible assets, corporate rights and/or securities in exchange for funds or property [3]. I. Blank considers investments as an investment of capital with the aim of its further increase [4]. V. Zhymirov understands investment as the act of refusing today's consumption of goods for the sake of more complete satisfaction of needs in the following periods [5].

According to J. Krupka such definitions characterize investments in two ways: from the economic point of view – as a process of capital accumulation; from the social point of view – as an increase in goods for consumption [6]. In general, any investment involves the expenditure of resources to obtain certain benefits. The definition of the economic essence of investments has its own peculiarities, depending on the type of economic activity in which they are made. For example, in the agricultural sector, investments are characterized primarily by the areas of investment: crop production or livestock. L. Kustrich stating the peculiarities of agricultural investment notes that they are manifested in the fact that, along with the investment of capital in the objects of human labor results, as in other sectors of the economy, in agriculture they are also made in objects of nature, which, *ceteris paribus*, makes their activities more capital-intensive with a long payback period and high risks [7].

A prerequisite for the development of the agricultural sector is not only investment attraction, but also an adequate level of investment support sufficient for the efficient functioning of agricultural enterprises and the use of their entrepreneurial potential. Investment collateral is traditionally understood as:

- types of property and intellectual property invested in entrepreneurial and other activities that generate income or achieve social effect [8];
- a set of various conditions, resources, economic mechanisms, levers and measures necessary to ensure the normal (specified) course of investment processes [9];
- a continuous, consistent process of searching, attracting and using various types of investment resources necessary for the implementation of innovative activities [10];
- a complex dynamic system, the purpose of which is to promote the progressive development of agriculture and the economic complex as a whole by searching for the attraction, distribution and investment of monetary, material and intellectual resources of various sources of origin, taking into account the combined influence of macro- and microenvironmental factors to achieve promising socio-economic goals [11]. However, in the current economic realities, in order to overcome crisis situations, increase production volumes and maintain the required level of competitiveness of entities, the need for innovative support for the development of the agricultural sector is significantly actualized. The development of innovations in agriculture should take place simultaneously with the attraction of investments, which will make it possible to increase the values of the main indicators of the efficiency of it.

Investing in agricultural innovation is fundamental when viewed from the standpoint of long-term economic growth. Increasing the volume of production of agricultural products requires proper development of the material and technical base.

The increase in its size is carried out at the expense of additional investments of material and monetary funds aimed at expanding the production potential of agriculture. The sustainable development of the agro-industrial complex in the conditions of the formation of market relations requires investment activity, which is reflected in the provision of the necessary monetary and material resources to enterprises.

2 Related works

It is common knowledge that agriculture plays a crucial role in the economic well-being of the country. It largely determines the country's resilience to various external factors. Many scientists emphasize this, for example: G. Douglas, S. Parente, R. Rogerson [12]; S. Kerimkhulle, Z. Aitkozha, A. Saliyeva, Z. Kerimkulov, A. Adalbek, R. Taberkhan [13]; Z. Taishykov, M. Tolysbayeva, K. Zhumanazarov, S. Ibraimova, Z. Mizambekova [14]. But traditionally, agriculture needs investments and innovations to ensure proper development. Investments in the agricultural sector (plant breeding, animal husbandry, aquaculture, etc.) make it possible to achieve positive results and ensure sustainable permanent growth of agriculture. The problems regarding investments and innovations in agriculture are also the subject of numerous discussions among scientists around the world. In particular, the publication, by E. Mamatzakis and C. Staikouras: [15], based on data from twenty-eight EU member states, proved that investments in general have a positive effect on income from agriculture. Such factors of investments of agricultural enterprises as sales volumes, investment subsidies and cash flow are explored in the paper of O. Aleksandrova, I. Fertő, A.-H. Viira [16].

At the same time, the authors divided the cash flow into an unstable part, which refers to market income, and a stable part, which is reflected in the provision of subsidies. They concluded that the lending process is affected by farm subsidies, not by market income. The negative impact of loans on the economic results of farmers is highlighted in a publication By B. Pandey, P. Bandyopadhyay, S. Kadam and M. Singh, in which a quantitative analysis was performed and attention on the violation of aspects of social sustainability was focused [17]. The agricultural lending process and its risks are analyzed in detail by A.R. Bilal and M.M.A. Baig [18]. The authors concluded that the insufficiently successful mechanism for assessing risks in crediting and the presence of serious problems in it affects late payment of interest on loans by agricultural producers. The issues how successfully credit funds are used by borrowers who are involved in agriculture in terms of different groups of farmers is highlighted in the work of B.L. Ahrendsen, C.B. Dodson, G. Short, R.L. Rainey, H.A. Snell [19]. The agricultural sector is subject to special taxation. Agricultural enterprises can choose a simplified or general taxation system. This also affects the ability to attract investments and innovations [20-24].

Innovations are the driving force behind the development of agriculture. Major shifts in the development of technology have caused a large-scale evolution in it and more efficient use of resources [25]. The role of innovations, natural resources, climate change in agriculture became the topic of research by X. Ren, Jun He, Z. Huang [26]. The results of their research showed that innovation significantly improves the ecological growth of agriculture, and that climate change plays a positive role in green development of agriculture. H. Shem Odame, J. Barack Okeyo-Owuor, J. Ghemoh Changeh, J. Okoth Otieno investigated inclusive innovations and drew attention to the fact that innovations often include simple technologies [27]. C. Gras, D. M Cáceres highlight the issue of technological innovations in agriculture as well as how they affect its sustainability. They are also investigating what solutions will help to develop agriculture [28]. However, not only technology plays an important role in the introduction of innovations in agriculture.

In particular, it is about the relationship between man and nature, which is aimed at forming a balance between social, economic and ecological phenomena. This is emphasized by scientists D. Andrade, F. Pasini, F. Rubio Scarano [31]. Although the transition and active implementation of the goals of sustainable development certainly require the expanded use of new technologies and relevant innovations on a systemic basis [30]. It is important to ensure hyper-transparency in agriculture. This becomes possible through the use of digital technologies (drones, satellites, sensors, blockchain, etc.) [31-33]. Scientists in publications [34, 35] emphasize the need to analyze innovative costs, which are carried out to ensure the effective management of agriculture.

The essence of innovation is interpreted by scientists in different ways. Innovation is observed as the development and implementation of a new idea, which is embodied in a new product, process, service, distinguished by originality, usefulness, value and leads to changes in the way of management and benefits society by foreign scientists: M. Ambramson [36], U. Kuniyoshi [37], R. Luecke, R. Katz [38], Cary L. Cooper, C. Argyris [39].

Domestic scientists, for example, S. Ilyashenko [40] and V. Yevtushevsky [41] consider innovation as the consequence of the implementation of the result of scientific activity with a set of effects. To summarize, innovation should be understood as the consequence of the use of innovations formed as a result of the use of intellectual potential, which has led to qualitative changes and caused a positive effect. The system of innovation support of agricultural enterprises is a set of various elements that are functionally interdependent, interacting and interrelated in the process of production, distribution, implementation and use of new technologies, products or services [42].

In view of the above, innovation and investment support for the development of the agricultural sector will be understood as a key factor in its effective functioning, which leads to maximizing the volume and diversification of agricultural production, increasing production capacity, forming own financial resources for further investment, increasing competitiveness and strengthening food security of the state. Thus, in today's conditions, it is extremely important to strengthen the economic security of the country, which includes the development of agriculture, the active involvement of innovations and investments in it. All this requires the use of a number of analytical tools.

3 Method and materials

The research uses general scientific and special methods of scientific knowledge, in particular scientific abstraction, heuristic analysis; methods of generalization of theoretical provisions; method of comparison, induction and deduction; methods of analysis and synthesis, formalization, grouping, tabular methods of presenting results; method of correlation analysis, etc.

Investment resources in the economic activities of relevant entities form an essential basis for supporting the development of agricultural sector processes (Fig. 1). Consequently, in 2013-2018 and in 2021 there was an increase in capital investment in agriculture, forestry and fisheries. This indicates the investment attractiveness and priority importance of this industry from the point of view of investment, despite the difficult conditions for the development of the domestic economy and negative socioeconomic trends. Instead, in 2022 there is a decline in absolute terms.

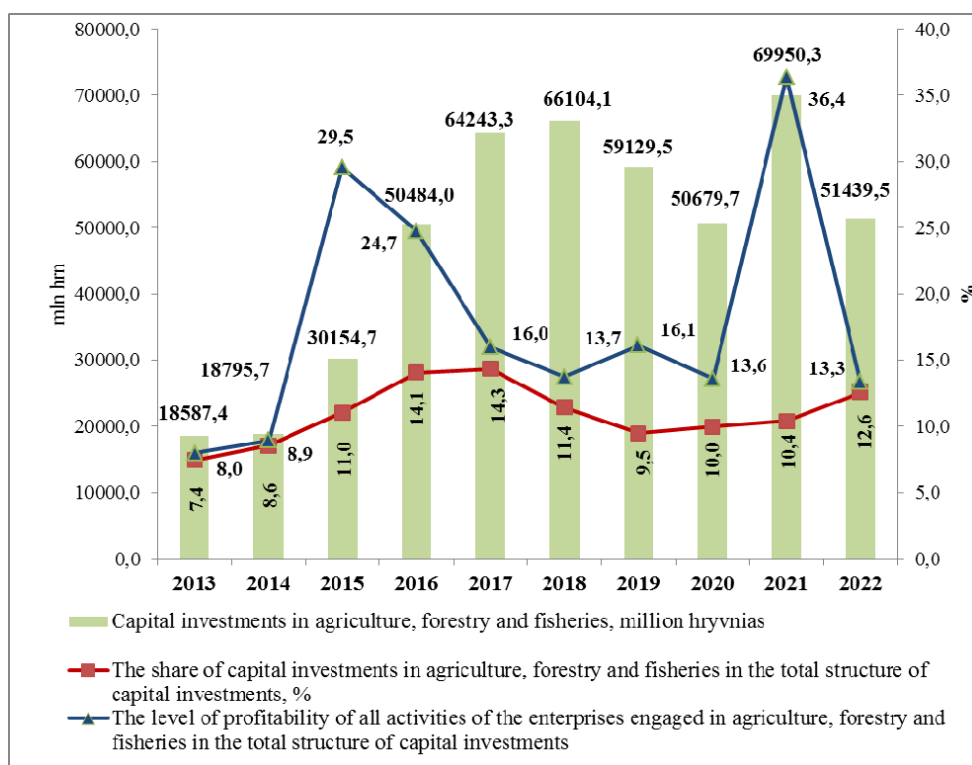


Fig. 1. Dynamics of capital investments in agriculture, forestry and fisheries of Ukraine (code "A" according to Classifier of types of economic activity-2010), their share in the total structure of capital investments and profitability of enterprises in 2013-2022 [43].

A slight slowdown in investment activity in agriculture, forestry and fisheries is due to the changing external environment, the unstable economic and political situation in Ukraine, stagnant economic processes, insufficiently justified changes in macroeconomic management of the agricultural sector, often unfavorable natural and climatic conditions, minimization of state financial support, the COVID-19 pandemic, deterioration of small business conditions and working conditions in general, and increased risks for investors. Obviously, the above has a negative impact on the development of the agricultural sector, namely, it leads to a reduction in agricultural production while increasing its cost, reducing competitiveness, labor productivity, etc.

The level of profitability of all activities of the enterprises engaged in agriculture, forestry and fisheries in the total structure of capital investments has similar dynamics. In particular, in 2022, profitability decreased from 36.4% to 13.3%. If we analyze the share of these capital investments in the total structure of capital investments in all types of economic activity, it should be noted that it decreased in 2018 (11.4%) and 2019 (9.5%). In 2020, it slightly increased (not significantly) and amounted to 10%, in 2021 – 10.4%, in 2022 – 12.6%. The analysis of the share of investments by sources of financing is presented in Table 1.

The results of the analysis of the share of capital investments in agriculture, forestry and fisheries of Ukraine by sources of financing show that more than 90 % of the total amount of capital investments is accounted for by the own funds of Ukrainian enterprises and organizations. Undoubtedly, active investment activity of the agricultural sector entities is an essential guarantee of their further successful development and functioning. The second largest share in the structure of capital investment, depending on the source of financing, is investments raised through bank loans.

Table 1. Dynamics of the share of capital investments in agriculture, forestry and fisheries of Ukraine by sources of financing in 2019-2021 (%) [43]

	Financing of capital investments					
	at the expense of the state budget	at the expense of local budgets	at the expense of own funds of enterprises and organizations	at the expense of bank loans and other borrowings	at the expense of other sources of financing	at the expense of investment companies, non-resident investors, etc.
2019	0.43	0.18	90.83	8.51	0.03	0.02
2020	0.28	0.09	90.65	8.61	0.31	0.06
2021	0.20	0.14	90.84	8.77	0.05	0

Thus, the existence of a link between the development of the agricultural sector and the credit market is confirmed. The high requirements for agricultural borrowers, their creditworthiness, collateral, etc. often slow down this process. It is noteworthy that agricultural producers often need to attract long-term credit resources to purchase new production assets, expand and upgrade the existing technological park to increase the scale of their operations. In contrast to long-term loans, short-term loans are mostly used to achieve current goals (field work, etc.). Simplifying the procedures for obtaining long-term loans for borrowers in the agricultural sector should be a priority for banks and a key element of the bank lending market. M. Kozhemiakina makes an apt statement in this regard: "The investment revival of the agricultural sector requires the attraction of such investments in production that would meet the need for the necessary types of material and technical resources and create conditions for the effective operation of enterprises. However, the deep crisis in Ukraine's economy not only caused destructive processes in material and technical support, but also led to a sharp reduction in labor resources, deterioration of their age composition, degradation of land resources, and a decline in agricultural production" [48].

Bank lending to the agro-industrial sector is an economic relationship to provide agricultural enterprises with a source of financing on the terms of repayment, payment, security, maturity, intended use and differentiation, accompanied by specific features inherent in enterprises [45]. Specific features of agriculture (dependence on weather and climatic conditions, duration of the production process, etc.) necessitate their consideration in the organization of the credit process and, in particular, the development of credit conditions. The specifics of banking activities are that banks use depositors' funds when lending to agricultural entities, and therefore are quite responsible in assessing the possible, usually high and not always controllable, risks that arise at the time of lending. The imperfection of the legislation in terms of protection of creditors' rights and the lending mechanism in general causes high credit risks, which leads to overstated lending rates. The NBU's high discount rate, in turn, does not contribute to an increase in the volume of loans issued. When making the final decision to issue a loan, financial reporting indicators are taken into account, which are not always objective and truthful, due to the poor quality of accounting at agricultural enterprises. The feasibility of raising a loan traditionally has to be substantiated in the financial planning system, which is not always able to provide evidence in time to support the need for such a decision. The land use statistics system also lacks reliable data. Difficulties in taking future harvests as collateral for loans significantly limit bank lending opportunities.

Bank loans contribute to the continuity of agricultural production. Given the existing risks that accompany the operation of agricultural entities, a significant number of banks place high demands on potential borrowers. The not always acceptable terms of long-term lending imposed by banks on potential borrowers – agricultural entities – is one of the key problems that hinder its active development.

As a rule, medium-sized enterprises account for the largest share of loans. At the same time, large enterprises receive loans much less frequently and in smaller amounts than small ones. Agricultural microbusinesses are also actively taking out bank loans to develop their operations. Since 2003, Ukraine has been operating a system of preferential lending to the agricultural sector, the economic essence of which is that loans are provided not to agricultural producers, but to banks (the state budget partially reimburses loan rates). Currently, the procedure for providing state financial support to enterprises by reducing the price of loans is determined by the Procedure for providing financial state support to business entities [46].

According to this document, interest compensation is provided to business entities that have received a loan in national currency from an authorized bank. Loans eligible for state support must meet a number of conditions. The program "Affordable Loans 5-7-9%" is implemented by the Entrepreneurship Development Fund (EDF). The sole participant of the EDF is the Government of Ukraine represented by the Ministry of Finance of Ukraine, which coordinates all aspects of the Fund's activities. However, in the current economic environment, government support for lending to the agricultural sector is insufficient and inefficient. The credit resources provided by banks under various existing programs are not able to fully meet the existing cash needs. To further intensify bank lending, government agencies should take the following measures: more actively implement the development and improvement of regulations governing bank lending; create new programs and introduce mechanisms to reduce the cost of loans; provide economic incentives to banks involved in lending to the agricultural sector, etc.

Another equally important factor that will contribute to the active development of the agricultural sector is the attraction of foreign capital, which is formalized in the form of foreign direct investment and contributes to the transfer of new experience, technologies, rational use and expansion of existing potential, including innovation, and opportunities. The dynamics of direct investments in agriculture, forestry and fisheries of Ukraine by components is shown in Table 2.

Table 2. Dynamics of direct investments in Ukraine (code "A" according to the Classifier of economic activities of Ukraine-2010) in 2019-2022 (USD million) [47].

Indicators		2019	2020	2021	2022	2022/2021	
						+;-	TP, %
1.	Direct investments in Ukraine, total, incl:	4909,1	-36,0	7320,0	556,9	-6763,1	7,6
1.1.	Direct investments in agriculture, forestry, and fisheries	38,0	224,7	1127,8	378,3	-749,5	33,5
	and fisheries, including:						
	in % of total direct investments	0,8	–	15,4	67,9	52,5	440,9
1.1.1.	Equity instruments	29,1	182,2	1208,9	293,1	-915,8	24,2
1.1.1.1	Equity instruments other than income reinvestment	73,2	-12,1	19,5	12,4	-7,1	63,6
1.1.1.2.	Reinvestment of income	-44,1	194,3	1189,5	280,7	-908,8	23,6
1.2.	Debt instruments	8,9	42,5	-81,2	85,2	166,4	–

Thus, the volume of direct investment in Ukraine in agriculture, forestry and fisheries has been growing in recent years: by 91.3% in 2020 and 83.1% in 2021. In contrast, in 2022, it decreased by 92.4%, which is due to the introduction of martial law in the country.

According to the National Bank of Ukraine, the largest volume of investments in Ukraine's sector is made by Cyprus, Germany, Denmark, the United Kingdom and Poland. At the same time, the countries of the European Union accounted for two-thirds of all investments during the study period [46]. Foreign companies such as Fromageries Bel, Louis Dreyfus, AgroFeed Kft, Limagrain, Grain Alliance, Glencore Agriculture Limited and others are currently operating in Ukrainian agriculture.

In the context of investment, Ukraine's land reform plays a significant role, as it has provided potential domestic investors with a number of opportunities. The opening of the land market made it possible to attract additional investment, increase the market for lending for land acquisition transactions and logistics for agricultural entities, expand infrastructure and develop the processing industry. The agricultural land market in Ukraine was launched on July 1, 2021. Until December 31, 2023, only individual citizens of Ukraine could purchase land in the amount of no more than 100 hectares per person. Since the beginning of 2024, legal entities have also been granted this right, and the permitted size has increased to 10,000 hectares.

Over the two years of land reform in Ukraine, about 275,157 hectares of agricultural land have been sold, which is 1% of all agricultural land, according to the Ministry of Agrarian Policy. In the more than two years since the market opened amid a full-scale war, land prices have risen by 10%. In the context of investment, Ukraine's land reform plays a significant role, as it has provided potential domestic investors with a number of opportunities. The opening of the land market made it possible to attract additional investment, increase the market for lending for land acquisition transactions and logistics for agricultural entities, expand infrastructure, and develop the processing industry.

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Thus, summarizing the above, it is possible to identify the basic components of investment support for the development of the agricultural sector of Ukraine as follows: private capital (own funds of enterprises and individuals); state investments (state and local budget funds); international investments (funds of investment companies); credit resources (bank lending).

The advantages of private investments are that a significant amount of investment can be attracted quickly with the possibility of choosing projects that will have high profitability. Instead, there is risk of capital loss, possibility of interference in project management, no state support. Speaking about state investments, it should be noted that the state can attract large sums of funds, the possibility of influencing projects from the point of view of state policy is assumed. However, there are bureaucratic obstacles, the possibility of inefficient spending of funds, projects lagging behind commercial markets. Regarding international investments, it should be stressed that their advantages are the attraction of international resources and knowledge, the possibility of entering international markets. The risk of political and economic instability in the country, the possibility of dependence on foreign capital, the possibility of conflicts between investors and the local population should not be ignored.

Quick access to capital, the possibility of increasing production volumes, choosing the loan repayment term – these are the main advantages of lending. On the other hand, high interest rates, the possibility of loss of loan collateral, insufficient volume of loans to support projects are its disadvantages.

The economic efficiency of the agricultural sector is determined not only by the availability of natural resources, in particular land, but also by the production and testing of innovative developments. The high level of profitability of the agricultural sector and its entities in the context of the intellectualization of the economy and society largely depends on the use of innovative developments in the process of agricultural production. As the experience of developed countries shows, it is only in the presence of an innovative vector of economic development that a high level of quality of life can be achieved. The state of innovative development of the country's economy is one of the indicators of competitiveness in the global market. Only countries with a significantly developed innovation component, which is reflected in the permanent introduction of innovations in all areas of activity, are able to lead the rankings of the world's leading countries.

Implementation of innovative activities in the context of the intellectualization of the economy involves ensuring a balance between environmental constraints that act as a deterrent to economic growth. In the context of globalization, the demand for the consumption of organic products is increasing, the production of which is possible if innovative developments are introduced into the production process. The main assessment methods that allow to reliably determine the innovation potential of any country are the use of various innovation indices, the methods of calculation of which are both criticized and approved by scientists from different countries. In the Strategy for the Development of the Sphere of Innovative Activity for the Period up to 2030 of 10.07.2019 No. 526-p. [49], a comparative analysis of the state of Ukraine's innovation system was conducted based on three indicators: the Global Innovation Index, the European Innovation Scoreboard Innovation Index and the Innovation Development Index presented by Bloomberg.

One of the most well-known is the Global Innovation Index (GII), which is developed by the Cornell University Business School, the World Intellectual Property Organization (WIPO), and the INSEAD research institute. The GII, calculated on the basis of 80 parameters, illustrates the innovative development of countries around the world, characterizing the state of affairs in education, infrastructure and business development, and is calculated as the average of two sub-indices.

The first sub-index is Innovation input. It is used to evaluate the elements of national economy. At the same time, 5 main groups of indicators are distinguished. Among them, the following can be highlighted: institutes; human capital and research; infrastructure; market sophistication; business sophistication. The Innovation output is the second sub-index. It captures actual evidence of innovation outputs and includes 2 sub-indices: knowledge and technology outputs; creative outputs. The value of the GII for Ukraine and its place among 142 countries in the dynamics for 2013-2023 is shown in Table 3.

Thus, analyzing recent years, it is worth noting that in 2022, Ukraine worsened its ranking and took 57th position (49th position in 2021) in the GII ranking (out of 132 countries), and ranked 34th among 39 European economies. In 2023, there was an improvement, with Ukraine ranked 55th and 34th among 39 European economies. North Macedonia is ahead of Ukraine, and the Philippines is in the ranking behind Ukraine. Also this year, for the first time, Ukraine entered the top 3 most innovative economies in the group of lower-middle-income countries (along with India and Vietnam). Switzerland was recognized as the most innovative economy in 2023. It is followed in the ranking by Sweden, the United States, the United Kingdom and Singapore. This year, Sweden has overtaken the United States and moved up to second place.

Singapore entered the top five and took the leading position among the economies of the Southeast Asia, East Asia and Oceania (SEAO) region.

Table 3. Global Innovation Index (GII) of Ukraine for 2013-2023 [50].

Years	Innovation inputs (Input rank)	Innovation outputs (Output rank)	Score	GII rank
2013	83	58	35,78	71
2014	88	46	36,26	63
2015	84	47	36,45	64
2016	76	40	35,72	56
2017	77	40	37,62	50
2018	75	35	38,52	43
2019	82	36	37,4	47
2020	71	37	36,32	45
2021	76	37	35,6	49
2022	75	48	31,0	57
2023	78	42	32,8	55

As it can be seen, in 2023 Ukraine demonstrated better indicators of Innovation outputs than Innovation inputs. It took 72nd place (last year – 48th) and 78th place (in 2022 – 75th) in the ranking of countries. It is advisable to evaluate the value of the GII, taking into account, first of all, the values of the sub-indices and the ranking of countries by them. The dynamics ranking by a number of components over the past 5 years is shown in Fig. 2.

Therefore, the lower the value of the indicator, the higher Ukraine's place in the ranking. The best results can be seen in the "Creative outputs" area: in 2023, Ukraine improved its results from 63rd to 37th place. Ukraine has good results in "Knowledge and technology outputs" (36th place in 2022). However, it deteriorated in 2023 and reached 45th place. The worst results were found for "Market sophistication" (102nd in 2022, 104th in 2023), as well as for "Institutions" (97th in 2022, 100th in 2023).

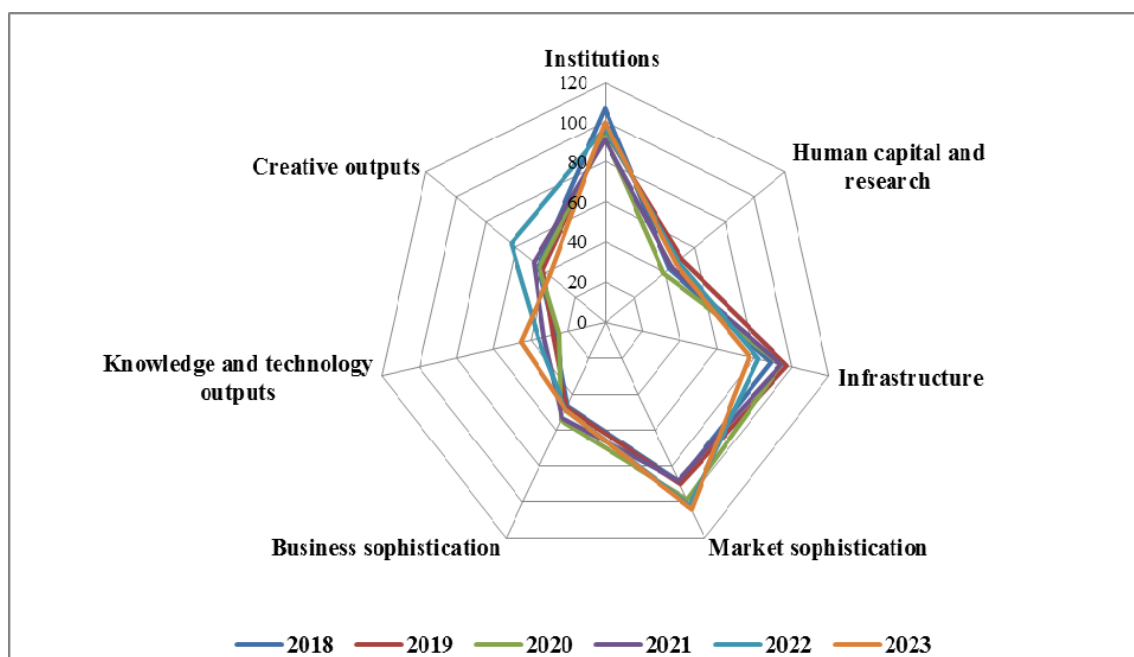


Fig. 2. Dynamics of the GII rank depending on the values of sub-indices taken into account in its calculation for 2018-2023 [50].

It should be noted that when calculating the "Creative outputs" sub-index, in particular the Global brand value, top 5,000, % GDP indicator, the first place in the ranking was taken by Kernel, which has the largest amount of land resources among all Ukrainian agricultural holdings. It is important to understand the close relationship between the sub-indices and the value of the GII itself. To do this, we will use correlation as a mathematical and statistical method to test hypotheses about the relationship between variables. Pearson's correlation coefficient is a measure of proportionality between two variables that indicates the natural changes in one variable as the values of the other variable increase or decrease. It is used in the case of pairwise dependence. It assumes a normal distribution of the general population (Table 4).

Table 4. Correlation coefficient of the relationship between the GII and its components for Ukraine.

No	Years and indicators	GII	Institutions	Human capital and research	Infra structure	Market sophistication	Business sophistication	Knowledge and technology outputs	Creative outputs
1.	2018	43	107	43	89	89	46	27	45
2.	2019	47	96	51	97	90	47	28	42
3.	2020	45	93	39	94	99	54	25	44
4.	2021	49	91	44	94	88	53	33	48
5.	2022	57	97	49	82	102	48	36	63
6.	2023	55	100	47	77	104	48	45	37
7.	Correlation coefficient between GII and indicator of:		-0,156	0,55	-0,75	0,7	-0,137	0,848	0,411

Thus, the relationship between the variables is as follows:

- GII and "Institutions" – absent, inverse correlation;
- GII and "Human capital and research" – moderate;
- GII and "Infrastructure" – absent, inverse correlation;
- GII and "Market sophistication" – moderate;
- GII and "Business sophistication" – not available, inverse correlation;
- GII and "Knowledge and technology outputs" – high;
- GII and "Creative outputs" – significant.

It is worth noting that the value of the correlation coefficient is not proof that there is a causal relationship between the characteristics under study, but is an assessment of the degree of mutual consistency in the changes in the characteristics.

In order to establish a causal relationship, it is necessary to analyze the qualitative nature of the phenomena. There is a linear functional relationship between GII and "Knowledge and technology outputs", which is given by the formula (1):

$$y = kx + x \quad (1)$$

where k and b – some integers,

x – an argument.

To estimate the parameters of the regression equation, we use the least squares method (Fig. 3).

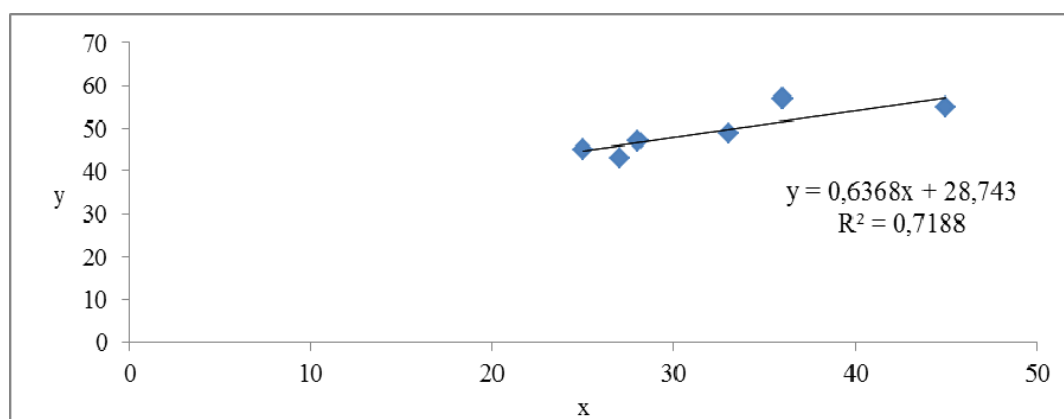


Fig. 3. Linear regression equation between GII and "Knowledge and technology" outputs .

Hence, the linear regression equation will look like this:

$$y = 0.6368 \times x + 28.743$$

Consequently, if the rating of the "Knowledge and Technology Outputs" indicator increases by one point, Ukraine's GII rating will increase by 0.6368.

The coefficient of determination R^2 measures the proportion of the variance relative to the mean that is "explained" by the regression. The R^2 value is an indicator of the degree of model fit to the data. The closer the coefficient of determination is to 1, the better the regression "explains" the dependence in the data. After performing the appropriate calculations, we have:

$$R^2 = 0.7188$$

Hence, the GII aims to cover the multidimensional aspects of innovation and provide tools that can help in developing policies to promote long-term growth in production, jobs, and productivity. In general, Ukraine's low ranking in the global ranking of economies according to the GII values over the past decade is due to the following factors: unfavorable political and business climate in Ukraine, imperfect legislation that is constantly changing, low investment attractiveness, inefficient use of available energy, lack of public procurement of innovations, and insufficient infrastructure development. The activation of factors contributing to sustainable growth and competitiveness of the Ukrainian economy becomes especially relevant in conditions of uncertainty and increased instability in global development trends. Today innovative activity in Ukraine is not going through the best of times caused by an insufficient level of financing, the outflow of qualified personnel, a high degree of riskiness, insufficient attention of society to this area, etc. The juxtaposition itself trends in the development of innovative activity of Ukraine and the leading countries of the world allows to identify potential ways of its activation and to outline possible options for solving existing problems.

Speaking about innovation, it is impossible not to mention the innovation potential as a set of available intellectual, technological, financial, economic, scientific and production resources with their respective infrastructure support, which are able to create new knowledge and an effective commercialization mechanism, as well as promote economic, scientific and technological development. It is the innovative potential of agricultural enterprises that is traditionally assessed first when it comes to selecting priority areas for innovation strategies.

The main components of innovation potential are the next:

- market (characterizes the correspondence of the capabilities of an agricultural enterprise to the market needs of innovations formed by the market environment);
- erudition (characterizes the availability of opportunities to create and adopt ideas, plans, innovations and bring them to the level of new technologies, designs, organizational and managerial decisions);
- employees, their distribution by professional training, departments at the level corresponding to the modern development of science and technology;
- technical and technological component, which shows the ability and efficiency of the agricultural enterprise's production capacities to respond to market needs;
- information and reference component, which characterizes the level of information support of the agricultural enterprise, the degree of accuracy of information necessary for making innovative decisions;
- interaction, which determines the possibilities of bringing the multidirectional interests of the subjects of the innovation process into line;
- research, which characterizes the availability of a stock of research results sufficient to generate new knowledge, the possibility of conducting research to test innovation ideas and evaluate the application of innovations in the production of new products.

Martial law in Ukraine, high inflation, exchange rate fluctuations, high-interest rates offered by banks, instruments to support innovations (investment funds, technology parks, business incubators,) limited financial resources and lack of qualified managers are the main reasons for the current lack of innovation activity of agricultural enterprises.

To overcome the obstacles in addressing the issues related to the innovation support of domestic agricultural enterprises, it is advisable to develop certain measures that address factors at both the macro and micro levels. Measures that will reduce the negative impact on innovation support at the macro level include improving the investment climate by creating an effective system of customs, tax and currency preferences; providing state guarantees for obligations to investors; liberalizing the conditions for the functioning of investment activity; developing the infrastructure of the stock market [51]. Measures that will reduce the negative impact on innovation support at the micro level can be singled out as improving the culture of corporate governance and corporate social responsibility, developing forms of accumulation of small investors' funds, ensuring the rights and interests of investors, stimulating the process of saving free funds of enterprises by reducing tax pressure, maintaining a system of investment risk insurance, ensuring the resource balance of business plans for investment and innovation projects.

4 Conclusions

The analysis of the relevant definitions made it possible to identify the innovation and investment support for the development of the agricultural sector as a key factor in its effective functioning, which leads to maximizing the volume and diversification of agricultural production, increasing production capacity, forming own financial resources for further investment, increasing competitiveness and strengthening food security of the state. Instead, its insufficiency will lead to risks and threats that will negatively affect the level of economic security of the country. The basic components of investment support for the development of the agricultural sector of Ukraine in the following composition: private capital (own funds of enterprises and individuals); state investments (state and local budget funds); international investments (funds of investment companies) and credit resources (bank lending) we distinguished in the study. Attention was also paid to their main advantages and disadvantages.

The index that can be used to conduct a comparative analysis of the state of Ukraine's innovation system is the GII, developed by the Cornell University Business School, the World Intellectual Property Organization and the INSEAD research institute. Calculated on the basis of 80 parameters, the GII illustrates the innovative development of countries around the world, characterizing the state of affairs in education, infrastructure and business development. According to the Global Innovation Index in 2022, Ukraine worsened its ranking and took 57th position (49th position in 2021) in the ranking of 132 countries, and ranked 34th among 39 European economies. In 2023, there was an improvement: Ukraine took 55th position and ranked 34th among 39 European economies. North Macedonia is in front of Ukraine in the ranking, and the Philippines is behind. Also this year, for the first time, Ukraine entered the top 3 most innovative economies in the group of lower-middle-income countries (along with India and Vietnam).

The results of the correlation analysis suggest that there is a high degree of correlation between GII and "Knowledge and Technology Outputs". It was found that if the rating of the "Knowledge and Technology Outputs" indicator increases by one, Ukraine's GII rating will increase by 0.6368. The values of the constituent indices (sub-indices) that are taken into account when calculating the indicators that form the GII should, first of all, outline key priorities and define specific tasks that will contribute to Ukraine's innovative development. Existing innovation programs and development strategies should be adjusted to meet these objectives. Tracking the dynamics, analyzing, forecasting and identifying the main trends based on international indices should become an important function of public administration officials.

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