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Material and technical base of agribusiness in EU countries and Ukraine

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▸ **Abstract.** The aim of this article was to assess the availability of basic means of production in Ukrainian agriculture, their use and renewal in comparison with EU countries, as well as to establish the impact of the technological level of the agricultural sector on its efficiency. The study was conducted on the basis of official statistical data from the United Nations. A comparative assessment of the modern level of provision of fixed assets in the agricultural sector of European countries and Ukraine was carried out. It was established that increasing the technological level of agricultural production ensured growth in added value in the country's agriculture, the level of labour productivity, its efficiency and a reduction in the number of employees. Analytical studies were conducted on the dynamics and effectiveness of investing fixed capital in the agricultural sector of European countries with different levels of material and technical support. It has been established that the indicators of provision and formation of fixed capital of Ukrainian agricultural enterprises, labour productivity and added value in agriculture in Ukraine were the lowest in the European space, which was a consequence of the low level of investment opportunities of farms and led to a deepening of the technical and technological backwardness of the industry and threatens the food security of Ukraine. It was determined one of the main factors determining the quantity and quality of agricultural products and the efficiency of Ukraine's agribusiness sector was the level of material and technical resources and their innovative development. The expanded reproduction, renewal and modernisation of the technical and technological support of Ukraine's agricultural production required the state to play an active role in shaping institutional and economic conditions

▸ **Keywords:** agriculture; fixed assets; fixed capital; technical re-equipment; real investments

▸ Introduction

Leading European countries are improving their positions in Ukrainian and global food markets by implementing the concept of sustainable development and transitioning to high-tech agricultural support, as the level of material

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and technical support for agriculture is a key factor in its competitiveness and profitability. The development of the material and technical base of agricultural enterprises is determined by the growth in the level of provision of their basic means of production. The volume and dynamics of growth in agricultural production, as well as its profitability, depend on the completeness of technical resources and their effective use.

Researcher Yu. Lipsky (2024) explored the reproduction and renewal of the material and technical base (MTB) of agricultural enterprises. The author noted that its structure and quality depend on a comprehensive assessment of land as both a means and an object of labour-considering natural and climatic conditions, land use, and soil characteristics. These factors influenced enterprise specialisation, production costs, and the choice of machinery, technology, and resources. The interrelation between land properties and technical resources determined not only the composition of an enterprise's material base, but also soil fertility, which depended on compliance with scientific technologies, the level of biologisation, and technological innovation. The problems of forming and renewing the fixed assets of the Ukrainian agricultural business were considered by V. Kopytko & O. Kopytko (2021), who noted that the use of intensive approaches to the reproduction of material and technical resources leads to an increase in production volumes and, most importantly, improves its quality characteristics. However, unlike leading countries, the agricultural sector in Ukraine was dominated by extensive methods of technical base reproduction, caused by price disparities between agricultural and industrial products. According to the authors, it was is disparity that was the key factor limiting farmers' ability to purchase the necessary material and technical resources, and therefore, the main task of the state in the field of price regulation should be to provide agricultural enterprises with a sufficient level of income for expanded reproduction. The calculation of the normative demand for fixed assets in agriculture for the production of agricultural products for the period up to 2025, which was carried out by a team of scientists led by O. Zakharchuk *et al.* (2024), shows that the modern value of fixed capital was 4.8 times less than the scientifically justified requirement, which was caused by the insufficiency of domestic agribusiness's own investment resources to ensure the model of expanded reproduction of fixed production assets. The researchers noted that one of the reasons for this situation was the underestimation of fixed assets in the agricultural sector, which led to an artificial overstatement of agricultural performance indicators. Another factor slowing down the pace of renewal of the machine and tractor fleet of agricultural enterprises was the high cost of foreign equipment and the degradation of domestic agricultural machinery manufacturing.

The need to increase investment in the fixed capital of agricultural producers was justified in the research of Yu. Voloshchuk (2018). The author drew attention to the insignificant renewal of the machine and tractor fleet with new generation equipment and the negative trends in the reduction of the total number of technical means in use by agricultural enterprises. In the author's opinion, the share of capital investments in the agricultural sector in the sectoral structure of Ukraine's economy should be at least equal to the share of agriculture in the gross value added of the state. The author also emphasised that in order to implement the model of expanded reproduction of the fixed assets of agricultural enterprises, it was necessary to ensure that the volume of acquisition and modernisation of fixed assets exceeded the volume of their disposal and write-off by more than 1.5 times. Innovative production technologies and technical means used for their implementation determined the level of progressiveness of the technological structure of agricultural production. The theoretical and methodological foundations for the qualitative assessment of technical means with the aim of obtaining objective information about their operational characteristics and the effectiveness of using innovative technologies in the agricultural sector were developed by O. Vyshnevetska (2024).

However, Ukraine's agricultural production was effectively deprived of the tools to solve financial problems in order to improve the material and technical base and increase capital investments, according to T. Shutko (2024). The author's analytical research confirmed that since 2018, capital investments in the agricultural sector of the Ukrainian economy have been steadily declining, which deepened its technological backwardness. The introduction of smart farming technologies has enabled modern agricultural enterprises in Denmark, Germany, Sweden and other leading countries to optimise their production costs and increase the productivity and profitability of their agribusinesses. These farms were models of highly intensive production of the sixth technological paradigm. Ukraine's strategic goal was accession the European Union, so the integration of the Ukrainian agricultural sector into the European market space required a comprehensive study of competitive conditions, identification of the main factors for increasing profitability and ensuring the sustainability of agricultural production in the context of economic globalisation. The need for expanded reproduction of the material and technical support of Ukraine's agricultural sector as an important factor in its competitiveness and the problems of investment activity of agricultural enterprises have been substantiated by researchers, but a number of aspects have remained outside the scope of comprehensive analysis, which emphasised the need for further research on this topic. The aim of this study was to assess the availability of basic fixed production assets in Ukrainian agriculture, their use and renewal in comparison with EU countries, and to determine the impact of the technological level of the agricultural sector on its efficiency. The objectives of research were to identify the factors of efficiency of Ukrainian agribusiness, reveal the shortcomings of the system of reproduction of the main means of agriculture, and develop proposals for optimising state policy to stimulate the renewal of technical support for agricultural enterprises on an innovative basis.

▸ Materials and methods

The work applied the dialectical method of scientific cognition, as well as both general scientific and specific research methods. In particular, economic and statistical methods (comparative analysis, average and relative values, index analysis, tabular and graphical methods) were used in analytical studies to assess the state, dynamics

and trends in the development of fixed assets in agriculture. System analysis was used to identify factors affecting the efficiency of updating fixed assets in the agricultural sector. Using abstract-logical and generalisation methods, conclusions were formulated and priority areas of regulatory state policy were identified to stimulate the expanded reproduction of fixed capital in the agricultural sector.

The information base of the study was based on scientific publications on the formation, use and renewal of fixed assets in agriculture, official statistical data from the Food and Agriculture Organisation of the United Nations (FAO) from 2000 to 2021, information from electronic resources, and the results of the authors' own calculations (FAOSTAT, 2023). The chronological scope of the analysis was limited to 2021 to ensure the most objective assessment of the potential of Ukraine's agricultural sector and its development trends, without taking into account the negative impact of the war on economic processes. To assess the technological level of the agricultural sector, the methodological approaches from FAOSTAT (2023) were used. Specifically, the ratio of the added value of agricultural products to the value of agribusiness fixed assets was determined, which showed, how many units of added value are generated from each unit of fixed capital invested. In high-income countries, this indicator was below 0.5, which meant that their agricultural production was largely high-tech and mechanised. In many low- and lower-middle-income countries, this indicator exceeded one, indicating a less capital-intensive agricultural sector.

The collection of statistical information and the formation of a database included the following indicators: the value of fixed assets in agriculture in actual and comparative prices; the size of agricultural land; the level of employment in agriculture; the value of gross output in actual prices; the added value of agriculture in comparative prices; the value of real investments (gross fixed capital formation) in agriculture in comparative prices. In total, indicators from 12 European countries (Bulgaria, Denmark, Spain, Italy, Netherlands, Germany, Poland, Romania, Hungary, France, Sweden, Switzerland) and Ukraine were analysed. A comparative analysis of the availability of fixed assets for agricultural production was carried out using indicators of capital-labour ratio and capital-labour intensity. For the analytical study of the efficiency of the use of fixed assets in agribusiness, indicators of labour productivity, return on assets and capital intensity were used. The pace of technical re-equipment of production was assessed by the level of real investment in the fixed capital of agricultural enterprises, and the efficiency of fixed asset renewal was reflected in the dynamics of the added value of agricultural products. The dynamics of the indices of employment in the agricultural sector, the level of real investment, capital intensity of labour and added value of agriculture compared to 2000 were presented graphically for eight countries.

Results and Discussion

In the source Eurostat (2024) was noted that over almost a decade – from 2015 to 2024 – labour productivity in agriculture in the European Union countries increased by 37.2%. Real factor income relative to production costs increased by 11%, while labour costs in the agricultural sector decreased by 19.1%. In other words, Europe is addressing the issue of food security by steadily increasing agricultural production with less use of labour and production resources through the introduction of sustainable production technologies based on automated and robotic technical means and systems. Researcher I. Dvornyk (2021) analysed the dynamics of labour productivity per employed worker in Ukrainian agriculture and found that it grew by 48.81% in 2015-2019, specifically by 44.61% in crop production and in animal husbandry – by 61.78%. At the same time, the current level of labour productivity in Ukrainian agricultural production indicates that the available resource potential is not being fully utilised and does not meet the modern requirements for the development of agribusiness.

The low level of labour productivity in Ukraine's agricultural production is a consequence of the mismatch between the level of technical equipment of agricultural producers and the requirements of innovative development of the industry. To establish the level of provision of the agricultural sector with means of production, the efficiency of their use and renewal, the indicators of the European Union countries and Ukraine were studied based on open statistical data from the FAOSTAT (2023) (Table 1).

Table 1. Provision of basic agricultural assets in European countries (2021)

Country	Fixed assets of the AIC, mln USD	Area of agricultural land, thsd ha	Employment in agriculture, thsd people	Capital provision, thsd USD/ha	Capital-labour ratio, thsd USD/person
Bulgaria	7,365	5,046	195.1	1.46	37.75
Denmark	40,335	2,618	59.4	15.41	679.04
Spain	81,454	26,228	810.2	3.11	100.54
Italy	185,784	12,403	921.2	14.98	201.68
Netherlands	72,620	1,812	207.5	40.08	349.98
Germany	204,970	18,240	524.2	11.24	391.01
Poland	23,291	14,719	1,525.5	1.58	15.27
Romania	45,501	13,079	1,445.2	3.48	31.48
Hungary	31,525	5,049	207.4	6.24	152.00
Ukraine	31,783	41,892	2,744.9	0.76	11.58
France	136,510	28,554	703.8	4.78	193.96
Sweden	57,842	1,529	102.0	18.47	567.08
Switzerland	55,358	3,003	112.0	36.21	494.27

Source: based on FAOSTAT (2023)

According to FAOSTAT (2023), Ukrainian farmers' access to basic resources amounted to USD 759 per 1 hectare of agricultural land. For comparison, in Poland and Bulgaria, this figure was twice as high, in Italy, Sweden and Denmark, it exceeded the Ukrainian figure by almost 20 times, and in the Netherlands, by more than 50 times. While in Germany there are 90 tractors per thousand hectares of agricultural land, in Ukraine there are only ten, most of which are morally and physically worn out. Given the experience of neighbouring countries and the prospects for Ukraine's integration into the European community, it is important to develop competitive advantages for Ukrainian agricultural products on global food markets. Significant factors in increasing competitiveness in the global food market include: improving product quality through greening production; systematic modernisation of the agricultural sector, automation and robotisation of technological processes, introduction of innovative resource-saving and soil-protecting technologies, and development of deep processing of products. Ukraine is already taking certain steps in this direction: in 2010-2021, gross agricultural production increased from USD 28.3 to 51.4 billion, catching up with Germany, Italy and Spain, where average gross production volumes remained stable. However, the results of the analysis of the efficiency of agricultural production in terms of labour productivity and land use as the main means of production show significant untapped potential in the Ukrainian agricultural sector.

As shown in Table 2, in 2021, gross output per hectare of agricultural land in Ukraine amounted to USD 1,226.1, while in Germany this figure reached USD 2,888.7, in Spain – USD 2,172.4, and in Italy – USD 4,267.3. The Netherlands achieved the highest level of land use efficiency in Europe – USD 10,320.3 per hectare, which exceeds the Ukrainian level by more than 8 times.

Table 2. Efficiency of use of fixed assets in agricultural production in European countries (2021)

Country	Total gross agricultural output, mln USD	Gross output production per 1 ha of agricultural land, thsd USD	Labour productivity, thsd USD/person	Capital output ratio	Capital intensity
Bulgaria	5,851.4	1,159.6	29.99	0.79	1.26
Denmark	9,901.1	3,781.9	166.69	0.25	4.07
Spain	56,978.8	2,172.4	70.33	0.70	1.43
Italy	52,927.3	4,267.3	57.45	0.28	3.51
Netherlands	18,700.4	10,320.3	90.12	0.26	3.88
Germany	52,689.1	2,888.7	100.51	0.26	3.89
Poland	29,315.8	1,991.7	19.22	1.26	0.79
Romania	19,334.5	1,478.3	13.38	0.42	2.35
Hungary	8,240.8	1,632.2	39.73	0.26	3.83
Ukraine	51,365.4	1,226.1	18.71	1.62	0.62
France	83,837	2,936.1	119.12	0.61	1.63
Sweden	8,174.1	1,517.3	46.58	0.08	12.18
Switzerland	4,750.8	5,346.0	72.98	0.15	6.77

Source: based on FAOSTAT (2023)

Labour productivity, measured by the value of gross output per employee, in Ukraine's agricultural sector is USD 18,710 per employee, which is 5.4 times less than in Germany, 3.8 times less than in Spain, in Italy – 3 times, and in the Netherlands – 4.8 times. Denmark and France demonstrate the highest labour productivity indicators – USD 166.7 thousand and USD 119.1 thousand, respectively. Labour productivity is a key indicator reflecting the level of development of agriculture and the technological structure of its production systems, and the level of labour productivity directly correlates with its capital intensity. Interestingly, Ukraine has the best indicators of capital intensity and return on capital among European countries, despite its lower level of material and technical support. This once again emphasises the priority of technical and technological modernisation of the Ukrainian agricultural sector in the context of economic globalisation.

The technical re-equipment of agricultural production requires significant capital investments in material and technical resources, primarily in modern technology, which is a determining factor in the competitiveness of products and the final productivity of production (Mykhaylov, 2018). The technological modernisation of agriculture increasingly relies on renewable energy and resource-efficient technologies. Recent studies confirm the effectiveness of integrating solar energy systems into agricultural processes. For instance, O. Sadovoy *et al.* (2024) demonstrated the optimisation of solar power plants for sprinkler irrigation systems in southern Ukraine, which can significantly reduce energy dependence and operational costs in crop production. According to estimates by Ukrainian economists, the modern level of material and technical support for agribusiness in Ukraine is about one-third of the normative requirement and directly depends on the investment potential of a particular farm. The gross accumulation of fixed capital in the agricultural sector directly depends on the inflow of real investments into the agro-industrial complex. As can be seen from Table 3, in 2021, they amounted to USD 2,642.2 million in Ukraine, which is more than in Bulgaria, Hungary, Denmark, and Sweden. At the same time, only USD 963 of investment per employee in Ukrainian agriculture

was accounted for, while in Bulgaria this figure was USD 3,756, in Hungary – 8,207, in Poland – 3,288. Sweden, Germany, France, Denmark, the Netherlands and Switzerland invested more than USD 20,000 per employee in the technological development of the agricultural sector, exceeding the amount of investment in Ukraine by 21 to 33 times.

Table 3. Efficiency of fixed capital investment in the agricultural sector of European countries (2021)

Country	Investments in fixed capital, mln USD	Real investments per agricultural worker, thsd USD	Real investments per 1 ha of agricultural land, thsd USD	Added value of agricultural production, mln USD	Added value per agricultural worker, thsd USD	Capital output ratio of agricultural added value
Bulgaria	732.8	3.756	728	3,671	18.82	0.50
Denmark	1,627	27.391	1,688	4,418	74.38	0.11
Spain	7,560.1	9.331	1,505	39,478	48.73	0.48
Italy	12,648.1	13.730	3,300	40,926	44.43	0.22
Netherlands	5,639.3	27.177	8,620	15,619	75.27	0.22
Germany	12,119.5	23.120	1,670	30,460	58.11	0.15
Poland	5,016.4	3.288	1,038	15,275	10.01	0.66
Romania	2,684.7	1.858	1,041	13,612	9.42	0.30
Hungary	1,702.1	8.207	1,257	6,349	30.61	0.20
Ukraine	2,642.2	0.963	519	21,746	7.92	0.68
France	15,262.1	21.685	1,676	47,860	68.00	0.35
Switzerland	3,547.9	31.678	1,695	5,091	45.46	0.09
Sweden	2,096.6	20.555	5,389	8,240	80.78	0.14

Source: based on FAOSTAT (2023)

The distribution of investments in 2021 per unit of agricultural land in European countries is also the lowest for Ukraine – USD 519 per 1 hectare. Among the European Union countries under consideration, the smallest investments per hectare of land use were in Bulgaria and Poland – USD 728 and USD 1,038, respectively. Most countries invest between USD 1,300 and USD 1,700 per hectare. The Netherlands, with investments of USD 8,620 per hectare, occupies the leading position. According to the methodology for assessing the technological level of the industry used in international statistics, the level of technical and technological support for agricultural production is determined by the ratio of the added value of agricultural products to the value of fixed assets in agribusiness (hereinafter referred to as the return on added value), which shows how many units of added value are obtained in agriculture from each unit of fixed capital invested. In high-income countries, this indicator is below 0.5, which means that their agricultural production is largely high-tech and mechanised. In many low- and lower-middle-income countries, this indicator exceeds one, indicating a less capital-intensive agricultural sector.

Denmark, Sweden and Germany have developed agricultural production facilities, which confirms the level of return on added value of their agriculture, which is 0.11, 0.14 and 0.15, respectively. In contrast, Ukraine, Poland and Bulgaria are countries with a low technological level of production processes and a significant share of manual labour in agribusiness, and each unit of fixed capital invested ultimately yields 0.5 to 0.68 units of value added. Added value, also known as the sum of factor incomes, is formed in the production process from three components: the result (income) from the use of labour, land and fixed capital. It is calculated as the difference between the market price of gross output and the cost of purchased resources (seeds, fuel, fertilisers, plant protection products, feed) and services used in production. Added value includes wages, depreciation, profit, rent, taxes. The higher the added value, the higher the investment opportunities and profits. The analysis showed that Ukraine has the lowest level of added value in agriculture per employee, at 7.92 thousand US dollars. For comparison, this indicator is 58.11 in Germany, 74.38 in Denmark, and 80.78 in Sweden. This means that Ukrainian farmers have up to 10 times less internal investment resources for modernisation and development of production.

Income from the use of labour is directly correlated with income from the use of fixed assets. The capital-labour ratio of Ukrainian farmers is the lowest in Europe, so the growth in added value in agriculture in Ukraine over the last 20 years has been achieved exclusively through the intensification of land use. In fact, Ukrainian agricultural producers have taken a kind of "loan" from future generations by depleting soil fertility in order to maintain the competitiveness of their products on global markets. Ukrainian agricultural producers still do not take into account the removal of nutrients and microelements from the soil that are used to form the harvest. The above conclusion is confirmed by an analysis of the dynamics of such indicators of the efficiency of fixed assets as the indices of changes in the number of agricultural workers, their capital-labour ratio, the added value they produce, and the amount of investment in the material and technical re-equipment of the agricultural sector in comparative prices for 2015 (Fig. 1).

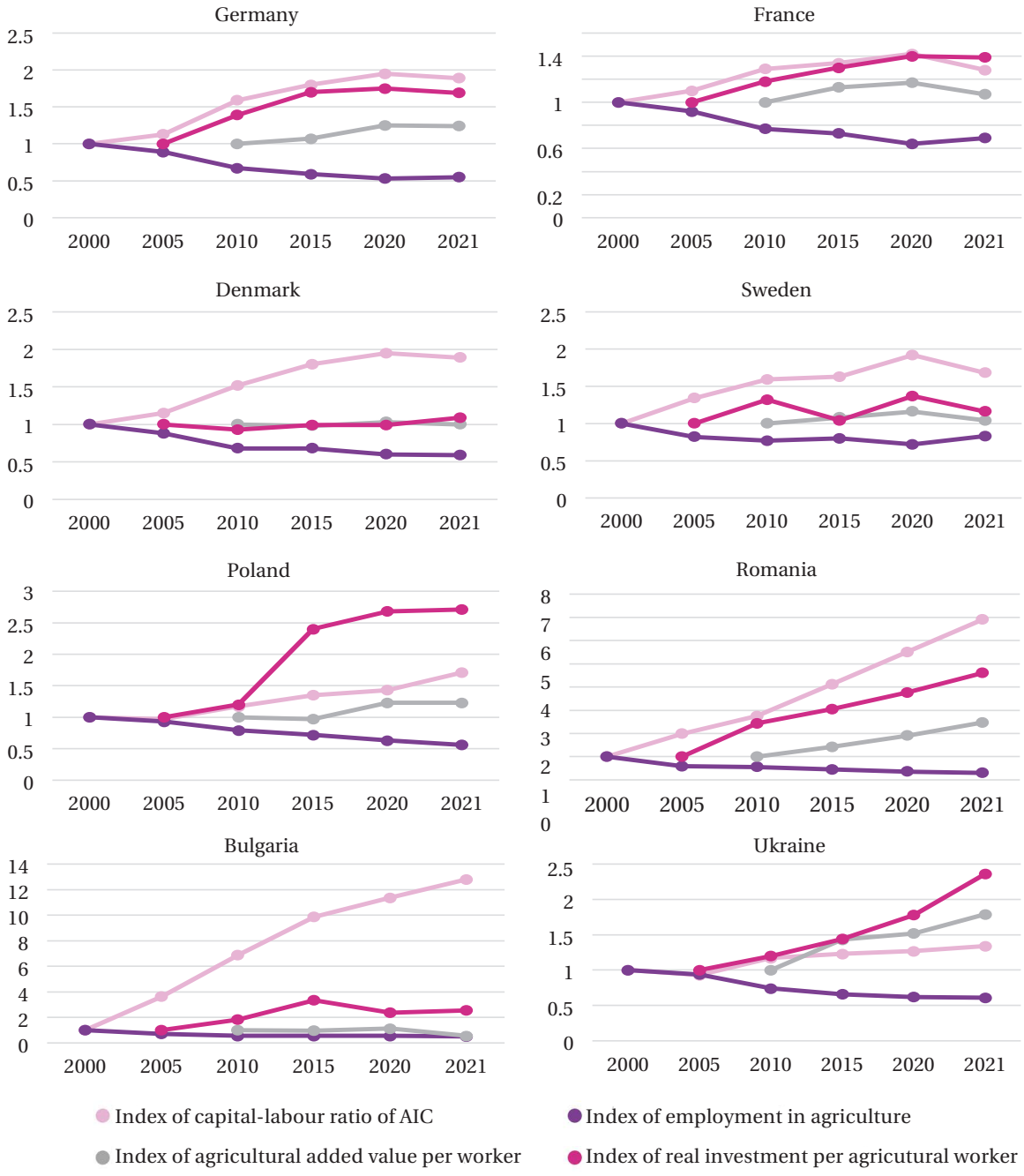

Figure 1. Dynamics of the economic efficiency of the agricultural sector in European countries, compared to the indicators of the year 2000

Source: based on FAOSTAT (2023)

The dynamics of these indicators in European countries with a high level of technological development – Germany, France, Denmark, Sweden – are similar in nature and rate of growth or decline. Thus, capital-labour ratios in agriculture in Germany, France, Denmark and Sweden have increased 1.5-2 times over 20 years, employment in the agricultural sector has decreased by 30-50%, while added value per employee has increased from 10 to 20%. The rate of investment in technical re-equipment of the agricultural sector in Germany and France has increased 1.7-1.8 times over 15 years, while in Denmark and Sweden it has remained consistently high, ensuring their food security and the gradual release of workers from labour-intensive processes. EU countries with the lowest capitalisation of the agricultural sector have a relatively high rate of growth in real investment in the fixed capital of agricultural enterprises: Poland – 2.7; Romania – 4.6; Bulgaria – 2.6. At the same time, the technical equipment of labour in agriculture increased 12.8 times in Bulgaria, 1.7 times in Poland, and 6.9 times in Romania, while the number of employees decreased by 44%, 49%, and 70%, respectively. Characteristically, the growth rate of added value in

agriculture per employee does not exceed the growth rate of investment and capital equipment. In Ukraine, however, the dynamics are different: the capital equipment of labour with fixed means of production increased 1.3 times, while added value increased 1.8 times. The data confirm that the increase in added value is not due to technical and technological re-equipment of production, but to the intensive use of land resources, i.e. their depletion. High market demand for grain and oilseeds is prompting Ukrainian farmers to exhaustively use arable land. In particular, there has been a sharp increase in the area under corn, sunflower and rapeseed cultivation. Sunflower cultivation poses a particular threat, as it accounts for more than 30% of the crop structure in some farms.

At the same time, Ukraine, as a supplier of agricultural products to the world market, annually exports significant amounts of nutrients that plants have consumed from the soil to form crops, especially micronutrients, which are not fully compensated for by fertilisers. According to S. Balyuk *et al.* (2019), the grain exported in the 2016-2017 marketing year contained: 811 thousand tonnes of nitrogen, 302 thousand tonnes of phosphorus and 211 thousand tonnes of potassium. To compensate for these losses, it was necessary to apply: 2.4 million tonnes of ammonium nitrate, 0.58 million tonnes of ammophos and 0.53 million tonnes of potash salts. Thus, large agricultural holdings received a significant part of their profits from the use of soil resources and violate natural laws, in particular the law of mandatory compensation (in full) for nutrients removed from the soil. This led to intensive dehumanisation of soils, since 95-97% of nitrogen and about 50% of phosphorus were contained in the organic part of the soil, and their absorption by plants required increased mineralisation of humus. And if the law on the mandatory return of nutrients removed with the harvest was not constantly observed, the soil will become completely depleted in the near future, and even the most fertile chernozems will cease to provide at least some harvest, especially against the backdrop of deteriorating climatic conditions.

Land has been, is, and will remain the main means of agricultural production, and fertility is its main value, which should be preserved for future generations. Ukrainian soils and their preservation require a comprehensive approach and increased attention from the state, farmers, and scientists. According to the FAO, approximately 20% of Ukraine's agricultural land has undergone significant degradation, and the rest is under serious threat. Ukrainian soils have lost about 30% of their humus, and the ploughing rate remains one of the highest in the world at 53.9% (for comparison: in Poland 36.5%, in Germany 34.1%, in the USA 17.5%, in China 12%). The governments of advanced countries strictly protect state interests and consider land to be a valuable resource. In France, in particular, maximum control over its effective use is exercised, exclusively by persons who permanently reside in the relevant area and have the appropriate level of qualification. After testing their level of knowledge and justified areas of use, they receive a licence, and the concepts of ownership and use rights are separated. The procedure for using agricultural land resources in Ukraine currently differs significantly from the above, therefore it needs to be reviewed and a protectionist state policy developed. Land, in particular soil fertility, should be considered as a specific investment resource that provides added value to agricultural products on a par with fixed assets and labour resources. Fertility must be restored and increased, and the value of land must grow accordingly.

Instead, state authorities proudly report on their leadership in global markets for the sale of agricultural raw materials. Despite all these "achievements," even in the successful year of 2021, Ukraine received only USD 7.9 thousand in added value from agribusiness per employee. per employee, while in Bulgaria this figure was USD 18.8 thousand, in Hungary – USD 30.6 thousand, in Germany – USD 58.1 thousand, in France – USD 68.0 thousand, and in Sweden – USD 80.8 thousand. The data presented clearly shows that increasing exports of agricultural raw materials is the wrong path for the development of the agricultural sector. In pursuit of high yields, Ukrainian agricultural producers use a wide range of synthetic plant protection products, which leads to the contamination of soil, water bodies and groundwater. Intensive agricultural production technologies deplete the soil, harm the environment and the health of the Ukrainian population and call into question the food security of future generations of Ukrainians (FAOSTAT, 2023).

In the current conditions of global economic development, raw materials and food supplies are strategic market resources on which national security and sustainable development depend. The core position, shared with the authors led by N. Basyurkina *et al.* (2023) that Ukraine should adopt the experience of advanced countries, whose agricultural policy priorities are: comprehensive support for agribusiness development; ensuring national food security; encouraging exports of processed agricultural products while restricting imports; stimulating the development of own processing industry and imports of agricultural raw materials for its needs. B. Iegorov *et al.* (2024) noted that in Ukraine, as in most countries of the world, grain and its processed products (bread products) form the basis of the state's food security, as they were the main group of food products and animal feed. High calorie content and long shelf life determined the role of grain in the formation of food reserves – it was a strategic product. Bread products satisfied about 40% of the daily food requirement and up to 50% of the protein and carbohydrate requirement. Ukraine's grain policy has undergone significant structural changes, as a result of which the dominance of state interests has been superseded by the priority of exporting agri-food raw materials (Nikishyna, 2012). Such distortions have led to the formation of a raw material model of Ukrainian agri-food exports, the dominance of single-crop production oriented towards the demand of foreign markets, and a decrease in grain processing volumes at Ukrainian enterprises. Such transformational changes contradict the national interests of Ukraine, as they lead to the loss of the reproductive function of the food market while financing the development of the processing industry in countries that export Ukrainian agricultural raw materials. The higher export potential of feed grain and the relatively low cost of its cultivation compared to food grain have led to the predominance of feed in the structure of gross grain harvests. At the same time, Ukraine compensates for the shortage of high-quality durum wheat flour

for bread and pasta production by importing the relevant grain or finished products, which leads to job and financial losses due to the reduction of production cycles in the Ukrainian agri-food market.

Taking into account the best practices of the functioning and development of agri-food complexes in advanced countries, it was advisable to focus Ukraine's strategic agricultural policy on stimulating the production of food products with higher added value and increasing the volume of exports of deeply processed products, reducing dependence on imports of grain, products of plant and animal origin, fresh vegetables and seed material. The key task of Ukraine's agri-food sector was to transition from a raw material-based to an investment and innovation-based type of development. At the modern stage of scientific and technological progress in the agri-food sector, the very nature of technologies and production methods was changing. They were becoming more science-intensive, and their implementation requires the use of the latest technology and appropriate organisational support. The transition to advanced robotic information technologies can be called the second "green revolution", as they were changing the established paradigm of agricultural production and taking it to a qualitatively new level.

The European Green Deal (European Union, 2019) in agriculture defined the biologisation of farming as the main tool for improving soil quality and fertility, the key elements of which are: scientifically based soil-protecting crop rotations, modern biotechnological solutions, precision farming technologies, and the balanced use of mineral fertilisers and chemical crop protection products. The transition to the latest technologies in agricultural production, which will ensure the sustainable development and food security of the country, requires the modernisation of the technical and technological base of agribusiness, the development and implementation of innovative, complex, robotic and automated technical means that will ensure high precision and quality of technological operations, their timeliness, energy and resource efficiency. It should be noted that, from the perspective of current research, innovative complex agricultural machinery includes the latest ground-based mobile energy, aviation and transport-technological means, combine harvesters, aggregates, multi-operation technological machines, technological lines, equipment, etc., including computerised and automated systems for controlling their operation and robotic systems for performing technological operations based on new methods of their working bodies' interaction with the soil environment, technological materials, agricultural crops, weeds, microbiota, animals, poultry and agricultural products, ensuring a reduction in specific energy costs, improving the quality of technological operations and minimising the negative impact on the environment.

Due to shortcomings in the organisation of production processes, crop yields depend on natural conditions by almost 80%. At present, the use of precision farming systems allows the impact of climate change on crop production efficiency to be offset and reduced to 20%, while the remaining 80% is determined by the level of technology and management in the agricultural business. By focusing on scientific and technological progress in their development, equipment and technologies have become the most important factors in the efficiency of agricultural production. They determine the level of land productivity, the efficiency and comfort of labour, the cost and quality of products, and shape the social and economic factors of the development of the agricultural sector of Ukraine's economy (Hrytsyshyn, 2024).

The results of current study are consistent with international research emphasising the role of innovation and capital deepening in improving agricultural productivity. According to J.-F. Hulot & N. Hiller (2020), investments in agricultural research and innovation across EU countries generated multi-layered benefits that extended beyond immediate production growth. These included higher resource-use efficiency, environmental sustainability, and long-term resilience of the agricultural system. Their findings demonstrated that every euro invested in research and innovation in the EU agricultural sector can yield up to five times its value in socio-economic returns. In this context, Ukraine's limited investment capacity – USD 963 per agricultural employee in 2021 – highlighted the importance of public policy instruments to stimulate innovation and attract private capital into agribusiness. Y. Sheng *et al.* (2022) also underscore that productivity growth in agriculture across 17 OECD countries was driven largely by capital deepening and induced innovation – the process by which technological change responds to relative factor scarcities and price shifts. Their evidence showed that countries maintaining consistent investment in fixed assets and R&D experienced faster convergence in total factor productivity (TFP). The Ukrainian case, characterised by low capital intensity and technological lag, fits the opposite pattern, suggesting that inadequate reinvestment slows TFP growth and widens productivity gaps with more developed economies. Overall, these insights confirmed that sustainable agricultural modernisation depended not only on capital accumulation, but also on innovation-driven productivity gains and institutional support mechanisms ensuring the effective use of investment resources.

The results of this study aligned with broader international evidence demonstrating that technological modernisation and capital deepening are decisive factors in agricultural productivity growth. According to M. Petrick & M. Kloos (2012), disparities in agricultural capital productivity across EU member states were primarily determined by differences in access to investment resources and innovation intensity. This corresponded with Ukraine's relatively low capital intensity, where limited access to affordable financing constrains the renewal of fixed assets and the introduction of modern equipment. Similarly, T. Kijek *et al.* (2016) emphasised that knowledge capital – human skills, training, and technological awareness – played a critical role in shaping total factor productivity in European agriculture. Ukraine's lag in labour productivity and capital provision suggests an urgent need to invest not only in physical assets but also in education, extension services, and innovation transfer systems. Global evidence from the World Bank's Harvesting Prosperity report (Fuglie *et al.*, 2020) further confirms that sustained productivity growth in agriculture depends on large-scale technological diffusion supported by research, infrastructure, and market integration. Countries that

successfully modernised their agro-industrial systems – such as Denmark, the Netherlands, and France – did so by combining targeted subsidies, credit access, and innovation policy incentives. Finally, D. Shen *et al.* (2023) illustrated, using China's experience, how capital deepening can mitigate the effects of a declining rural workforce and enhance labour productivity, reinforcing the broader relevance of technological investment in achieving sustainable agricultural development. Together, these findings underscored that Ukraine's challenge mirrors global trends: to transform agriculture from labour-intensive to knowledge- and capital-intensive production through innovation, financial reform, and state support mechanisms that ensure inclusive, long-term growth.

Therefore, the state should not stand aside from these threats and should stimulate the innovative development of agricultural technologies in Ukraine, the technical re-equipment of agribusiness with innovative Ukrainian ally produced equipment, and ensure the preservation of soil fertility and agroecosystems at the legislative level. The further development of the agricultural sector and maintaining the competitiveness of its products requires the formation of an effective material and technical base (MTB) for agricultural enterprises based on modern innovative transformations. The importance of fixed assets in the development of the agricultural sector in the context of the adoption of new high-performance technologies was constantly growing. The optimal quantity and rational structure of fixed assets, as well as their effective use, ensured not only an increase in production volumes, but also an increase in its economic and social efficiency.

▸ Conclusions

The main factor determining the quantity and quality of agricultural products and the efficiency of Ukraine's agribusiness sector was the level of its material and technical base and its innovative development. Ukraine's agricultural sector demonstrated one of the lowest levels of capitalisation in Europe: the capital intensity of labour amounted to only USD 11.58 thousand per person, which was almost 60 times lower than in Denmark (USD 679.04 thousand) and more than 30 times lower than in Germany (USD 391.01 thousand). The level of capital provision per hectare of agricultural land in Ukraine was USD 0.76 thousand, while in the Netherlands this figure reached USD 40.08 thousand, and in Sweden – USD 18.47 thousand. Labour productivity in Ukrainian agriculture remained critically low – USD 18.71 thousand per employee compared with USD 100.51 thousand in Germany and USD 166.69 thousand in Denmark. Gross agricultural output per hectare in Ukraine equaled USD 1.23 thousand, which was 3.5 times lower than in Italy (USD 4.27 thousand) and almost 8 times lower than in the Netherlands (USD 10.32 thousand). Such disparities clearly indicated the technological backwardness of the domestic agricultural sector and the urgent need for its modernisation. The volume of real investments in fixed capital in Ukraine's agriculture in 2021 amounted to USD 2.64 billion, or only USD 963 per employee, while the same indicator in Sweden exceeded USD 20 thousand, in Denmark – USD 27 thousand, and in Switzerland – USD 31.7 thousand. Investments per hectare of agricultural land were the lowest among the analysed countries – USD 519 per hectare in Ukraine versus USD 1,688 in Denmark and USD 8,620 in the Netherlands. The added value per agricultural worker in Ukraine reached only USD 7.92 thousand, which was 7 to 10 times lower than in most EU countries.

The expanded reproduction, renewal, and modernisation of the technical and technological support of agricultural production in Ukraine required the attention of the state to create institutional and economic conditions for increasing the investment potential of agribusiness, increasing its fixed capital, through the development and implementation of state target programmes, simplifying access to preferential lending, applying leasing mechanisms. Without active state participation and strategic investment, the gap between Ukraine and technologically advanced European countries will continue to widen, threatening national food security and the competitiveness of domestic agricultural products. Prospects for further research may include a more detailed assessment of the effectiveness of different investment mechanisms – such as preferential lending, public-private partnerships, and leasing – in stimulating technological renewal in Ukraine's agricultural sector.

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▸ Conflict of Interest

None.

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▸ **Анотація.** Метою цієї статті було оцінити забезпеченість сільського господарства України основними засобами виробництва, ефективність їх використання та оновлення у порівнянні з країнами Європейського Союзу, а також визначити вплив технологічного рівня аграрного сектору на його ефективність. Дослідження було проведено на основі офіційних статистичних даних Організації Об'єднаних Націй. Було здійснено порівняльну оцінку сучасного рівня забезпеченості основними засобами аграрного сектору європейських країн і України. Виявлено, що підвищення технологічного рівня сільськогосподарського виробництва забезпечує зростання доданої вартості в аграрному секторі України, підвищення продуктивності праці, ефективності діяльності та скорочення чисельності працівників. Проведено аналітичні дослідження динаміки та ефективності інвестування основного капіталу в аграрному секторі європейських країн із різним рівнем матеріально-технічного забезпечення. Встановлено, що показники забезпеченості та формування основного капіталу українських сільськогосподарських підприємств, продуктивності праці та доданої вартості в аграрному секторі країни є найнижчими серед країн Європи. Це стало наслідком низького рівня інвестиційних можливостей господарств, що призвело до поглиблення техніко-технологічної відсталості галузі та становило загрозу продовольчій безпеці України. Визначено, що одним із головних чинників, які зумовили кількість і якість сільськогосподарської продукції та ефективність агробізнесу України, став рівень матеріально-технічних ресурсів і їх інноваційний розвиток. Розширене відтворення, оновлення та модернізація техніко-технологічного забезпечення сільськогосподарського виробництва України потребують активної ролі держави у формуванні інституційних та економічних умов

▸ **Ключові слова:** сільське господарство; основні засоби; основний капітал; технічне переоснащення; реальні інвестиції