



Structural analysis of the development of competitive agricultural activity in Ukraine under wartime conditions

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► **Abstract.** The relevance of the study was determined by the need to identify structural changes in the agricultural sector that occurred under wartime conditions, as well as by the search for effective managerial decisions capable of ensuring the competitiveness of agrarian entrepreneurship within the new economic realities of a shifting institutional environment. The aim of the study was to conduct a structural analysis of the efficiency of agricultural enterprises across regions in order to identify spatial development patterns and to assess the degree of influence of the wartime factor on the economic performance of agricultural production. The study employed the method of cluster analysis, which made it possible to group the regions of Ukraine according to the level of economic efficiency of agricultural enterprises on the basis of multidimensional statistical indicators, including gross output, revenue, profitability, return on investment and investment activity per hectare of agricultural land. The analysis yielded four clusters of regions, which demonstrated significant differences in the level of enterprise performance, resource provision and adaptation to wartime conditions. It was established that the greatest damage was sustained by regions with a high level of concentration in crop production, whilst territories with a more diversified structure demonstrated relatively higher resilience. As a result of the study, the resource base and productive performance of agricultural enterprises were analysed across the identified clusters. The research hypothesis regarding the significant influence of production specialisation on enterprise resilience under adverse institutional conditions was confirmed. The specific features of

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the current territorial zoning of agricultural production were analysed and enterprise development strategies were identified across the respective clusters. The economic effects of agricultural enterprise operation were determined across the respective clusters, and the relationship between the level of specialisation and enterprise losses arising from the deterioration of farming conditions in 2022 was established. The practical value of the study lies in the possibility of using the results obtained to develop targeted support programmes for agrarian entrepreneurship, to plan measures for the spatial development of the sector and to formulate policy for the recovery of agriculture in the post-war period

► **Keywords:** formation of competitiveness; economic efficiency; wartime impact; agrarian entrepreneurship; structural changes; spatial development

► Introduction

Contemporary trends and prospects for the development of agricultural activity in Ukraine were shaped by the influence of wartime conditions (2022-2025). The wartime factor acted as a trigger for the transformation of economic management systems, causing structural changes in their competitiveness and socioeconomic performance. In the structural dimension of the analysis, the agricultural sector was examined from the perspective of assessing opportunities, the potential to adapt to wartime risks and the prospects for post-war recovery. Wartime risks exerted a destructive influence on agricultural production with regard to the physical accessibility of production and economic potential, restructured product marketing channels and altered the competitiveness of businesses. The sector's ecosystem found itself in a situation that required a search for opportunities to respond effectively to changes in market conditions. The deepening of destructive factors, the decline in enterprise competitiveness, the deactivation of numerous support mechanisms for agrarian business and the shifting cost-benefit ratio provided grounds for timely monitoring of the structural changes that had occurred within the sector.

As noted by Yu. Lupenko *et al.* (2023a), active hostilities caused a range of far-reaching impacts on the agricultural sector of Ukraine. Numerous agricultural and processing enterprises were destroyed or substantially damaged; cultivated areas and production volumes declined; logistical links were severed and sales markets were blocked, which substantially distorted the structure of the sector. The post-war reconstruction of agriculture was intended to address the damage inflicted on the agricultural sector by Russian aggression and to determine the direction of structural transformations. Agricultural activity was carried out within diverse organisational structures that organised the production of competitive goods. Such activity took place within an ecosystem oriented towards ensuring efficiency and competitiveness. A.-I. García-Agüero *et al.* (2023) indicated that accessible infrastructure, the natural resources of a territory, applied technologies, education, agricultural worker training and policy constraints were of decisive importance. Cluster analysis proved to be an effective instrument of structural analysis of the development of competitive agricultural activity. It made it possible to identify the strengths and weaknesses of a set of producers, as well as to delineate the cost-benefit balance of constructing agrarian business along territorial lines. A.H. Sadeli *et al.* (2023) noted that within the agri-food chain, the competitiveness of an agricultural commodity was established through the formation of its consumer quality. Achieving competitive

and successful development of agricultural activity was made possible under conditions of effective coordination of the interests of the chain's participants. It was important to address this issue in a balanced manner so as to ensure that agriculture worldwide remained sustainable and beneficial to all stakeholders. I. Ali & I. Gölgeci (2020) identified the established level of trust among participants in agricultural activity structures as a significant component of social capital, a factor of particular relevance for small enterprises. L. Bartóková & J. Ďurčová (2022) noted that small forms faced competition from large resource suppliers and consumer demands, which affected their market position.

The realisation of business capabilities in achieving the development of competitive agricultural activity was multifaceted. Agricultural activity in Ukraine traditionally had its own national characteristics. The possibilities became real within the sector to ensure: national and global food security; territorial development; and the resilience of the economy to numerous destructive external influences, including wartime risks. A. Dibrova *et al.* (2023) argued that food security in Ukraine had become an obligation of both agribusiness and the state, which was required to be taken into account in assessments of the development of competitive agricultural activity. Ukraine's agricultural sector found itself in a difficult situation owing to hostilities and export restrictions since 2022; accordingly, it was important to achieve a balance to ensure sustainable growth. O. Skydan *et al.* (2023) noted that achieving this balance was to be of decisive importance for ensuring the long-term success of the sector, particularly in respect of developing competitive agricultural activity. Its development in Ukraine was institutionally dependent on the entrepreneurship system. Yu. Lupenko *et al.* (2023b) indicated that the essence of agrarian entrepreneurship as a form of economic management was revealed through its principal functions: resource mobilisation, organisational-productive and creative-innovative, which methodologically denoted the factors of competitiveness. M. Malik *et al.* (2023) argued that, given the destructive influence of the wartime factor, the processes of integrating cooperative formations were of particular importance for the organisational-economic provision of food security stability and the rational use of agricultural resources. Through capable entrepreneurship and cooperation, the relatively stable development of competitive agricultural activity in Ukraine was structurally built up.

The food security aspect in the context of qualitatively meeting the needs of the population was also of importance, since addressing the challenges of providing

Ukraine's citizens with essential foodstuffs under martial law required a comprehensive approach and immediate measures. These measures included the development of effective strategies for the supply and distribution of food resources, ensuring the accessibility and quality of foodstuffs, the introduction of social support programmes for vulnerable population groups, support for agriculture and the development of local food markets, as well as the attraction of international aid and support. Corresponding analytical confirmation of the above and other practical aspects of agricultural activity was positioned through empirical assessments of development trends. The aim of the study was to conduct a structural analysis of the development of agricultural activity under the influence of wartime conditions. This was necessary in order to substantiate the hypothetical conclusion that economic entities exhibited, on the one hand, an inability to rapidly restructure their businesses, whilst on the other hand remaining relatively resilient depending on their specialisation, which affirmed their competitiveness in conditions of progressively increasing market turbulence.

► Materials and Methods

The study was carried out within the framework of a project aimed at assessing the consequences of Russia's military aggression for Ukraine's agricultural sector and determining the directions of compensatory policy for the development of agrarian entrepreneurship. The methodological foundation was provided by the principles of structural analysis of the economic efficiency of agricultural enterprises, employing the tools of cluster analysis. Cluster analysis was applied as the primary method of synthesising multidimensional data and identifying internally homogeneous groups (clusters) of regions according to the level of economic efficiency of agricultural production. This approach made it possible, with a high degree of analytical precision, to systematise the set of research objects according to a range of indicators, to determine the spatial characteristics of agricultural enterprise performance and to characterise the structural heterogeneity of the agricultural sector under wartime conditions. The classification of Ukraine's regions was conducted using the within-group means method (k-means algorithm), which was based on minimising distances between objects within clusters and maximising distances between cluster centroids. This method made it possible to identify latent patterns within large datasets and to produce an interpretable classification of regions according to the selected characteristics. The number of clusters ($K = 4$) was determined empirically on the basis of the balance between cluster homogeneity and the representativeness of the grouping. Calculations were conducted within 100 iterations in order to achieve a stable distribution of objects across groups.

The analytical base of the study encompassed statistical information published on the website of the State Statistics Service of Ukraine (n.d.) for 2022, pertaining to the activity of agricultural enterprises across all oblasts of Ukraine. The following indicators were used for classification, characterising the economic efficiency of enterprises per 1 hectare of agricultural land: X_1 – gross crop output, UAH thousand; X_2 – gross livestock output, UAH thousand;

X_3 – revenue, UAH thousand; X_4 – profit (loss), UAH thousand; X_5 – capital investment, UAH thousand; X_6 – investment attraction ratio, kopiyyky per UAH of revenue; X_7 – return on total activity, %; X_8 – return on capital, %; X_9 – return on equity, %. All indicators were of a relative character, which ensured correct comparison of regions with differing areas of agricultural land. The selection of these parameters in particular was determined by their significance for assessing enterprise performance and their representativeness under the conditions of transformational pressure on the sector in the context of full-scale war (2022-2025). The application of the cluster approach made it possible not only to identify the typology of the territorial development of agricultural production but also to characterise the nature of the wartime factor's influence on enterprise economic efficiency across regions, which was of importance for substantiating adaptation strategies and formulating support policies.

► Results and Discussion

Russia's military aggression against Ukraine, which commenced in 2022, transformed the institutional structure, dynamics, priorities and resultant indicators of agrarian entrepreneurship development, as well as its role in guaranteeing national food security. Entrepreneurship, as an important market institution, embodied the concepts of innovativeness, realising the functional role of innovation creation and diffusion, and constituted the organisational-economic foundation for ensuring the sustainable development of rural territories. The capacity to achieve sustainability depended directly on the performance and qualities of entrepreneurship, which were shaped under the influence of institutional policy and stimulation mechanisms, the subjects of which were the state and the market. The war, having created risks for agricultural business, formed an environment of general compulsion for producers to restructure economic management systems, to reorganise and to relocate – an accelerated transformation involving the adaptation of entrepreneurial activity institutions in connection with the movement of the economy and the state towards the coalitions of the European Union, whose market in 2022 became established as the primary and largest market for the sale of Ukraine's agri-food sector products.

As a result of analysing the principal problematic factors relating to the agricultural sector, a structural – specifically institutional – model was identified that projected the potential level of entrepreneurial efficiency. Attention was focused on this aspect in the course of analysing the composition of economic entities and assessing the institutional efficiency of organisational forms according to criteria of their adaptation to wartime conditions. In this regard, the institutional capacity of various forms to perform economic and social functions was manifested, demonstrating the competitive viability of entrepreneurial projects. The efficiency of agricultural enterprises was examined through an understanding of the functional role of their organisational-legal forms. Under force majeure circumstances and market turbulence caused by Russian military aggression, organisational form was of significance for: achieving entrepreneurial resilience and a balanced cost–benefit ratio; preserving production

capacity; and readiness to rationally relocate business. In this context, aspects of institutional efficiency were delineated, since the organisational-legal form conditioned the statuses, norms and traditions within which, and under

the influence of which, an enterprise functioned and achieved certain results. The formation of the Ukrainian entrepreneurship model proceeded in an evolutionary manner (Table 1).

Table 1. Characteristics of the entrepreneurial management model in the agricultural sector of Ukraine's economy

Period	Enterprise subject structure
Before 1991 (Soviet era)	Agricultural enterprises, by organisational-legal form – collective farms and state farms
1991-1999 (early period of Ukrainian independence)	Agricultural enterprises, by organisational-legal form – collective agricultural enterprises, state enterprises. Farming enterprises
1999-2005 (period of formation, consolidation and development of the institutional model of entrepreneurial management)	Agricultural enterprises, by organisational-legal form – business partnerships, agricultural cooperatives, private and state enterprises. Farming enterprises
2006-2025 (period of development of integrated corporate-type structures through attracted, including foreign, capital)	Large-scale integrated corporate-type structures. Agricultural enterprises, by organisational-legal form – business partnerships, agricultural cooperatives, private and state enterprises. Farming enterprises. Small family farming enterprises and household farms

Source: compiled by the authors

Market transformations made it possible to form a powerful entrepreneurial sector in Ukrainian agriculture, capable of realising the favourable potential of Ukraine's natural and climatic conditions in producing quality goods with high competitiveness on global food markets. The development of the export potential of Ukrainian agricultural producers was facilitated by foreign policy directed towards integration into the European Union. The importance of the European Union's single agricultural product market for Ukrainian exporters can hardly be overestimated, both in view of its convenient geographical location and developed logistics, and in view of the substantial volume of solvent demand. Prior to the commencement of the active phase of armed aggression in 2022, the combined market of European Union countries had, in 2021, become the world's third largest importer of agri-food products, second only to

China and the United States. Total external purchases of agricultural products amounted to USD 199 billion (9.1% of global agricultural imports), in which Ukraine's share reached 3.9%, a high figure considering that the European Union had become the world's largest exporter of agricultural products. Over the period from 2017, when the Association Agreement between Ukraine and the EU came fully into force, to 2021, exports of Ukrainian agricultural products grew at an average annual rate of 12.6% and reached USD 27.7 billion (State Statistics Service of Ukraine, n.d.). Alongside this, agricultural exports were concentrated on a narrow range of goods: grain crops (wheat and maize), vegetable oil and meal, and oilseed crops (soya and rapeseed), whose combined share as of 2021 reached 85%. It should be noted that this tendency was maintained during the acute phase of military aggression (after 2022) (Fig. 1).

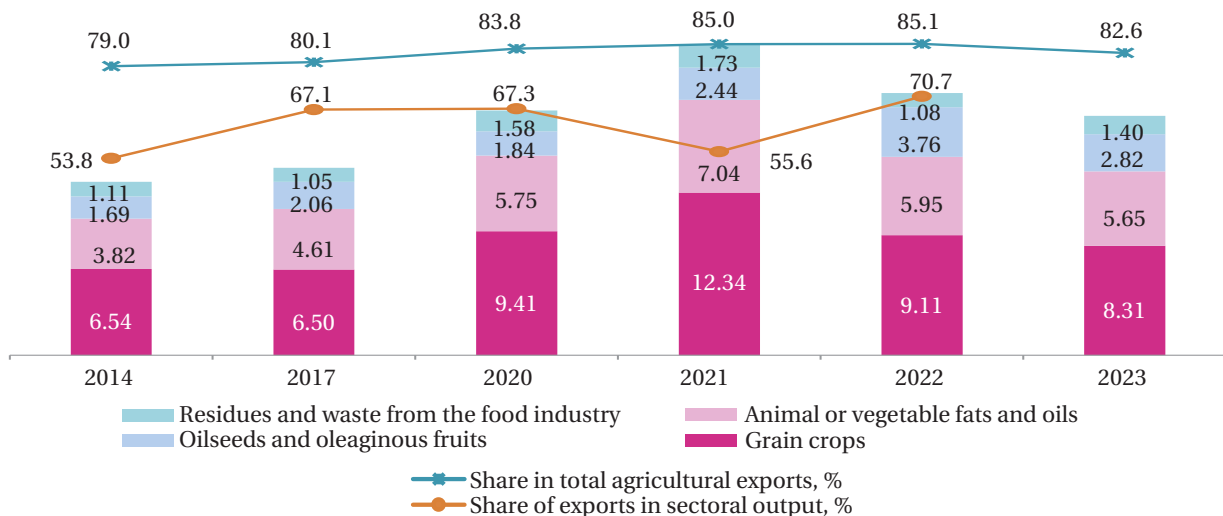


Figure 1. Dynamics of Ukraine's agricultural exports by major commodity groups, USD billion

Source: State Statistics Service of Ukraine (n.d.)

The orientation of Ukraine's agricultural sector towards a narrow commodity export segment conferred advantages from production specialisation, but entailed significant risks associated both with the intensification of competition in target sales markets and with the disruption of

traditional supply chains for these products as a result of crises linked to the worsening of the geopolitical situation. Given that exports accounted for up to 70% of total sectoral output, changes in export volumes directly affected the functioning of Ukraine's agricultural sector as a whole (Fig. 2).

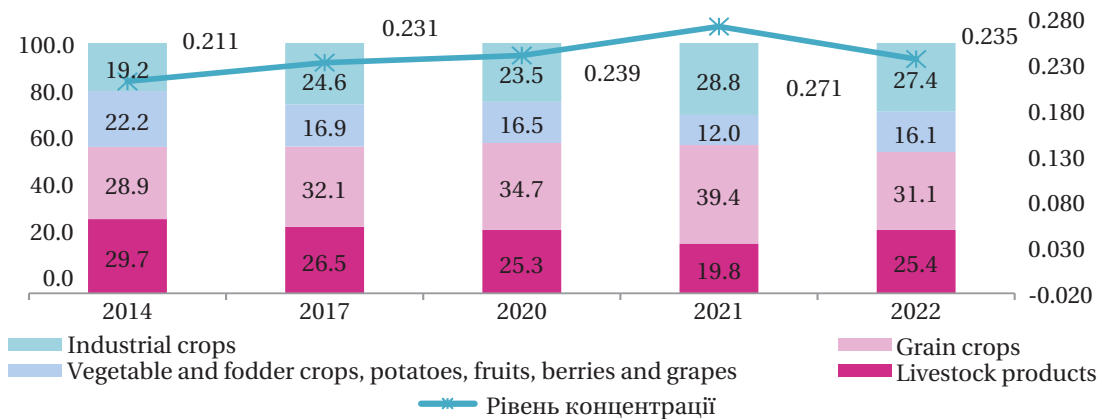


Figure 2. Structure and concentration level of agricultural output (across all categories of farm households), %
Source: State Statistics Service of Ukraine (n.d.)

From 2014, the structure of agricultural output underwent substantial changes. The share of grain crops rose from 28.9% to 39.4%, and the share of industrial crops increased from 19.2% to 28.8% in 2014 and 2021 respectively. In 2022, when exports were impeded by the disruption of traditional logistical routes, the share of grain and industrial crops in this period stood at 31.1% and 27.4% respectively. The calculated specialisation coefficients indicated their growth in 2014-2021 within a range corresponding to the average level of 0.211, whilst in 2012-2013 the value stood at 0.196-0.201, indicating a low level of specialisation (State Statistics Service of Ukraine, n.d.). The growth in the level of specialisation was driven by agricultural producers' aspiration to concentrate efforts on the production of high-margin goods in demand on external markets, in the absence of alternative state policy incentives. Given that raw materials with low added value were being exported, this tendency was to be considered negative at the sectoral level, as it carried risks of a reduction in the level of national food security and a decline in the incomes of sector participants as a result of deteriorating export conditions.

At the level of Ukraine's agricultural enterprises, this tendency was manifested even more acutely. Unlike household farms, which operated to meet the population's food needs, entrepreneurial structures were directed exclusively towards the maximisation of profit through the production of export-oriented crop products: the combined share of grain, grain-legume and industrial crops over the period from 2019 to 2023 fluctuated at the level of 78.6-82.6%, and specialisation coefficients stood at 0.33-0.36, gravitating towards a high level of specialisation (State Statistics Service of Ukraine, n.d.). The production structure of agricultural enterprises was formed accordingly – concentration on three crops occurred: sunflower, wheat and maize, whose combined share in sown area grew from 65.3% in 2014 to 75.9% in 2021, and concentration coefficients from 0.184 to 0.215 respectively (Fig. 3). With the beginning of the active phase of Russia's military aggression against Ukraine, the share of wheat and maize decreased, which was associated with a decline in the economic efficiency of their cultivation due to the complication of export conditions caused by the destruction of traditional logistics routes.

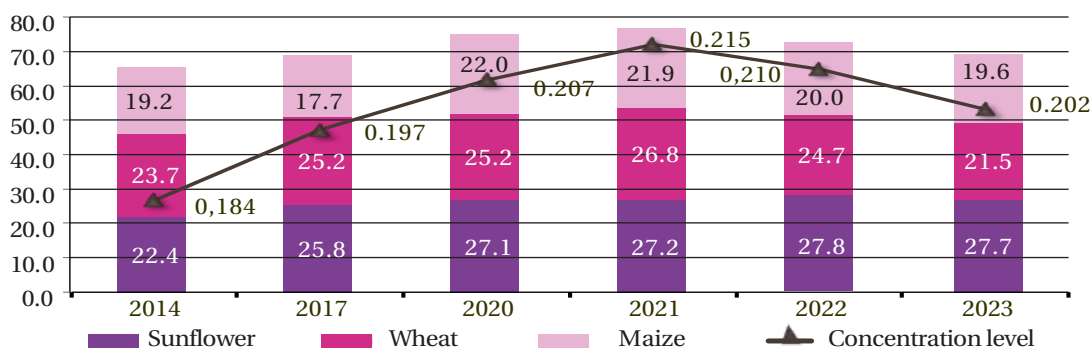


Figure 3. Share of sown areas under wheat, maize and sunflower and the concentration level in total sown area of agricultural enterprises, %

Source: State Statistics Service of Ukraine (n.d.)

In the relatively favourable period before 2022 – the beginning of the acute phase of military aggression – such a level of concentration was justified by increased revenues of enterprises resulting from favourable conditions in global agricultural commodity markets. Since 2014, the volumes of produced and sold output, as well as the value added of enterprises in the sector, had been growing at a high rate, and during 2019-2021 value added began to grow at a rate exceeding that of sales volumes. This stimulated sector enterprises to expand sown areas – by 1.4 million hectares from 2014 (State Statistics Service of Ukraine, n.d.). The number of enterprises in the sector grew until 2020, when a general decline in business activity began, caused by the onset of the COVID-19 pandemic. Alongside this, specialisation in less labour-intensive types of crop products led to a 15% reduction in the number of persons employed in the

sector. With the onset of the acute phase of Russia's military aggression against Ukraine (from February 2022), owing to occupation, bombardment, contamination with explosive ordnance and a significant deterioration in the economic conditions of farming, the resource base of agricultural enterprises was substantially reduced. Compared with average values for 2019-2023, by 2023 a loss of 16.3% of sown area and 22,700 employed workers was recorded, the number of active enterprises declined by 16.8%, whilst volumes of produced and sold output remained unchanged against a background of rising food prices and exchange rate. Value added declined sharply in 2022-2023, which narrowed the financial base for the development of agricultural enterprises. Table 2 summarises the key data on the development of enterprises not only in agriculture as a whole but also in hunting and related services.

Table 2. Key development indicators of agricultural, hunting and related service enterprises

Indicators	2014	2015	2015 relative to 2014	Rate of change, 2016-2018	2019	2021	Rate of change, 2019-2021	Average for 2019-2021	2022/2023	2022/2023 relative to average for 2019-2021
Volume of produced output, UAH billion	273.5	394.6	144.3	113.3	592.0	974.9	119.3	733.8	706.8/734.4	96.3/100.1
Volume of sold output, UAH billion	213.9	362.3	169.4	113.2	556.3	918.7	120.5	693.5	680.5/780.1	98.1/112.5
Value added, UAH billion	125.5	183.9	146.6	103.2	205.4	521.3	137.2	330.1	278.3/246.0	84.3/74.5
Number of enterprises, thousand units	46.0	46.7	101.6	102.6	50.2	47.8	98.2	49.1	32.8/40.9	66.8/83.2
Number of employed workers, thousand persons	628.9	597.6	95.0	99.1	566.7	535.7	97.3	545.7	454.5/422.0	83.3/77.3
Sown areas, million ha	18.9	18.8	99.2	101.2	19.7	20.3	101.4	19.9	16.5/16.7	82.8/83.7

Source: State Statistics Service of Ukraine (n.d.)

The performance of Ukraine's agricultural enterprises was shaped at the regional level where, despite equal institutional and economic conditions, characteristic features of a natural-climatic and sociocultural nature determined the specific character of entrepreneurship development within these territorial complexes. From 2014, wartime risks were added to these factors, which constrained entrepreneurial activity in regions affected by the war in eastern Ukraine. Therefore, in order to obtain substantiated conclusions regarding the interdependence of the established structure of Ukraine's agriculture and its performance characteristics, the structural analysis was deepened by an examination of the spatial features of agricultural sector enterprise functioning. To address the problem of synthesising multidimensional characteristics of regional conditions for agricultural enterprise development, the apparatus of cluster analysis was employed.

The cluster classification of Ukraine's regions according to indicators of agricultural enterprise activity in 2022

yielded 4 clusters. Cluster 1 comprised Vinnytsia, Zhytomyr, Kirovohrad, Sumy and Chernihiv regions; Cluster 2 comprised Volyn, Zakarpattia, Ivano-Frankivsk, Lviv, Rivne, Ternopil, Khmelnytskyi, Cherkasy and Chernivtsi regions; Cluster 3 comprised Dnipropetrovsk, Mykolaiv, Odesa and Kharkiv regions. The average performance indicators of enterprises in Cluster 4 (Donetsk, Zaporizhzhia, Luhansk and Kherson regions) proved to be the worst. Enterprises in these regions suffered most severely from hostilities and incurred the greatest losses. It should be noted that from 2014 the average indicators of all four clusters remained at a fairly high level: the wartime factor's influence on the agricultural sector was of a localised character – at that time only individual districts of Luhansk and Donetsk regions were occupied, the economic activity of which was predominantly of an industrial specialisation. Nevertheless, from 2014 onwards differences in the development of the resource base of agricultural enterprises across the different clusters could already be observed (Table 3).

Table 3. Resources by cluster

Clusters	2014	2015	Rate of change, 2014-2015	Rate of change, 2016-2018	2019	2021	Rate of change, 2019-2021	Average for 2019-2021	2022/2023	2022/2023 relative to average for 2019-2021
Number of enterprises, thousand units										
Cluster 1	11.4	11.6	101.9	103.0	13.0	12.9	100.4	12.9	11.0/12.5	85.3/96.6
Cluster 2	13.3	13.4	100.9	102.8	14.5	14.1	99.0	14.3	10.7/12.9	74.9/89.7
Cluster 3	13.9	14.4	103.1	102.2	14.9	13.5	95.7	14.3	9.6/11.8	66.6/82.1
Cluster 4	7.4	7.4	99.5	102.4	7.8	7.3	97.5	7.6	1.5/3.8	20.3/50.0
Number of employed workers, thousand persons										
Cluster 1	206.8	197.5	95.5	98.4	185.5	176.5	97.9	179.6	167.6/147.9	93.4/82.3
Cluster 2	204.4	196.7	96.2	100.7	197.7	182.6	96.9	188.1	181.8/181.7	96.6/96.6
Cluster 3	129.9	122.3	94.1	97.8	108.7	103.3	96.6	104.1	84.9/79.2	81.5/76.1
Cluster 4	87.8	81.2	92.4	98.6	74.7	73.3	98.0	73.9	20.2/13.2	27.3/17.9
Sown areas, million ha										
Cluster 1	6.22	6.31	101.4	100.8	6.53	6.72	101.3	6.63	6.54/6.46	98.6/97.4
Cluster 2	4.39	4.38	99.8	101.9	4.68	4.85	101.6	4.77	4.85/4.81	101.7/100.9
Cluster 3	4.90	4.88	99.5	100.7	5.03	5.10	100.8	5.01	4.37/4.90	87.3/97.8
Cluster 4	3.40	3.21	94.3	101.8	3.43	3.58	102.0	3.50	0.72/0.50	20.7/14.2

Source: State Statistics Service of Ukraine (n.d.)

Favorable conditions on global agricultural markets led to the expansion of sown areas and the growth in the number of enterprises across Ukraine. The full-scale invasion of 2022 caused catastrophic changes in the operating conditions of agricultural enterprises, primarily in regions where occupation and active hostilities took place, as well as those bordering them. In 2022, Clusters 3 and 4 respectively recorded 33.4% and 79.7% fewer active enterprises compared with the 2014-2021 period. Sown areas there contracted by 12.7% and 79.3% respectively. In contrast,

in regions belonging to Clusters 1 and 2 it proved possible to preserve the productive foundation of agricultural entrepreneurship. In 2023, sown areas were restored in regions belonging to Cluster 3; however, in Cluster 4 the contraction of sown areas continued. A negative tendency was the contraction of areas in regions belonging to Cluster 2, which had not been directly affected by hostilities. Changes in the resource base of agricultural enterprises were correspondingly reflected in the performance of economic activity (Table 4).

Table 4. Performance by cluster

Clusters	2014	2015	2015 relative to 2014	Rate of change, 2016-2018	2019	2021	Rate of change, 2019-2021	Average for 2019-2021	2022/2023	2022/2023 relative to average for 2019-2021
Volume of produced output, UAH billion										
Cluster 1	93.3	147.3	157.9	110.7	205.9	412.9	127.4	284.1	268.1/283.6	94.3/99.8
Cluster 2	98.2	128.2	130.6	117.5	220.7	297.9	112.7	246.6	295.1/306.1	119.7/124.2
Cluster 3	51.9	76.6	147.4	111.5	104.0	163.7	115.5	125.0	119.5/134.0	95.6/107.2
Cluster 4	30.0	42.5	141.6	112.1	61.4	100.4	118.8	78.1	24.0/10.6	30.8/13.6
Volume of sold output, UAH billion										
Cluster 1	68.6	132.9	193.8	108.6	191.1	381.8	131.0	260.6	246.6/281.4	94.6/108.0
Cluster 2	80.2	123.6	154.1	118.7	213.6	296.5	112.8	245.5	305.1/355.7	124.3/144.9
Cluster 3	40.8	68.3	167.2	111.7	96.6	149.0	116.1	115.7	105.4/132.2	91.1/114.3
Cluster 4	24.4	37.6	154.2	112.2	55.1	91.3	119.8	71.8	23.4/10.7	32.6/15.0
Value added, UAH billion										
Cluster 1	40.5	70.2	173.2	92.7	53.7	249.7	164.7	133.9	103.4/84.5	77.3/63.1
Cluster 2	48.1	61.5	127.9	112.1	98.0	145.2	118.8	112.8	111.0/111.5	98.4/98.9

Table 4, Continued

Clusters	2014	2015	2015 relative to 2014	Rate of change, 2016-2021			Rate of change, 2019-2021		Average for 2019-2021	2022/2023	2022/2023 relative to average for 2019-2021
				2016	2017	2018	2019	2020			
Value added, UAH billion											
Cluster 3	24.7	34.7	140.3	106.1	35.7	77.0	123.0	51.8	50.4/ 46.2	97.4/ 89.2	
Cluster 4	12.1	17.5	144.5	101.2	18.0	49.4	139.7	31.7	13.5/ 3.9	42.5/ 12.3	

Source: State Statistics Service of Ukraine (n.d.)

The period from 2014 to 2021 was characterised by high rates of growth in the value-based results of agricultural enterprise economic activity; however, in the spatial dimension these indicators changed unevenly. Cluster 1 demonstrated the greatest amplitude of changes, where accelerated growth in volumes of sold output alternated with periods of the greatest decline. With the onset of the acute phase of military aggression, the indicators of Cluster 4, comprising the most severely affected regions, declined catastrophically and continued to fall in 2023. In regions belonging to Cluster 2, agricultural enterprises managed to restore growth rates in production and sales volumes to a level corresponding to prevailing inflation rates, thereby maintaining value added at the average level for 2014-2021. Enterprises of Cluster 3, despite the decline in production volumes in 2022, ensured positive development dynamics in 2023, arresting the fall in value added at 11% below the

average level for 2019-2021. In contrast, in regions belonging to Cluster 1 a decline in production volumes continued, alongside a corresponding fall in value added of 36.9% compared with the average level for 2014-2021 (State Statistics Service of Ukraine, n.d.). Considering that these included regions distant from the zone of hostilities and taking into account the preceding trends in performance changes, the hypothesis regarding the influence of the level of production specialisation on the resilience of agricultural enterprises under adverse conditions became relevant. Given the concentration of Ukrainian agricultural enterprises primarily on the production of crop products and the absence of current statistical information, the assessment of the level of specialisation at the regional and cluster level was carried out using the indicator of the concentration level of sown areas under individual agricultural crops: sunflower, wheat and maize (Table 5).

Table 5. Concentration level of sown areas under sunflower, wheat and maize in agricultural enterprises by cluster

Clusters	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cluster 1	0.198	0.200	0.208	0.208	0.208	0.225	0.245	0.246	0.228	0.215
Cluster 2	0.172	0.177	0.177	0.177	0.177	0.182	0.195	0.201	0.194	0.181
Cluster 3	0.228	0.253	0.254	0.254	0.254	0.248	0.253	0.269	0.263	0.236
Cluster 4	0.216	0.274	0.268	0.268	0.268	0.249	0.270	0.275	0.323	0.346

Source: State Statistics Service of Ukraine (n.d.)

Following the characterised general tendencies towards the growth in the shares of sunflower, wheat and maize sown areas, agricultural producers chose between strategies of deepening specialisation to maximise profits or diversification to reduce risks, depending on the natural-climatic potential of the territory and the economic-organisational capabilities of the region's enterprises. The spatial differentiation of economic conditions for entrepreneurship development was determined by the characteristics of social and human capital in individual territories, the presence of large-scale integrated structures and the distance from the zone of hostilities. The calculated cluster indicators of sown area concentration clearly demonstrated the specific features of the current territorial zoning of agricultural production. Clusters 3 and 4 were characterised by high concentration coefficients compared with the remaining clusters and encompassed the arid southern and eastern regions of Ukraine. Concentration on less water-demanding crops – wheat and sunflower, and in Odesa, Mykolaiv and Kherson regions on barley – pursued the objective of optimising costs per unit of produced output. Regions belonging to Cluster 1 were well supplied with moisture, which made it possible to maximise revenue per unit of sown area by combining high-margin

crops – maize, sunflower and wheat. Clusters 1, 3 and 4 were represented by regions in whose economic system agro-holdings occupied a prominent position – structures that had powerful financial resources for compensating revenue losses during adverse periods. In contrast, the mental and cultural-historical characteristics of the rural population of western regions belonging to Cluster 2 promoted the development of individual forms of entrepreneurship which, in the absence of a powerful financial base, diversified production to guard against the risks of adverse market conditions. The difference in the performance of the aforementioned strategies was demonstrated by graphs of the dynamics of sold output volumes and value added per unit of sown area (Fig. 4).

The strategies of Clusters 3 and 4 yielded small but stable levels of revenue and value added per unit of cultivated area. Concentration on high-margin crops in Cluster 2 under favourable conditions made it possible to achieve significant growth in value added per 1 ha of sown area; however, in dynamic terms this indicator demonstrated considerable volatility, and in adverse periods declined to the level of the preceding clusters. The most successful proved to be the diversification strategy, which ensured stable performance indicators, demonstrated relative

resilience to crisis economic conditions and, over the long term, made it possible to accumulate a greater mass of value added from agricultural activity. Alongside this, the aforementioned strategies led to fundamentally different outcomes under conditions of wartime uncertainty. The

performance of agricultural enterprise economic activity across clusters exhibited differences, which were characterised by calculated losses. The corresponding assessment of these losses is presented in Table 6 – using the example of the principal agricultural crops (wheat, maize and sunflower).

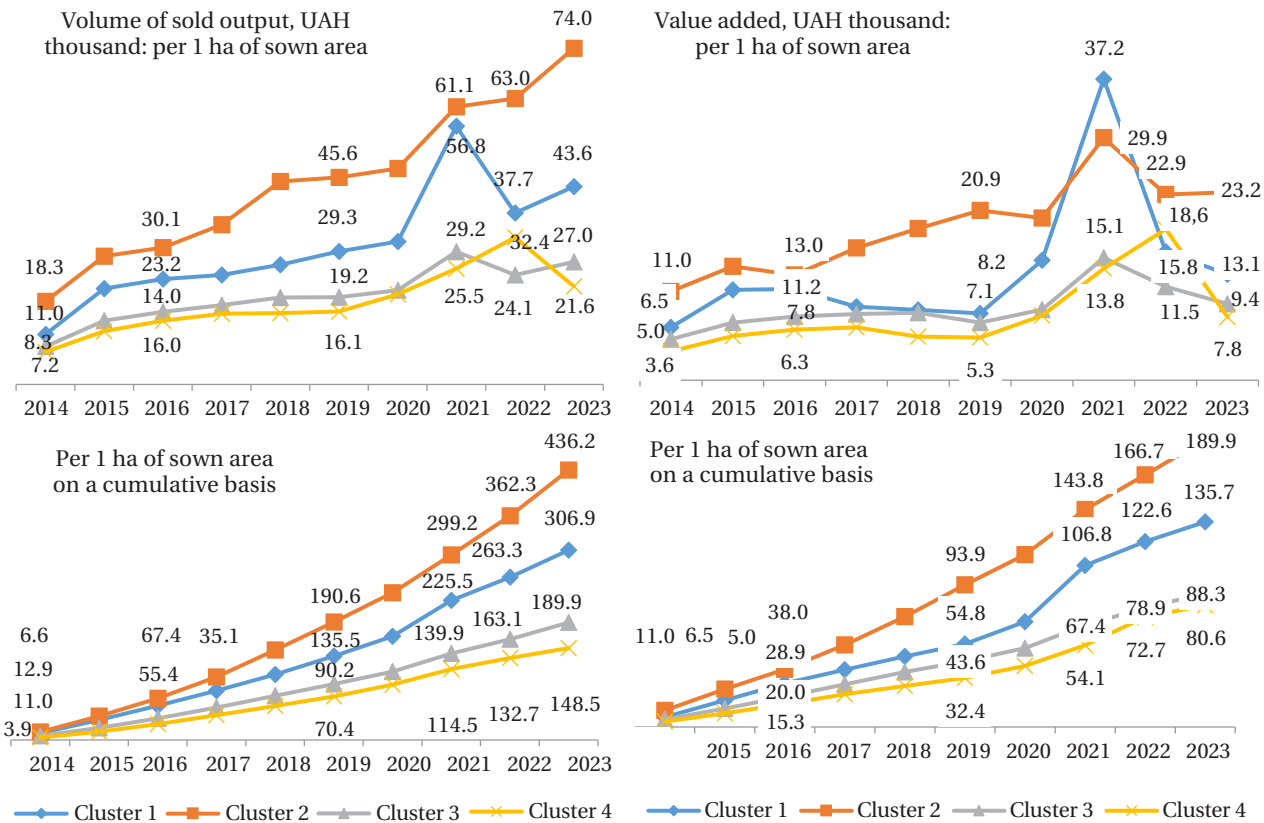


Figure 4. Performance of agricultural enterprise economic activity by cluster, UAH thousand
Source: State Statistics Service of Ukraine (n.d.)

Table 6. Estimated losses of agricultural enterprises by cluster due to changes in wheat, maize and sunflower production volumes (2022)

Clusters	Harvested area, thousand ha		Yield, t/ha		Production volume, thousand tonnes in 2022		Total losses, million tonnes	Due to losses, million tonnes		Value of losses, UAH billion
	average for 2019-2021	2022	average for 2019-2021	2022	(actual)	(estimated)		area	yield losses	
Wheat										
Cluster 1	1,158.2	1,217.9	49.1	44.7	5.45	5.69	-0.24	0.29	-0.53	-1.07
Cluster 2	970.2	978.8	53.3	51.8	5.07	5.17	-0.10	0.05	-0.15	-0.46
Cluster 3	1,704.2	1,520.6	39.2	32.6	4.96	6.69	-1.73	-0.72	-1.01	-7.66
Cluster 4	1,360.5	257.6	37.5	30.4	0.78	5.10	-4.32	-4.14	-0.18	-19.16
Total	5,193.1	3,974.9	43.6	40.9	16.26	22.65	-6.39	-4.52	-1.87	-28.35
Maize										
Cluster 1	2,374.3	1,753.9	73.5	68.3	11.98	17.46	-5.47	-4.56	-0.91	-23.40
Cluster 2	1,315.8	1,167.2	82.3	75.3	8.79	10.83	-2.04	-1.22	-0.81	-8.71
Cluster 3	417.8	296.1	54.0	49.9	1.48	2.26	-0.78	-0.66	-0.12	-3.34
Cluster 4	110.8	8.8	63.4	41.4	0.04	0.70	-0.67	-0.65	-0.02	-2.85
Total	4,218.6	3,226.0	74.1	69.1	22.29	31.25	-8.95	-7.09	-1.87	-38.29
Sunflower										
Cluster 1	1624.1	1927.6	27.9	24.3	4.69	4.53	0.16	0.85	-0.69	1.80

Table 6, Continued

Clusters	Harvested area, thousand ha		Yield, t/ha		Production volume, thousand tonnes in 2022		Total losses, million tonnes	Due to losses, million tonnes		Value of losses, UAH billion
	average for 2019-2021	2022	average for 2019-2021	2022	(actual)	(estimated)		area	yield losses	
Sunflower										
Cluster 2	780.3	939.9	30.1	26.2	2.46	2.35	0.11	0.48	-0.37	1.27
Cluster 3	1659.0	1401.4	22.1	17.7	2.48	3.67	-1.19	-0.57	-0.62	-13.43
Cluster 4	1202.7	197.9	19.8	17.9	0.35	2.38	-2.03	-1.99	-0.04	-22.85
Total	5266.1	4466.8	24.6	22.4	9.99	12.93	-2.94	-1.23	-1.71	-33.20

Source: State Statistics Service of Ukraine (n.d.)

Thus, complex transformations had occurred in agriculture and it continued to develop under difficult conditions; however, Ukraine had international support, which assisted in resisting external challenges. O. Goncharenko *et al.* (2023) outlined the introduction of new organisational management models in crop and livestock production based on integration principles and support of small farm operation, which contributed to sectoral resilience and competitiveness; even under the influence of the wartime factor, the sector followed the efficiency patterns of the sectoral production structure. D. Khalizov (2023) noted that, given that Ukraine had become one of the world leaders in the export of grain and oilseed crops, Russia's invasion had a significant impact on agriculture and food security throughout the world. In 2020-2021, Ukraine exported nearly 6 million tonnes of vegetable oil, accounting for over 47% of global sales of the product. The beginning of 2022 caused a shock on the global oilseed market: prices rose substantially and supply volumes declined. In February 2022, the global food price index reached a historic high following steady growth during 2019-2021. It was determined that the number of people suffering from inadequate food security worldwide could reach a 15-year high as a result of the consequences of the war and COVID-19. S. Moshenskyi *et al.* (2024) noted that these problems were substantially exacerbated under the conditions of full-scale war, which complicated the implementation of effective state agricultural policy. The temporary occupation of Ukrainian territories, contamination and mining of agricultural lands and the unstable front line led to a reduction in the production volumes of principal crops. Russia's military invasion caused a shortage of financial and material-technical resources – seeds, fertilisers and fuel – which made it impossible to maintain technological standards and reduced the areas of cultivated land.

K. Happe *et al.* (2008) emphasised that the effectiveness of state policy as a regulator depended on the structure of agricultural entities – their form, size and specialisation. Small agricultural business was considered the most adaptive to a turbulent market, demonstrating flexibility, resource mobility and innovative activity. M. Humeňuk *et al.* (2022) and O. Shpykuliak *et al.* (2024) reached the conclusion that small enterprises were capable of promptly changing their asset structure and introducing modern production organisation practices. In general, effective agricultural activity was required to be based not only on consideration of socioeconomic conditions but also on ecological responsibility. In the context of growing

challenges associated with climate change, soil degradation and the depletion of natural resources, the concept of sustainable land use acquired particular relevance. U. Karbivska *et al.* (2024) noted that this implied not only conservation but also the active replenishment of energy and natural resources, as well as the restoration of agroecosystems, which became the foundation for long-term productivity and ecological balance. This required a balanced approach that ensured agriculture throughout the world was sustainable and beneficial to all stakeholders. From a social and economic perspective, the level of labour productivity became one of the key factors in developing competitive agricultural activity. Yu. Bilenko (2022) observed that the substitution of labour with other production factors was not always sufficient for its effective maximisation, particularly under conditions of workforce shortages caused by war and migration processes.

In the context of the infrastructural provision of competitive activity in the agricultural sector, agrolistics became important, acquiring critical significance under wartime conditions. H. Kryshchal (2023) noted that the organisation of effective logistical routes, the reconstruction of railway, road and waterway infrastructure, and ensuring quality product transportation became necessary conditions for the stable functioning of agricultural production. The war became a destabilising factor for all segments of the organisational-economic development of Ukraine's agricultural sector. O. Nechyporenko *et al.* (2022) warned that the physical destruction of enterprises, farming businesses and production capacities would lead to a decline in gross output volumes and a disruption of food security. One of the key directions for enhancing competitiveness was the introduction of a model of precision management of production and trade processes based on digitalisation. W. Liu *et al.* (2022) noted that the use of digital tools facilitated the coordination of supply chains, the innovative development of marketing, improved access to resources, the strengthening of production and distribution infrastructure and the enhancement of institutional support for the resilience of agricultural activity. Thus, Russia's military invasion had a significant impact on Ukraine's agriculture, resulting in a decline in production volumes, a disruption of food security and a deterioration of the economic situation. At the same time, innovative approaches became important for adapting to wartime conditions and maintaining the competitiveness of the agricultural sector, including sustainable development, digitalisation and the improvement of logistical processes.

► Conclusions

The structural analysis based on the cluster methodology made it possible to characterise the economics of the regional development of Ukraine's agricultural sector. It was established that the agrarian management system underwent deformation in accordance with the configuration of the resource base and the natural and economic conditions of the regions. In particular, as a result of the relocation of production facilities and enterprise management systems to safer areas, certain production capacities were lost or underwent unproductive relocation. It should be noted that the economic unviability, natural-climatic unsuitability and entrepreneurial inexpediency of cultivating certain types of products in a different region were evident. In particular, the physiological characteristics of certain agricultural crops cultivated by enterprises relocated from the occupied south of Ukraine were such as to render this process naturally and economically impractical.

Russia's war against Ukraine caused a deconcentration of production; in particular, in crop farming the resource-oriented model deepened, with a maximisation of the cultivation of export-oriented crops with a potentially stable positive sales margin. Traditionally, these include soya, sunflower and maize. Within the framework of this study, trends in the concentration of agricultural output were analysed and compared with the principal development trends of sector enterprises. To deepen the conclusions, the specific features of the formation of agricultural enterprise performance at the regional level were determined through a cluster analysis of the structure of Ukraine's agricultural production operating under wartime conditions. The results of the study demonstrate that in 2014-2021 the agricultural sector of Ukraine showed high growth rates: exports of agricultural products reached USD 27.7 billion with an average annual increase of 12.6%, while the structure of production was characterised by a

high level of concentration, with up to 85% of exports accounted for by cereals, oilseeds and products of their processing. At the same time, the full-scale war caused losses to the sector's resource base: in 2023, compared with the average level of 2019-2021, sown areas decreased by 16.3%, the number of enterprises by 16.8%, and employment fell to 22.7 thousand workers. The relative resilience of enterprises across clusters under crisis economic conditions was assessed by estimating their calculated losses resulting from changes in the production volumes of wheat, maize and sunflower during the crisis caused by the onset of the acute phase of military aggression. The development of competitiveness in the agricultural sector slowed due to the decline in domestic demand for foodstuffs and the intensification of the polarisation of the socio-economic development of rural territories, characteristic of all natural-economic zones. The prospects for further research lie in conducting a structural analysis of competitiveness across agricultural enterprises of various organisational and legal forms and sizes.

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► Conflict of Interest

None.

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Структурний аналіз розвитку конкурентоспроможної сільськогосподарської діяльності в Україні за впливу умов воєнного часу

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► **Анотація.** Актуальність дослідження зумовлена необхідністю ідентифікації структурних змін в аграрному секторі, що відбулися в умовах війни, а також пошуком ефективних управлінських рішень, здатних забезпечити конкурентоспроможність аграрного підприємництва в нових економічних реаліях змінного інституційного середовища. Метою дослідження стало здійснення структурного аналізу ефективності сільськогосподарських підприємств у регіональному розрізі для визначення просторових закономірностей розвитку та ступеня впливу воєнного фактору на економічну результативність аграрного виробництва. У дослідженні використано метод кластерного аналізу, що дозволив згрупувати регіони України за рівнем економічної ефективності підприємств сільськогосподарства на основі багатовимірних статистичних показників, зокрема валової продукції, доходу, прибутковості, рівня рентабельності та інвестиційної активності у розрахунку на один гектар сільськогосподарських угідь. Результатом проведеного аналізу стало виокремлення чотирьох кластерів регіонів, які продемонстрували суттєві відмінності в рівні результативності діяльності підприємств, ресурсному забезпеченні та адаптації до воєнних умов. Встановлено, що найбільшої шкоди зазнали регіони з високим рівнем концентрації рослинницького виробництва, тоді як території з більш диверсифікованою структурою продемонстрували відносно вищу стійкість. У результаті дослідження в розрізі сформованих кластерів було проаналізовано ресурсну базу та результативність виробничої діяльності сільськогосподарських підприємств. Підтверджено гіпотезу дослідження щодо значного впливу спеціалізації виробництва на стійкість господарств в несприятливих інституційних умовах. Проаналізовано особливості актуальної територіальної зональності сільськогосподарського виробництва та ідентифіковано стратегії розвитку підприємств у розрізі відповідних кластерів. Визначено економічні ефекти функціонування сільськогосподарських підприємств, які розподілені за відповідними кластерами та встановлено зв'язок між рівнем спеціалізації і втратами сільгоспідприємств від погіршення умов господарювання в 2022 році. Практична цінність дослідження полягає у можливості використання отриманих результатів для розроблення цільових програм підтримки аграрного підприємництва, планування заходів з просторового розвитку галузі та формування політики відновлення сільськогосподарства в післявоєнний період

► **Ключові слова:** формування конкурентоспроможності; економічна ефективність; воєнний вплив; аграрне підприємництво; структурні зміни; просторовий розвиток