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Ensuring Protection of the Competitiveness of Farms in the Modified Macro and Micro Environment of the Multifactor Risk

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ABSTRACT

The article considers a comprehensive methodological approach to protect the competitiveness of farms in the macro- and micro-environment of multifactor risk, taking into account the balanced component of competitive advantages of small agricultural businesses. From the standpoint of the implementation of the integrated value, multifactorial risk factors in the system of competitiveness protection are substantiated, which are associated with the problems of adequate resource management and ensuring the economic performance of farms in the future. A methodical approach to modelling multifactorial risk is proposed, which determines the simultaneous influence of formative and distributed factors in their direct and cross-activation relative to each other. The interrelation of cross-activation of basic factors of external and internal environment is formed, which provides protection of competitiveness of farms in macro- and micro-environment of multifactorial risk. Based on the results of the sensitivity analysis, the target factors of change for controlling the protection system, factors-levers of management, for influence on the protection system and factors-indicators, for protection of the problem situation are singled out. The level of protection of competitiveness of farms in the economic zones of Polissya, Forest-Steppe and Steppe of Ukraine by factors-indicators is analyzed. The potential level of profitability of economic activity of farms by regions of Ukraine is determined. The influence of the efficiency of farms on the level of their competitiveness is determined and the assessment of multifactorial risk within the production of agricultural products is carried out. Scenarios of cognitive modeling are determined. They determine the impulses of interaction of basic factors and optimal values of weighted coefficients of protection of competitiveness of farms in macro- and micro-environment of multifactor risk.

Keywords: Competitiveness; Farms; Cost; Income; Profitability.

JEL Classification: Q10; D40

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Garantizar la Protección de la Competitividad de las Explotaciones Agrícolas en el Entorno Macro y Micro Modificado del Riesgo Multifactorial

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RESUMEN

El artículo considera un enfoque metodológico integral para proteger la competitividad de las explotaciones agrícolas en el macro y microentorno de riesgo multifactorial, teniendo en cuenta el componente equilibrado de las ventajas competitivas de las pequeñas empresas agrícolas. Desde el punto de vista de la aplicación del valor integrado, se fundamentan los factores de riesgo multifactorial en el sistema de protección de la competitividad, que están asociados a los problemas de gestión adecuada de los recursos y de garantía de los resultados económicos de las explotaciones en el futuro. Se propone un enfoque metódico para modelar el riesgo multifactorial, que determina la influencia simultánea de los factores formativos y distribuidos en su activación directa y cruzada entre sí. Se forma la interrelación de la activación cruzada de los factores básicos del entorno externo e interno, que proporciona la protección de la competitividad de las explotaciones en el macro y microentorno del riesgo multifactorial. Sobre la base de los resultados del análisis de sensibilidad, los factores objetivo de cambio para el control del sistema de protección, los factores-palancas de gestión, para la influencia en el sistema de protección y los factores-indicadores, para la protección de la situación problemática son señalados. Se analiza el nivel de protección de la competitividad de las explotaciones agrícolas en las zonas económicas de Polissya, Bosque-Estepa y Estepa de Ucrania por factores-indicadores. Se determina el nivel potencial de rentabilidad de la actividad económica de las explotaciones agrícolas por regiones de Ucrania. Se determina la influencia de la eficiencia de las explotaciones en el nivel de su competitividad y se realiza la evaluación del riesgo multifactorial dentro de la producción de productos agrícolas. Se determinan los escenarios de la modelización cognitiva. Se determinan los impulsos de interacción de los factores básicos y los valores óptimos de los coeficientes ponderados de protección de la competitividad de las explotaciones agrícolas en el macro y microentorno del riesgo multifactorial.

Palabras clave: Competitividad; Eplotaciones agrícolas; Costes; Ingresos; Rentabilidad.

Clasificación JEL: Q10; D40

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1. Introduction

The agricultural sector of the national economy of any state with in-depth content of farm development is determined by their institutional and economic ability to acquire, maintain and expand their own share of agricultural markets through effective levers of market influence. Socio-economic significance of farms in the national economy, on the one hand, leads to increased competitiveness and food security of the state as a whole, on the other – the position of a group of small agricultural enterprises is weakened in the world market and in the integrated structure of the domestic agro-industrial sector. At the same time, they are suppliers of quality products and long-term environmentally friendly land use (Kyrnis, 2020; Kasyanov et al., 2019).

The functioning of farms is accompanied by regular fluctuations in economic dynamics, caused by cycles of risks of different origins. On the one hand, risks ensure the demise of outdated forms and methods of management, on the other hand, they destroy the potentially viable economic system of entities that for subjective or objective reasons were not ready to resist the destabilizing factors of internal and external environment (Golub and Dvornyk, 2018; Daus et al., 2019). The risk is especially significant for farms, as their impact on macroeconomic fluctuations in the state, industries and regions provokes a crisis of microeconomic genesis of small agricultural businesses and their individual products. Accordingly, the combined influence of external and internal environmental factors exacerbates the destructive nature of the macro- and micro-environment of farms, which requires increasing the level of competitiveness in their economic system (Verbuch and Bratkovska, 2020).

The issue of risk occupies the opinion of many researchers in various fields of human activity, but much attention in the modern methodology of risk assessment is disclosed in the works of such scientists as: P. Barry (1984), P. Drucker (1997), F. Harrison (1999), Lester A. and Digman (1999), L. Martynova (2016), O. Prokopenko, V. Omelyanenko and J. Klisinski (2018), B. Rayzberg (1992), K. Redhed and S. Hyus (1996), L. Robinson, P. Barry and J. Klibenstein (1984), E. Utkin (1997), I. Zagaytov (2008). The economic nature of the category “risk”, systematization of its manifestation, species structure and certain characteristics are widely considered in the scientific works of domestic scientists – V. Andriichuk and I. Bauer (1998), I.Buzko, I. Trunina and D. Zahirniak (1996), S. Filyppova, I. Bashynska, B. Kholod, B. Prodanova, L. Ivanchenkova and V. Ivanchenkov (2019), V. Granaturov and I. Litovchenko (2005), F. Nayt. (2003), Dzh. Neyman and O. Morgenshtern (1970), D. Vasylkivskyi (2015), V. Vitlinskyi and H. Velykoivanenko (2004), V. Zbarskyi and A. Lypoviak-Mielkozorova (2011). The following scientists have studied the forms of economic protection of competition in the market of agricultural products and the search for alternative tools that ensure the competitiveness of farms: I. Ansoff (1999), I. Chychkalo-Kondratska (2010), O. Kordoba (2009), S. Oleksenko (2012), V. Pivtorak (2014), Yu. Susidenko and M. Vozniuk (2017), O. Tomilin (2012), T. Yavorska (2013). However, the process of diagnosing the protection of the competitiveness of farms through the assessment of multifactor risk in the institutional environment ensures the security of competitive positions of small agricultural businesses, given the information asymmetry and negative external influences on their functioning.

The priority of our study is to substantiate a comprehensive methodological approach to protect the competitiveness of farms in the macro- and micro-environment of multifactorial risk, taking into account the balanced component of competitive advantages of small agricultural businesses.

2. Materials and Methods

An in-depth comprehensive understanding of multifactorial risk as an element of managing economic relations in business processes contains an effective component – economic losses that threaten the competitiveness of economic entities with corresponding consequences for the economy. For any variety of factors, the effective value of risk is in the plane of activity of small agricultural businesses (Khudyakova and Dmitriyev, 2007). Risk is a probabilistic category, which means a change in the parameters of the economic system of farms under the dynamic influence of external and internal factors of development (Shahov, 2000). Large number of risk derivatives, including “risk of reduced yields", "risk of increased business costs", "risk of loss of profitability", "risk of loss of business activity", "insolvency risk", are just factors that cause the probability of aggregate risk. They need to be integrated into a single systematic assessment, as the diversity of risks is confusing and distances from ensuring a stable level of farm competitiveness (Bystrenina, 2015; Sultanbekov and Nazarova, 2019).

Risk, as "the deviation of a parameter of the economic system from a given target value by an amount not exceeding the allowable deviation of this parameter" (Hetman and Shapoval, 2007), allows, on the one hand, to realize the economic interests of farms, and on the other hand – to identify their threat competitiveness (Yermoshenko et al., 2004). From the standpoint of the implementation of the integrated value, macro- and micro-environment of multifactor risk in the system of competitiveness protection is associated with the problems of adequate resource management and ensuring the economic needs of farms in the future (Buyanov et al., 2001). The division of risks into "pure" and "speculative" is quite fair. The latter can be understood as the risk of shortfall in excess profits in order to further increase its cash. Instead, farms are mostly exposed to "pure" risks: long production and financial cycle, dependence on natural and climatic conditions, the level of development of market infrastructure, price parity with related industries (resource sphere). Moreover, direct economic losses mean the cutting of production volumes to form a stable material base (Naimy and Zeidan, 2019; Daus et al., 2018).

It should be noted that the assessment of multifactor risk allows to create an original methodological apparatus, forming the theoretical basis. First, the theoretical basis of the study has objective generalizing results on the scale of local threats of loss of profit and ensuring the competitiveness of small agricultural businesses. Secondly, the deepening of the risk assessment methodology brings its content closer to the position of universal action of correct calculation (Vitlinskyi et al., 2004; Khudyakova et al., 2020), and reflects the probable nature of the event in the plane of optimal management decisions. Therefore, the primary task of minimizing multifactorial risk is to systematize tracking, identify patterns and significant relationships between its manifestations (Da Silva and Jardón, 2019; Alibekov et al., 2020).

The high dynamics of changes in the causal links between the factors of protection of competitiveness in the economic system of farms complicates the application of formalized methods of risk assessment based on extrapolation of the past and traditional methods of statistical modeling. After all, the process of making managerial decisions determines a certain information situation, which characterizes the appropriate level of risk in determining the future parameters of the economic system. This involves the use of a mathematical apparatus of probability theory (Donets, 2006), adapted to game models of risk assessment (Yavorska, 2013); probabilistic distribution of parameters using cluster and analysis of variance (Prosvetov, 2005); use of the apparatus of simulation and cognitive modeling of systems (Harrison, 1999; Kalimbetov et al., 2019).

Evaluation of multifactorial events, in addition to concentrating on typical and recurring situations, involves an unacceptably limited number of possible results (Vitlinskyi and Velykoivanenko, 2004; Khudyakova et al., 2019). At the same time, the dominants of the random factor, the methods of dynamic forecasting displace static patterns and simple extrapolation dependencies. After all, the forecast extrapolation allows obtaining only a partial forecast, which depicts changes in only certain aspects of the protection of the competitiveness of farms. Therefore, individual parameters of competitiveness protection, which do not have systemic properties, are replaced by systemic forecasting based on cognitive technologies (Chen, 2019).

It should be noted that the factor of change (modification) of the parameters of competitiveness of farms in the macro- and micro-environment is a risk factor. Formalization of a meaningful description of risk is its mathematical model, which includes two parties with opposing interests. The most common case of calculations involves a finite number of options for choosing risk minimization solutions $C_1, \dots, C_m$ (each option corresponds to the result $r_i, i = 1, \dots, m$, i.e. it is necessary to find the option with the highest value of the result – $max\, r_i$ is accepted as profit, net income, profitability, other integrated indicator of competitiveness). It is advisable to apply the criterion (Trusova et al., 2019; Zhigir, 2021) (Eq. 1):

$$C_0 = \{C_{io} | C_{io} \in C \wedge r_{io} = \max_i r_i\} \quad (1)$$

The multiplicity of possible solutions is described by a matrix (Eq. 2):

$$R = |r_{iy}|_{\substack{i=1,\dots,m \\ j=1,\dots,n}} \quad (2)$$

Next, in search of the most optimal solution, the target functions with the minimum criterion are introduced (Trusova et al., 2019) (Eq. 3):

$$C_0 = \{C_{io} | C_{io} \in C \wedge r_{io} = \max_i \min_j r_{ij}\} \quad (3)$$

However, the parameters for protecting the competitiveness of farms are represented by a set of feedbacks in the set of its elements, the behavior of which depends on the random deviation of a number of factors. Thus, a simplified formalized model of the real situation can only describe the problem of choosing the direction of minimizing the risk of not achieving a stable level of competitiveness ($r_{io} = \min_j r_{ij}$, or $r_{io} = \max_j r_{ij}$, or $r_{iO} = \min_i \left[\max_j (\max_i r_{ij} - r_{ij}) \right]$ or $_{ir} = \frac{1}{n}\sum_{j=1}^{n} r_{ij}$r).

The methodical approach to modeling multifactorial risk determines the simultaneous influence of formative and distributed factors in their direct and cross-activation relative to each other (Khudyakova and Senchenko, 2003). Accordingly, the relationship of cross-activation of basic factors (BF) of the external and internal environment is formed, which protects the competitiveness of farms in the macro- and micro-environment of multifactorial risk. The variety of cross-activation options should be formalized taking into account as many horizontal and vertical links as possible, quantitative and qualitative characteristics of the object of study (Bissenov et al., 2014).

Modification of factors of competitiveness protection, which in the conditions of asymmetric information, especially factors of external macro- and micro-environment, provide multivariate results of economic activity of farms, are determined by procedures of logical-mathematical, probabilistic and fuzzy set analysis, and cognitive modeling. The latter methodological interpretation forms a system of indicators that are the parameters of protection of the competitiveness of small agricultural businesses that minimize the threat to the results of economic activity (Herasymenko and Zhemoida, 2009; Tastulekov et al., 2019). In addition, this technique allows building a cognitive map that takes into account ways to optimize the resource potential of the farm through the basic factors that are interpreted as key parameters (Fig. 1).

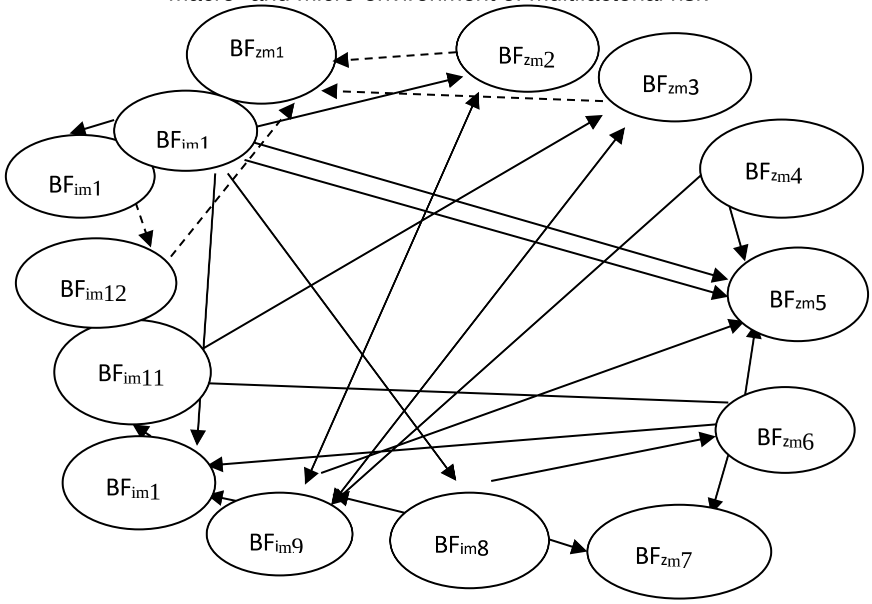
Cognitive analysis of the model "Protection of the competitiveness of the farm is carried out according to the formula (Granaturov and Litovchenko, 2005). (Eq. 4):

$$G = (V, E), V = \left\{ \begin{matrix} BF_{ee1, BFee2, BFee3, BFee4, BFee5, BFee6, BFee7, BFie8,} \\ BFie9, BFie10, BFie11, BFie12, BFie13, BFie14 \end{matrix} \right\} \quad (4)$$

where, *V*– sets of vertices that correspond to external and internal risk factors; *E*– sets of arcs that reflect the direct impact of macro- and micro-environment of multifactor risk on the parameters of competitiveness protection.

The relationship of parameters involves the construction of adjacency matrices that have certain characteristics. Thus, at the value (+1) there is an increase (decrease) of the factor $BFeei, BFiei$ which leads to an increase (decrease) $BFeej, BFiej$; at the value (-1) there is an increase (decrease) of the factor $BFeei, BFiei$, which leads to a decrease (increase) $BFeej, BFiej$; when the value (0) there is a weak or no connection between the factors $BFeei, BFiei$ and $BFeej, BFiej$. The intensity of interaction is assessed on a scale: 0.1 – no direct impact; 0.5 – weak impact; 1.0 – average impact; 2.0 – strong impact.

Figure 1 Cognitive relationship of external and internal environment of competitiveness of the farm with the macro- and micro-environment of multifactorial risk



Source: developed by the authors.

In this case, the process of risk propagation in the model G is determined by $U_i, i = 1,2,\dots, n-11$ and is the quantitative value of each vertex equal to 1; $p_i(t)$ – changes in the vertex x_i at the moment of time t, when the influence of this change on x_i at the moment t is described by the function $\pm p_j(t)$ depending on the positive or negative arc sign that combines x_i with x_j and equals ± 1. Next, using the risk spread rule in the model, the numerical values are determined $Q_i = 1$ (Vitlinskyi et al., 2002). (Eq. 5):

$$U_i(t+1) = U_i(t) + \sum_{j=1}^{n} f(V_j, V_i) p_j(t) \tag{5}$$

Vectors $P_1, P_2, \dots, P_6$ demonstrate changes in the parameters of protection of the competitiveness of the farm in the macro- and micro-environment of multifactor risk (i.e. peaks of risk factors), which are modeled step by step $n_1, n_2, \dots, n_6$ and are defined as follows: $n_1\colon\ P_1 = Q_1$, $n_2\colon P_2 = Q_1 \times A$, $n_3\colon P_3 = Q_1 \times A^2$, $n_4\colon P_4 = Q_1 \times A^3$, $n_5\colon P_5 = Q_1 \times A^4$, $n_6\colon P_6 = Q_1 \times A^5$.

According to the obtained matrices, the influence of each factor on the system of protection of a small agricultural business in the market is analyzed, and, thus, determining their role in the development of competitiveness of the farm. Based on the results of the sensitivity analysis, groups are distinguished from all factors, namely: target factors of change, for the management of the protection system; control levers to influence the protection system; indicators, to protect the problem situation. In this case, the indicator factors are indicators of fuzzy form, which are transformed into quantitative normative indicators.

From the standpoint of the methodology, the rationing procedure is proposed to convert indicators into dimensionless values, by calculating the normative coefficients, as the ratio of the actual value of the protection indicator (I_{act}) to standard (potentially possible, the highest among competitors) (I_{st}) (Donets, 2006). (Eq. 6):

$$C_{st} = {}^{I_{act}}/_{I_{st}} \tag{6}$$

In order to calculate the level of protection of competitiveness through an integrated indicator, it is necessary to determine how likely it is that competitors will simulate each individual advantage of a small agricultural business entity. At the same time, the qualitative characteristic of each individual protection measure is the level of its simulation, which is proposed to be measured in the range from 0 to 1 (0 – competitors have no obstacles to simulate competitiveness protection measures; 1 – competitors will never be able to repeat the benefits of protecting competitiveness). In the case where the weighting factor is identical to the level of its simulation, the higher the probability that the farm will be able to repeat the protection measures, the greater the weighting factor. That is, the level of simulated advantage I and its weighting factor ω are opposite values and are displayed as follows: $\omega = 1 - I$. Thus, the weighted normalized coefficients of protection of competitiveness are proposed to be calculated by formulas (7)-(8).

1) weighted standardized coefficients of protection of competitiveness of the farm (Redhed and Hyus, 1996):

$$C_{bk}^{+} = \left(1 - \frac{I_{sec}}{I_{act}} ()^{+}\right) \tag{7}$$

$$C_{bk}^{-} = \left(1 - \frac{I_{act}}{I_{sec}} ()^{+}\right) \tag{8}$$

where, C_{bk}^{+} and C_{bk}^{-} – weighted normalized coefficients of protection of competitiveness of the farm, which have, respectively, a direct and inverse relationship with the level of economic activity; ω^{+}– the probability that the protection of the competitiveness of the farm will be reproduced by competitors.

2) weighted normalized coefficients of protection of competitiveness of the competitor (Eqs. 9-10) (Redhed and Hyus, 1996).

$$C_{c}^{+} = -\left(1 - \frac{I_{act}}{I_{c}}\right)(1 - \omega^{-}) \tag{9}$$

$$C_{c}^{-} = -\left(1 - \frac{I_{c}}{I_{act}}\right)(1 - \omega^{-}) \tag{10}$$

where, C_{c}^{+} and C_{c}^{-}– weighted normalized coefficients of protection of competitiveness of the competitor; ω^-– the probability that the farm is able to reproduce measures to protect the competitiveness of the competitor.

The integrated coefficient of protection of competitiveness is calculated by formula (Eq. 11):

$$I_{ind} = \frac{\sum_{i=1}^{n} C_{bk.i}}{\sum_{i=1}^{n}(1 + \omega_{i}^{+})} - \frac{\sum_{j=1}^{m} C_{c.j}}{\sum_{j=1}^{m}(1 + \omega_{j}^{-})} \tag{11}$$

where, I_{ind} – the integrated coefficient of protection of competitiveness; $C_{bk.i}$ and $C_{c.j}$ – weighted normalized coefficients of protection of competitiveness of the farm and its competitors, respectively; ω_{i}^{+} and ω_{j}^{-} – the probability that the farm and its competitors, respectively, will be able to reproduce the protection of competitiveness; n – the number of measures to protect the competitiveness of the farm; m– the number of measures to protect the competitiveness of a competitor.

Thus, the function of protecting the competitiveness of the farm reflects the levels of simulation of protection measures (Donets, 2006). (Eq. 12-13):

$$I_{ind} = F(C_{bk},\ C_{c},\ I{+^{-}}_{sec} \tag{12}$$

$$I_{ind} = F(C_{bk},\ C_{c},\ I{+^{-}}_{sec} \tag{13}$$

where I^{+}, I^{-} – levels of simulation of measures to protect the competitiveness of the studied farm and a competitor, respectively.

It is proposed to use the scale of distribution of farms according to the level of protection of competitiveness into four groups: critical level, low, medium and high levels of protection of competitiveness of the subject. In this case, the center of the scale according to arithmetic mean for the uniform distribution of values takes values from 0 to 1 and is 0.5 For normalized coefficients, determined without weighing, the scale has the form: less than 0 – critical level of protection of competitiveness of small agricultural businesses; (0; 0.33) – low level of competitiveness protection; (0.33; 0.67) – medium level of competitiveness protection; (0.67;1.00) – high level of competitiveness protection.

To substantiate the possibility of using such a scale on the arithmetic weighted average, the mathematical expectation of the probability of repetition of measures is used to protect competitiveness. This probability is inverse to the level of simulation, which is used as a weighting factor for quantitative indicators of competitiveness. The average value of the probability of repetition of advantages by competitors is 0.5. (Donets, 2006). Then, the integrated coefficients of competitiveness protection at the central point of the weights will be determined as follows (based on Eq. (11)) (Vitlinskyi et al., 2002). (Eq. 14-16):

$$I_{ind} = \frac{\sum_{i=1}^{n} C_{bk.i}\,(1-\omega_{mean}^{+})}{\sum_{i=1}^{n}(1+\omega_{mean}^{+})} + \frac{\sum_{j=1}^{m} C_{c.j}\,(1-\omega_{mean}^{-})}{\sum_{j=1}^{m}(1+\omega_{mean}^{-})} \quad (14)$$

$$(1-\omega_{mean}^{+}) = \omega_{mean}^{+} = 0.5(1-\omega_{mean}^{-}) = \omega_{mean}^{-} = 0.5 \quad (15)$$

then

$$I_{ind} = \frac{\sum_{i=1}^{n} C_{bk.i}}{n} + \frac{\sum_{j=1}^{m} C_{c.j}}{m} \quad (16)$$

where, ω_{mean}^{+}, ω_{mean}^{-} – the average level of probability of repeating measures to protect the competitiveness of the farm and its competitors, respectively.

The expression $\frac{\sum_{i=1}^{n} C_{bk.i}}{n} + \frac{\sum_{j=1}^{m} C_{c.j}}{m}$ is an integral indicator of competitiveness protection, which is calculated without weighting and which is distributed in the interval [0; 1] with the center 0.5. The limits of the integral coefficient for the arithmetic weighted average and simple level are presented in Table 1.

Table 1 Scale of the integrated indicator of competitiveness protection

Level of competitiveness protection	Values of limits of an interval	
	lower limit	upper limit
Critical level of competitiveness protection	-1.000	0.000
Low level of competitiveness protection	0.001	0.333
Average level of competitiveness protection	0.334	0.667
High level of competitiveness protection	0.668	1.000

Source: developed by the authors.

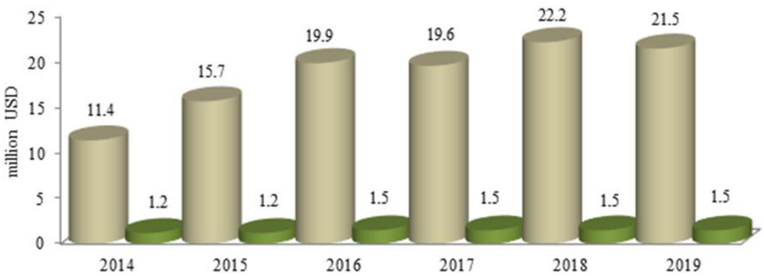
Thus, the main criterion for choosing a method for assessing the level of protection of the competitiveness of the farm in the macro- and micro-environment of multifactor risk is access to quantitative parameters of economic activity of competitors using the methods of systematic multidimensional analysis.

3. Results and Discussion

Thus, during 2014-2019, the total volume of gross output increased by 54% or more than 228.4 million USD and similar indicators for crop production and animal husbandry increased by 60% and 10% respectively. The total share of livestock products in farms does not exceed 7%, which indicates the efforts of the vast majority of farmers to carry out their own production activities with minimal capital investment. This strategy is also typical for the crop industry; it allows farmers to use the maximum quantity of resources (land, partly logistical) on a lease basis (Fig. 2).

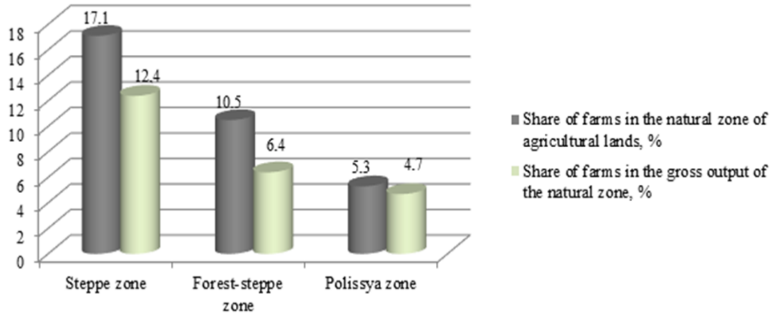
The Steppe zone farms have the greatest influence on the formation of the total gross output. In 2019, their share was 12.4% with the national average – 7.9% (Fig. 3). Farms in the Forest-Steppe zone control 10.5% of agricultural lands of the region, growing 6.4% gross output; in Polissya zones they provide 4.7% of the volume of gross output from the general structure. It should be noted that all farms that have effectively realized their potential are characterized by high costs per one ha and the level of crop yields, compared to other producers. At the same time, the amount of money spent per one USD of income in farms with the coefficient of completeness of the use of competitive potential equal to 1.000 is significantly lower.

Figure 2 Volume of gross agricultural output per farm in Ukraine, million USD



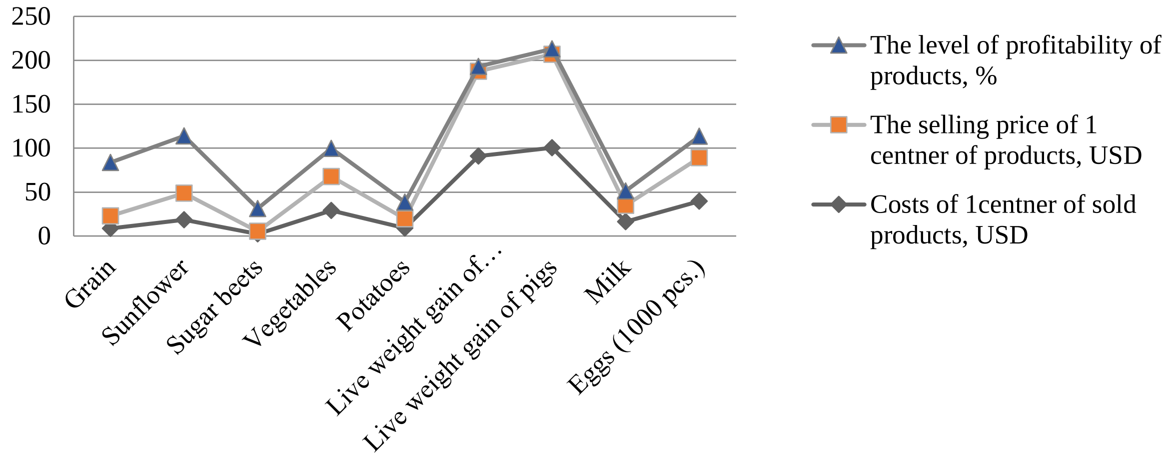
To receive one USD of income, leading farms, regardless of the economic zone of their location, need to invest significantly fewer financial resources than small businesses that have not used the full potential. The dynamics of the level of protection of the competitiveness of agricultural products of farms in the Steppe zone, on average per region corresponds to the general trends in the regions of Ukraine as a whole, although it has some differences. In particular, in crop production there is a synchronicity of sinusoidal changes of this indicator, which exceeds the national average by 10%. Thus, the regional specificity of the activities of farms is due to the presence of a significant number of informal small agricultural businesses of the commodity type, which use share lands for the production of cereals and sunflower, but which cannot sell their own crops.

Figure 3 The level of development of farms in the economic zones of Ukraine



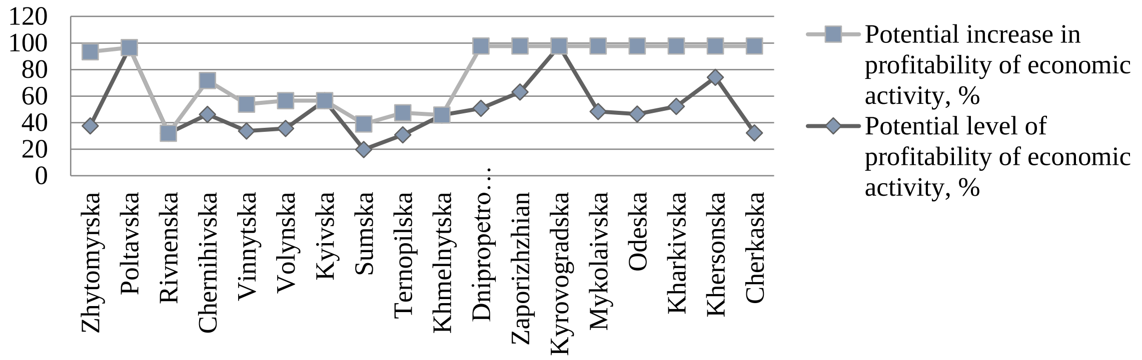
The low level of protection of the competitiveness of farms in the Forest-Steppe zone is demonstrated by the ratio of cost, sales price and level of profitability of production of basic products in the Association of Farmers and Private Landowners of Agricultural Enterprises of Ukraine (Fig. 4). Thus, the cost of 1 centner of increase in live weight of cattle exceeds the cost of production of 1 centner of grain in 10.0 times, and the costs associated with the production of sunflower are twice lower than the cost 1000 of eggs.

Figure 4 The level of protection of the competitiveness of farms in the Forest-Steppe zone of Ukraine by factors-indicators on average for 2003-2019, USD / centner



The most significant changes in the level of profitability are observed in the activities of farms in the Steppe zone. The potential increase in the profitability of forest-steppe farms ranges from 16% to 20% (Fig. 5).

Figure 5 The level of protection of the competitiveness of farms in Polissya, Forest-Steppe and Steppe of Ukraine by the potential level of profitability of economic activity on average in 2019, %



Risk protection measures for the competitiveness of farms on average per region for all economic zones of Ukraine are the efficient use of land resources. Thus, in 2019 in one region there are on average 1359 small agricultural businesses that use a total of 150.6 thousand hectares of agricultural land, the average size of each is 111.0 hectares, among large farms there are 30 subjects that have an average size of land 1562 hectares, medium and small – subjects that cultivate on average 78 hectares of land. At the same time, the intensity of production by farms in 2019 per 100 hectares of agricultural land has more than doubled, compared to the level of 2009.

During the period 2009-2019 exports of crop and livestock products increased more than in 13 times, the positive balance of which increased more than in 4.5 times If in 2009-2018 the average annual export of agricultural products amounted to 624.8 million USD, import – 470.3 million USD and the positive balance – 154.5 million USD, then in 2019 there was a rapid growth to 1175.5; 471.2 and 704.2 million USD respectively.

In 2009, farms in the regions of Ukraine received an average of 1.39 thousand USD of profit per 100 hectares of agricultural land, in 2017-2019, the intensity of this economic indicator amounted to 12.3 thousand USD, i.e., increased in 8.9 times, at the level of profitability – 36.1%. There was an increase in gross output per employee in the farm more than in 7.5 times (i.e., in 2009 it averaged 1.1 thousand USD, in 2019 – 8.2 thousand USD).

In order to determine the level of protection of the competitiveness of farms in one region of Ukraine, as part of the system of agricultural entrepreneurship, method of effective competition was used, based on weighted coefficients (formula (13) - (17), simulating the criteria and areas of protection (Lapusta and Sharshukova, 1998). The system synergy of functionality of subjects of small agrarian business is provided (Yastremskyi, 1992). (Eqs. 17-21):

$$C_{farm} = E_f + F_p + E_o + C_g \tag{17}$$

$$E_f = C + R_{as} + P_g + P_l \tag{18}$$

$$F_p = Ca + C_s + C_l + P_l \tag{19}$$

$$E_o = P_s + O_{fp} + C_{ut} + C_{ad} \tag{20}$$

$$C_g = O_{pq} + C_{ampr} + C_{ad} \tag{21}$$

where, C_{farm} – the criterion for protecting the competitiveness of the farm; E_f – criterion for protecting the efficiency of production activities of the farm;F_p– criterion for protection of the financial condition of the farm; E_o – criterion for protecting the effectiveness of the organization, the sale of goods on the market; C_g – criterion for protecting the competitiveness of products (goods); C– weighted cost per unit of output; R_{as} – weighted return on assets; P_g – weighted return on goods; P_l– weighted labor productivity ratio; C_a – weighted coefficient of autonomy of the enterprise; C_s – weighted solvency ratio of the enterprise; C_l– weighted liquidity ratio; T_{ca} – weighted turnover ratio of current assets; P_s – weighted coefficient of profitability of sales; O_{pq} – weighted product quality ratio; C_{ampr} – weighted ratio of the average market price and the sale price of the farm; C_{ad} – weighted efficiency ratio of advertising and sales promotion.

Table 2 The level of protection of the competitiveness of agricultural production of farms on average per region of Ukraine in 2018-2019

Factors-indicators	The size of the land area of farms, hectares				Farms together	Other agricultural enterprises	On the average on one region
	less than 50	51-100	101-500	more than 50			
Number of farms	35	6	9	5	55	23	2790
The collected area, thousand hectares	0.858	0.427	2.560	4.30	8.20	15.11	1231.0
The Income, thousand USD	180.6	29.0	364.2	303.7	877.5	8485.5	385738.6
Product profitability, %	59.9	-21.9	37.2	40.3	38.8	33.8	50.9
Number of employees, people	61	13	28	17	119	872	20200
Average salary, USD	305.2	333.4	399.5	456.8	337.5	246.7	217.9
Iec.p.	1.13	-0.41	0.7	0.76	0.73	0.66	2
Is.p.	1.4	1.5	1.8	2.1	1.5	1.13	2
Ie.p.	3.4	3.2	3.5	4.1	3.46	3.2	2.9
Ip.c.	5.93	4.32	6.03	6.96	5.74	4.99	6.9

The coefficients substantiating the criteria for protection of the level of competitiveness of farms are obtained: $C_{farm} = 0.14E_f + 0.31F_p + 0.25E_o + 0.3C_g$, $E_f = 0.29C + 0.21R_{as} + 0.39P_g + 0.11P_l, F_p = 0.28Ca + 0.24C_s + 0.33C_l + 0.15P_l$, $E_o = 0.37P_s + 0.29O_{fp} + 0.21C_{ut} + 0.13C_{ad}$, $C_g = 0.4O_{pq} + 0.3C_{ampr} + 0.3C_{ad}$. Thus, the results of calculating the level of protection of the competitiveness of farms on average per region of Ukraine convincingly show that it is quite high in farms of group IV, which exceeds the regional average (Table 2). Meanwhile, the level of protection of competitiveness is demonstrated by farms of the III group, where small agrarian business entities provide a sufficient level of wages to employees, adhere to environmental standards in production, organizational and economic processes.

The potential for increasing the level of protection of the competitiveness of farms for the vast majority of small businesses is related to improving the technical and technological support of the production process and the development of inter-farm relationships, as only one group of farmers exceeds the level of profitability. Grouping of farms by taxonomic indicator of the level of protection of competitiveness is presented in Table 3.

Table 3 The impact of the efficiency of farms in the Steppe zone of Ukraine on the level of their competitiveness for 2018-2019

Factors-indicators	Group of farms by level of competitiveness		
	I – low	II – average	III – high
Average rating by: level of competitiveness	25.0	15.0	5.0
coefficient of efficiency of production activity	22.0	16.0	6.0
coefficient of efficiency of management activity	25.0	14.0	5.0
coefficient of efficiency of sale	25.0	14.0	6.0
Employment, people / 1000 hectares	30.0	33.0	35.0
Gross output per 1 hectare, USD	246.1	454.2	919.1
Cost of $ 1 marketable products, USD	1.0	0.8	0.6
Labor productivity, thousand USD	8.1	13.8	26.6
Profit per 1 hectare, USD	-5.68	99.9	341.9
Profit per 1 average employee, USD	-187.8	3038.7	9878.8
Profitability of sales, %	-2.3	28.2	59.2
Profitability of activity, %	-2.3	22.0	37.2

Taking into account the zone of risky agriculture (Steppe zone of Ukraine), to assess the completeness of the use of competitive advantages of farms, multifactor risk is divided between seven-component coefficient, elasticity coefficient, weighting factor and weighted risk factor by types of agricultural products (Table 4). Thus, the most significant in the production and sale of cereals and legumes is the risk of reducing the share of sales, sunflower seeds – the risk of lower prices, milk – the risk of reducing milk yield from 1 cow, the risk of beef production is moderate. Using the methodological apparatus of the functional model "Protection of the competitiveness of the farm", cognitive modification was made of the basic factors of the macro- and micro-environment in the external and internal environment.

It is suggested to include to the factors of external impact: $BFzm1$ – demographic situation in the village; $BFzm2$ – the level of employment of the rural population; $BFzm3$ – ecological safety of the region; $BFzm4$ – state policy to promote the development of farms; $BFzm5$ – socio-economic development of the region; $BFzm6$ – development of inter-economic relations; $BFzm7$ – the level of infrastructure development. To the factors of the internal environment – $BFim8$ – scientific substantiation of activity; $BFim\ 9$ – qualification of employees; $BFim10$ – effective use of technical and technological means; $BFim11$ – use of land resources; $BFim12$ – interpersonal relations of members of the farm; $BFim13$ – interpersonal relations of members of the farm; $BFim14$ – interpersonal relations of members of the farm.

Table 4 Assessment of the multifactorial risk of competitiveness of farms in the Steppe zone within the types of products

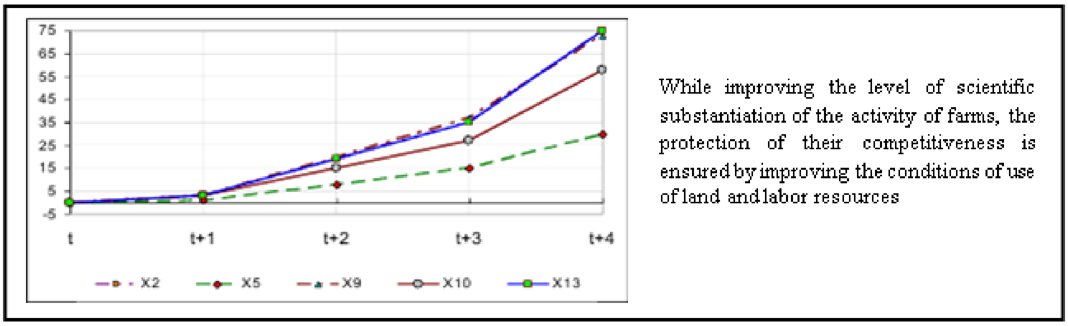
Type of risk	Seven-component coefficient, C_7	Coefficient of elasticity, $\|E\|$	Coefficient of weight, ω	Weighted coefficient of risk, R	Level of risk
Cereals and legumes					
Reduction of yield	0.16	154.8	0.08	0.01	low
Reduction of the price	0.14	40.5	0.02	0.00	low
Reduction of a share of realization	0.21	2006.0	1.00	0.21	high
Sunflower					
Reduction of yield	0.09	66.1	0.20	0.09	moderate
Reduction of the price	0.19	56.7	0.17	0.19	elevated
Reduction of a share of realization	0.04	331.0	1.00	0.04	low
Milk					
Reduction of yield	0.17	3.9	1.00	0.17	elevated
Reduction of the price	0.12	1.0	0.25	0.03	low
Reduction of a share of realization	0.18	1.3	0.34	0.06	moderate
Cattle meat					
Reduction of yield	0.07	4.9	1.00	0.07	moderate
Reduction of the price	0.59	0.6	0.11	0.07	moderate
Reduction of a share of realization	0.09	3.6	0.74	0.06	moderate

Source: developed and calculated by the authors.

An acceleration and deceleration matrix are used for all stimulating and decelerating interactions. In the inner part of the system, in the acceleration matrix, the most significant in terms of interaction are $BFzm6, BFim8, BFim9, BFim12, BFim13, BFim14$; by the deceleration matrix – $BFim10$, $BFim11$. Factors that strongly influence other factors within the system are $BFzm4$, $BFzm6$, $BFim10$, $BFim12$, $BFzm12$; the most influential are $BFzm2, BFzm5, Bzm7, BFim10, BFim11$. Factors that accelerate the system are ranked: $BFim9, BFim10, Bim11, BFzm6, BFim14$, $BFim8, BFzm5$, $Bzm2$, with the most active factors – $BFim12$, $BFzm4$, $Bim8$, $BFim13$, $BFzm6$, $BFim14$, $BFim9$, $Bim3$, $BFzm1$; factors that restrain the system $Bim11, BFim10, BFzm2, BFim14, BFim9$, while the maximum activity is demonstrated by $Bim12, BFim14, BFim11, BFzm1$. Factors are divided into: target – $Bzm2, BFzm5, BFim9, BFim10, BFim13$; leverage factors – $Bzm4, BFzm6, BFim8, BFim11, BFim14$; factors-indicators – $Bzm1, BFzm3, BFzm7, BFim12$.

The results of cognitive modeling confirm the ability of farms to survive independently, in the absence of state support under the conditions of the appropriate level of labor use. At the same time, in the absence of an appropriate level of technical and technological support, as well as in the unsatisfactory nature of the use of labor (own or involved), the protection of the competitiveness of the farm becomes weak and critical. Given the interaction scenarios 15, 16, 17, which demonstrate the best results of protecting the competitiveness of small businesses, through scientifically sound measures aimed at the effective use of the resource base (especially labor resources), important components in this process are creation of inter-economic associations of cooperative-corporate types, as well as the presence of a favorable state policy (Figs. 6-8). Thus, according to scenario 15, under which the momentum of interaction is carried out in three vertices $BFim8 = 1, BFim11 = 1, BFim14 = 1$ (Fig. 6), there is a stable state of the system of protection of the competitiveness of the farm in the region (Yastremskyi, 1992). At the same time, there is an increase in all weighted coefficients, which are the parameters of protection for a set of macro- and micro-environment of multifactorial risk (Kiseleva, 2007).

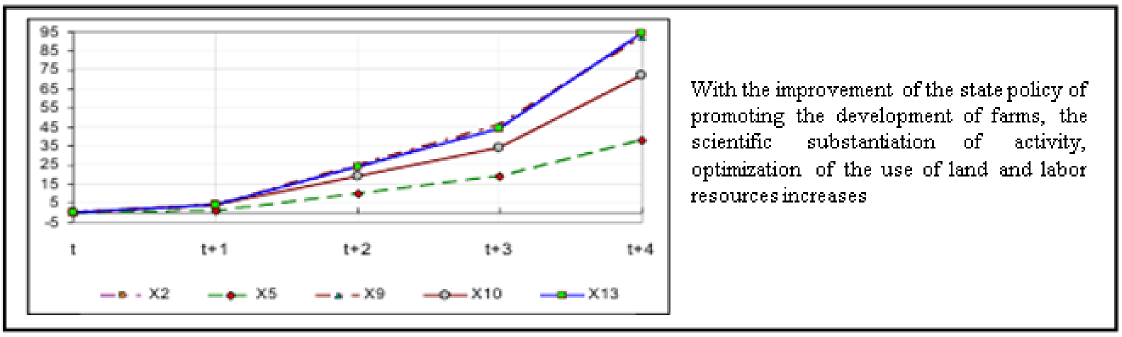
Figure 6 The results of cognitive modeling of the behavior of the protection system of the competitiveness of farms in the region (scenario 15: Impulse comes to 3 vertices $BFim8 = 1, BFim11 = 1, BFim14 = 1$)



Source: developed and calculated by the authors.

This proves that the implementation of their own economic activities on scientifically sound principles, allows to increase the use of available resource potential. The farmers are able to ensure the competitive operation of their own business units, which, in turn, has a positive impact on overall welfare and socio-economic development of rural areas in the region. According to scenario 16, under which the momentum of interaction is carried out in four vertices $BFzm4 = 1, BFim8 = 1, BFim14 = 1$ (Fig. 7), the state of the competitiveness protection system is stable, there is a significant increase in all weighted coefficients for a combination of macro-and micro-environment risk factors.

Figure 7 The results of cognitive modeling of the behavior of the protection system of the competitiveness of farms in the region (scenario 16: Impulse comes in 4 vertices $BFzm4 = 1, BFim8 = 1, BFim14 = 1$)

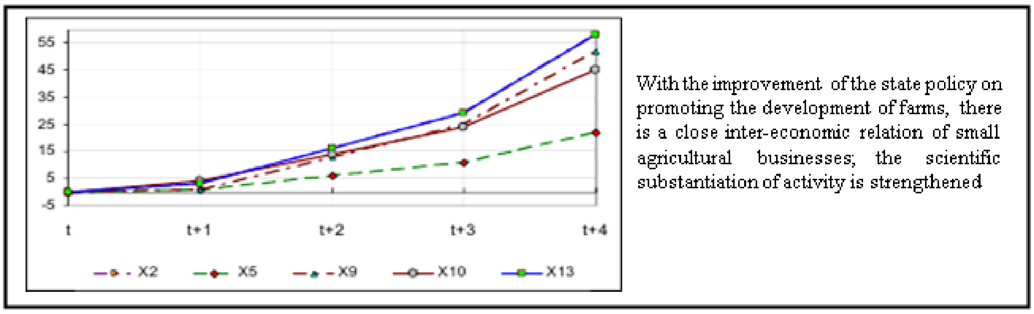


Source: developed and calculated by the authors.

Taking into account the support of farms by the state and the use of modern technical and technological innovations, the available resource potential is optimized, which is able to provide competitive advantages of an individual entrepreneurial unit, while avoiding active cooperation with other agricultural entrepreneurs. State support (regulatory, organizational, etc.) can replace participation in cooperatives. According to scenario 17, under which the momentum of interaction is carried out in three vertices $BFzm4 = 1, BFzm6 = 1, BFim8 = 1$ (Fig. 8), there is a stable state of development of the competitiveness protection system and growth of all weighted coefficients by a combination of macro- and micro-environment risk factors.

Under the conditions of state support for the development of the system of protection of competitiveness of farms, organizational and institutional support of their economic activity is created, which stimulates small business farmers to conduct production and economic activities on a scientifically sound basis in the long run. It should be noted that active inter-farm cooperation is a prerequisite for the successful implementation of this scenario.

Figure 8 The results of cognitive modeling of the behavior of the protection system of the competitiveness of farms in the region (scenario 17: Impulse comes to 3 vertices $BFzm4 = 1, BFzm6 = 1, BFim8 = 1$)



Source: developed and calculated by the authors.

4. Conclusions

Ensuring the protection of the competitiveness of farms includes both purely economic and social aspects, as this segment of agricultural entrepreneurship also performs a village-preserving function. In this case, the production of competitive products is an integral part of ensuring the protection of competitiveness and efficient operation of farms in modern conditions, and one of the indicators of competitiveness is the level of marketability, which reflects the degree of conformity of product properties to market needs. At the same time, the protection of the competitiveness of farming as a component of the system of agricultural production necessitates the assessment not only of the dynamics of the relevant indicators of economic activity, but also requires the study of the general context, the study of causation. In particular, the dynamics of gross agricultural output produced by farms of Ukraine indicates the presence of two parallel trends, each of which is ambiguous, namely: the growth of production in the transformation of its structure and reducing the number of representatives of this segment of agricultural entrepreneurship, both trends are clear. Thus, analyzing the directions of modeling the system of protection of competitiveness of farms and the results of their economic activity, it should be noted that the only clearly formulated state initiative for this segment of agricultural production can be considered only organizational and legal measures to stimulate and secure a certain group of small entities of agrarian business of formal status - family farms. In the long run, this economic status is able to provide appropriate conditions for the development of competitiveness in the regions of Ukraine and the transformation of the agricultural sector into an attractive investment sector of the economy, focused on rapid returns. This will help stimulate the active share of the population to self-realization in small agricultural business and slow down the process of depopulation of rural areas.

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