

MANAGEMENT OF DETERMINANTS OF PRODUCTION COSTS IN THE AGRICULTURAL SECTOR: A CASE STUDY OF UKRAINE

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Abstract

The purpose of the study is to model and quantify the impact of basic factors on the amount of production costs in the agricultural sector of Ukraine., as well as to substantiate directions for improving cost management efficiency based on correlation and regression analysis. The article examines the factors shaping the cost structure of agricultural enterprises using forecasting modelling. It is substantiated that the dynamics of production costs are formed under the influence of interrelated labour and production-resource factors, among which the key ones are the volume of agricultural output, average wages, employment level, and the efficiency of fixed assets utilization. It is established that the most significant positive impact on the dynamics of costs in the agricultural sector of Ukraine is exerted by production volume and average wages, whereas the return on assets produces a restraining compensatory effect. Based on the estimated model, a forecast of costs up to 2030 is carried out, which indicates the preservation of an upward growth trajectory under an inertial scenario of agricultural sector development.

Key words: cost management, cost determinants, agricultural sector, production cost, economic efficiency, production processes, correlation and regression modelling

INTRODUCTION

Under the conditions of structural changes in the economic sphere and the strengthening of internal asymmetries in the activities of the agricultural sector of Ukraine, the issue of effective regulation of production costs, which are a key determinant of financial results and competitiveness of agricultural enterprises, is gaining increased scientific and practical significance. Instability in the structure of resource provision, rising prices of material components of production, as well as asymmetry between the rates of change in costs and performance indicators generate systemic risks that lead to a decline in the economic efficiency of agricultural activity. Under such conditions, traditional approaches

to accounting and analytical support for cost management prove to be insufficient for the adequate identification of the factors shaping costs and for substantiating managerial decisions. A particular complexity in this regard is associated with the multifactorial nature of costs, which is inherent in agriculture. In turn, this is determined by a complex combination of technological, organizational-production, and institutional parameters that are in constant dynamic interaction. Consequently, the absence of an integral methodological framework oriented towards the systemic management of cost determinants limits the possibilities for forming adaptive models of cost optimization

and increasing the profitability of agricultural production.

In this aspect, the problem lies not only in the quantitative reduction of costs but also in the necessity to form an economically justified mechanism for their structural transformation. Moreover, such a transformation should be carried out with due regard to the specifics of production cycles and resource constraints of agricultural enterprises, which requires in-depth scientific analysis and methodological reconsideration of existing management approaches.

In contemporary scientific research, the issue of cost management in agricultural production is considered through the prism of cost formation, optimization of resource provision, and enhancement of business performance. At the same time, priority attention is focused on identifying determinants that determine the structure of costs, analyzing their impact on financial performance indicators, and creating an appropriate methodological toolkit for controlling. The issue of regulating the cost component in the agricultural sector has been reflected in scientific research, in particular in the works of N. Antoniuk [1], I. Arakelova [2], L. Cherchyk [3], M. Dziamulych [4-13], N. Khomiuk [14], M. Khvesik [15], V. Kostiuk [16], I. Mazniev [17], A. Popescu [18-27], M. Rudenko [28-29], V. Sarioglu [30], O. Shubalyi [31-35], A. Verzun [37].

At the same time, there remains a need for a comprehensive analysis of the systemic interaction of factors influencing the costs of agricultural enterprises, which determines the necessity of developing integrated models for managing cost determinants.

In this context, this article aimed to set up an economic and statistical model for assessing the effect of key determinants on production costs in Ukraine's agriculture and also to substantiate directions for increasing cost management efficiency based on correlation and regression analysis.

MATERIALS AND METHODS

As mentioned above, to quantitatively assess the impact of determinants on the level of production costs in the agriculture of Ukraine. The data have been taken from State Statistics Service of Ukraine [36] and also from [35].

The study applied methods of correlation and regression analysis, which allow to identify the direction and strength of relationships between the dependent and independent variables. At the same time, a multifactor linear regression model of the following form was used as the basic analytical framework:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon,$$

where:

y – denotes production costs of agricultural enterprises;

x_1 – number of employed persons in agriculture;

x_2 – average monthly wage;

x_3 – volume of agricultural output;

x_4 – return on fixed assets;

β_i – model parameters;

ε – random error term.

The estimation of model parameters was carried out using the least squares method, which involves minimizing the sum of squared residuals:

$$\sum_{i=1}^n (y_i - \hat{y}_i)^2 \rightarrow \min$$

The quality of model approximation was evaluated using the coefficient of determination:

$$R^2 = 1 - \frac{\sum (y_i - \hat{y}_i)^2}{\sum (y_i - \bar{y})^2}$$

In addition, the statistical significance of individual parameters was tested using the Fisher F-test and the Student t-test.

To detect multicollinearity among the independent variables, the Pearson pairwise correlation matrix was employed.

Forecasting of production costs up to 2030 was carried out on the basis of the estimated regression equation by extrapolating the trends of the explanatory variables and substituting their forecast values into the model.

RESULTS AND DISCUSSIONS

The need for targeted regulation of factors that shape production costs in the agricultural sector is due to their key role in ensuring financial stability, strengthening competitive positions, and maintaining the strategic efficiency of the functioning of agricultural enterprises. In particular, it should be noted that the high level of resource intensity of production processes in agriculture creates increased sensitivity of production costs to changes in prices of material, energy, and labour resources, which requires a systemic approach to identifying the key factors shaping

costs. Managing cost determinants makes it possible to minimize their absolute level and to ensure a rational cost structure that is consistent with the technological parameters of production and the strategic development objectives of enterprises. In this context, management acts as a tool for enhancing resource efficiency and for forming an adaptive model of economic behaviour of agricultural economic entities. To analyze the composition of costs in the agricultural sector of Ukraine, we will refer to the materials presented in Figure 1.

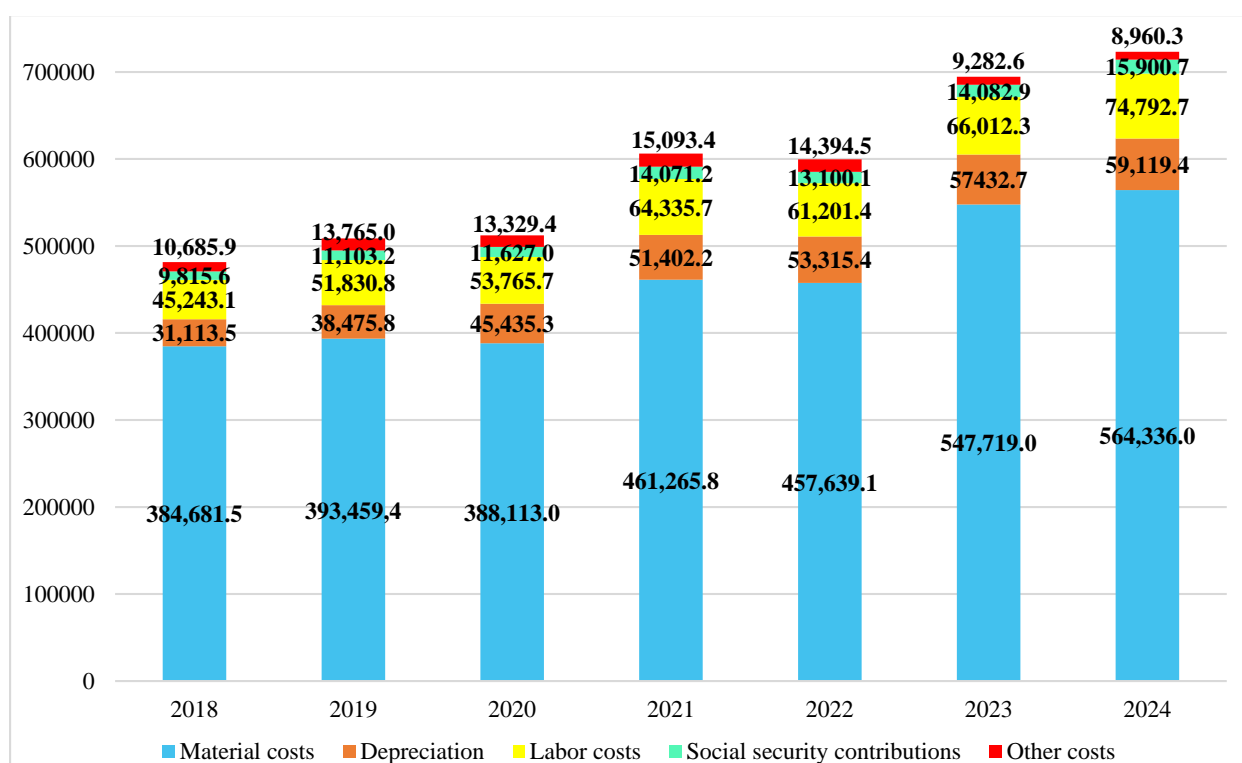


Fig. 1. Dynamics of the structure of production costs in the agricultural sector of Ukraine in 2018–2024, million UAH
 Source: compiled by the authors based on [36].

The analysis of the cost structure indicates the dominance of material costs, the volume of which increased from approximately UAH 385 billion in 2018 to more than UAH 564 billion in 2024. Such dynamics reflect an increase in the resource intensity of production and a rise in the cost of material and technical components. Depreciation charges also show a steady upward trend, from UAH 31 billion to almost UAH 59 billion, which indicates growing capital intensity and the renewal of fixed assets. It should also be noted that labour costs increased from UAH 45 billion to nearly

UAH 75 billion, which is a consequence of labour shortages and rising labour costs. Social contributions during the analyzed period grew more moderately, maintaining a proportional dependence on the wage fund. At the same time, fluctuations in other cost components are characterized by the absence of a stable trend, which may indicate the unsystematic nature of decision-making regarding the regulation of indirect costs. In general, the configuration of the cost structure indicates an increase in the importance of material and resource and investment components in the formation of the

cost of production, which increases the dependence of agricultural production on the parameters of resource supply and actualizes the need for comprehensive improvement of cost management mechanisms.

If we speak about the key determinants of production costs in agriculture, then, in our opinion, they should include the number of employed persons and the average level of wages of hired workers. This is determined by the fact that these elements form the basic component of the structure of variable and semi-fixed costs that are directly related to ensuring the functioning of the production process. At the same time, employment indicators reflect the scale of labor potential

utilization, which is directly related to the volume of production activity and the amount of organizational costs. The level of average wages, in turn, characterizes the monetary expression of the cost of labor and determines the change in the personnel compensation fund, which is one of the most sensitive elements in the cost structure. Accordingly, it can be argued that their interaction forms not only the quantitative but also the qualitative dimension of costs, since changes in wages directly affect productivity and the efficiency of human capital utilisation in agricultural production. Therefore, let us assess the dynamics of changes in these indicators over the past few years (Figure 2).

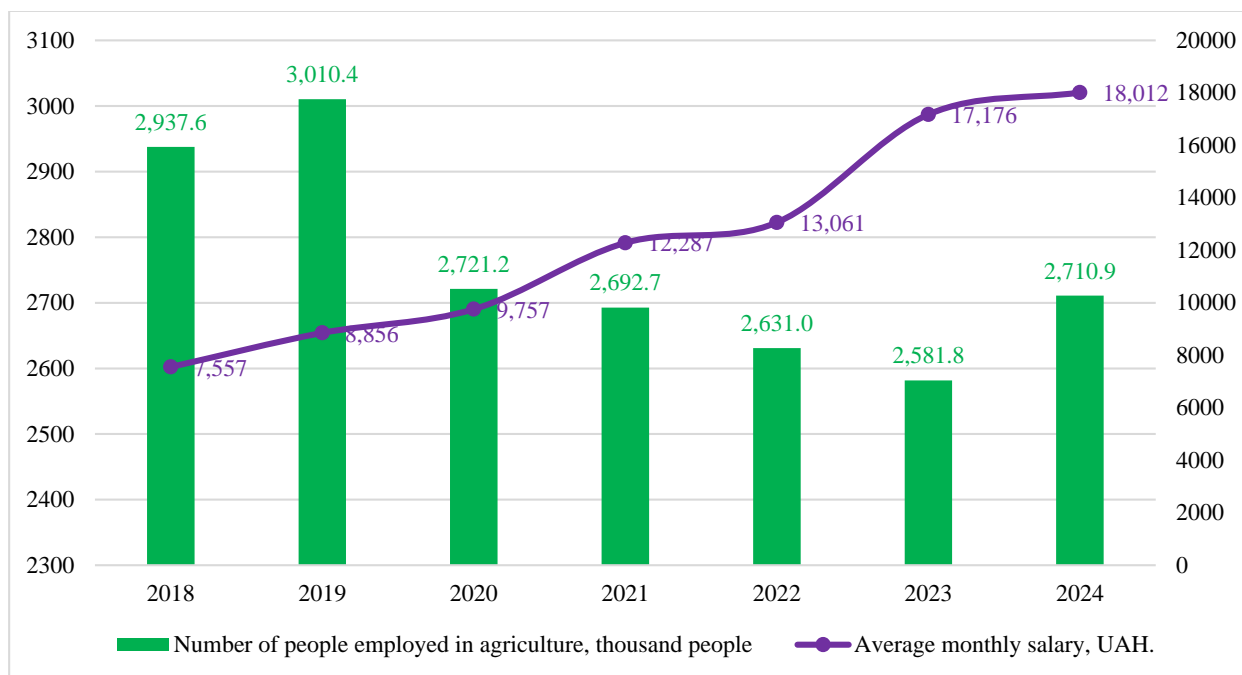


Fig. 2. Dynamics of the number of employed persons and the average level of wages in the agricultural sector of Ukraine for 2018-2024.

Source: compiled by the authors based on [36].

The results of the analysis indicate the presence of a stable divergent trajectory between employment indicators and the level of labor remuneration in the agricultural sector of Ukraine during 2018–2024. In particular, during this period the number of employed persons decreased from 2,937.6 thousand in 2018 to 2,581.8 thousand in 2023, which corresponds to a decline of 12.1%, with a slight recovery in 2024 to 2,710.9 thousand. At the same time, the average wage increased from UAH 7,557 in 2018 to UAH 18,012 in 2024,

that is, by 2.38 times. Such asymmetry indicates the compensatory nature of the growth in labour costs under conditions of shrinking labour resources. From this, it can be concluded that labour shortages increase the cost of the labour factor, which is reflected in the expansion of the personnel payroll and the increasing importance of the labor component in the formation of the cost of agricultural products.

Also, in our opinion, it is advisable to take into account such factors of cost dynamics as the

scale of production and the efficiency of the use of fixed capital, since they directly determine the configuration and level of costs of agricultural business entities and set the economic prerequisites for redistribution between constant and variable cost elements. In particular, the expansion of production volumes, other things being equal, forms the manifestation of the scale effect, which leads to a reduction in the share of fixed costs per unit of output and contributes to the growth of aggregate cost efficiency. The return on assets indicator, in turn, characterizes the degree of intensity of the use of production capital and

determines the level of capital intensity of the technological process. At the same time, it should be taken into account that in the agricultural sector, insufficient return on fixed assets provokes a disproportionate increase in depreciation and operating expenses. Conversely, its increase makes it possible to minimise losses from underutilisation of production capacities and to optimise the cost structure in the long run, which is especially important for agricultural production. Therefore, let us assess the changes in these indicators over the analysed period (Figure 3).

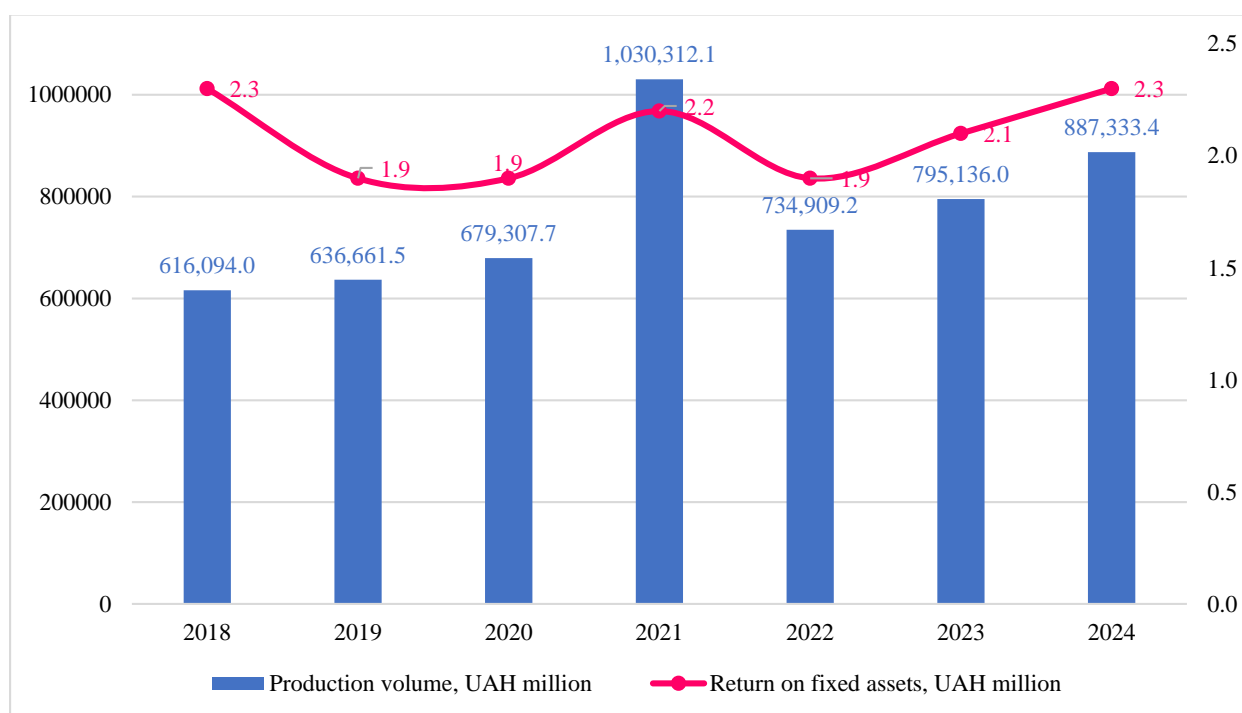


Fig. 3. Dynamics of production volume and return on assets of agricultural enterprises in Ukraine for 2018-2024. Source: compiled by the authors based on [35].

The analysis shows that during the analyzed period, there was an uneven change in the indicators of production volume and return on assets of enterprises in the agricultural sector of Ukraine. In particular, production volume grew moderately during 2018–2020, after which in 2021 there was a sharp increase to UAH 1,030,312.1 million. At the same time, during the specified time interval, the return on capital decreased from UAH 2.3 to 1.9 million, which indicates a faster increase in the cost of fixed capital compared to the efficiency of its involvement in the production process. The subsequent decline in production volume in 2022 was accompanied by the persistence of a

low level of asset turnover (1.9), which in turn, led to an increase in the share of depreciation and maintenance costs for fixed assets in the cost structure of agricultural enterprises. At the same time, the revival of production activities and improvement in capital return indicators in 2023–2024 reflect an increase in the intensity of capital utilization and a reduction in inefficiency in the area of costs.

In general, one can state a structural transformation of the cost formation model of Ukraine's agricultural sector, which manifests itself in the simultaneous reduction of labour potential, rising labour costs, and unstable efficiency of fixed asset utilization. The

divergence between employment dynamics and wage growth creates increasing pressure on production costs through higher specific labour costs, while fluctuations in production volume and return on fixed assets lead to variable capital intensity of production processes. Taken together, this indicates the strengthening role of factor-based cost management as a key condition for ensuring the economic balance of agricultural enterprises. In order to comprehensively

determine the impact of individual factors on the value of production costs in the agricultural sector of Ukraine, using the tools of the MS Excel analytical package, we will conduct a correlation-regression study aimed at identifying and quantitatively interpreting the relevant relationships. The variables include the cost formation factors discussed above, which characterise the labour and production-resource parameters of agricultural enterprises' activity (Table 1).

Table 1. Dynamics of analytical indicators for constructing a correlation and regression model of the impact of factors on production costs in the agricultural sector of Ukraine for 2010–2024

Year	Production costs of agricultural enterprises, million UAH (y)	Number of employed persons in agriculture, thousand persons (x ₁)	Average monthly wage in the agricultural sector, thousand UAH (x ₂)	Volume of agricultural output, million UAH (x ₃)	Return on fixed assets of agricultural enterprises, million UAH (x ₄)
2010	121,219.2	3,094.5	1.47	189,405.0	2.2
2011	172,426.9	3,393.8	1.85	253,569.0	2.3
2012	134,317.9	3,496.0	2.09	258,270.1	2.3
2013	157,670.9	3,577.5	2.34	196,385.2	1.9
2014	189,915.6	3,091.4	2.56	286,905.6	2.5
2015	274,981.5	2,870.6	3.31	416,620.0	3.5
2016	326,544.6	2,866.5	4.20	474,884.1	2.8
2017	388,918.6	2,860.7	6.06	524,120.7	2.5
2018	481,539.6	2,937.6	7.56	616,094.0	2.3
2019	508,633.7	3,010.4	8.86	636,661.5	1.9
2020	512,270.3	2,721.2	9.76	679,307.7	1.9
2021	606,168.2	2,692.7	12.29	1,030,312.1	2.2
2022	599,650.5	2,631.0	13.06	734,909.2	1.9
2023	694,529.2	2,581.8	14.63	795,136.0	2.1
2024	723,109.0	2,710.9	18.01	887,333.4	2.3

Source: [36].

The correlation and regression model equation obtained as a result of the conducted analysis reflects the dependence of production costs of agricultural enterprises in Ukraine on a set of labour and production-resource determinants and has the following form:

$$y = -18,2547.3 + 48.2x_1 + 21,365.7x_2 + 0.54x_3 - 32,418.5x_4$$

From the presented equation it can be seen that the coefficient for the variable “number of employed persons” (48.2) indicates that an increase in the number of employees by 1 thousand persons is, on average, accompanied by an increase in production costs by UAH 48.2 million, which reflects a direct scale effect of labour resource expansion on the overall level of costs. The parameter estimate for the “average wage” factor (21,365.7) indicates that an increase in the average monthly wage by UAH 1,000 is associated with an increase in total production costs by approximately UAH

21.4 billion, which confirms the leading role of labor payments as a cost driver in the formation of the cost of agricultural products. The most significant impact on costs is exerted by the variable “production volume”, the coefficient of which equals 0.54, meaning that production costs increase on average by UAH 0.54 million when production volume increases by UAH 1 million, which reflects the technological dependence of costs on output dynamics. At the same time, the coefficient for the indicator of return on fixed assets has a negative value (–32,418.5), which indicates a decrease in production costs on average by UAH 32.4 billion when the return on fixed assets increases by one unit. This confirms the compensatory effect of improving the efficiency of fixed asset utilization and its role in restraining the accumulation of costs of agricultural enterprises.

Summarizing the results of the correlation and regression analysis, it can be concluded that the constructed model adequately reflects the

economic nature of production cost formation in the agricultural sector of Ukraine and is characterized by high explanatory power. The dominant influence on the level of costs is exerted by production volume and average wages, which confirms the decisive role of the scale of activity and the cost of labour resources in the cost model of agricultural enterprises. At the same time, the negative effect of return on fixed assets indicates the restraining effect of increasing capital efficiency, which creates potential for optimizing production costs without reducing production performance.

Table 2 presents the main parameters of the developed regression model that describes the impact of explanatory variables on production costs of agricultural enterprises in Ukraine.

Table 2. Coefficient characteristics of the regression-correlation model of the influence of explanatory variables on the level of production costs of entities in the agricultural sector of Ukraine

Indicator	Coefficient (B)	Standard error	t-statistic	p-value
Production costs of agricultural enterprises (y)	-182,547.3	74,120.5	-2.46	0.029
Number of employed persons in agriculture (x ₁)	48.2	20.0	2.41	0.033
Average monthly wage in the agricultural sector (x ₂)	21,365.7	3,457.8	6.18	<0.001
Volume of agricultural output (x ₃)	0.54	0.056	9.72	<0.001
Return on fixed assets of agricultural enterprises (x ₄)	-32,418.5	15,650.2	-2.07	0.048

Source: own research.

The main parameters of the developed correlation and regression model indicate the following.

- the coefficient of determination $R^2 = 0.96$ points to a very high level of explanatory power of the model, since about 96% of the variation in production costs is explained by the combined influence of the included determinants. This confirms the adequacy of the formed system of factors for analyzing the cost behaviour of agricultural enterprises;
- the adjusted coefficient of determination $Adj. R^2 = 0.94$ practically does not differ from the

basic R^2 , which indicates the absence of redundant variables and high stability of the estimates taking into account the sample size and the number of factors;

- the value of the Fisher F-statistic $F = 56.8$ at the significance level $p < 0.001$ confirms the overall statistical significance of the model and allows rejection of the null hypothesis about the absence of a relationship between costs and explanatory variables, which testifies to the econometric reliability of the constructed model;

- the analysis of Student's t-statistics shows that statistically significant factors are production volume and average wages, for which the p-values are less than 0.05. The number of employed persons and return on fixed assets also have a significant effect, but of lower magnitude, which reflects the dominance of scale and value-based determinants in the formation of costs of agricultural enterprises.

In addition, let us evaluate the correlation matrix (Table 3).

Table 3. Pearson pairwise correlation matrix

Indicators	Production costs of agricultural enterprises (y)	Number of employed persons in agriculture (x ₁)	Amount of wages in the agricultural sector (x ₂)	Volume of production of agricultural enterprises (x ₃)	The return on assets of agricultural enterprises (x ₄)
Agricultural production costs (y)	1.00	0.62	0.94	0.97	-0.41
Agricultural employment (x ₁)	X	1.00	0.58	0.55	-0.12
Amount of wages in the agricultural sector (x ₂)	X	X	1.00	0.91	-0.36
Volume of agricultural output (x ₃)	X	X	X	1.00	-0.29
Return on fixed assets of agricultural enterprises (x ₄)	X	X	X	X	1.00

Source: own research.

The analysis of the correlation matrix indicates the presence of strong positive relationships between production costs of agricultural enterprises and most explanatory variables. In particular, the highest correlation coefficient is observed between costs and production volume ($r = 0.97$), which confirms the decisive role of

the scale of economic activity in the formation of production costs. A high level of correlation is also found between costs and average wages ($r = 0.94$), which indicates a significant influence of the cost of labour resources on cost dynamics. A moderate positive relationship between costs and the number of employed persons ($r = 0.62$) reflects the scale effect of labour involvement. At the same time, a negative correlation is recorded between costs and return on fixed assets ($r = -0.41$), which points to the compensatory nature of improving the efficiency of fixed asset

utilisation. In addition, it should be noted that strong interrelationships are observed among some explanatory variables, in particular between production volume and wages ($r = 0.91$), which indicates the presence of multicollinearity and explains the reduced statistical autonomy of certain coefficients in the regression model.

Additionally, using the constructed correlation-regression relationship, we will forecast trends in changes in production costs in the agricultural sector of Ukraine for the following time horizons. (Figure 4).

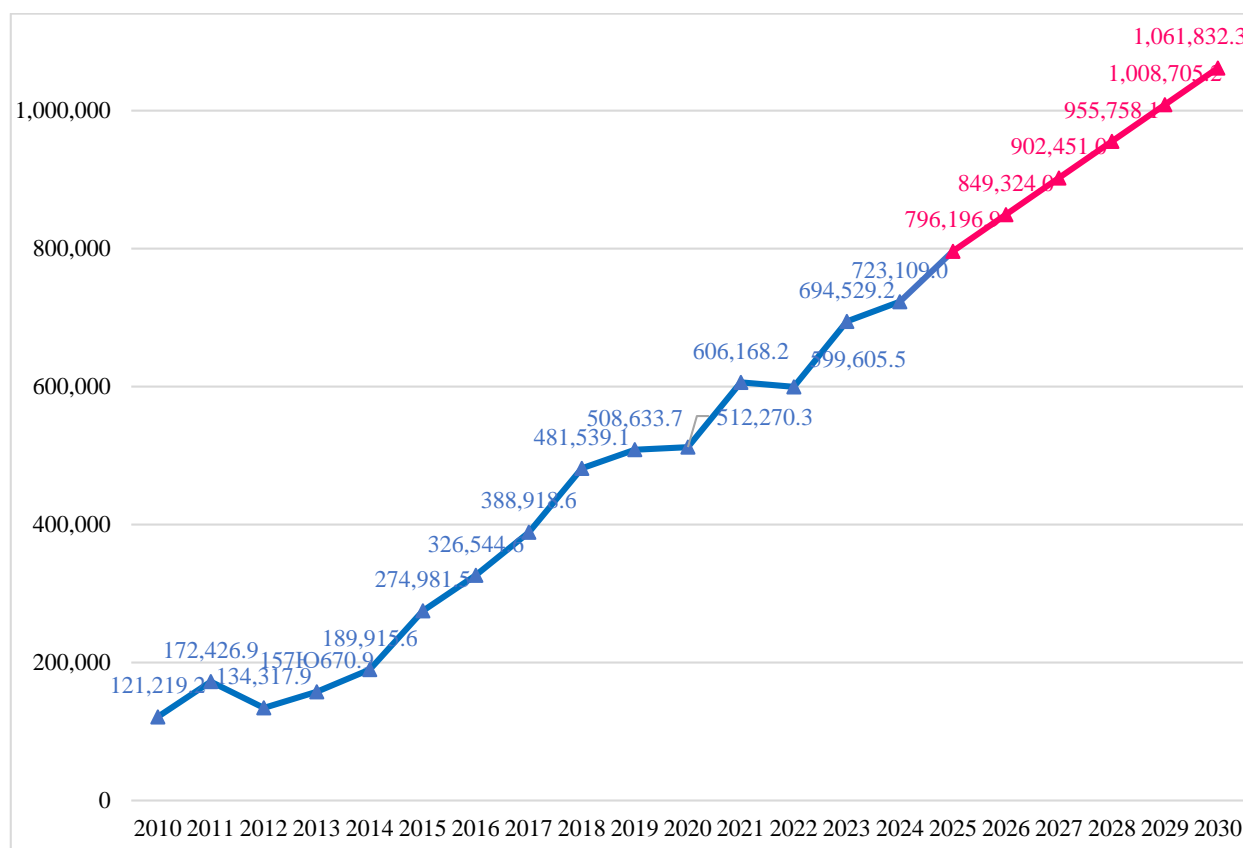


Fig. 4. Forecast of changes in production costs in the agricultural sector of Ukraine until 2030, million UAH. Source: own calculations.

The results of the obtained estimates give grounds to state the preservation of a stable vector of growth of production costs in the agricultural sector of Ukraine in the medium-term time interval. The forecast construction is built on the basis of correlation-regression dependence, demonstrates a gradual increase in total costs without sharp structural breaks, which indicates the inertial nature of cost dynamics provided that the current parameters of the factor environment are maintained. In

particular, the forecast values increase from approximately UAH 796 billion in 2025 to more than UAH 1.06 trillion in 2030, which implies an increase of almost one third over the forecast period. It is expected that the main contribution to this growth will be ensured by the expansion of production volumes and the further increase in the cost of labour resources, which reflects the dominance of scale and value-based determinants in the cost model. At the same time, it is advisable to take into

account the restrictive effect of the return on capital indicator, which manifests itself in preventing a rapid increase in costs, indicating partial compensation through improved efficiency of fixed asset utilization. Overall, the forecast illustrates that by 2030 cost growth will have an evolutionary character, and their further optimization will require structural changes in resource provision and management of production processes in the agricultural sector.

CONCLUSIONS

The obtained results of the study made it possible to form a generalized analytical idea of the mechanisms for regulating production cost factors in the agricultural sector of Ukraine through integrated consideration of labor and resource-production parameters. The analysis shows that the dynamics of costs is not a consequence of the action of individual isolated influences, but arises as a result of their interconnected functioning within a single economic mechanism. At the same time, it was established that the scale of agricultural output and the level of average wages play a decisive role in the formation of the level of costs, which indicates the predominance of scale-price factors in the cost structure and emphasizes the key importance of both production volumes and labor costs. At the same time, the number of employed persons acts as a factor of a scale nature, the influence of which is manifested through the expansion of organizational and production costs. The negative impact of return on fixed assets indicates the compensatory effect of increasing the efficiency of fixed asset utilization, which creates potential for restraining costs without reducing production performance.

Thus, it is appropriate to state that the rationalization of production cost policy in the agricultural sector involves the use of a comprehensive approach aimed not so much at their formal reduction, but at increasing the effectiveness of transforming the resources involved into the final economic results of the activities of business entities. This determines the need for a coordinated combination of

personnel, production, and financial policies of agricultural enterprises within a unified cost management strategy. The implementation of such an approach will make it possible to ensure long-term economic balance and functional sustainability of the development of Ukraine's agricultural sector.

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