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FORECASTING THE LEVEL OF INVESTMENT ENSURE OF AGRICULTURAL DEVELOPMENT

Abstract. Assessment of the formation of the level of investment ensure and its impact on the indicators of agricultural development requires the use of mathematical methods of parametric forecasting. The methodological approaches have been substantiated and methodical approach to forecasting the level of investment ensuring of agricultural development has been developed in the paper. Investment ensure for agriculture has been proposed to be considered simultaneously as a result of the influence of internal and external factors, as well as a factor affecting the parameters of the industry's development. The use of gross value added in agriculture as an indicator of the efficiency of investment ensuring and the parameter of agricultural development has been substantiated. The methodical approach to the analysis of investment ensure based on time factor has been improved. Multi-factor econometric model has been developed for assessing the influence of factors (profitability level, volume of lending, state support, foreign direct investment) on the level of investment ensure for agriculture. Indicators of investment ensure of agricultural development have been forecast on the basis of econometric model using data extrapolation method by linear, logarithmic, polynomial and exponential mathematical functions for each factor. An econometric model for assessing the impact of the level of investment ensure on gross value added in agriculture has been developed and used to predict the level of agricultural development. The projected values of investment and gross value added in agriculture in Ukraine have been calculated in an optimistic, realistic and pessimistic scenario. The need to increase the efficiency of agricultural producers, the volume of lending and state support to achieve the appropriate parameters of investment ensure for agricultural development has been substantiated.

Keywords: investment, investment ensure, development, gross value added, forecasting, econometric model, agriculture.

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ПРОГНОЗУВАННЯ РІВНЯ ІНВЕСТИЦІЙНОГО ЗАБЕЗПЕЧЕННЯ РОЗВИТКУ СІЛЬСЬКОГО ГОСПОДАРСТВА

Анотація. Оцінка формування рівня інвестиційного забезпечення і його впливу на показники розвитку сільського господарства потребує використання математичних методів параметричного прогнозування. Обґрунтовано методологічні засади і розроблено методичний підхід до прогнозування рівня інвестиційного забезпечення розвитку сільського господарства. Запропоновано інвестиційне забезпечення сільського господарства розглядати одночасно як результат впливу внутрішніх і зовнішніх факторів та як фактор, що впливає на параметри розвитку галузі. Обґрунтовано, що показником ефективності інвестиційного забезпечення і параметра розвитку сільського господарства доцільно використовувати валову додану вартість у сільському господарстві. Удосконалено методичний підхід до аналізу інвестиційного забезпечення на основі урахування фактору часу. Розроблено багатофакторну економетричну модель для оцінки впливу факторів (рівня рентабельності, обсягів кредитування, державної підтримки, прямих іноземних інвестицій) на рівень інвестиційного забезпечення сільського господарства. Спрогнозовано показники інвестиційного забезпечення розвитку сільського господарства на основі економетричної моделі з використанням методу екстраполяції даних за лінійною, логарифмічною, поліноміальною та степеневою математичними функціями для кожного фактору. На основі розробленої економетричної моделі оцінки впливу рівня інвестиційного забезпечення на валову додану вартість у сільському господарстві розраховано прогнозні значення інвестицій та валової доданої вартості в сільському господарстві України за оптимістичним, реалістичним і песимістичним сценаріями. Обґрунтовано потребу підвищення ефективності діяльності виробників, нарощування обсягів кредитування та державної підтримки для досягнення відповідних параметрів інвестиційного забезпечення розвитку сільського господарства.

Ключові слова: інвестиції, інвестиційне забезпечення, розвиток, валова додана вартість, прогнозування, економетрична модель, сільське господарство.

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ПРОГНОЗИРОВАНИЕ УРОВНЯ ИНВЕСТИЦИОННОГО ОБЕСПЕЧЕНИЯ РАЗВИТИЯ СЕЛЬСКОГО ХОЗЯЙСТВА

Аннотация. Обоснованы методологические основы и разработан методический подход к прогнозированию уровня инвестиционного обеспечения развития сельского хозяйства. Обосновано в качестве показателя эффективности инвестиционного обеспечения и параметра развития сельского хозяйства использовать валовую добавленную стоимость в сельском хозяйстве. На основе разработанной многофакторной эконометрической модели для оценки влияния факторов (уровня — рентабельности, объемов кредитования, государственной поддержки, прямых иностранных инвестиций) на уровень инвестиционного обеспечения сельского хозяйства спрогнозированы показатели инвестиционного обеспечения развития сельского хозяйства с использованием метода экстраполяции данных. Разработана эконометрическая модель оценки влияния уровня инвестиционного обеспечения на валовую добавленную стоимость в сельском хозяйстве и использована для прогнозирования уровня развития сельского хозяйства.

Ключевые слова: инвестиции, инвестиционное обеспечение, развитие, валовая добавленная стоимость, прогнозирование, эконометрическая модель, сельское хозяйство.

Формул: 3; рис.: 1; табл: 4; библи.: 12.

Introduction. There is a thesis in scientific literature that investment ensure of agriculture is an important prerequisite for the efficient functioning of the industry. The amount and directions of investment largely determine the technological level of production; provide conditions for economic, social and environmental efficiency in the agricultural sector. In this, investment ensure should be considered as a tool for the achievement of agricultural development. The determination of trends and prospects for agricultural development should be based on a scientifically grounded level of investment ensure. Assessment of the formation of the level of investment ensure and its impact on the indicators of agricultural development requires the use of mathematical methods of parametric forecasting.

Analysis of research and problem statement. The conceptual foundations of the assessment and tendencies in the formation of investment ensure for agriculture have been studied by domestic and foreign scientists. In particular, Y. Lupenko, A. Gutorov, O. Gutorov carried out a comprehensive scientifically grounded monitoring of investment ensure for the development of

integration relations in the agricultural sector of Ukrainian economy [1]. Yu. Lupenko, O. Zakharchuk substantiated the need to increase the rate of innovation and investment development for the provision of material and technical base of agriculture in the country [2], calculated three options of investment ensure and identified the need for investments by 2025 based on the value of fixed assets in agriculture [3]. M. Kisil studied the strategic directions of investment for the development of agriculture [4]. At the same time, the issues of the forecast assessment of investment ensure for agriculture in the context of achieving the agricultural sector's development is the subject of scientific discussion and need further study.

The purpose of the research is to substantiate the methodological approaches and develop methodical principles for forecasting the level of investment ensure of agricultural development.

Research results. An important stage in the research of investment ensure is forecasting its level to meet the needs of agricultural development. The main dominant here is the thesis that the development of agriculture is the goal, while the investment ensure of the industry — one of the tools to achieve it [5]. In the context of forecasting, investment ensure for agriculture is proposed to be considered simultaneously as: 1) the result of many internal (sectoral structure and efficiency) and external factors (market conditions, lending, state support, foreign investments); 2) the factor providing one of the most important conditions for industry development — the possibility of reproduction of all factors of production.

In order to assess the effectiveness of investment ensure for agriculture it is expedient to use gross value added (GVA), rather than the output of agricultural products [6]. According to the System of National Accounts (CHC'93) [7] and the European system of national and regional accounts (ESA95) [8], gross value added for each economic sector is calculated as the difference between gross output and intermediate consumption at basic prices. The GVA in agricultural sector reflects the additional value created in the production process and provides the opportunity to reproduction of land, labor and capital. The use of GVA as an indicator of the effectiveness of investment ensure is an important methodological tool for forecasting agricultural development.

The methodological approach to analysis of investment ensure has to be improved. In the research of the influence of factors on investment ensure (investment as a result), it has been proposed to evaluate the investment amount for the year (t_n), and the value of factors (independent variables), respectively, for the previous year (t_{n-1}). In turn, investment ensure as a factor (independent variable) to determine for the year (t_n) and the gross value added in agriculture as a dependent variable should be evaluated by the results of next year (t_{n+1}) (Fig.).

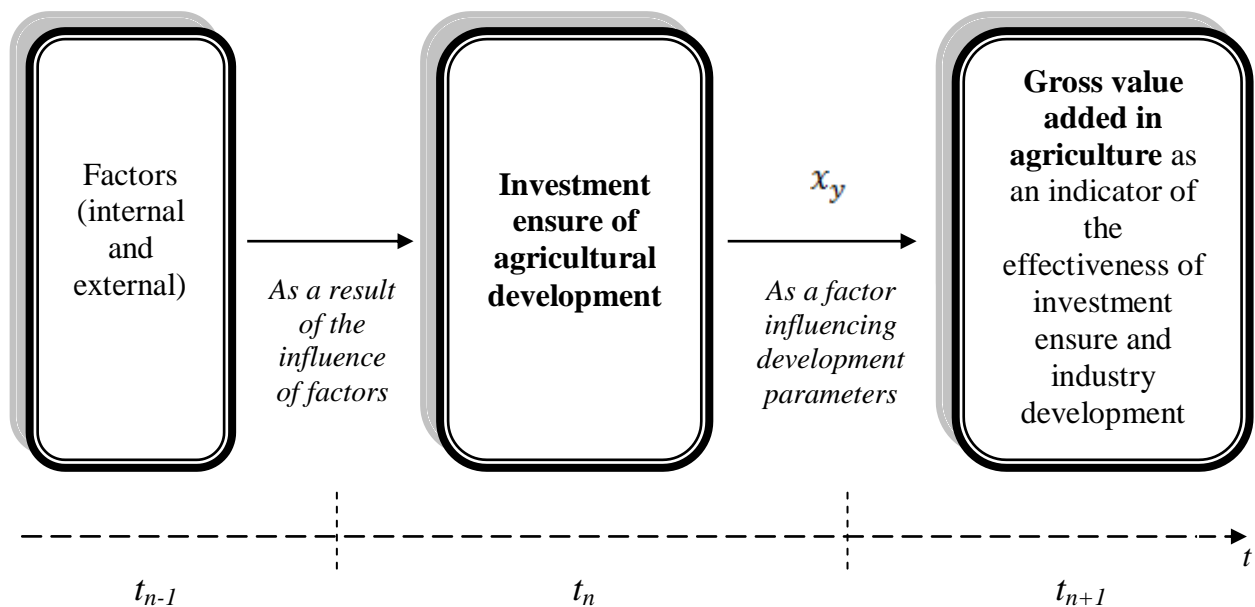


Fig. Stages of the forecasting of the level of investment ensure and modeling its influence on the parameters of agricultural development

Source: built on the basis of [5, p. 89].

Researchers from different countries widely use econometric modeling for forecasting [9—11]. Extrapolation has been chosen among other methods for practical application, which is connected with the analysis of the trends of the studied objects development with the subsequent forecasting.

The correlation and regression analysis has been applied to determine the existence and to define the type of functional dependency of the level of investment ensure of agriculture on the factors influence. According to A. M. Novikov, regression analysis allows not only to describe quantitatively the dependence between variables, but also allows to do forecasting [12].

To analyze the impact of factors on the level of investment ensure of agriculture, 4 factors have been included in the model.

These factors have causal relation with dependent variable; the model has the necessary attributes of adequacy with these factors:

$$Y_{x_{1...n}} = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 \quad (1)$$

where $Y_{x_{1...n}}$ — investment per 1 hectare of arable land, UAH;

x_1 — profitability level, %;

x_2 — lending per 1 hectare of arable land, UAH;

x_3 — state support per 1 hectare of arable land, UAH;

x_4 — foreign direct investment in agriculture per 1 hectare of arable land, USD.

As a result of the correlation and regression analysis using the software packages of «Microsoft Office Excel» and «STATISTICA», a multi-factor econometric model of dependency of — the level of investment ensure for agriculture from the selected factors has been derived:

$$Y_{x_{1...n}} = -3059,829 + 18,760x_1 + 0,604x_2 + 2,624x_3 + 58,855x_4 \quad (2)$$

The coefficient of multiple correlation $R=0,993$ indicates a very close relation between the level of investment ensure of the industry and the selected factors. The coefficient of determination $R^2 = 0,986$ indicates that the selected factors determine the change in the investment per 1 hectare of agricultural land by 98.6%. Since the value of $F = 34.51$ exceeds $F_t = 4.12$ (for $m = 4$, $n = 7$ for $\alpha = 0.05$), the determination coefficient is statistically significant, and the regression equation is statistically reliable.

On the basis of the determined beta coefficients and the correlation matrix, the coefficient of determination has been decomposed into separate factors and their significant impact on the level of investment ensure has been determined (*Table 1*).

Table 1

Indicators of the relationship strength and ranking results
of the certain factors influence on the investment ensure of agriculture in Ukraine

Factors	Beta coefficients	Coefficients of correlation	Share of certain factors, %	Ranking
x_1 — profitability level, %	0,46717	0,860326	24,766	2
x_2 — lending per 1 hectare of arable land, UAH	0,409547	0,785789	19,830	3
x_3 — state support per 1 hectare of arable land, %	0,605809	0,958334	35,774	1
x_4 — foreign direct investment in agriculture per 1 hectare of arable land, USD	0,373757	-0,85239	19,631	4
Total	x	x	100,000	x

Source: calculated by the authors themselves.

State support has the greatest impact on the size of investments per unit area of land, the value of foreign investment — the lowest. The developed econometric model is adequate and can be used to predict the level of investment ensure of agriculture.

The forecast has been made on the basis of the study of trend models of factors' time series by constructing a mathematical function of aligning the time series for each factor.

For this purpose, linear, logarithmic, polynomial and exponential mathematical functions have been used.

The selection of a certain mathematical function for extrapolation and selection of the most adequate of them have been carried out, firstly, on the economic sense of the factor in dynamics, and secondly, on the accuracy of the approximation (*Table 2*).

Table 2

Forecast of the level of investment ensure of agriculture in Ukraine according to the extrapolation of factors for 2020—2024

Indicators	Designation	Mathematical function	Predictive values of the studied indicators				
			2019	2020	2021	2022	2023
Profitability level, %	X_1^{ln}	$y = 3,254x + 13,914$	46,45	49,70	52,96	56,21	59,46
	X_1^{lg}	$y = 8,17498\ln(x) + 16,973$	35,80	36,58	37,29	37,94	38,55
	X_1^{exp}	$y = 18,279x^{0,2499}$	32,50	33,28	34,01	34,70	35,35
Lending per 1 hectare of arable land, UAH	X_2^{ln}	$y = 134,14x + 613,14$	1955	2089	2223	2360	2491
	X_2^{lg}	$y = 417,16\ln(x) + 641,67$	1602	1642	1678	1712	1743
	X_2^{pl}	$y = -8,381x^2 + 201,19x + 512,57$	1686	1712	1745	1711	1687
State support per 1 hectare of arable land, UAH	X_3^{exp}	$y = 474,31e^{0,0621x}$	883	939	999	1063	1131
	X_3^{ln}	$y = 40,036x + 455$	855	895	935	975	1015
	X_3^{lg}	$y = 104,11\ln(x) + 488,35$	728	738	747	755	763
Foreign direct investment in agriculture per 1 hectare of arable land, USD	X_4^{lg}	$y = -2,4811\ln(x) + 21,193$	15,48	15,24	15,03	14,83	14,65
	X_4^{exp}	$y = 22,367e^{-0,0548x}$	12,93	12,24	11,59	10,97	10,39
	X_4^{ln}	$y = -0,9429x + 21,943$	11,76	10,82	9,88	8,94	7,99
			2020	2021	2022	2023	2024
Investment per 1 hectare of arable land, UAH	$Y_{x_{1...n}}$	$Y_{x_{1...n}} = -3059,829 + 18,760x_1 + 0,604x_2 + 2,624x_3 + 58,855x_4$	2219	2496	2783	3081	3391
	$Y_{x_{1...n}}$		1585	1688	1790	1891	1992
	$Y_{x_{1...n}}$		1171	1172	1174	1133	1095

Source: calculated by the authors themselves.

According to a realistic scenario, the growth of investment ensure for agriculture in 2020—2024 could be 25.7%. This requires an annual increase in the profitability rate by 0.7 p.p., lending per 1 hectare of arable land by 35 UAH, state support by 40 UAH. According to the pessimistic scenario, investment ensure may decline by 6.5% if the level of lending and state support of the industry remains at 2017 level.

A model with the necessary attributes of adequacy has been developed to determine the impact of the level of investment ensure on the parameters of agricultural development:

$$Y_{x_{1...n}} = 2278,375 + 4,292x \quad (3)$$

where $Y_{x_{1...n}}$ — GVA in agriculture per 1 hectare of arable land, UAH;

x — investment per 1 hectare of arable land, UAH.

The coefficient of multiple correlation $R = 0.757$ indicates a tight relationship between the dependent variable and the factors. The coefficient of determination $R^2 = 0.573$ indicates that investment ensure determines the change of GVA in agriculture per 1 ha of arable land by 57.3%. Since the value of $F = 6.70$ exceeds $F_t = 5.59$ (for $m = 1$, $n = 7$ for $\alpha = 0.05$), the coefficient of determination is statistically significant, and the regression equation is statistically reliable. The developed econometric model has been used to predict the level of agricultural development. The forecasting results are shown in the *Table 3*.

Table 3

Forecast of gross value added in agriculture of Ukraine
per 1 hectare of arable land for 2021—2025

Scenarios	Predictive values of GVA in agriculture per 1 hectare of arable land, UAH				
	2021	2022	2023	2024	2025
Optimistic	11803	12990	14222	15503	16834
Realistic	9081	9523	9961	10395	10827
Pessimistic	7305	7307	7317	7141	6977

Source: calculated by the authors themselves.

It has been determined that according to the optimistic scenario the GVA in agriculture per 1 hectare of arable land for 2021—2025 will increase by 42.6%, in realistic scenario — by 19.2%. According to a pessimistic forecast, the reduction of the GVA in agriculture per unit area is 4.5%.

Based on the data of *Tabl. 2* and *3* the predictive value of investment and gross value added in agriculture of Ukraine have been calculated (*Table 4*).

Table 4

The forecast of investment and gross value added in agriculture
in Ukraine for 2020—2025

Predictive values of investment in agriculture, billions UAH					
	2020	2021	2022	2023	2024
Optimistic	92,1	103,5	115,5	127,8	140,7
Realistic	65,8	70,0	74,3	78,5	82,6
Pessimistic	48,6	48,6	48,7	47,0	45,4
Predictive values of GVA in agriculture, billions UAH					
	2021	2022	2023	2024	2025
Optimistic	487,9	538,9	590,1	643,2	698,4
Realistic	376,8	395,1	413,3	431,3	449,2
Pessimistic	303,1	303,2	303,6	296,3	289,5

Source: calculated by the authors themselves.

It has been determined that investments in agriculture at the level of 66-83 billion UAH per year will provide an annual increase in the GVA in agriculture by 0.78%; investments at the level of 92—140 billion UAH — by 1.61% respectively.

The results of the conducted research confirm the results obtained by the The Institute of Agrarian Economics NSC. According to scientists, the need for investments in the fixed assets renewal at the level of 10% of their value (the level of reproduction) is 73—75 billion UAH; at the level of 15% (technical modernization) — 110 billion UAH, at the level of innovative modernization — 150 billion UAH [3].

Consequently, the developed methodological principles for forecasting the level of investment ensure can be considered sufficiently justified and can be used in forecasting indicators of investment ensure of agriculture, taking into account the parameters of its development.

Conclusion. When forecasting, the investment ensure of agriculture should be considered simultaneously as a result of the internal (sectoral structure and efficiency) and external factors (market conditions, lending, state support, foreign investment), and as a factor which enable reproduction of land, labor and capital. In order to assess the effectiveness of investment ensure, it is expedient to use gross value added in agriculture as a development indicator.

Using the method of forecasting on the basis of the extrapolation allowed predicting the indicators of investment ensure for agricultural development. In an optimistic scenario for the development of agriculture, investments are needed at the level of 92-140 billion UAH per year. This will ensure an increase in gross value added in agriculture by 1.61% annually. According to a realistic scenario, investments amount of 66—83 billion UAH per year will contribute to an increase in gross value added in agriculture by 0.78% annually. It has been determined that increase of the state support, profitability level and lending needed for the formation of investment ensure of agriculture. It has been substantiated (pessimistic scenario) that if the level of lending and state

support of the industry is maintained at the level of 2017, the investment ensure may decrease by 6.5% and the gross value added in agriculture may decrease by 4.5%.

The developed methodic for forecasting investment ensure is sufficiently substantiated and can be used to predict the parameters of investment ensure of agricultural development.

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