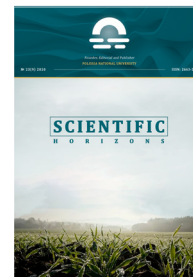


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Financing of Ukrainian agricultural enterprises: Correlation-regression analysis

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Abstract. The relevance of this study is determined by the fact that financing is a key element of the effective economic activity of agricultural enterprises and the industry as a whole, its food security and the restoration of the work of agricultural enterprises, especially amidst a full-scale war and in the post-war period. The purpose of this study was to investigate the relationship between the obtained net profit (loss) and the sources of financing of agricultural enterprises of Ukraine for 2014-the first half of 2023. The study used general scientific methods (analysis of the dynamics of the volume of financing sources (equity, loans, capital investments, state aid, and deposits), analysis of the net profit of agricultural enterprises, formation of the structure of financing

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sources, determination of growth rates of indicators), and specific research methods (correlation analysis and multivariate regression method). The authors of the study suggested using the method of correlation-regression analysis with further forecasting of indicators using Chaddock's tables, Fisher's and Student's tests. The correlation-regression analysis established that a decisive share in financial support is own capital, while the smallest share is state aid. But in connection with the full-scale war in the country and limited own resources, the authors of the study proposed to involve bank loans and state aid more widely in their own economic activities. A correlation-regression analysis was developed to identify the dependence of the financial results of agricultural enterprises (net profit (loss)) and their sources of financing for 2014-2021, a regression equation was developed, and a forecast of the possible net profit (loss) of agricultural enterprises for the future period of 2023-2027 was made. The practical value of the findings is that these results can be used by the host activities of the agricultural enterprise of Ukraine and during the development by state bodies of the Strategy for the Development of the Agricultural Sector and their support programs

Keywords: net profit (loss); sources of financing; agricultural enterprise; agriculture; influencing factors; correlation; own funds; credit; state aid

INTRODUCTION

With the onset of a full-scale war in Ukraine, many countries to which Ukrainian agricultural products were exported are suffering from food shortages, and their prices have risen sharply. During the war, the financing of Ukrainian agricultural enterprises is a particularly relevant and difficult task because many agricultural producers have suffered destruction and damage to the infrastructure, lost agricultural machinery and equipment, many agricultural lands are still mined, access to financial resources has been limited due to the growth of risks affecting the solvency of agricultural enterprises, the prices of fuel and lubricants, fertilizers and seed material have increased, the processes of selling grown products, logistics routes and the number of fraudsters has increased. To the above-listed challenges faced by Ukrainian agricultural producers, it is worth adding the premeditated destruction of the Kakhovka HPP by Russia and the flooding of more than 10,000 sown agricultural lands in the right-bank territory of the Kherson region (much more in the left-bank part of the region) and the damage caused to agriculture in the amount of more than UAH 10 million. Therefore, Ukrainian agrarians face the important question of finding sources of financing their economic activity that will help restore the lost production potential of the enterprise and stabilize its financial security. The relevance of this study is enhanced by the fact that more than a third of agricultural enterprises do not have the possibility of self-financing, and therefore causes a steady increase in the importance of theoretical and practical consideration of approaches to the formation of sources of financing in the wartime.

Many scientific achievements are devoted to the issue of financial support of agricultural enterprises. However, this issue stays relevant. Thus, Ongena *et al.* (2013) define the term "financing" and claim that it is the process of providing monetary resources for the implementation of certain economic activities or projects, and this study focuses on financial decisions in

the conditions of risky entrepreneurship and reflects the relationship between financial decisions, risk, and enterprise management.

Tatarinov *et al.* (2021) note that financing, in other words, is a resource-balanced coverage of the needs of expanded reproduction of enterprises, organizations, institutions at the expense of own and/or borrowed funds, which is achieved through economically sound financial planning.

There are also other interpretations of scientists regarding financial support, which is one of the principal factors in the effectiveness of the state's implementation of its functions in terms of commodity-money relations (Karnaushenko *et al.*, 2020; Kozyuk *et al.*, 2023). Furthermore, there is a slightly different opinion held by Leo *et al.* (2019). Ben *et al.* (2020), who claim that financing from banking institutions of other enterprises is a risky activity for banks, and also claim that the issue of shares by an enterprise is one of the main ways of attracting financial resources to economic activity.

Sirenko *et al.* (2020) believe that "institutions are a synergistic combination of opportunities and limitations of the development of the agricultural sector, the structuring of its connections, a combination of the system of factors, organizational components, processes, and results of their activities". Shushkova & Kulchytskyi (2022) analysed the sources of formation of agricultural enterprises of Ukraine in 2016-2020 and noted that the financial resources of the enterprise are one of the key ones. Without them, it is impossible to meticulously organize the processes of creation, operation, and development of each business entity.

Shahini *et al.* (2023) analysed the profitability of agricultural production, influencing factors and determining areas for its improvement. Financial results and their sources of financing are directly one of the factors that affect the profitability of an agricultural enterprise.

Considering the importance of various sources of financing of agricultural enterprises, it is worth noting

the research of Malii & Syzykova (2023), who note that the normal functioning of agriculture without credit resources is practically impossible, and “the main areas of stabilization of the lending mechanism should be the development of a set of measures by the state and the banking system, aimed at developing a system of interaction with the agricultural sector of the economy: increasing budget allocations, rational use of budget funds, lowering interest rates for the agricultural sector”.

Chumak & Brazhnyk (2022) claim that “the profit of an agricultural enterprise is the main financial source of its scientific and technical development, capital and financial investments, improvement of the commodity and material base and other forms of investment”. Pomaz & Sarana (2022) examine the issue of financing agricultural enterprises, analysing various sources of financing and their impact on the sustainability and efficiency of agricultural enterprises. The classification of sources of financing of an agricultural enterprise is given on a real example.

Voloshchuk *et al.* (2023) note that the coordination and combination of efforts of business structures, state authorities and local governments are highly effective in improving the financial situation of agricultural enterprises, and investigate the problems of financing the agricultural sector in Ukraine, consider the issue of access to loans for agricultural enterprises and the role of national support in the development of agriculture.

The purpose of this study was to investigate the specific features of financing Ukrainian agricultural enterprises during the period of financial instability, to identify the relationship between the obtained financial result and various sources of financing of agricultural enterprises of Ukraine for the periods of 2014-1st half of 2023, and the possibility of forecasting profits or losses based on correlation-regression analysis.

MATERIALS AND METHODS

The basis of the methodological approach in the study is the general scientific methods used: 1) analysis of open data, namely: during the analysis of the dynamics of the volume of financing sources (equity, loans, capital investments, state aid, and deposits), analysis of the net profit of agricultural enterprises, formation of the structure of financing sources, determination of growth rates of indicators; 2) graphic method, when constructing a diagram of the structure of sources of financial support of agricultural enterprises of Ukraine for 2014-2022 (1st half of 2023) and displaying forecast values of the dependence of indicators of net profit and sources of financing of agricultural enterprises; 3) method of generalization, when summarizing and forming research conclusions. The research used specific research methods, namely: 1) correlation analysis – to determine the direct or inverse relationship between indicators, i.e., to investigate how the amount of net profit (loss) of the enterprise's activity changes with an increase or

decrease in the use of financing sources); 2) the multi-factor regression method – to determine the influence of factors on the performance indicator based on the regression equation, i.e., to identify the relationship between the sources of financial support and the financial result of the enterprise for 2014-2022 (1st half of 2023)

The study used open statistical data from the official websites of the State Statistics Service (2022), the Ministry of Agrarian Policy and Food of Ukraine (2023), the Ministry of Economy of Ukraine (2023), the National Bank of Ukraine (2023) regarding the financial activity of agricultural enterprises of Ukraine, their lending, national and international support, capital investments.

The application of the statistical analysis method helped identify the dynamics of the net profit (loss) of the activities of agricultural enterprises of Ukraine, the volume of sources of financial support for agricultural enterprises of Ukraine, analyse the structure of the sources of financial support for agricultural enterprises of Ukraine, as well as make a correlation-regression analysis of the dependence of net profit (loss) on the sources of financing of agricultural enterprises of Ukraine.

Correlation-regression analysis helped establish how strongly one variable depends on another, whether there is a statistically significant relationship between them, and to predict the value of one variable based on another. The principal indicator of correlation analysis is the correlation coefficient, which indicates the degree of linear relationship between variables.

Regression analysis was used to build a mathematical model that describes the relationship between the dependent variable (the variable to be predicted) and one or more independent variables (factors). Regression analysis can be used to determine which variables have the greatest effect on the dependent variable and how. In addition, regression analysis allows predicting the value of the dependent variable based on the values of the independent variables.

In regression analysis, the method of least squares is used to construct the regression equation. This method allows finding the best linear approximation of the dependent variable (in this case, the net profit) from the independent variables (in this case, the volume of financial support from various sources), and therefore it is worth applying the following formula to form the regression equation:

$$y = a - b\bar{x} \quad (1)$$

where: y is the dependent variable (in our case, net profit); x is the independent variable (amount of financial support); a is the intercept (the coefficient responsible for the value of Y at $X=0$); b is the regression coefficient (indicates the change in Y when X changes by one unit).

Formulas can be used to obtain the values of coefficients a and b :

$$b = \sum \frac{(x-\bar{x})(y-\bar{y})}{(x-\bar{x})^2} \quad (2)$$

$$a = \bar{y} - bx \quad (3)$$

where: Σ is the sum; x is the mean value of the independent variable, y is the average value of the dependent variable.

After calculating the values of the coefficients a and b , the obtained regression equation can be used to predict the values of the dependent variable (net profit) based on the known values of the independent variable (the amount of financial support).

The quality of the econometric model is determined by indicators such as the coefficient of determination, Fisher's and Student's criteria. Fisher's test (F-statistic) is used to test the statistical significance of the relationship between independent and dependent variables in a regression model. Student's criterion (t-test) is used to assess the statistical significance of individual regression coefficients. Therefore, the quality of the model should be checked according to the following formulas:

$$\sigma(y)^2 = \bar{y}^2 - (\bar{y})^2 \quad (4)$$

$$\sigma(x)^2 = \bar{x}^2 - (\bar{x})^2 \quad (5)$$

The correlation coefficient (r) measures the degree of linear relationship between two variables. This coefficient takes values in the range of -1 to 1. A value of 1 indicates a full positive linear relationship, -1 indicates a full negative linear relationship, while a value of 0 indicates no linear relationship. To determine the tightness of the linear connection, the correlation coefficient is determined according to the following formula:

$$r_{xy} = b \frac{\sigma(x)}{\sigma(y)} \quad (6)$$

The value of the correlation coefficient can be interpreted as follows:

If $r > 0$, there is a positive linear relationship between the variables. If $r < 0$, there is a negative linear relationship between the variables. If $r = 0$, there is no linear relationship between the variables.

The coefficient of determination (r^2) is used to measure the variation in the dependent variable that can be explained by the independent variable (or variables) in a linear regression model. r^2 indicates how much of the variance of the dependent variable can be explained by the independent variables used.

The coefficient of determination takes a value between 0 and 1. A value of 0 means that the independent variables do not explain any of the variation in the dependent variable, while a value of 1 means that all the variation in the dependent variable can be explained by the independent variables. The coefficient of determination is calculated by squaring the correlation coefficient (r^2x).

The value of the coefficient of determination can be interpreted as follows:

The closer the value of r^2 is to 1, the better the model explains the variation in the dependent variable. The closer the value of r^2 is to 0, the less the ability of the model to explain the variation of the dependent variable.

RESULTS AND DISCUSSION

The agricultural sector is the main component of the economy of Ukraine, which has positive trends towards development and expansion. This is confirmed by the analysis of statistical data on the dynamics of profits of agricultural enterprises for 2014-2021 and partially displayed data for January-September 2022 (Table 1).

Table 1. Dynamics of net profit (loss) of agricultural enterprises of Ukraine for 2014-2021, UAH million

Years	Net income from product sales and net earned insurance premiums	other operating income	other income	Total
2014	214,972.50	41,820.50	5,414.50	262,207.80
2015	366,966.40	68,659.20	15,378.10	451,008.40
2016	402,597.40	47,501.80	6,811.20	456,910.90
2017	452,760.10	40,368.20	6,846.60	499,974.90
2018	528,657.80	49,067.20	10,282.40	588,554.00
2019	560,598.70	94,702.70	16,315.40	671,617.70
2020	602,684.40	67,388.00	11,223.30	681,306.20
2021	770,262.80	110,758.20	14,270.90	895,298.70
9 months of 2022	-392.20	-392.20
R_{gr} , 2021 in % to 2014	358.31	26484	263.57	341.45

Note: ... – no data

Source: compiled based on the data from the State Statistics Service of Ukraine (2023)

Having examined the data in Table 1, the dynamics of the net profit of agricultural enterprises of Ukraine has a positive value during 2014–2020. The growth rate (R_{gr}) of this indicator increased by 341.45% (or +633,090.90 million UAH). In connection with the full-scale war in Ukraine, for January–September 2022,

agricultural enterprises received losses in the amount of UAH 392.2 million.

The percentage ratio of the total number of enterprises to the enterprises that received losses is 56%, i.e., every second agricultural enterprise received losses in 9 months of 2022.

Table 2. Dynamics of the volume of sources of financial support of agricultural enterprises of Ukraine for 2014–2021 and not in full for 2022–1st half of 2023, UAH million

Year	Equity	Loans	Capital investments	State aid	Deposits	Total
2014	163,931.68	55,335.00	18,388.10	4,624.44	27,849.00	270,128.22
2015	275,303.78	48,425.00	29,309.70	3,472.60	17,111.00	373,622.08
2016	369,370.89	55,374.00	49,660.00	3,062.90	20,293.00	497,760.79
2017	436,337.64	59,706.00	63,400.70	4,326.50	21,126.00	584,896.84
2018	482,978.74	67,675.00	65,059.40	7,737.80	22,564.00	646,014.94
2019	522,778.66	61,600.00	58,555.40	3,090.57	24,260.00	670,284.63
2020	612,250.89	61,486.00	50,189.40	4,664.97	41,063.00	769,654.26
2021	796,549.72	82,600.00	49,127.38	4,665.00	50,058.00	983,000.10
2022	...	55,108.00	...	1,647.50	...	56,755.50
January–June 2023	...	35,900.00	...	1,560.00	...	36,107.00
R_{gr} , 2021 in % to 2014	485.90	149.27	267.17	100.88	179.75	363.90

Note: ... – no data

Source: State Statistics Service of Ukraine (2023); Ministry of Agrarian Policy and Food of Ukraine (2023); Ministry of Economy of Ukraine (2023); National Bank of Ukraine (2023); Verkhovna Rada of Ukraine (2023)

Equity is formed at the expense of internal cash flow in the form of net income and depreciation deductions, while external – contributions from founders (shareholders), free financial support. The size of the net income does not change the size of the company's equity essentially, as it reproduces it in the part of the replacement fund and multiplies it in the part of the net profit. Therefore, the dynamics of the amount of equity capital for 2014–2021 has a positive tendency to increase, the growth rate is 4.86 times (or +632,618.04 million UAH).

The formation and conduct of effective entrepreneurial activity by agricultural enterprises requires the involvement of credit resources. It is credit, as one of the tools of influence on the production process, which is a solution to the problems of financial support of subjects of entrepreneurial activity in the agrarian sphere. Synenko & Kovalova (2020) claim that the availability of credit resources considerably impacts the expansion of financial opportunities, the effective use of material resources and cash receipts, the acceleration of the turnover of the means of production and the increase of the level of competitiveness of the enterprise. Therefore, the attraction of loans has positive dynamics, the growth rate is 49.27% (or +27,265.0 million UAH).

The volume of capital investments mastered by agricultural enterprises from 2014 to 2018 inclusive has

a positive tendency to increase. Thus, the growth rate of this source of financing is 353.81% (or by +46,671.3 million UAH). During 2019–2021, there was a decrease in the volume of capital investments by 16.11% (or by -9,428.02 million UAH).

State financial support for the agriculture of Ukraine in 2021 was implemented through the financing of the following programs: partial compensation for the cost of agricultural machinery and production equipment (according to the plan, UAH 1 million); cheaper loans (according to the plan, UAH 1.2 million); financial support for the development of farms (according to the plan, UAH 0.5 million); financial support for the development of horticulture, viticulture, and hops (according to the plan, UAH 0.3 million); provision of additional financial support to family farms through the mechanism of added payment for the benefit of insured persons – members/heads of family farms of a single contribution to mandatory state social insurance (according to the plan, UAH 0.2 million) (Ministry of Agrarian Policy and Food of Ukraine, 2023). However, the volume of this type of financing is insufficient. This is confirmed by the growth rate, which is 0.88% (or +30.56 million UAH), comparing 2021 to 2014.

Deposits, as one of the sources of financial security of the enterprise, appear in the form of financial savings in bank accounts. The growth rate of this

indicator is 79.75% (or + UAH 22,209.0 million) for the analysed period. Notably, the data for 2022 and the 1st half of 2023 are not available on the official websites of state bodies (the State Statistics Service of Ukraine,

the Ministry of Agrarian Policy and Food of Ukraine, the Ministry of Economy of Ukraine, and the National Bank of Ukraine) for such indicators as equity capital, capital investments, and deposits.

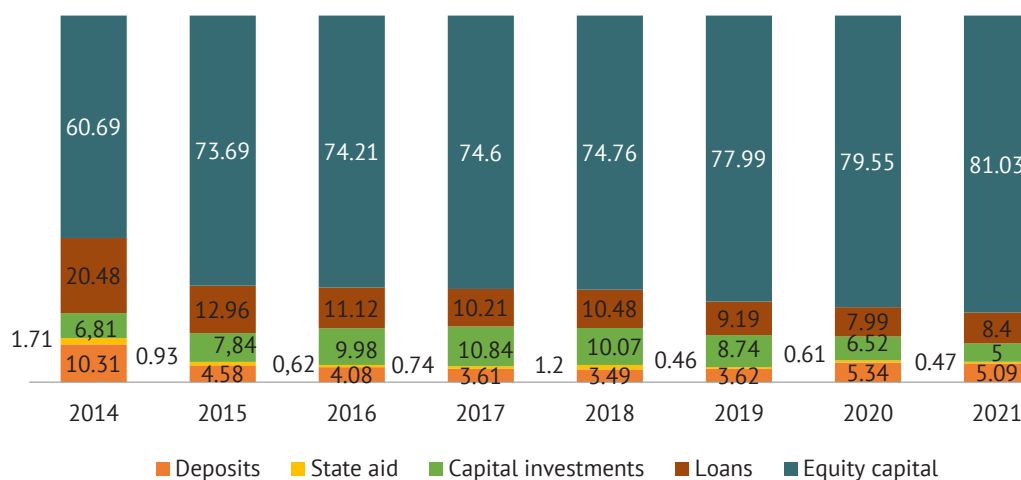


Figure 1. Structure of sources of financial support of agricultural enterprises of Ukraine for 2014-2021, %

Source: State Statistics Service of Ukraine (2023); Ministry of Agrarian Policy and Food of Ukraine (2023); Ministry of Economy of Ukraine (2023); National Bank of Ukraine (2023); Verkhovna Rada of Ukraine (2023)

Considering the obtained data, the share of equity capital in the structure of sources of financial support for 2014-2021 is 60.69% in 2014 and 81.03% in 2021. The smallest component in the structure of financial support is the share of state funding, the value of which is 1.71% in 2014 and 0.47% in 2021. Lending takes the leading place among the sources of financing, namely obtaining loans from banking structures through the issuance of bond loans and financial leasing. Therefore, the attraction of loans has the largest share in the structure of financing sources in 2014 – 20.48%, and the smallest in 2020 – 8.40%. Capital investments for the financing of agricultural enterprises in the overall structure of financing sources account for the smallest

value in 2021 – 5%, and the largest in 2017 – 10.84%. The share of the volume of deposits in 2014 is 10.31%, and in 2021 – 5.09% as part of sources of financing.

To determine the dependence of the net profit (loss) of agricultural enterprises on the volume of financing sources, a correlation-regression analysis was conducted. Given that some data are not available for 2022 and the 1st half of 2023, the starting data for the correlation-regression analysis will be data from 2014 to 2021, because starting from February 2022 and until the end of the war cannot be considered standard and usual periods of operation of agricultural enterprises, since during this period agricultural enterprises are on the verge of survival, not further development (Table 3).

Table 3. Output data of the correlation-regression analysis of the dependence of net profit (loss) on the sources of financing of agricultural enterprises of Ukraine, UAH million

Year	Net profit (loss) (y)	Sources of funding, UAH million				
		Equity (x_1)	Loans (x_2)	Capital investments (x_3)	State aid (x_4)	Deposits (x_5)
2014	262,207.80	163,931.68	55,335.00	18,388.10	4,624.44	27,849.00
2015	451,008.40	275,303.78	48,425.00	29,309.70	3,472.60	17,111.00
2016	456,910.90	369,370.89	55,374.00	49,660.00	3,062.90	20,293.00
2017	499,974.90	436,337.64	59,706.00	63,400.70	4,326.50	21,126.00
2018	588,554.00	482,978.74	67,675.00	65,059.40	7,737.80	22,564.00
2019	671,617.70	522,778.66	61,600.00	58,555.40	3,090.57	24,260.00
2020	681,306.20	612,250.89	61,486.00	50,189.40	4,664.97	41,063.00
2021	895,298.70	796,549.72	82,600.00	49,127.38	4,665.00	50,058.00

Source: State Statistics Service of Ukraine (2023); Ministry of Agrarian Policy and Food of Ukraine (2023); Ministry of Economy of Ukraine (2023); National Bank of Ukraine (2023); Verkhovna Rada of Ukraine (2023)

Let us build a correlation matrix that allows determining the relationship between net profit and

selected sources of financing of agricultural enterprises of Ukraine (Table 4).

Table 4. Correlation matrix of the dependence of the net profit (loss) of enterprise activity on sources of financing

Factor name	Net profit (loss)	Equity capital	Loans	Capital investments	State aid	Deposits
Net profit (loss)	1					
Equity capital	0.980895	1				
Credits	0.823391	0.85682	1			
Capital investments	0.551913	0.597216	0.442987	1		
State aid	0.122592	0.171105	0.420934	0.299565	1	
Deposits	0.705662	0.755108	0.769698	0.008046	0.140414	1

Source: calculated by the authors of the study based on the following sources: State Statistics Service of Ukraine (2023); Ministry of Agrarian Policy and Food of Ukraine (2023); Ministry of Economy of Ukraine (2023); National Bank of Ukraine (2023); Verkhovna Rada of Ukraine (2023) using the statistical function "CORREL" in Microsoft Office Excel

According to the Chaddock scale, the net profit of agricultural enterprises and sources of financing such as equity are directly dependent on each other, the correlation is too high (correlation coefficient is 0.963), loans – the correlation is high (correlation coefficient 0.747), capital investments – the correlation is significant (correlation coefficient 0.605), state aid – the correlation is weak (correlation coefficient 0.116), deposits – the correlation is moderate (correlation coefficient 0.360). This analysis confirms that the most important source of financing according to the given matrix is equity capital. Considering the fact that, as of May 5, 2023, the regions of Ukraine most affected by the war with the Russian Federation are Donetsk, Luhansk, Kherson,

and Zaporizhzhia regions (the Cabinet of Ministers highlighted the most..., 2023), the results of the correlation-regression analysis for agricultural enterprises in these regions may not be reliable, since most agricultural enterprises in these territories are not operational, or have been destroyed or completely looted by the occupiers. The total number of agricultural enterprises registered in these regions is 11,542 farms. For such agricultural enterprises, there are many state and international support programs that can replace equity in financing the economic activity of the enterprise (Table 5). Table 6 shows the results of calculating the relationship between net profit and the amount of financial support of agricultural enterprises of Ukraine.

Table 5. Support of Ukrainian agricultural enterprises under martial law

Seq. No.	Organization	Program name	Period	Total cost	Notes
1.	USAID	Agricultural and Rural Development Program (AGRO)	for 5 years (until 2024)	USD 35 million	To agricultural producers who suffered the most from the war
		Project "Credit resources for agricultural producers"	for 7 years (until 2023)	USD 8.9 million	To credit unions, which subsequently provide loans to micro and small agricultural producers
		"Agricultural Sustainability Initiative in Ukraine"	–	USD 100 million	Aimed at the export of Ukrainian agricultural products
2.	FAO together with the Ukrainian government	Humanitarian aid from FAO – temporary facilities for grain storage	until 03.11.2022	30,000 pieces of sleeves for grain storage	Agricultural producers are given polymer sleeves for grain storage
3.	Ukrainian government	Law No. 2445-IX dated July 27, 2022	–	–	Agricultural producers who purchase goods used to ensure the storage of grain and/or oil crops are exempt from import duty taxation
		Resolution of the Cabinet of Ministers of Ukraine No. 694 dated July 8, 2009 as amended on April 12, 2022 (No. 434)	–	–	Simplified procedure for registration of agricultural machinery

Table 5, Continued

Seq. No.	Organization	Program name	Period	Total cost	Notes
3.	Ukrainian government	State program "Affordable loans 5-7-9%"	-	up to UAH 60 million per agricultural producer	Agricultural producers who have movable and immovable property and need financial resources
4		"eRobota" program	12 months for project implementation	No more than UAH 7 million per project	Grant applications for the construction of one modular greenhouse with an approximate area of 2 hectares (from 1.6 to 2.4 ha) according to a standard project, or for planting gardens (up to UAH 400,000 per ha)
5	The EU together with the Ukrainian government	support programs financed by the EU	until 15.11.2022, but due to numerous applications, the program was suspended on 16.08.2022	UAH 1 billion	Micro and small agricultural producers were able to receive funds per unit of cultivated land or cattle
6	EU	subsidy program for small farmers	2023	USD 80 million	for small farmers who keep up to 100 cows or cultivate from 1 to 120 ha

Source: Support of the agricultural sector... (2022); State support for agriculture... (2022); Support for agriculture in 2023...(2023)

Table 6. The results of calculating the relationship between net profit and the amount of financial support of agricultural enterprises of Ukraine

No.	x	y	x*y	x ²	y ²	\bar{y}	$y - \bar{y}_x$	$\frac{ y - \bar{y}_x }{y}$	$(y - \bar{y}_x)^2$
1	270.13	262.21	70,830.79	72,970.22	68,754.08	-35.74	297.95	0.12	88,774.20
2	373.62	451.01	168,506.36	139,591.90	203,410.02	9.41	441.60	0.02	195,010.56
3	497.76	456.91	227,431.52	247,765.02	208,766.75	10.63	446.28	0.02	199,165.84
4	584.90	499.97	292,432.45	342,108.01	249,970.00	19.49	480.48	0.04	230,861.03
5	646.01	588.54	380,202.73	417,328.92	346,379.33	40.17	548.37	0.07	300,709.66
6	670.28	671.62	450,173.45	449,275.28	451,073.42	57.62	614.00	0.09	376,996.00
7	769.65	681.31	524,370.24	592,361.12	464,183.32	56.86	624.45	0.09	389,937.80
8	983.00	895.30	880,079.90	966,289.00	801,562.09	57.32	837.98	0.09	609,430.03
Result	4,795.35	4,506.87	2,994,027.4	3,227,689.5	2,794,099	-	-	0.54	2,390,885.12
Average value	599.42	563.36	374,253.43	403,461.18	349,262.38	-	-	-	-
	122.27	178.57	-	-	-	-	-	-	-

Source: calculated by the authors of the study based on the following sources: State Statistics Service of Ukraine (2023); Ministry of Agrarian Policy and Food of Ukraine (2023); Ministry of Economy of Ukraine (2023); National Bank of Ukraine (2023); Verkhovna Rada of Ukraine (2023) using the statistical function "CORREL" in Microsoft Office Excel

The parameters of the regression equation are calculated as follows:

$$b = \frac{374,253.43 - 599.42 \times 563.36}{403,461.18 - (599.42)^2} = 0.83;$$

$$a = \bar{y} - b\bar{x} = 563.36 - 0.83 \times 599.42 = 65.84.$$

The empirical equation of a simple linear regression is defined as follows:

$$\text{Net profit volume } Y = a + bx = 65.84 + 0.83x.$$

The quality of the econometric model is determined by indicators such as the coefficient of determination, Fisher's and Student's criteria. The quality of this model is determined as follows:

$$\sigma(y)^2 = 349,262.38 - 563.36^2 = 31,887.89;$$

$$\sigma(y) = 178.57$$

$$\sigma(x)^2 = 403,461.18 - 599.42^2 = 44,156.84;$$

$$\sigma(x) = 210.13.$$

To determine the tightness of the linear relationship, the correlation coefficient is determined as follows:

$$r_{xy} = 0.83 \frac{210.13}{178.57} = 0.98;$$

Coefficient of determination:

$$r^2_{xy} = 0.98^2 = 0.96.$$

The obtained indicators are evidence that the net profit (y) is explained by the variation of factor x – the amount of financial support by 98.0%, and by other factors by 2.0%. Ponedilchuk et al. (2021) states that “the financial security of agricultural production is based on the assessment of the financial results of business entities, which are determined by a set of financial and economic indicators. National financial policy should direct the participants of financial relations to the implementation of political, social, and economic goals, determining the aims and ways of their achievement. The state should play a key role in the innovation process and consider its impact on the financial support of research and development and act as a large and sometimes the main investor in new knowledge and technologies. This situation is explained by the fact that the branch of agriculture is specific, namely, natural conditions exert the greatest influence on obtaining a net profit. State regulation of prices, tariffs, tax rates and benefits, the demographic situation, the prices of production resources, competition, and inflation are also among the factors affecting profit. The authors of the study agree with the opinion of Byba & Kovalets (2016) that the main factor in the growth of the profit of an agricultural enterprise is the reduction of the cost of production. Therefore, it is possible to propose factors affecting the reduction of the cost of production of agricultural enterprises: increasing the technological level of production (improvement of equipment, technology, mechanization, automation of production processes, use of new, more productive varieties of agricultural crops and animal breeds); improvement of production and labour organization (development of production specialization, improvement of labour organization); change in the structure and volume of production (relative reduction in contingent costs, change in the structure of production); improving the use of natural resources, using cheaper materials, waste-free production technologies; industry and other factors.

Such a group of factors as indicators of the use and movement of fixed assets, namely agricultural machines and equipment used in the production process, considerably affects the profit of an agricultural enterprise. In the conditions of technological advance, agricultural machinery is constantly updated and modernized, technologies are created that are more productive and less energy-consuming. That is why, by investing in the modernization of fixed assets, the owners of

agricultural enterprises reduce the cost of production due to more productive technologies. The uniqueness of agriculture also lies in the fact that it is dependent on such a factor as soil fertility. Although in Ukraine, 67% of land that is suitable for agriculture is covered with fertile chernozem, over the years land resources are depleted and become less productive. Hmyria et al. (2019) call the reasons for the loss of soil quality its improper use, environmental pollution, and depletion by certain crops, and therefore there is a need to increase soil fertility. Furthermore, in the territories that were under occupation and are still under occupation, there is a prominently dangerous level of land mining, and with the detonation of the Kakhovka HPP – the flooding of fertile lands and the loss of their quality indicators.

Therefore, the determined value of the coefficient of determination indicates the identification of one of the many influencing factors on the volume of the obtained net profit.

Average error of approximation:

$$A = \frac{1}{n} \sum_{i=1}^n \left| \frac{y_i - Y_x(x_i)}{y_i} \right| \times 100\% = (0.54/8) \times 100\% = 6.75\%$$

The significance of the regression equation was assessed using Fisher's F-test:

$$F = \frac{r_{xy}^2}{1-r^2_{xy}} (n-2) = \frac{0.96}{1-0.96} \times 6 = 144.$$

The tabular value of the criterion for degrees k=1 and k=5 is $F_{\text{tab}}=6.61$. Since $F_{\text{fact}}=144 > F_{\text{tab}}=6.61$, the regression equation is determined to be statistically significant, and the constructed model is adequate.

Evaluation of the statistical significance of the regression parameters using the Student's t-test: the tabular value of the t-criterion for the number of degrees of freedom $df=n-2=16-2=14$ i $\alpha=0.05$ is $t_{\text{tab}}=2.57$.

Random errors of regression parameters and correlation coefficient:

$$S_{\text{dep}} = \sqrt{\frac{\sum_{i=1}^n (Y(x_i) - Y_i(x_i))^2}{n-2}} = \sqrt{\frac{2,390,885.12}{6}} = 19.96.$$

The standard error of the regression coefficient $m(a)$:

$$m(a) = S_{\text{gen}} \frac{(\sum x^2)^{\frac{1}{2}}}{\sigma_y n} = 631.25 \frac{3,227,689.5}{162.618 \times 7} = 9.91.$$

Standard error of parameter b:

$$m(b) = \frac{S_{\text{gen}}}{\sigma(x) \sqrt{n}} = \frac{9.91}{210.13 \times 2.83} = 0.02.$$

The error of the Pearson correlation coefficient $m(r)$:

$$m(r) = \sqrt{\frac{1-r^2}{n-2}} = \sqrt{\frac{1-0.96}{6}} = 0.08.$$

Indicators of the factual values of the coefficients t_a, t_b, t_r :

$$t_a = a/m(a) = 65.84/19.96 = 3.29;$$

$$t_b = b/m(b) = 0.83/0.02 = 0.1;$$

$$t(0.05,5) = 2.57.$$

$$t_r = r/m(r) = 0.98/0.08 = 12.25;$$

Confidence intervals for regression parameters a, b :

$$a \pm t_{tab}m(a) = 65.84 \pm 2.57 \times 9.91 = 65.84 \pm 25.46; a \in [40.38; 91.3];$$

$$b \pm t_{tab}m(b) = 0.83 \pm 2.57 \times 0.1 = 0.83 \pm 0.26; b \in [0.57; 1.09].$$

Parameters a, b are within the specified limits, do not take zero values, and therefore are statistically significant.

Since the model is adequate and its parameters are significant, it is possible to build a forecast of data for 2023, if it is planned to increase the volume of financial support by 20% compared to 2021 and starting from

2024 to increase this indicator by 10% in each subsequent year. Therefore, an increase in the volume of funding sources by 20% is:

$$x_p = 1.20 \times 983 = 1,179.6 \text{ UAH billion}$$

Therewith, the forecast value of net profit will be as follows:

$$Y_x(x_p) = Y_x(1,179.6) = 65.84 + 0.83 \times 1,179.6 = 1,044.91 \text{ UAH billion}$$

Since statistical data for 2023 are missing due to the lack of reports in the databases (the reporting deadline has not yet arrived), the authors of the study made a forecast

for 2023. The forecast of the net profit of agricultural enterprises for 2023 with a probability of 0.96 is in the range from UAH 963.41 billion to UAH 1,081.41 billion (Fig. 1).

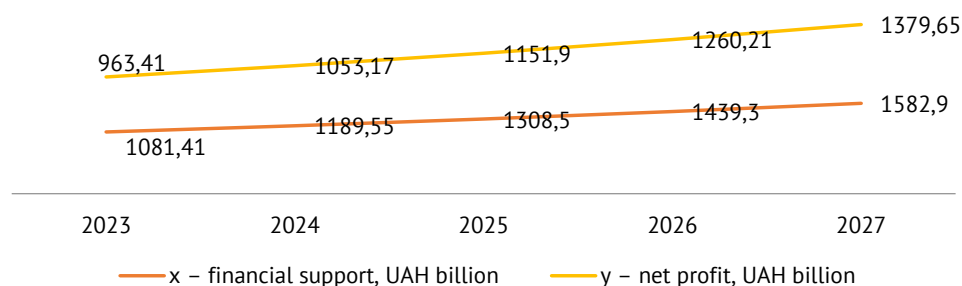


Figure 2. Forecast value of dependence of net profit indicators and sources of financing of agrarian enterprises, UAH billion
Source: calculated by the authors of the study based on the following sources: State Statistics Service of Ukraine (2023); Ministry of Agrarian Policy and Food of Ukraine (2023); Ministry of Economy of Ukraine (2023); National Bank of Ukraine (2023); Verkhovna Rada of Ukraine (2023) using the statistical function "CORREL" in Microsoft Office Excel

Determination of the accuracy of the forecast factoring in the error and the confidence interval:

$$\Delta p = t_{tab} \times m(x_p) = 2.57 \times m(x_p)$$

$$m(x_p) = S_{gen} \left(1 + \frac{1}{n} + \frac{(x_p - \bar{x})^2}{n\sigma^2}\right)^{\frac{1}{2}} = 19,96 \times \sqrt{1 + \frac{1}{8} + \frac{(1,179.6 - 599.42)^2}{8 \times 44,154.62}} = 28.77;$$

$$\Delta p = 2.57 \times 28.77 = 73.9.$$

Confidence interval of the forecast:

$$Y_x(x_p) \pm \Delta p = 1,044.91 \pm 73.9.$$

According to the obtained results, the research of the results of other scientists becomes increasingly necessary. Thus, Adewale *et al.* (2022) conducted research on the impact of bank lending on the volume of agricultural products grown by agricultural producers in Nigeria. As a result, the researchers found that agricultural bank credit ($\beta=0.667173, t=5.961095$ & $P<0.05$) has a significant positive effect on agricultural production and bank lending has a significant positive effect

on agricultural productivity in Nigeria. Which, in turn, is confirmed by the results obtained in the present study, namely: a high correlation between the net profit of agricultural enterprises and loans. A study by Magazzino & Santeramo (2023) also confirms the results obtained, as the effect of the credit-volume-productivity relationship (as highlighted by the statistical significance of the relationships between the variables) is stronger for developing countries and OECD countries, and weaker for less developed countries and NFID countries.

Furthermore, it is possible to partially agree with the results of Zakaria *et al.* (2019), who found a non-linear

U-shaped relationship between financial development and productivity in the agricultural sector in five Asian countries. The authors of the study do not fully agree with the opinion of Olowu *et al.* (2019), as their study states that “financial development and agricultural value added reduce employment in 11 African countries”, while the study by Farooq *et al.* (2021) emphasizes the unidirectional causality between access to credit and the decline in agricultural production. Therefore, during the war, Ukrainian agricultural producers should pay more attention to bank lending programs, state aid, and international grant programs, rather than relying on equity capital.

CONCLUSIONS

Based on the conducted correlation-regression analysis, it was proved that equity, loans, capital investments, state aid, and deposits have a sufficient influence on the volume of financial support. Equity capital is the main source of financing the activities of enterprises, but its volume is insufficient to fully ensure the financing of entrepreneurial activities. Therefore, the authors of this study used other types of financing for the analysis. A correlation matrix of the dependence of net income on sources of financial support was also formed, which shows the correlation coefficient of equity – 0.981 (the correlation is too high), the correlation coefficient of loans – 0.823 (the correlation is high), the correlation coefficient of capital investments – 0.552 (the correlation is noticeable), the correlation coefficient of state aid – 0.122 (the correlation is weak), the correlation coefficient of deposits – 0.705 (the correlation is moderate). During the war, agricultural producers should pay attention to bank loans, as the Ukrainian government has developed and implemented particularly good lending programs for agricultural enterprises;

furthermore, one can also take advantage of international aid from various international organizations.

The correlation coefficient between the amount of net profit received and the amount of financial support for agricultural enterprises is 0.94, which is evidence of a close connection between the selected data. The initial statistical sample is represented by annual data for 2014-2021. As a result of data processing, an empirical simple linear regression equation was constructed. Having carried out some calculations regarding the significance of all parameters of the model, it was proved that the built model is adequate, and a forecast can be made based on this model.

In the perspective of further research, it is necessary to substantiate the legal conditions for attracting the main sources of financing, to identify their advantages and disadvantages for entrepreneurial activity. Since the issue of financial support needs a detailed solution, the research of the main sources of financing should be expanded, distinguishing them from each other in more detail. Furthermore, it is necessary to focus on the following understanding, for various sources of financing to work effectively in a difficult time for the entire country, it is necessary to develop an effective integrated model of financing agricultural enterprises that would factor in the specifics of each region (especially during a full-scale war in the country, when the territories are still occupied, or those that were recently de-occupied) and an individual business entity (determining its needs).

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CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

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Фінансування українських сільськогосподарських підприємств: кореляційно-регресійний аналіз

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Анотація. Актуальність даного дослідження зумовлена тим, що фінансування є ключовим елементом ефективної господарської діяльності аграрних підприємств та галузі в цілому, її продовольчої безпеки та відновлення роботи сільськогосподарських підприємств особливо у період повномасштабної війни та в після воєнний період. Метою статті було дослідження взаємозв'язку між отриманим чистим прибутком (збитком) та джерелами фінансування підприємств сільського господарства України за період 2014- I півріччя 2023. У дослідженні використано: загальнонаукові методи (аналіз динаміки обсягів джерел фінансування (власний капітал, кредити, капітальні інвестиції, державна допомога та депозити), аналіз чистого прибутку діяльності сільськогосподарських підприємств, формування структури джерел фінансування, визначення темпів приросту показників) та специфічні методи дослідження (кореляційний аналіз та метод багатofакторної регресії). Автори дослідження запропонували використання методу кореляційно-регресійного аналізу з подальшим прогнозуванням показників, використовуючи таблиці Чеддока, критерії Фішера та Ст'юдента. При проведенні кореляційно-регресійного аналізу встановлено, що визначну частку в процесі фінансового забезпечення становить власний капітал, а найменшу частку становить державна допомога. Але в зв'язку з повномасштабною війною в країні та обмеженими власними ресурсами, автори дослідження запропонували більш ширше залучати банківські кредити та державну допомогу у власну господарську діяльність. Набули подальшого розвитку проведення кореляційно-регресійного аналізу виявлення залежності фінансового результату діяльності аграрних підприємств (чистого прибутку (збитку)) та їх джерел фінансування за 2014-2021 рр., розроблено рівняння регресії, здійснено прогнозу можливого чистого прибутку (збитку) діяльності аграрних підприємств на майбутній період 2023-2027 рр. Практична цінність отриманих результатів проведеного дослідження полягає в тому, що дані результати можуть бути використані у господарській діяльності аграрного підприємства України та під час розробки державними органами Стратегії розвитку аграрного сектору та їх програм підтримки

Ключові слова: чистий прибуток (збиток); джерела фінансування; аграрне підприємство; сільське господарство; фактори впливу; кореляція; власні кошти; кредит; державна підтримка