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## **FINANCIAL SUPPORT AND FORECASTING OF FOOD PRODUCTION USING ECONOMIC DESCRIPTION MODELING METHODS**

**Abstract.** The article considers the financial programs used by the state to support food production based on the use of methods of economic descriptive modeling. It is established that the interpretation of the essence and strategy of financing in practice has quite different approaches. It has been proven that the formation of an effective system of financing food production involves the relationship and effective redistribution between different sources of financial resources. It is substantiated that agriculture has all the prerequisites for productivity growth provided that investment in the Ukrainian agricultural sector increases and effective budget financing. In this regard, the features of food production based on the use of descriptive modeling capabilities using the software package Statgraphics XVII Centurion. Because of the analysis, it is established that the main parametric criterion, which depends on the level of food production in the country as a whole and individual regions, determines the indicator of agricultural production, quantitative parameters of which are taken as a basis for calculating self-sufficiency, import coverage, calories, consumption, profitability and others. Estimation of this indicator by means of modeling allowed to make the forecast of dynamics of change of its volumes for the next twelve time periods for the purpose of preliminary definition of level of food production. For this purpose, the economic and mathematical tools of estimation of forecast dynamics of change of volumes of agricultural production for the future periods are used. Modeling of the indicator of agricultural production per person per year was carried out by research on the normality of distribution using Kolmogorov —

Smirnov, Anderson — Darling compliance tests and a modified Kolmogorov — Smirnov test. According to the results of comparative analysis of seventeen different models and five compliance tests, it was found that most of the statistical tests are quadratic model, based on which the projected volumes of agricultural production per person per year and calculated for each forecast year (period) with a reliability of 95% lower and upper limits of the studied indicator. It is established that by 2030 in Ukraine with a high probability the growth trend of agricultural production will continue, and at a high rate. The article outlines the benefits of using economic modeling methods in the study of a particular problem.

**Keywords:** financial programs, financial support, food production, forecasting methods, economic modeling, national economy.

**JEL Classification** B41, C33, C53, G32, E62

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## **ФІНАНСОВА ПІДТРИМКА І ПРОГНОЗУВАННЯ ПРОДОВОЛЬЧОГО ВИРОБНИЦТВА**

### **ЗА ДОПОМОГОЮ МЕТОДІВ ЕКОНОМІЧНОГО ОПИСОВОГО МОДЕЛЮВАННЯ**

**Анотація.** Досліджено фінансові програми, які використовуються державою для підтримки продовольчого виробництва на основі використання методів економічного описового моделювання. Установлено, що трактування суті та стратегії фінансування на практиці має досить різні підходи. Доведено, що формування дієвої системи фінансування продовольчого виробництва передбачає взаємозв'язок та ефективний перерозподіл між різними джерелами фінансових ресурсів. Обґрунтовано, що сільське господарство має всі

передумови для зростання продуктивності за умови нарощування інвестицій в українську аграрну галузь та ефективного бюджетного фінансування. У зв'язку з цим досліджено особливості продовольчого виробництва на основі використання можливостей описового моделювання з допомогою програмного пакета Statgraphics XVII Centurion. У результаті аналізу встановлено, що основним параметральним критерієм, від якого залежить рівень продовольчого виробництва як країни в цілому, так і окремих регіонів, визначено показник виробництва сільськогосподарської продукції, кількісні параметри якого беруться за основу при розрахунку коефіцієнтів самозабезпечення, покриття імпорту, калорійності, достатності споживання, рентабельності та інших. Оцінка цього показника за допомогою моделювання дозволила скласти прогноз динаміки зміни його обсягів на майбутні дванадцять часових періодів з метою попереднього визначення рівня продовольчого виробництва. Для цього використано економіко-математичний інструментарій оцінки прогнозованої динаміки зміни обсягів сільськогосподарського виробництва на майбутні часові періоди. Проведено моделювання показника виробництва сільськогосподарської продукції на одну особу за рік шляхом досліджень на нормальність розподілу за допомогою тестів відповідності Колмогорова — Смирнова, Андерсона — Дарлінга та модифікованого тесту Колмогорова — Смирнова. За результатами порівняльного аналізу сімнадцяти різних моделей і п'яти тестів на відповідність виявлено, що найбільше статистичних випробувань проходить квадратична модель, на основі якої складено прогнозні обсяги виробництва сільськогосподарської продукції на одну особу за рік і розраховано для кожного прогнозного року (періоду) із достовірністю 95 % нижні та верхні межі досліджуваного показника. Установлено, що до 2030 року в Україні з великою вірогідністю тренд зростання обсягів виробництва сільськогосподарської продукції буде продовжений, причому досить високими темпами. Доведено переваги застосування методів економічного моделювання при дослідженні визначеної проблеми.

**Ключові слова:** фінансові програми, фінансова підтримка, продовольче виробництво, методи прогнозування, економічне моделювання, національна економіка.

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**Introduction.** Modern transformational processes of socio-economic, legislative and regulatory, organizational mechanisms make significant adjustments in the development of the food production system. Today, agricultural enterprises due to objective factors, the specifics of industrial production cannot solve the problem of stabilization and strengthening of production capacity. They need financial support for the main activity, purchase of new machinery and equipment, mineral fertilizers, plant protection products, formation of current assets.

The strategy of stable financing should be aimed at constantly providing the food market with the necessary amounts of financial resources. This means that the state must provide funds for program activities aimed at ensuring optimal nutrition for all segments of society.

To achieve the result, it is necessary to conduct a reliable, comprehensive analysis of this complex socio-economic system on the appropriate grounds, measured on various scales, using the tools of economic and mathematical descriptive modeling. It is in the process of multidimensional data analysis that it is possible to adequately assess the food system, form its reliable model in the economy and choose the optimal financial security model.

The aim is to investigate the financial programs to develop measures to finance food production using methods of economic descriptive modeling.

The main research methods were scientific abstraction, logical generalization, graphic, economic modeling of food production, visual reflection the system of food production for future periods and for the development of a financial model.

**Analysis of research and problem statement.** In a market economy, the role of financial resources in ensuring food production is extremely large. However, neither international trade in food, nor financial assistance, are able to ensure financial and food security in the current world economic order, although they still contribute to its increase in some countries, especially developed ones.

The growth of financing and the deepening of financial markets in food production are constrained by a number of factors, such as inefficient government policies, high operating costs for remote rural areas, covariance of agricultural production, food markets and price risks, low demand due to food fragmentation and inelasticity, experience of financial institutions in managing loan portfolios of agricultural products. Nevertheless, on the other hand, population growth and the change in preferences in the diet of the middle class for better products leads to an increase in the need for financial resources [1].

Despite the significant number of theoretical and practical developments of scientists in solving this problem such as S. Ayaz [2], P. Bergevin [3], F. Dong [4], V. Q. Duy [5], W. E. Johnston [6], Smith [7] and others, some issues remain debatable and need more detailed justification, taking into account current political changes, geopolitical situation, market conditions of agricultural production, business conditions, climate.

Analysis of publications on the problems of financial support of agricultural enterprises, including agricultural producers, shows that they mostly work at their own expense [8].

Statistical studies show that in recent years the domestic economy has been maintained largely by the agricultural sector. O. Radchenko considers that the basis of agricultural production and sales is formed by large-scale enterprises, having an extensive infrastructure and access to foreign markets, because it is exports in recent years provides stability of results and revenues of the industry [9].

According to M. Kisil, agricultural production affects the development of the whole economy. This is evidenced by the correlation coefficient — 0.6 — between the indicators of investment per 1 hectare of agricultural land and gross regional product. In view of this, the slowdown in investment activity in agriculture causes corresponding changes in the dynamics of Ukraine's economy [10].

Thus, agriculture, both due to its own development and due to the deterioration of the situation in other sectors, is one of the leading sectors of the Ukrainian economy. It should be noted that it has all the prerequisites to become even more productive, as claimed by both domestic and foreign experts. World Bank experts call an important condition for productivity growth — increasing investment in the Ukrainian agricultural sector [11].

N. Maslak and O. Maslak believe that agricultural enterprises need significant funds to finance their current activities, the introduction of new technologies, insurance of existing risks, development of trade and transport infrastructure [8].

The interpretation of the essence and strategy of financing the agricultural sector in practice has quite different approaches. For example, according to World Bank analysts, by 2050 the demand for food will increase by 70%. It will require at least \$ 80 billion in annual investment, most of which must come from the private sector [12].

The vast majority of researchers on this issue believe that the organization of financial support for agricultural enterprises is implemented in such forms as the use of own resources, the use of credit resources, budget funding on a non-refundable basis [13].

In this regard, the study of the financing of the agricultural sector and the choice of an effective model of financial support for agricultural producers is an important task that requires the application of appropriate theoretical and methodological approaches and recommendations to ensure economic and agricultural development in today's economic instability.

**The results of research.** The formation of an effective system of financing agriculture provides for interconnection and effective redistribution between different sources of financial resources. Given the significant number of financial instruments on the Ukrainian market, agribusiness, unfortunately, has limited access to resources.

It should be noted that effective public administration of the expenditure side of the budget, financing and implementation of targeted comprehensive programs to support food production in market economies is the main form of management of agro-food entities.

Today, the agro-industrial complex has rather vague prospects for public financial policy. Against the background of economic instability, declining GDP, uncertainty of the vector of development in agriculture, support for the agricultural sector remains purely formal and has little

effect on its development. In addition, the stated support for small business in rural areas is more of a social than an economic measure [9].

Agricultural enterprises have established themselves as budget donors. This is evidenced by data on expenditures for programs to support the development of agriculture, provided by the Law of Ukraine «On the State Budget of Ukraine for 2019» (*Table 1*).

Table 1

**The structure of general and special funds of the state budget  
for agricultural financing programs in 2019**

KPKVK	Name of the program	UAH million	%
<b>General fund</b>			
2801030	Financial support for measures in the agro-industrial complex by reducing the cost of loans	127,2	2,2
2801230	Financial support for farm development	800,0	13,5
2801350	State support for the development, establishment and supervision of young orchards, vineyards and berries	400,0	6,8
2801460	Providing loans to farms	200,0	3,4
2801540	State support of the livestock industry	3500,0	59,2
2801580	State support for agricultural producers	881,8	14,9
<b>Total</b>	<b>X</b>	<b>5909,0</b>	<b>100,0</b>
<b>Special fund</b>			
2801180	Financial support for activities in the agro-industrial complex	5,0	9,2
2801460	Providing loans to farms	44,5	82,0
2801490	Financial support of measures in the agro-industrial complex on the terms of financial leasing	4,8	8,8
<b>Total</b>	<b>X</b>	<b>54,3</b>	<b>100,0</b>

Source: based on [1; 14].

Analysis of the data in *Table 1* shows that among the budget programs to support agricultural producers, the largest share was occupied by the financing of the livestock industry UAH 3.5 billion or 59.2% of the general fund of the budget and lending to farms UAH 44.5 million or 82.0% for the special fund. The least funds are provided for the allocation of «cheap» loans by the state for agricultural producers of UAH 127.2 million (2.2%) and lending to farmers — UAH 200 million (3.4%). The special fund provides the least funds for financial leasing in agriculture — UAH 4.8 million (8.8%).

There are currently six financial support programs for farmers and agricultural producers, while only one for farmers [15]. It can be concluded that the state stimulates only large and farms, while for ordinary peasants financial assistance can be only in animal husbandry, and only that which relates to the fattening of young cattle [20—31]. Traditional activities for Ukrainians, such as fattening pigs, poultry, crop production, horticulture and berry growing, are overlooked.

Along with the study of planned indicators of state financial assistance and existing programs to support the agro-industrial complex, the analysis of their implementation is extremely important (*Table 2*).

Table 2

**Implementation of support programs for agricultural producers on October 30, 2019**

№	Name of the program	Planned indicator, UAH million	Actually mastered, UAH million	Deviation, UAH million	Percentage of execution, %
1	State program to support the livestock industry, storage and processing of agricultural products	3500,0	718,2	-2781,8	20,5
2	Financial support for farmers	881,8	145,4	-736,4	16,5
3	Financial support for farm development	800,0	71,0	-729,0	8,9
4	State support for the development of horticulture and berry growing	400,0	120,8	-279,2	30,2
5	Providing loans to farms	200,0	60,0	-140,0	30,0
6	Financial support of agro-industrial complex due to cheaper loans	127,2	98,3	-28,9	77,3
	<b>Total</b>	<b>5909,0</b>	<b>1213,7</b>	<b>-4695,3</b>	<b>20,5</b>

Source: based on [1; 16].

Analysis of the data in *Table 2* shows that among all programs, the most funded support for measures in the agro-industrial complex by reducing the cost of loans — the percentage of 77.3%. However, it should be mentioned that this program occupies the smallest share among all programs 127.2 million UAH or only 2.2% (see *Table 1*).

As of July 2019, UAH 707.1 million was disbursed of the planned UAH 5.9 billion for 6 programs. At that time, not a single hryvnia was spent under the program of financial support for the development of farms [1; 16].

The development of long-term forecasts for the development of agro-industrial production should become a permanent and extremely important area of financial activity of the Government of Ukraine. The process of harmonizing the parameters of agricultural policy, financial planning and forecasting economic growth is becoming increasingly complex. Therefore, an effective tool for achieving long-term priorities and goals of state development should be modeling the main activities [17].

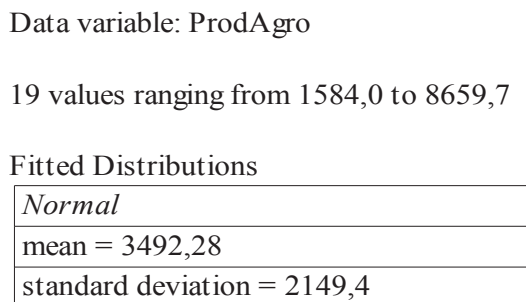
We will analyze the production of agricultural products per person per year. Studies have shown [18], this indicator is one of the main parametric criteria, which depends on the level of food security of the country as whole and individual regions. Quantitative parameters of the indicator of agricultural production are the basis for calculating the coefficients of self-sufficiency, coverage of imports, calories, adequacy of consumption, profitability and many others.

Successful solution of food security problems as a complex socio-economic system also involves multidimensional statistical analysis using special mathematical packages. To conduct such research, we use the statistical analysis program Statgraphics XVII Centurion. The statistical package provides many opportunities for in-depth, visual analysis of data from socio-economic systems, which are described by various features measured on metric and non-metric scales [17].

The analysis will be conducted based on initial data [18], where the indicator «agricultural production per capita per year» has the symbol  $X_1$ .

In our economic and statistical calculations, the indicator «agricultural production per capita per year» is marked as ProdAgro.

The general analysis of the investigated parameter is given in *Fig. 1*.



**Fig. 1. General analysis of the studied indicator ProdAgro**

Source: author’s development.

As can be seen from *Fig. 1*, the period for which the analysis of the studied indicator is 19 years. The minimum value is at the level of 1584.0 kg per person, and the maximum value is 8659.7 kg. The average value of the data is 3492.28 kg, and the standard deviation of the analyzed data is 2149.4 kg.

Next, check whether the studied indicator corresponds to the normal distribution using compliance tests. To do this, we use three tests: Kolmogorov — Smirnov, Kolmogorov — Smirnov test modified and Anderson — Darling test [18, p. 208].

The Kolmogorov — Smirnov test makes it possible to determine the empirical accumulated frequencies and compare them with theoretical frequencies. Used when the source data is ordered.

The calculation criterion of testing is the point at which the two distributions will have the maximum difference in modulus.

Modified Kolmogorov statistics are used for complex hypotheses. The test is sensitive to the difference between both sample means and standard deviations of the samples, the coefficients of their asymmetry and excess. This versatility is achieved by reducing the power of the criterion [19, p. 63].

The Anderson — Darling test is analogous to the Smirnov or Lehmann — Rosenblatt homogeneity criteria, but somewhat more powerful.

The results of the analysis for the normality of the distribution are shown in *Fig. 2*.

**Goodness-of-Fit Tests for ProdAgro**

**Kolmogorov-Smirnov Test**

	<i>Normal</i>
DPLUS	0,29762
DMINUS	0,187318
DN	0,29762
P-Value	0,0690604

**Modified Kolmogorov-Smirnov D**

	<i>Normal</i>
D	0,29762
Modified Form	1,34052
P-Value	<0.10

**Anderson-Darling A<sup>2</sup>**

	<i>Normal</i>
A <sup>2</sup>	1,83154
Modified Form	1,83154
P-Value	>=0.10

**Fig. 2. Analysis of the studied indicator ProdAgro on the normality of the distribution**

*Source:* author’s development.

The results of three tests for normal distribution show that the studied indicator corresponds to it. This is evidenced by the fact that the lowest value of the level of significance (*P*-value) among all testing scenarios is greater than or equal to 0.05. With this value, we cannot reject the hypothesis that the indicator «agricultural production per capita per year» (ProdAgro) has a normal distribution with a probability of 95%. Therefore, the studied indicator ProdAgro can be adequately modeled in further research.

After examining the production of agricultural products per person per year from the standpoint of normal distribution and confirming this distribution using tests Kolmogorov — Smirnov, Anderson — Darling and modified Kolmogorov — Smirnov test, it is advisable to proceed to determine the projected dynamics of changes in agricultural production for future period’s preliminary determination of the level of food security.

To do this, we first conduct a general analysis of different forecasting models to select the best for our sample (*Fig. 3*).

Data variable: ProdAgro

Number of observations = 19

Start index = 1

Sampling interval = 1,0 year(s)

**Forecast Summary**

Forecast model selected: Quadratic trend =  $2003,55 + -206,161 t + 27,3103 t^2$

Number of forecasts generated: 12

Number of periods withheld for validation: 0

	<i>Estimation</i>	<i>Validation</i>
<i>Statistic</i>	<i>Period</i>	<i>Period</i>
RMSE	667,581	
MAE	473,488	
MAPE	13,7192	
ME	1,67538E-13	
MPE	-2,41074	

**Trend Model Summary**

<i>Parameter</i>	<i>Estimate</i>	<i>Std. Error</i>	<i>t</i>	<i>P-value</i>
Constant	2003,55	512,46	3,90967	0,001248
Slope	-206,161	117,994	-1,74722	0,099762
Quadratic	27,3103	5,73163	4,76483	0,000211

Fig. 3. General analysis of forecasting models

Source: author’s development.

As can be seen from Fig. 3, the analyzed data cover 19 periods. The forecast period consists of 12 intervals, which corresponds to the forecast period from 2019 to 2030. Based on the results of the general analysis, a quadratic model was chosen, which assumes that the most accurate prediction for future data is given by a quadratic regression curve, which is suitable for all initial data.

The value (*P*-value) for the square term of the model is 0.000211, which is less than 0.05, so we can conclude with a probability of 95.0% about the high reliability of the prediction.

Next, we will conduct a comparative analysis of 17 forecasting models (A—Q) to select the best for the indicator ProdAgro (Fig. 4).

In the tables of Fig. 4 summarizes the results of a comparative analysis of 17 different models for the analysis of the original data. The results of five tests for compliance of the model with the analyzed data show that the selected model E (quadratic model) passes four tests: RUNS, RUNM, AUTO and MEAN.

Thus, the model with the lowest value of the Akaike Information Criterion (AIC) is model E, which was used to make forecasts [32—38]. The results of the comparative analysis confirmed the results of the general analysis of the selected model.

**Model Comparison**

Data variable: ProdAgro

Number of observations = 19

Start index = 1

Sampling interval = 1,0 year

**Models**

- (A) Random walk
- (B) Random walk with drift = 393,094
- (C) Constant mean = 3492,28
- (D) Linear trend = 91,8316 + 340,045 t
- (E) Quadratic trend = 2003,55 + -206,161 t + 27,3103 t<sup>2</sup>
- (F) Exponential trend = exp(7,05277 + 0,0942311 t)
- (G) S-curve trend = exp(8,24803 + -1,35469 /t)
- (H) Simple moving average of 2 terms
- (I) Simple exponential smoothing with alpha = 0,9999
- (J) Brown's linear exp. smoothing with alpha = 0,4142
- (K) Holt's linear exp. smoothing with alpha = 0,9999 and beta = 0,1453
- (L) Brown's quadratic exp. smoothing with alpha = 0,1982
- (M) ARIMA(1,0,0)
- (N) ARIMA(2,1,2)
- (O) ARIMA(1,1,1)
- (P) ARIMA(0,1,0)
- (Q) ARIMA(1,0,1)

**Estimation Period**

Model	RMSE	MAE	MAPE	ME	MPE	AIC	HQC	SBIC
(A)	892,724	477,383	10,7767	393,094	7,76017	13,5886	13,5886	13,5886
(B)	824,757	511,725	14,8927	-1,01055E-13	-6,87563	13,5354	13,5439	13,5851
(C)	2149,4	1898,9	64,9226	9,57363E-14	-34,7859	15,4511	15,4596	15,5009
(D)	1007,29	762,861	29,5892	9,57363E-14	-3,74745	14,0406	14,0574	14,14
<b>(E)</b>	<b>667,581</b>	<b>473,488</b>	<b>13,7192</b>	<b>1,67538E-13</b>	<b>-2,41074</b>	<b>13,3231</b>	<b>13,3483</b>	<b>13,4722</b>
(F)	795,322	596,562	18,281	114,825	-2,2002	13,568	13,5848	13,6674
(G)	1966,14	1531,78	44,6042	420,418	-10,599	15,3782	15,395	15,4776
(H)	1061,87	583,726	12,7828	531,932	10,5142	14,0408	14,0492	14,0905
(I)	892,737	452,27	10,2098	372,427	7,3522	13,6938	13,7023	13,7436
(J)	861,313	503,763	11,7696	237,205	5,59954	13,6222	13,6306	13,6719
(K)	853,271	464,494	12,1285	115,033	-1,21466	13,7087	13,7255	13,8081
(L)	827,953	536,538	12,7809	160,608	3,02088	13,5432	13,5516	13,5929
(M)	781,477	480,171	12,7613	23,7646	-3,33691	13,4276	13,436	13,4773
(N)	690,489	448,407	12,4916	193,324	3,68238	13,4959	13,5295	13,6947
(O)	776,122	455,502	10,9944	87,8407	0,319209	13,5191	13,536	13,6186
(P)	892,724	477,383	10,7767	393,094	7,76017	13,5886	13,5886	13,5886
(Q)	805,248	498,692	13,3233	7,65181	-4,17132	13,5928	13,6097	13,6922

Model	RMSE	RUNS	RUNM	AUTO	MEAN	VAR
(A)	892,724	OK	OK	OK	OK	***
(B)	824,757	OK	OK	OK	OK	***
(C)	2149,4	OK	**	***	***	***
(D)	1007,29	***	*	*	OK	OK
<b>(E)</b>	<b>667,581</b>	<b>OK</b>	<b>OK</b>	<b>OK</b>	<b>OK</b>	<b>***</b>
(F)	795,322	OK	*	OK	OK	**
(G)	1966,14	OK	**	***	**	**
(H)	1061,87	OK	OK	OK	OK	***
(I)	892,737	OK	OK	OK	OK	***
(J)	861,313	OK	OK	OK	OK	***
(K)	853,271	OK	OK	OK	OK	***
(L)	827,953	OK	OK	OK	OK	***
(M)	781,477	OK	OK	OK	OK	***
(N)	690,489	OK	OK	OK	OK	**
(O)	776,122	OK	OK	OK	OK	***
(P)	892,724	OK	OK	OK	OK	***
(Q)	805,248	OK	OK	OK	OK	***

**Fig. 4. Comparative analysis of forecasting models**

Source: author's development.

Before the start of forecasting, we will make a mathematical adjustment of the original data, the essence of which is to determine the forecast values of the studied indicator for the previous period and their deviations from the actual data (*Table 3*).

Table 3

**Mathematical adjustment of ProdAgro source data**  
**Forecast Table for ProdAgro**

Model: Quadratic trend =  $2003,55 + -206,161 t + 27,3103 t^2$

Math adjustment:

Period	Data	Forecast	Residual
1	1584,0	1824,7	-240,7
2	1763,0	1700,47	62,5298
3	1800,0	1630,86	169,139
4	1616,0	1615,87	0,127864
5	1950,0	1655,5	294,496
6	1966,0	1749,76	216,244
7	2028,0	1898,63	129,371
8	1909,0	2102,12	-193,122
9	2248,0	2360,24	-112,236
10	2219,6	2672,97	-453,371
11	2194,3	3040,33	-846,026
12	2589,9	3462,3	-872,401
13	4892,5	3938,9	953,602
14	5588,8	4470,11	1118,69
15	5895,7	5055,95	839,749
16	5595,0	5696,41	-101,409
17	5977,5	6391,49	-413,987
18	5876,3	7141,19	-1264,89
19	8659,7	7945,51	714,195

Source: author's development.

Based on the data in *Table 3* we make a forecast using a quadratic model of agricultural production per capita per year (*Table 4*).

Table 4

**Forecast of agricultural production per capita per year**

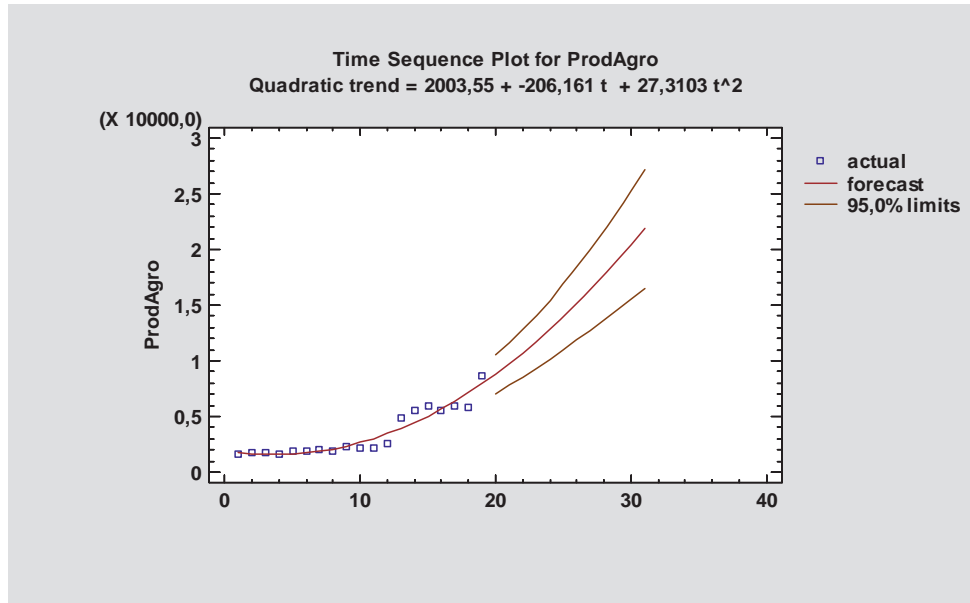
Period	Forecast	Lower 95,0%	Upper 95,0%
		Limit	Limit
20 (2019)	8804,45	7020,34	10588,5
21 (2020)	9718,01	7779,97	11656,0
22 (2021)	10686,2	8557,13	12815,2
23 (2022)	11709,0	9352,18	14065,8
24 (2023)	12786,4	10166,3	15406,6
25 (2024)	13918,5	11000,8	16836,1
26 (2025)	15105,1	11857,3	18352,9
27 (2026)	16346,4	12737,1	19955,7
28 (2027)	17642,3	13641,3	21643,3
29 (2028)	18992,8	14571,1	23414,6
30 (2029)	20398,0	15527,1	25268,8
31 (2030)	21857,7	16510,2	27205,3

Source: author's development.

Data analysis *Table 4* shows that the projected volume of agricultural production per capita per year is likely to increase over the next twelve years. In addition, for each forecast year (period) with a reliability of 95%, the lower and upper limits of the studied indicator were calculated. Thus, by 2030 in Ukraine, the trend of growth in agricultural production will most likely continue, and at a high rate.

The results of the study for better perception of information can be visualized using a graphical method.

Let us build a time schedule of the studied indicator (*Fig. 5*).

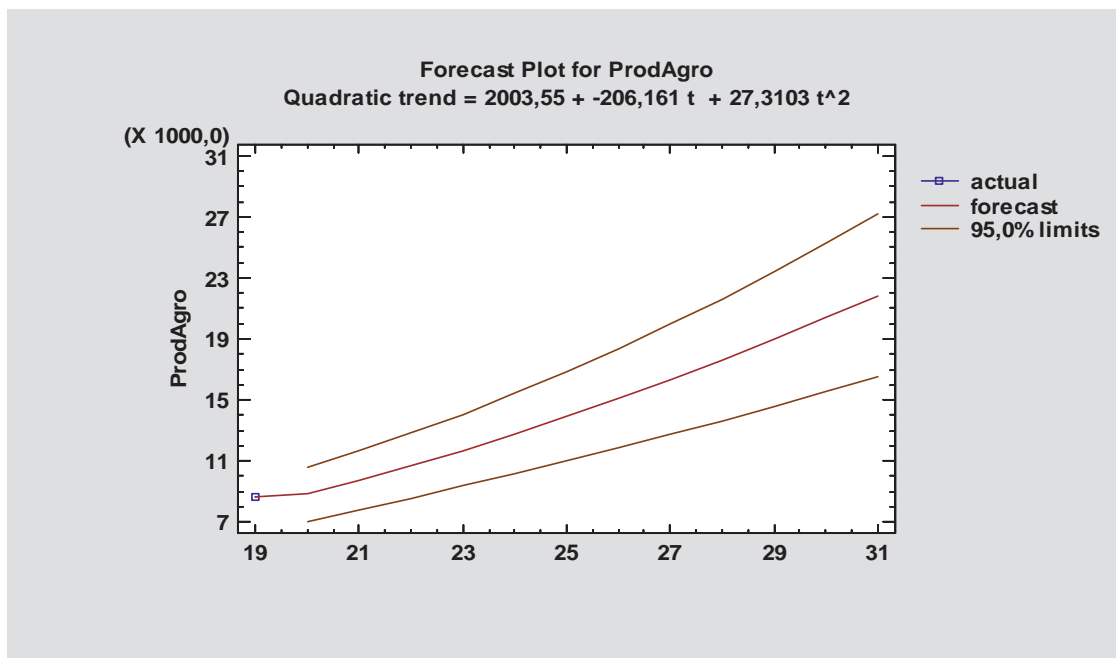


**Fig. 5. ProdAgro forecast time trend**

Source: author’s development.

Analysis of the values of *Fig. 5* shows that the time forecast of the studied indicator until 2030 is quite good, even if the situation will develop according to the scenario of the lower quantile, the possible values of which exceed the actual data for the period 2000—2018.

Let us construct the forecast schedule of dynamics of change of the investigated indicator (*Fig. 6*).



**Fig. 6. Predictive quadratic trend ProdAgro**

Source: author’s development.

As can be seen from *Fig. 6*, the actual quadratic trend line transitions to the forecast rising line [39—42]. At the same time, there is a significant deviation between the upper and lower limits, as well as deviations from the main forecast line of the trend. In any case, according to the worst-

case scenario, the indicator of agricultural production per capita per year reaches the actual level of 2018, starting in 2022.

Based on the analysis, we can conclude about the importance of food production in the economy of Ukraine and ineffective government policy on its financial support.

**Conclusions.** Thus, the results of investigation can lead to a number of important conclusions.

1. It is established that direct budget subsidies for agricultural production are ineffective short-term state support, more profitable for large agricultural firms. In Ukraine, the choice of financing model for agriculture should be guided by such factors as productivity growth, reducing the impact of seasonal and cyclical price fluctuations, optimizing government spending, reducing the impact of financial shocks, fair market competition without many natural monopolies, part of own products, reduction of public debt and tax burden on the economy.

2. Attracting external financial resources by agricultural enterprises is quite problematic, large integrated agricultural formations have an advantage here. Small commodity farmers have limited access to financial resources, including traditional bank lending.

3. It is established that the indicator of agricultural production determines the main parametric criterion on which the level of food production of both the country as a whole and individual regions depends.

4. According to the results of modeling by studies on the normality of the distribution using compliance tests (see *Fig. 3*) and the results of comparative analysis of seventeen different models and five compliance tests (see *Fig. 4*) found that most statistical tests are quadratic model (see *Table 3*).

5. According to the results calculated in *Table 4* until 2030 in Ukraine with a high probability the growth trend of agricultural production will continue, and at a high rate.

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