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MODELING OF ADDED VALUE AS A FINANCIAL INDICATOR OF ACTIVITY OF AGRICULTURAL ENTERPRISES IN THE REGIONS OF UKRAINE

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Abstract
The added value of agricultural enterprises in the regions of Ukraine has been examined in the article. Emphasis is placed on certain indicators in the assessment of added value of agricultural enterprises, which directly affect its formation. The method of added value formation in the activity of agricultural enterprises in the regions of Ukraine is considered. A forecast of added value in the activities of agricultural enterprises has been made on the basis of the STELLA program, which made it possible to show its growth due to the following factors: wages, capital investments and direct material costs. Suggestions were proposed to increase added value in the activities of agricultural enterprises in the regions of Ukraine due to the growth of capital investments, wages, balancing direct material costs. The results of the forecast obtained with the help of STELLA program, as well as the results of the conducted researches will promote the deepening of methodical experience in the field of modeling with application of approaches of system dynamics.

Keywords: *agricultural enterprises, added value, STELLA programs, direct material costs, capital investments.*
JEL Classification: *C59, Q14, O16.*

Introduction

In the system of the national economy, great hopes are placed on the agricultural sector to ensure food security. In conditions of turbulence, the activity of agricultural enterprises is the locomotive of development not only of the agricultural sector, but of the entire economy, especially during the pandemic (COVID19). Exports of agricultural products from Ukraine are growing every year, and in a pandemic, such growth is only accelerating. In particular, the share of agricultural products in Ukrainian exports has increased more than 4 times over the past 19 years. In 2001, it was only 9%, and as of 2020 - 38% (Agropolit). Instead, mainly low - added value agricultural products are exported (German-Ukrainian Forum). At the same time, products of the agricultural sector with high added value are being replaced even in the domestic market.

Most scientific publications deal only superficially with the issue of estimating added value in the activities of agricultural enterprises in the regions of Ukraine T. Landina and O. Bondarenko (2008); O. Shpykuliak and I. Bilokinna (2019). There are classical or modern European approaches to the methodology of estimating added value created at individual agricultural enterprises V. Rud (2015). Some Yu. Moroz (2011); V. Yakubiv et all. (2019), research focuses on the peculiarities of added value in the vertical integration of agricultural enterprises. Approaches that mainly deepen the essence of the concept of value added are considered N. Mykhailitska (2009). Also in the scientific literature there are publications that reveal the world and European experience in defining and applying the concept of “economic added value” O. Varchenko (2012); I. Zhurakovska et all. (2020); V. Glazyrin et all. (2018).

Decomposition of business entities by size revealed the fact that low growth rates of added value of agricultural enterprises are characteristic of all identified types of enterprises except micro-enterprises, and is accompanied by falling profitability, and the added value sector of micro-enterprises increases O. Alekseeva (2021).

Research and methods

The main purpose of the article is to summarize the existing methodological approaches to assessing the effectiveness of agricultural enterprises in the regions of Ukraine. The algorithm of added value formation and directions of improvement of information support of the analytical process has been substantiated, which is confirmed by the data of the State Statistics Service of Ukraine. To achieve this goal, the following tasks were identified: analysis of methodological approaches to determining the effectiveness of agricultural enterprises; development of an algorithm for studying the formation of added value; study of the components of information support of the process of research of agricultural enterprises and development of directions for its improvement. In order to achieve the objectives, an appropriate system of research methods was used: monographic - in formulating the purpose and conclusions of the study, the results of which are reflected in the article.

The method of theoretical generalization of foreign and domestic scientists was used in the critical analysis of existing methodological approaches to evaluating the activities of agricultural enterprises in the regions of Ukraine. In substantiating measures to improve the process of studying the effectiveness of agricultural enterprises and generalizing the conclusions used general scientific methods of cognition, such as dialectical method, analysis and synthesis, induction and deduction, systemic integrated approach. When conducting a study of the effectiveness of agricultural enterprises in the regions of Ukraine the principles of the concept, which takes into account the activities of all parts of the production process, were followed.

The computer program STELLA created by the American firm High Performance Systems B. Richmond (2001) was applied to forecast the performance of agricultural enterprises of Ukraine for the period 2001-2019 per 1 hectare of agricultural land in UAH. The STELLA (Structural Thinking, Experiential Learning Laboratory with Animation) model is used to build predictive computer models and is based on the theory of system dynamics L. Bertalanffy, (1976); J. Forrester (1978). The STELLA program successfully combined mathematical differential equations and a well-developed graphical interface W. Kwaśniecki (1998); L. Aschepkova (2002); I. Kozak and V. Parpan (2009); Balaniuk et al. (2019).

The STELLA program provides an opportunity to develop original models of systems, including economic ones, and to conduct their research V. Barlas (1996); R. Costanza and S. Gottlieb (1998); R. Costanza et all., (1998); J. Doyle and D. Ford (1998); W. Kwaśniecki (1998); J. Sterman (2000); G. Coyle (2000); R. Costanza and A. Voinov (2001); L. Aschepkova (2002); H. Akkermans and K. Oorshot (2005); Z. Sokolovskaya

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(2011); Z. Sokolovskaya and O. Klepikova (2011); Z. Sokolovskaya and N. Yatsenko (2014); Z. Sokolovskaya and N. Klepikova (2015); J. Waltersa et all. (2016); D. Ford (2019); I. Balaniuk et all. (2019); M. Yearworth (2020).

The collected indicators of added value, capital investments, direct material costs, wages are inserted into the STELLA computer program. Statistical data from 2001 to 2019, first processed in the statistical program Statistics12. In particular, it investigates the relationships between variables that affect the formation of added value (DODANA VARTIST).

Multifactor analysis was performed between 4 variables, such as: added value (DODANA VARTIST; Added value) capital investment (KAPITALNI VKLADENNJA), direct material costs (PRJAMI MATERIALNI VYTRATY), wages (OPLATA PRACI) per 1 ha of agricultural land. For this purpose, the file *"Pokaznyky dijalnosti silskohospodarskych pidpryjemstv"* was inserted into the statistical program Statistics12 (the name is given in Latin because the English-language versions of the Statistics and STELLA programs were used for the analysis).

In the future, the data is inserted into the statistical program Statistics 12 in which we select Advanced Models and General Regression. In the next step, select Polynomial regression and specify variables (Variables), among which the variable dependent is added value (DODANA VARTIST) and independent variables, such as capital investment (CAPITAL VKLADENNJA), direct material costs (PRJAMI MATERIALNI VYTRATY) and wages.

The considered example of the created economic model executed by means of the STELLA program showed it as accessible, transparent and clear. The formed equations at the stage of construction of the STELLA model can be easily corrected or repeated by other researchers. Moreover, the simulation results are presented in the form of graphs and tables. The effect of obtaining graphical results is important for the development of methods of economic research using modern computer programs.

The use of typical elements processed in STELLA programs (Stock, Flow, Converter, Action Connector) allows you to build your own economic model quite accurately.

Research results and discussion

Foreign practice shows O. Varchenko (2012); G. Zapsha and P. Sakhatskyi (2017) that the main priority for financial managers is to accumulate capital and increase the value of the company, which allows both investors and owners of the company to feel confident in the strategy of development and added value formation. Agricultural producer is no exception.

If an agricultural enterprise is not able to carry out the growing capitalization of its activities, then in market conditions, its operation can be problematic. Agricultural enterprises in most cases seek to satisfy the interests of investors. To do this, they are forced to ensure the profitability of their activities and show the economic effect. Without creating added value, the calculated financial indicators have a purely economic meaning and can be used only in the analysis. The benefit in this case may not be expected. Thus, the question of formation and methods of calculating value added is ripe. The management of agricultural enterprises in cooperation with financial managers, in today's economic conditions, seeks to manage both costs and accumulated capital. As agricultural enterprises analyze the current situation, determine the impact of both positive and negative factors on their activities and form a task that needs to be solved.

The solution of the problem consists in the following stages: we set statistical values in the program Statistics 12, we choose by usual methods optimum values of *Case no & res*, we carry out the analysis of standardized ends for a variable dependent added value, we form the prognostic equation using the Print prediction equation to *Report window tab*. Simulations by Euler's method, a system of finite-difference equations was automatically created, which allowed us to describe the behavior of the object under study in the STELLA program.

The results of regression analysis of the variable dependent added value (DODANA VARTIST) showed almost zero values of *P* (Fig. 1).

	Test of SS Whole Model vs. SS Residual (Pokaznyky dijalnosti silskohospodarskyh pidpryjemstv. Dodana vartist. Added value										
Dependent Variable	Multiple R	Multiple R2	Adjusted R2	SS Model	df Model	MS Model	SS Residual	df Residual	MS Residual	F	p
DODANA VARTIST	0,995766	0,991550	0,987325	139075256	6	23179209	1185177	12	98764,76	234,6911	0,000000

Figure 1. Results of regression analysis, variable dependent DODANA VARTIST in Statistics
**Source: calculated by the authors*.

Analysis of standardized ends for the variable dependent added value (DODANA VARTIST) showed a lack of values greater than ± *3 sigma* (Fig. 2), which indicates a lack of significant data deviations.

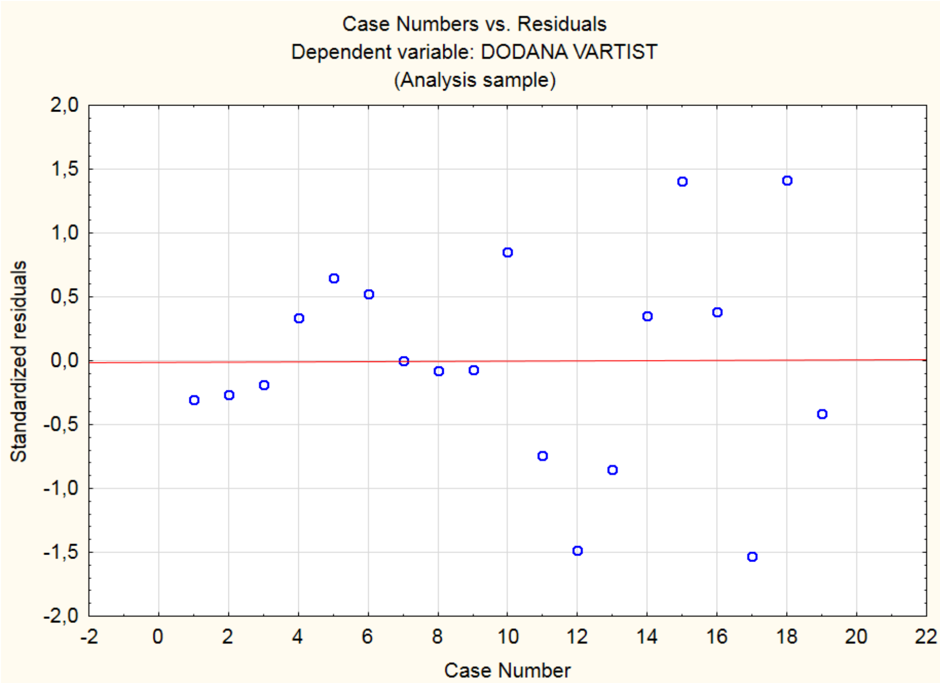

Figure 2. Placement of standardized deviations for the dependent variable value added (DODANA VARTIST)
**Source: calculated by the authors.*

To form a prognostic equation, use the Print prediction equation to Report window tab (Fig. 3).

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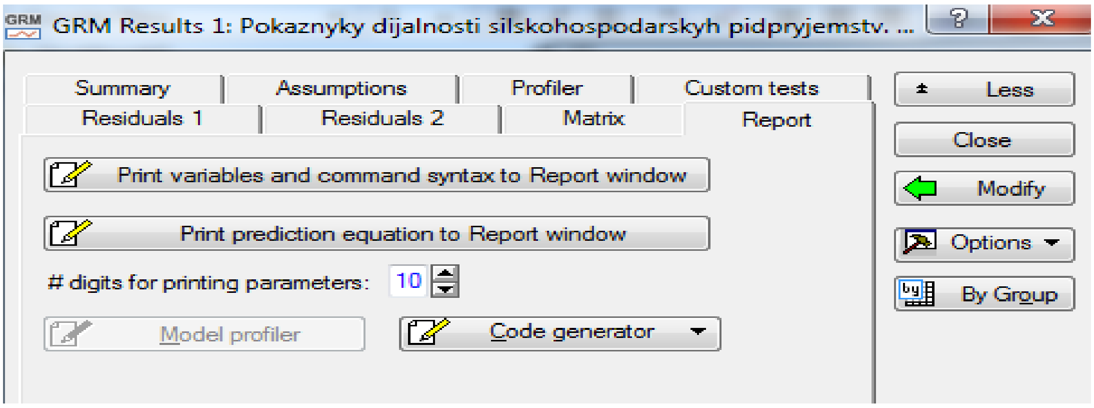

Figure 3. Creating a prognostic equation in the program Statistics 12

**Source: calculated by the authors.*

Here we only note that the collected data were analyzed for dependent variables in order to exclude cases that could violate the established regression equation. In the end, after excluding insignificant samples, the regression equations were determined, parts of which were all variables (factors) that had an impact on the studied variable. All factors were tested for the probability test $p < 0.05$ to exclude those that showed a lack of statistical reliability. After statistical processing of the collected data, a mathematical equation was obtained, which characterizes the relationships between the selected parameters.

In order to be able to insert the equation into the STELLA program, commas have been replaced by dots, and quotation marks have been removed next to the names of all variables. After that, the equation took the following form:

*Prediction equation for: Dodana vartist = 790.185501226 + 2.77978435212 * Capital investment-0.000486524312411 * Capital investment ^ 2 + 1.59260601344 * Direct material costs-0.000108074589745 * Material costs * Payments * 8807070708.*

This equation was inserted into the INFLOW element in STELLA.

When creating a model in the STELLA program, the user forms only the design of the model, and the modeling algorithm and the program are created automatically. Creating a model of the system occurs on two levels: visual and mathematical equations.

Visually, the symbols of the four main elements are presented in the upper left corner of the window (Fig. 4), such as: rectangle (Stock) I. Blahun and I. Blahun (2020) - to determine the stock; tap sign (Flow) - to indicate the flow; circles (Convertet) to denote the auxiliary variable (which can be used to describe the parameters of the model as well as auxiliary dependencies describing the system), as well as arrows (Connector) to denote the interactions between individual variables in the model. We construct the diagram of transitions, taking the corresponding "elements" (rectangle, flow, circle and arrow) from the menu and transferring them to the corresponding place on the screen as it is shown in figure (Fig. 4).

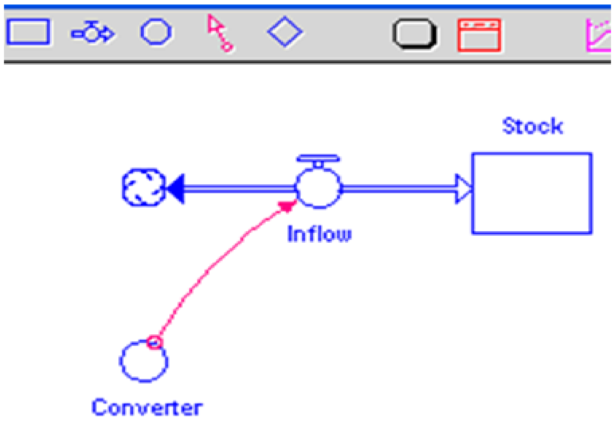

Figure 4. Fragment of the Stella program window 8.1.1

**Source: calculated by the authors.*

At the mathematical level, the models of system dynamics are systems of finite-difference equations, which are solved on the basis of a numerical algorithm of integration (according to the Euler or Runge-Kutt scheme) with a constant *DT* step (Fig. 5) and given initial values. The formation of the model by the method of system dynamics is carried out with the help of causal diagrams. Diagrams determine the relationship between variables and are marked graphs (Z. Sokolovskaya, 2011).

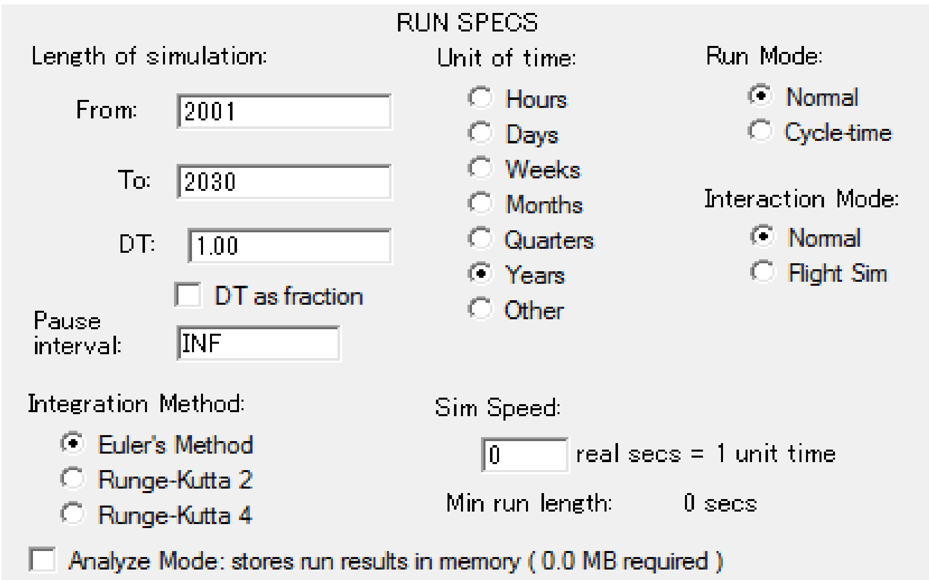

Figure 5. Setting simulation parameters by the Euler method

**Source: calculated by the authors.*

Graphical construction of elements in the structure of the model allows you to automatically create a system of finite-difference equations that describe the behavior of the object under study. That is, the level of equations is built in STELLA automatically on the basis of alternating information about the structure of the model and the values of its parameters. The model works at the level of detailed equations that describe the behavior of the studied system. A fragment of the model code is given in the figure (Fig. 6).

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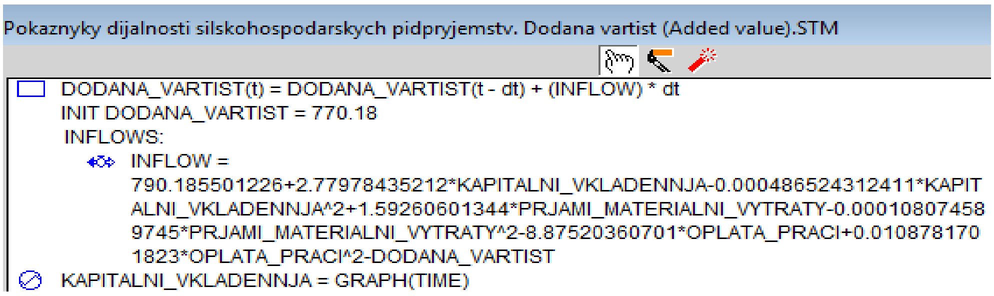

Figure 6. Fragment of automatically generated code in STELLA for the Stock variable rectangle (DODANA VARTIST) with INFLOW input stream

**Source: calculated by the authors.*

When using methods and models of system dynamics, you can change the format of parameters and use various mathematical, logical and other functions that are built into STELL in the BUILTINS icon (Fig. 7), including ROUND (to round the expression to an integer), MAX, MIN) I. Kozak and V. Parpan, (2009).

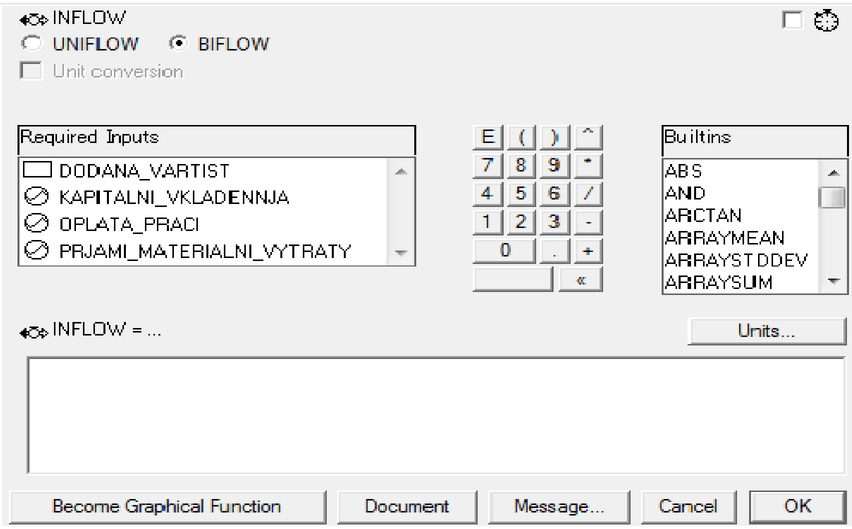

Figure 7. Ability to select BUILTINS functions in the STELLA program

**Source: calculated by the authors.*

As we see before modeling in the STELLA program; similarly to Statistics 12, 4 variables were selected that were the most statistically significant, in which the materiality limit p was set to 0.05 (ie only those variables in which the result is estimated as statistically significant). These are variables such as: variable added value (DODANA VARTIST) and independent variables, such as capital investment (KAPITALNI VKLADENNJA), direct material costs (PRJAMI MATERIALNI VYTRATY), and wages (OPLATA PRACI).

The STELLA model uses the Graphical Function. A graphical element of the STELLA program such as (Graph Pad) and a tabular element (Tabel Pad) are also used, which show the forecast results. A detailed description of the STELLA program interface and methodology can be found in the I. Kozak and V. Parpan, (2009).

Data from 2001 have been introduced into the model. Data from 2019 were used only to verify the created model. That is, the model was verified (the results of the forecast for 2019 were compared with real statistics from 2019).

After verification of the model, a forecast of possible changes in the studied parameters by 2030 was made.

After implementing the data, we can get the results in the form of model interfaces (Fig. 8), graphs (Fig. 9) or tables (Fig. 10, 11).

The figure (Fig. 8) shows a block diagram of the model. The relationships between variables are designed as graphical functions in the STELLA language. The convenience of this method is that you can change the appearance of the function directly on the computer screen with the mouse cursor. We see the rectangle created in the model (DODANA VARTIST) in the form of stock (Stock) for added value of agricultural enterprises of Ukraine per 1 hectare of agricultural land in UAH.

This stock is replenished with a flow (INFLOW) with a feedback arrow. DODANU VARTIST through INFLOW is affected by 3 Converters - capital investments (KAPITALNI VKLADENNJA), direct material costs (PRJAMI MATERIALNI VYTRATY), and wages (OPLATA PRACI). On the right there is a *Graph Pad* element called *Hrafik prohnozu* and a *Table Pad* element called *Tablycja prohnozu*.

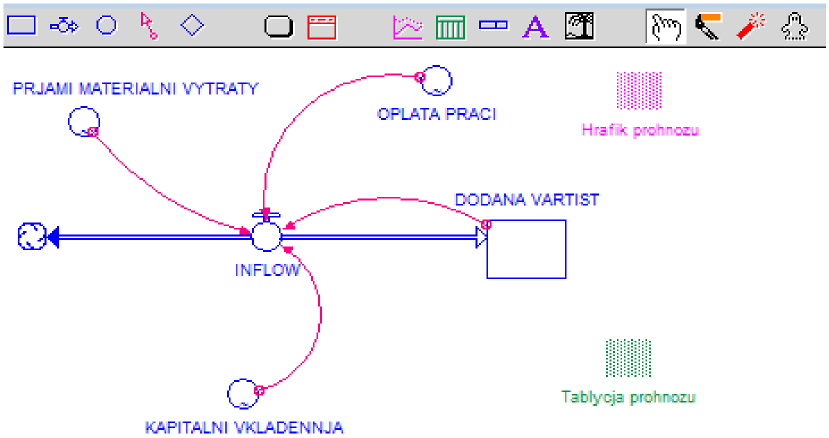

Figure 8. The interface of the created model in the STELLA program

**Source: calculated by the authors.*

The verification of the model consisted of comparing the real data from 2019 with the data predicted in the model for 2019. We see that the model is 97 – 99 % in the real data of 2019. Thus, in 2019 the real data for the variable DODANA VARTIST amounted to UAH 8667.74, for CAPITAL INVESTMENT - UAH 1431.34, for PRJAMI MATERIAL VYTRATY - UAH 6461.2, for OPLATA PRACI - UAH 719.66. per 1 hectare of agricultural land.

Accordingly, the forecast model showed (Fig. 9) in 2019 - for the variable DODANA VARTIST 8390 UAH. per 1 ha, for KAPITALNI VKLADENNJA UAH 1,448. per 1 ha, for the variable PRJAMI MATERIALNI VYTRATY UAH 6,602. per 1 ha, for the variable OPLATA PRACI UAH 731 per 1 ha. These data are highlighted under the names at the top of the figure and show the values of the parameters for DODANA VARTIST, KAPITALNI VKLADENNJA, PRJAMI MATERIALNI VYTRATY, OPLATA PRACI as of 2019. They relate to an additional vertical line (2019.00) which shows 2019 and is visible in the figure between 2018 and 2024.

That is, in the model we have the opportunity to specify data from any year using an additional vertical line with the highlight of the selected year, as well as to highlight the values of the analyzed parameters this year. Since this is shown for the 2019 data for which the model was verified.

From the verification we see for 2019 that the difference between the real and verified data in the model is very small and is equal to 277.74 UAH for DODANA VARTIST. which is 3.2% (real data 8667.74, and the projected 8390 UAH). There is even

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less difference between real and verified in the model data for KAPITALNI VKLADENNJA. It is equal to UAH 16.66. i is 1.2% (real data UAH 1,431.34, and projected UAH 1,448). For PRJAMI MATERIAL EXPENSES, respectively, UAH 140.8. ie 2.1% (actually UAH 6,461.2 and verified in the forecast of UAH 6,602 per 1 ha). For OPLATA PRACI, respectively, UAH 11.34, which is 1.5% (actually UAH 719.66 and verified in the forecast of UAH 731 per 1 ha of agricultural land).

That is, the deviation in the forecast from the real data for 2019 at the level of 1.2 - 3.2%, which means that the model is verified and included in the real data for 2019 at the level of 96.8-98.8%. Moreover, for DODANA VARTIST the model in the verification in 2019 showed a tendency to slightly underestimate the data (real data 8667.74 UAH, and the projected 8390 UAH), while for KAPITALNI VKLADENNJA, PRJAMI MATERIALNI VYTRATY, and OPLATA PRACI to slightly overestimate compared to real data this year.

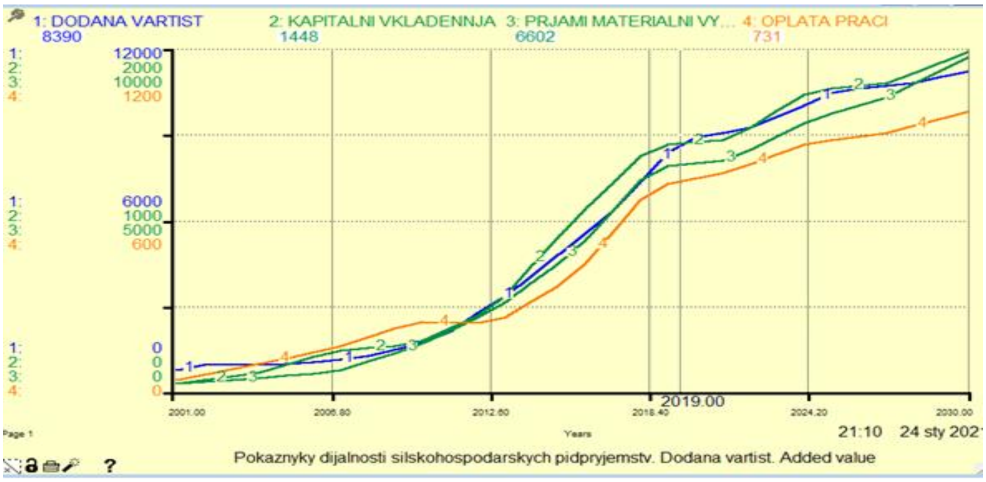

Figure 9. Graphical display of forecasting results in the STELLA program

**Source: calculated by the authors.*

It is possible to indicate the data from 2019 (for which the model was verified) also in the table (Fig. 10). Here we see values up to 2 decimal places.

We also see the data of DODANA VARTIST per UAH per 1 ha of agricultural land (8390 UAH) in 2019 for which the model was verified, as well as the value (11051.96 UAH) of the analyzed parameter in 2030 of the forecast (Fig. 11). For the predicted values in the table we see a special sign that separates the thousands.

As we can see (Figs. 11, 12), the model created in the STELLA program predicts that by 2030, with an increase in capital investment, direct material costs, wages, a projected increase in added value is possible. This means that further changes may be observed in Ukraine N. Pylypiv et all. (2018).

Specific values of the predicted analyzed variables by 2030 can be seen in the figures in the tabular form (Fig. 10, 11), as well as in the figures with numbered lines of variables (Fig. 9, 12).

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Years	DODANA VARTIST	KAPITALNI VKLADENNJA	OPLATA PRACI	PRJAMI MATERIALNI VYTRATY
2001	770.18	50.00	42.00	250.00
2002	965.79	70.69	60.28	301.72
2003	959.51	91.38	78.55	353.45
2004	959.50	114.48	97.07	406.90
2005	973.17	159.31	117.76	475.86
2006	1†059.79	204.14	138.45	544.83
2007	1†152.74	242.76	161.21	648.28
2008	1†275.31	256.55	192.24	889.66
2009	1†498.49	270.34	223.28	1†131.03
2010	1†729.85	301.72	244.48	1†413.79
2011	2†100.59	374.14	242.76	1†793.10
2012	2†756.87	446.55	241.03	2†172.41
2013	3†377.01	560.34	262.07	2†627.59
2014	4†054.80	736.21	317.24	3†196.55
2015	4†838.75	912.07	372.41	3†765.52
2016	5†588.87	1†075.86	455.17	4†481.03
2017	6†398.14	1†227.59	565.52	5†343.10
2018	7†353.36	1†379.31	675.86	6†205.17
2019	8†390.45	1†448.28	731.38	6†601.72

Figure 10. Forecast of possible changes in the analyzed parameters

**Source: calculated by the authors.*

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Years	DODANA VARTIST	KAPITALNI VKLADENNJA	OPLATA PRACI	PRJAMI MATERIALNI VYTRATY
2019	8†390.45	1†448.28	731.38	6†601.72
2020	8†927.11	1†462.07	750.34	6†687.93
2021	9†096.77	1†475.86	769.31	6†774.14
2022	9†272.47	1†547.59	799.14	7†077.59
2023	9†639.53	1†644.14	833.62	7†474.14
2024	10†072.32	1†740.69	868.10	7†870.69
2025	10†487.92	1†773.79	884.66	8†143.10
2026	10†654.41	1†791.03	896.72	8†384.48
2027	10†752.46	1†808.28	908.79	8†625.86
2028	10†840.80	1†865.86	933.28	9†006.90
2029	11†051.96	1†927.93	959.14	9†403.45
Final	11†255.34	1†990.00	985.00	9†800.00

Figure 11. Results of forecasting from 2019 to 2030 in the STELLA program

**Source: calculated by the authors.*

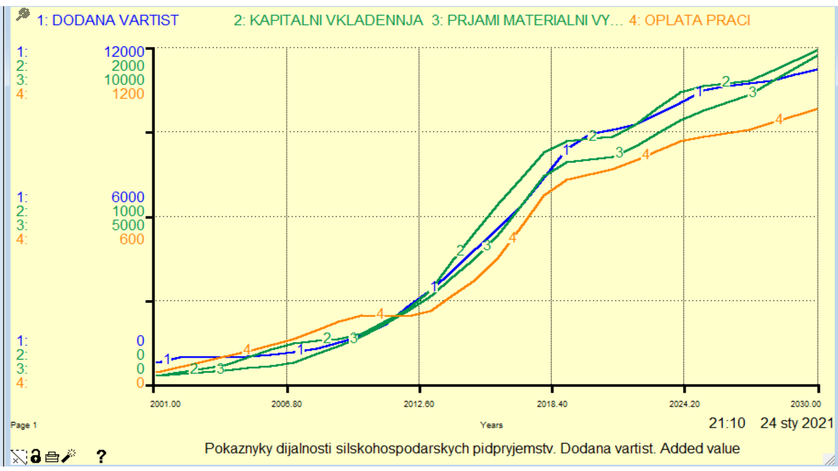

Figure 12. Graphical display in the STELLA program of the results of forecasting the analyzed indicators

**Source: calculated by the authors.*

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Each line on the chart has its own corresponding number. For example, DODANA VARTIST has the number 1. Respectively KAPITALNI VKLADENNJA number 2, PRJAMI MATERIALNI VYTRATY number 3, and OPLATA PRACI number 4. The analyzed indicators also have the corresponding line color in the STELLA program. On the left side the figure shows the scale for each of the analyzed indicators.

As we can see from the forecast in the STELLA program after 2020, a slight slowdown in the growth rates of the analyzed indicators is also possible, but their growth trend will remain. That is, the model predicts slight fluctuations with a general upward trend.

The results of the forecast showed a possible increase in added value (DODANA VARTIST) by 2030 per 1 ha of agricultural land (Fig. 13) to UAH 11,225 with an increase in capital investment (KAPITALNI VKLADENNJA) to 1990 UAH (Fig. 14), direct material costs (PRJAMI MATERIALNI VYTRATY) to 9800 UAH (Fig. 15), and wages (OPLATA PRACI) to 985 UAH. (Fig. 16).

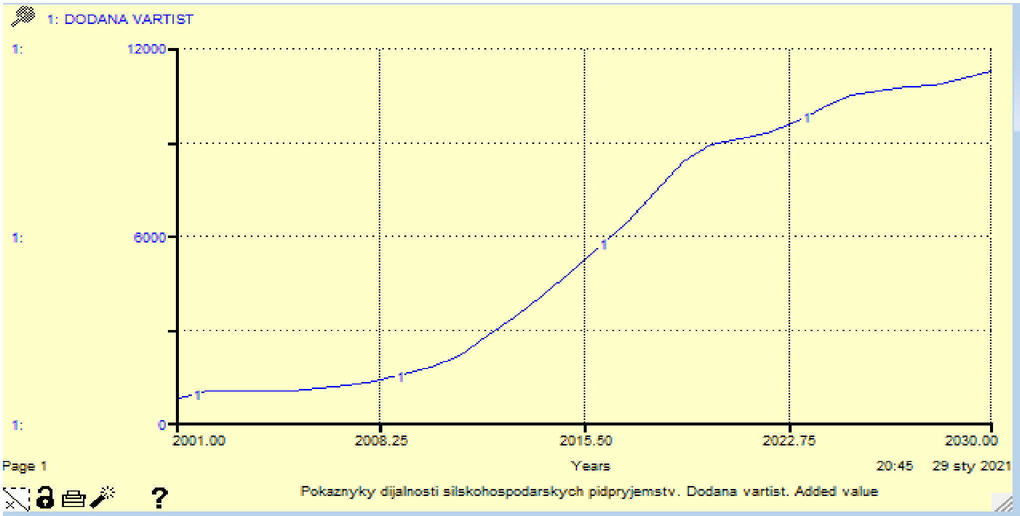

Figure 13. Graphical display in the STELLA program of the results of value-added forecasting (DODANA VARTIST)

**Source: calculated by the authors.*

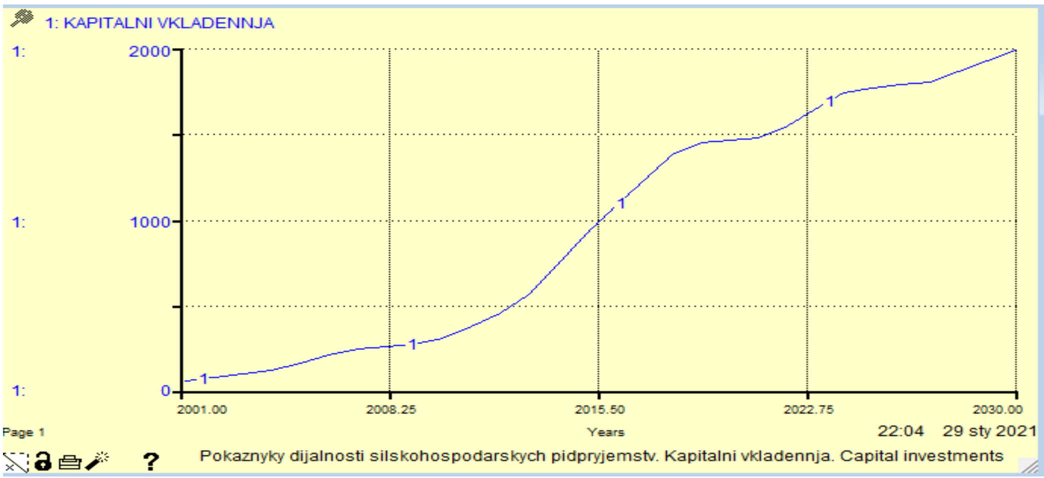

Figure 14. Graphical display in the STELLA program of results of forecasting of capital investments (CAPITAL INVESTMENT)

**Source: calculated by the authors.*

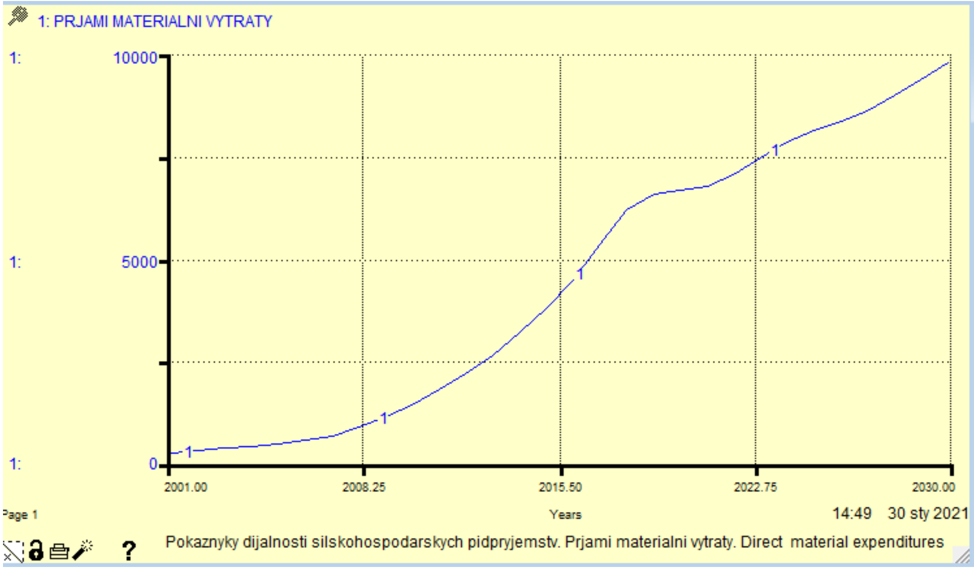

Figure 15. Graphical display in the STELLA program of the results of forecasting direct material costs (PRJAMI MATERIALNI VYTRATY)

**Source: calculated by the authors.*

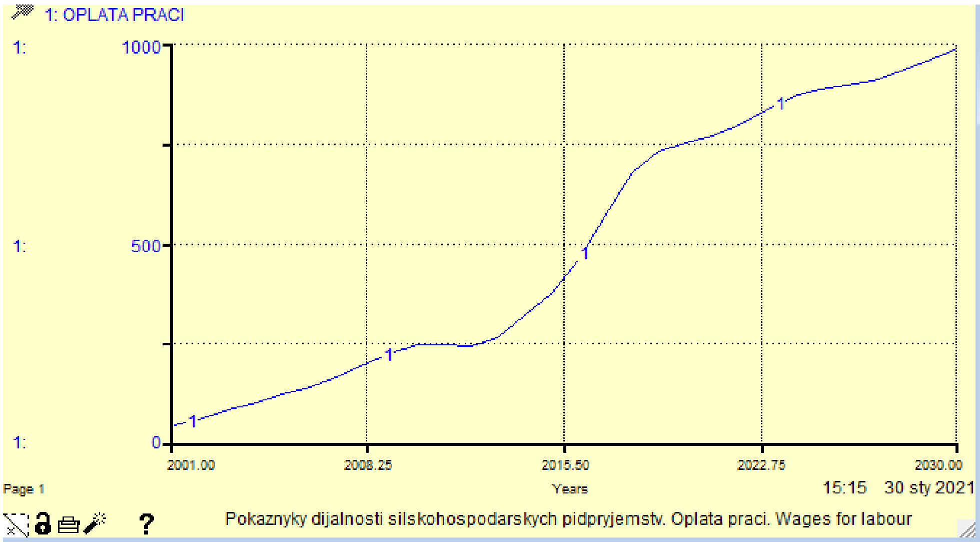

Figure 16. Graphical display in the STELLA program of salary forecasting results (OPLATA PRACI)

**Source: calculated by the authors.*

Actually, the use of STELLA as a special program of economic modeling is quite promising if we talk about its application in the economy. It should be noted that this type of model, which is based on the dynamics of systems and the STELLA program, has been actively applied in their research by domestic scientists I. Balanyuk et. all (2019) and other leading scientists of Ukraine P. Matkovsky (2019); M. Savka (2020). This program was used abroad by R. Costanza and S. Gottlieb (1998). They were the ones who began to actively use the STELLA program in their research.

We have proved that despite the growth of added value in agricultural activities of enterprises, there is a caveat that it will increase in the near future due to agricultural products with low added value. Therefore, the state is forced to build its strategy in the

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agricultural sector on the basis of agricultural production with high added value.

Conclusions

As the results of our research in Ukraine have shown, added value is an effective indicator of economic activity. The parameter predicted in the model (DODANA VARTIST) shows a steady increase until 2030. When forecasting the parameter (DODANA VARTIST), an original model was created in the STELLA program, which was used to determine the impact of capital investments, direct material costs and wages on the formation of added value in agricultural enterprises.

Forecasted indicators show an increase in capital expenditures, wages and direct material costs per 1 ha of agricultural land by 2030. Thus, capital costs will amount to UAH 1990.00, wages will amount to UAH 985.00, and direct material costs will amount to UAH 9800.00.

In general, the presented study can provide production expansion; increase the resource base of agricultural enterprises in the regions of Ukraine, especially when the effectiveness of their activities depends on the modern competitive environment, resource provision of production in accordance with the needs of target market segments.

The forecast changes in value added (DODANA VARTIST) of the indicators of activity of agricultural enterprises of Ukraine until 2030 per 1 hectare of agricultural land in UAH presented in the article and processed with the help of STELLA program can be the basis for planning agricultural production in the future.

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