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ESTIMATION OF DIGITALIZATION INVESTMENT PROJECTS IN AGRICULTURAL ENTERPRISES

Abstract. The future of agriculture is digital. In the context of accelerated digitalization of the agricultural sector of the economy, it is important to assess the effectiveness of certain tools of digitalization in the production and management of agricultural enterprises.

The purpose of the article is to assess the economic efficiency of the introduction of certain tools for digitalization of management in agricultural enterprises based on the analysis of investment projects depending on the size of the land bank of agricultural producers and their investment opportunities.

Results of the research. The forecast indicators of the value of money and discounting coefficients necessary for the construction of a strategic horizon of proposals for the implementation of individual investment projects of digitization tools have been calculated. An analysis of cash flow indicators in the implementation of individual investment projects for the purchase of digitization tools. The main economic indicators of efficiency of realization of investment projects at the land bank of the agricultural enterprise in 500 and 5000 hectares have been defined.

The expediency of practical introduction of digitization tools in agricultural enterprises has been substantiated. Calculations of efficiency indicators of acquisition of tools of digitalization of agricultural production have been conducted. This allows both large and small in size land bank agricultural enterprises to determine the feasibility of investing in investment projects of varying complexity.

Keywords: digitalization tools, agricultural enterprises, investment project, efficiency, land bank, financial resources.

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ОЦІНКА ІНВЕСТИЦІЙНИХ ПРОЄКТІВ ЦИФРОВІЗАЦІЇ В СІЛЬСЬКОГОСПОДАРСЬКИХ ПІДПРИЄМСТВАХ

Анотація. В умовах прискореної цифровізації аграрного сектору економіки актуальним є оцінка ефективності застосування окремих інструментів цифровізації у виробництво та управління сільськогосподарськими підприємствами.

Метою статті є проведення оцінки економічної ефективності впровадження окремих інструментів цифровізації управління в сільськогосподарських підприємствах на основі аналізу інвестиційних проєктів залежно від розміру земельного банку виробників аграрної продукції та їхніх інвестиційних можливостей.

Розраховано прогностичні показники вартості грошей і коефіцієнти дисконтування, потрібні для побудови стратегічного горизонту пропозицій із реалізації окремих інвестиційних проєктів інструментів цифровізації. Проведено аналіз показників грошового потоку при реалізації окремих інвестиційних проєктів із придбання інструментів цифровізації. Визначено основні економічні показники ефективності реалізації інвестиційних проєктів при земельному банку сільськогосподарського підприємства у 500 і 5 000 га.

Обґрунтовано доцільність практичного впровадження інструментів цифровізації в сільськогосподарських підприємствах. Проведено розрахунки показників ефективності придбання інструментів цифровізації сільськогосподарського виробництва. Це дозволяє як великим, так і малим за розмірами земельного банку сільськогосподарським підприємствам визначатися з доцільністю вкладення коштів у різні за складністю інвестиційні проєкти діджиталізації.

Ключові слова: інструменти цифровізації, сільськогосподарські підприємства, інвестиційний проєкт, ефективність, земельний банк, фінансові ресурси.

Формул: 0; рис.: 0; табл.: 4; бібл.: 11.

Introduction. The digital transformation of agricultural production has been seen as one of the ways to diversify the national economy, its reorientation from the raw material model of exports to the supply of products with high added value. To accelerate the implementation of digitalization processes, the Cabinet of Ministers of Ukraine has approved the Concept of Digital Economy and Society of Ukraine for 2018—2020 [1], which, in particular, provides for increased productivity and efficiency of agriculture through the introduction of modern digital technologies in business. The digitalization of the production and management processes of agricultural enterprises requires the integrated implementation of digital technologies. This implies a significant intensification of investment activities of agricultural enterprises in the direction of the introduction of certain digitization tools, which requires calculations of the economic efficiency of the implementation of digitization tools.

Analysis of research and statement of the problem. The research problems of efficiency of realization of tools of digitalization in practical activity of the enterprises are rather new though separate researches in the outlined direction have been conducted: Yu. Voloshchuk [2] — definition of directions of digitalization of the agricultural enterprises, O. Gudz [3] — digitalization as a competitive advantage of the enterprises, T. Koneva [4] — features of introduction of innovations by agrarian enterprises, M. Lobas, V. Rossokha [5] — mechanisms of management of innovative-technological development of agricultural sphere, Yu. Lupenko, M. Malik [6] — innovative providing of agriculture development, I. Svytnous [7] — methodological approaches to assessing the effectiveness of investment activities in terms of digitization tools, N. Sirenko [8] — digitization as a component of the agricultural enterprises' strategy and others.

Among foreign scholars, we have highlighted the works of M. Bacco, P. Barsocci, A. Voltaire, A. Gott, M. Ruggeri, E. Ferro, R. Huber [9; 10], which explored the prospects of using digitization tools in agricultural production and problems of efficiency of application of technologies of «precision agriculture» in the maintenance of sustainable development of agriculture. Paying tribute to respected scientists, we have emphasized that the dynamism of

digitalization and the need for practical application of digital technologies and their impact on the efficiency of agricultural enterprises functioning necessitate the deepening of research in this direction.

The article aims to assess the economic efficiency of the implementation of certain tools for the digitization of management based on the analysis of investment projects of agricultural enterprises depending on the size of their land bank and investment opportunities.

Results of research. The assessment of the economic efficiency of the implementation of certain tools for management digitization in agricultural enterprises should be carried out based on a comprehensive analysis of the investment project's financial performance. It is planned to use the basic indicators to assess its effectiveness:

- 1) net present value (NPV);
- 2) internal rate of return (IRR);
- 3) discounted payback period (PBP).

The methodology for evaluating the implementation of management digitalization tools in agricultural enterprises as an investment project involves the calculation of discounted incoming and outgoing cash flows within a certain project period. Given the relatively rapid obsolescence of digitalization tools, the maximum period of their implementation as an investment project is defined as medium-term — five years. Thus, when investing in the introduction of specific digitalization tools in 2020, the return on investment will be in 2021—2025.

The analysis of the implementation of individual investment projects in the agricultural sector has suggested that the level of validity of the economic efficiency of the investment project, associated with the use of digitization tools, depends on the correctness of calculations of projected revenue streams (revenues) and expenditures as $CF_{in}(i, t)$, $CF_{out}(i, t)$, $CF_{net}(i, t)$, where CF_{in} — incoming cash flow from the implementation of the investment project, which is associated with the use of the i -th digitization tool;

CF_{out} — the initial cash flow in the implementation of the investment project, which is associated with the use of the i -th digitization tool;

NCF — net cash flow, which is calculated as the difference between input and output flows;

i — serial number of the digitization tool;

t — the ordinal number of the year of implementation of the investment project.

In-depth attention has been paid to the proper justification of discount rates, which will reduce the current values of incoming and outgoing cash flows. In determining the forecast values of annual discount rates, we will have used the forecast values of three parameters that will objectively assess the value of money over time:

- 1) inflation (consumer price index);
- 2) the discount rate of the NBU;
- 3) market yield of 5-year IGLBs (domestic government bonds).

Based on each parameter, intermediate annual discount coefficients have been constructed, the ordinal number of which corresponds to the above-mentioned ordinal number of the corresponding macroeconomic indicator. And the total discount coefficients have been calculated as the geometric mean of the three intermediate coefficients.

The next step of the study is to substantiate the forecast values of intermediate discount rates. The National Bank of Ukraine has set an inflation target range (Consumer Price Index) with a target of «5% ± 1 percentage point» with a medium-term goal of 5%. Given the spread of the pandemic related to the mass disease COVID-19, the introduction of quarantine restrictions and deficit financing of budget expenditures (it is planned to increase the budget deficit from 2,5% of GDP to 7,5% of GDP) in Ukraine is expected to increase in the 2020-year inflation to 9% with its reduction in subsequent years to the medium term. However, the price of money is usually higher than inflation, so when calculating the discount rate (1) added 2 percentage points.

On the other hand, it is necessary to take into account the dynamics of the NBU discount rate, because it acts as a benchmark for interest rates. Given the fact that a commercial bank can get a loan at the rate of «accounting + 2 percentage points», this is the basis of the benchmark of the

price of money. But taking into account the risk premium as one of the elements will also be added 2 p.p. Therefore, the discount rate (2), based on the dynamics of the discount rate, has been calculated with the addition of 4 percentage points.

Forecast indicators of the value of money and discount rates in 2021—2025 have been presented in *Table 1*.

Table 1

**Forecasted indicators of the value of money and discount rates
in 2021—2025**

Indicator	2020	2021	2022	2023	2024	2025
Forecast inflation (CPI), %	9	7	6	5	5	5
Forecast NBU discount rate, %	10	9	9	8	8	7
Forecast market yield of IGLBs, %	12	11	10	9	9	8
Discount rate (1)	1,110	1,090	1,080	1,070	1,070	1,070
Discount rate (2)	1,140	1,130	1,130	1,120	1,120	1,110
Discount rate (3)	1,130	1,120	1,110	1,100	1,100	1,090
Discount rate	1,127	1,113	1,106	1,096	1,096	1,090

Source: calculated by the authors on the basis of data from the Ministry of Finance of Ukraine and the National Bank of Ukraine.

The algorithm for constructing a strategic horizon of proposals for the implementation of individual investment packages of digitization tools should take into account several key starting points: first, the uneven financial opportunities of agricultural enterprises, which will differentiate different investment options depending on available funds; secondly, the actual land bank of the agricultural enterprise (to take into account the effect of scale). Therefore, the calculations have been made here for agricultural enterprises that produce crop products on areas of 500 hectares and 5000 hectares. Also, when calculating the net cash flow, the average level of the index of growth of prices for crop products of 105% and the index of growth of costs of 110% is taken into account.

To ensure objectivity and reduce traditional risks in assessing the effectiveness of investment, the following provisions have been taken into account:

- 1) is estimated at the lower limit of the interval;
- 2) expenditures are estimated at the upper limit of the interval;
- 3) when adjusting for years the values of indicators that are constant, revenues increase by a factor of 1,05, and expenditures — 1,1;
- 4) the liquidation value of the asset is assumed to be zero;
- 5) it is assumed that agricultural enterprises are not payers of income tax, so the traditional approach for investment analysis to include in C_{fin} an additional component in the form of reduction of income tax through tax accounting of depreciation is not applied.

We consider that all these measures together ensure the avoidance of overly optimistic estimates, and therefore the economic efficiency of investment in the introduction of management digitalization tools in agricultural enterprises has been essentially calculated according to the pessimistic scenario of future net cash flows. At the same time, taking into account each item in the practical implementation of investment projects will increase their economic attractiveness.

For each project, cash flow calculations have been performed and efficiency indicators of its implementation have been determined. If digitization tools are used in different periods of agricultural work, the calculation of C_{fin} will have been carried out for each of them. Also, the weighted average yield per hectare (ARPU) and the share of the period in the formation of C_{fin} are determined.

An example of calculating the economic efficiency of an investment project for the purchase of autopilot and a course planner (with appropriate installation on a tractor), which can potentially be used in the process of tillage, pre-sowing preparation, sowing, and care of crops. The results of the calculation of cash flow indicators in the implementation of the above project have been presented in *Table 2*.

Table 2

**Cash flow indicators in the implementation of the procurement project
autopilot and course instructor**

Indicator	2020	2021	2022	2023	2024	2025
Incoming cash flow (Cfin)	0,0	394,9	414,6	435,4	457,1	480,0
Outgoing cash flow (Cfout)	220,0	4,4	4,4	4,4	4,4	4,4
Net cash flow (NCF)	-220,0	390,5	410,2	431,0	452,7	475,6
Discounted NCF	-220,0	350,8	332,7	318,4	304,7	293,4

Source: calculated by the authors.

Based on the data in *Table 2*, we have calculated the performance indicators of the project of investment in the purchase of autopilot and course indicator. At the land bank of the enterprise in 5000 ha the weighted average income per 1 ha (ARPU) in the first year of project implementation is 65,5 UAH, net present value (NPV) — 1380 thousand UAH, internal rate of return (IRR) — 181%, discounted payback period (PBP) — 0,69 years. Analysis of the income structure in terms of the above four stages of agricultural production has shown that the largest shares fall on crop care (64,1%) and pre-sowing preparation (26,2%). This is because the largest share of income is generated by the care of crops, which can be technologically realized on 5000 hectares. If the agricultural enterprise has an area of 500 hectares, the efficiency of this investment project deteriorates sharply: NPV = 443 thousand UAH, IRR = 72%, PBP = 1,66 years.

Detailed calculations of economic efficiency of investment projects for the acquisition of individual digitization tools have been conducted in a study [11], based on which a general summary table was formed, which will identify the most attractive by the criterion of economic efficiency of investment projects. Let's form the first table of indicators of efficiency of investment projects at the land bank of the agricultural enterprise in 5000 hectares (*Table 3*).

Table 3

**Indicators of efficiency of investment projects at land bank of the enterprise
in 5000 hectares**

№ Pro-ject	Digital tool	Investments, thousand UAH	Net present value (NPV), thousand UAH	Internal rate of return (IRR), %	Discount payback period (PBP), years	Weighted average income (ARPU), UAH / ha
1.	Autopilot + course pointer	220	1380	181	0.69	65,5
2.	System of automatic shutdown of sections of a sprayer	60	2094	881	0.14	75,3
3.	System of automatic shutdown of sections of a seeder	150	122	38	2,75	136,1
4.	System of liquid fertilizer application during sowing	90	207	80	1,52	146,5
5.	Differential method of fertilization	380	982	88	1,40	55,2
6.	Field condition monitoring (drones, UAVs)	235	196	39	2,72	17,6
7.	Alternative fertilization and PPE (drones)	308	151	28	3,36	22,0

Source: compiled by the authors based on their calculations.

Summarizing the data in *Table 3*, it can be stated that the most valuable for agricultural enterprises is the project № 5 on differentiated fertilization, which involves retrofitting the fertilizer spreader and conducting a comprehensive soil analysis (which costs an average of 61 UAH / ha) and requires 380 thousand UAH.

Investment. The most «democratic» in price option is the project № 2 (sprayer equipment with automatic shut-off system sections), investment in which is only 60 thousand UAH. Project № 2 has the highest level of net present value (NPV) and project № 3 has the lowest level. As for the internal rate of return (IRR), the highest performance is again the second project to purchase a system of automatic shutdown of the sprayer sections. The high efficiency of the second project has been explained by the possibility of processing a large area of agricultural land with this digital tool (which is significantly stretched in time, as it is used for both pre-sowing and soil care), which directly affects its efficiency. Project №7 has the lowest IRR of 28%, but not much higher IRR in projects № 6 and № 3 — 39% and 38% respectively. The second project has the shortest payback period — estimated at 0,14 years. The longest payback period is characterized by project № 7 on alternative fertilization and plant protecting tools (PPT) using drones.

The highest weighted average yield per 1 ha (ARPU) is provided by projects № 4 and № 3 — 146,5 and 136,1 UAH / ha, respectively, and the lowest — by projects № 6 and № 7 — 16 and 22 UAH / ha. Note that the most attractive in terms of selling price — the second project has an average among the calculated ARPU, which is equal to 75,3 UAH / ha.

The next step is to analyze the consolidated indicators of efficiency of investment projects related to digitalization of agricultural enterprise management, with the existing land bank of 500 hectares (*Table 4*) and note that the sixth and seventh investment projects involve the use of digitization tools such as drones, which are used to monitor the condition of fields and alternative fertilizers. Given the relatively high investment value of these digitization tools and the longest payback period of invested funds, even at a land bank of 5000 hectares, the feasibility of implementing the outlined digitization tools at a land bank of 500 hectares — is minimal. We consider those small agricultural enterprises should use drones and UAVs only in their joint use and cooperation, as the payback period of investments with a small sown area of a particular agricultural enterprise is disproportionately long.

Table 4

Indicators of efficiency of investment projects at land bank of the enterprise in 500 hectares

№ Project	Digital tool	Investments, thousand UAH	Net present value (NPV), thousand UAH	Internal rate of return (IRR), %	Discount payback period (PBP), years	Weighted average income (ARPU), UAH / ha
1.	Autopilot + course pointer	220	443	72	1,66	108,9
2.	System of automatic shutdown of sections of a sprayer	60	242	125	0,99	75,3
3.	System of automatic shutdown of sections of a seeder	150	122	38	2,75	136,1
4.	System of liquid fertilizer application during sowing	90	207	80	1,52	146,5
5.	Differential method of fertilization	380	- 135	- 4	7,76	39,6

Source: Calculated by the authors based on their calculations.

Table 4 shows the results of the calculations of key indicators for five investment projects at the land bank of the enterprise in 500 hectares.

The data in *Table 4* show that the most attractive investment project for agricultural enterprises with a land bank of 500 hectares is the second, which has the shortest payback period (within one year) and the highest rate of return (125%). The fifth investment project is the least attractive, as the net present value (NPV) and the internal rate of return (IRR) have negative values — (-135) thousand UAH and -4% respectively.

The next important step is the selection of specific investment projects for the purchase of digitization tools depending on the available financial opportunities and the size of the land bank of

the agricultural enterprise. The calculations given in the article allow us to choose the best options for investment depending on the number of funds available to the agricultural enterprise.

Thus, using the calculations, it is possible to offer agricultural enterprises separate sets of digitization tools and calculate their total efficiency indicators, which will serve as a starting point for building a comprehensive approach to the digitalization of the enterprise, as «point» digitization projects tend to have much lower efficiency and can provoke a negative experience of digitalization, which will slow down the overall process of the digital transformation of agricultural production and updating its technical and technological base.

Conclusions. Thus, the analysis of the implementation of investments in digitization tools for agricultural enterprises has allowed the formulating the following conclusions:

– both large and small agricultural enterprises (with a land bank of 500 ha or 5000 ha) have a wide range of options for investors depending on their financial capabilities;

– the most attractive sets of investment projects in digitization tools, which can choose agricultural enterprises, trying to maximize the level of NPV within certain investment opportunities, require a clear delineation of investment amounts and appropriate calculations using *Tables 3 and 4*;

– the calculations of the main indicators of the evaluation of the effectiveness of the implementation of investment proposals have proved the feasibility of investing funds of agricultural enterprises in digitalization tools. Some projects have higher efficiency indicators, others are slightly lower, but the general trend towards digitalization of agricultural enterprises has a solid economic basis.

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