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EVALUATION OF THE ECONOMIC EFFICIENCY OF RESTORATION OF DRAINAGE SYSTEMS IN THE HUMID ZONE OF UKRAINE: MAKING INVESTMENT DECISIONS

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Abstract. *Approaches to assessment of the economic effectiveness of restoring drainage systems in the humid zone of Ukraine are substantiated. A conceptual scheme has been developed that determines the stages of evaluation, sources of the input array of information, strategic orientation, and invariance of restoration projects, provides for considering a number of risks and limitations of a systemic and non-systemic nature when evaluating the project effectiveness of strategic alternatives. The basis of the evaluation is the results of the analysis of materials regarding the technical condition of drainage systems, the restoration of which in the drainage area is carried out according to two options: modernization of working (on an area of 1311.2 thousand ha) and restoration of non-working (on an area of 1962.9 thousand ha) drainage systems. In the calculations of restoration (modernization) costs, the results of a preliminary assessment of the cost of restoration work for various types of drainage systems (drainage, drainage-humidification, polder, and water circulation systems) were used based on the reduced costs for restoration of the intra-farm and inter-farm network, which were adopted in the "Strategy of Irrigation and Drainage ..." [27]. The economic indicators of the production of agricultural crops economically attractive to farming producers (grain corn, sunflower, rapeseed, soybean) were calculated under the conditions of their production before and after the implementation of the project of restoration (modernization) of drainage systems. The application of the traditional scheme for projected indicators calculating, at which the discount rate was defined as the weighted average cost of capital (WACC), is substantiated. Taking into account the specifics of drainage system restoration (modernization) projects and their duration, the weighted average rates for long-term loans and deposits (risk-free) for legal entities, taking into account the inflation component and the value of equity capital of agro-industrial complex enterprises, were chosen as the discount rate for the preliminary pre-investment analysis. Based on the calculation of the project effectiveness of the restoration (modernization) of drainage systems using the scenario approach according to the consolidated option for determining the payback of investment costs, it is proved that the options at the discount rates r1 (for 2021) and r2 (for the beginning of 2022), as well as the discount rate for the equity scheme, they give positive indicators of the investment project, which indicates the expediency of its implementation and economic efficiency. The internal rate of return for the three options shows a sufficient margin of safety (24–26%). The most economically expedient is the option with a source of financing from the equity capital of agro-industrial complex enterprises, for which the non-discounted (RR) and discounted (DPP) payback terms are 3.4 and 4.7 years, respectively.*

Keywords: *drainage system, restoration of drainage systems, economic efficiency, scenario approach, investment project*

Relevance of research. The global long-term practice of agricultural production on drained lands shows that the effective use of drainage systems and regulation of the water regime of the soil allows to ensure the stability of cultivation and growth of crop yields, strengthening of the economy of farms and positive socio-economic changes [1–5].

In the humid zone of Ukraine, there is powerful water management and reclamation (drainage) infrastructure, which is located on a total area of about 3.3 million hectares and includes 1.671 reclamation systems, in particular: 835 drainage systems of one-way action on an area of 1,6 million hectares (51%), 585 two-way drainage-irrigation systems on an area of 1.1 million hectares (34%) and 251 polder and water circulation systems on an area of 0.51 million hectares (15%) [6].

Reclamation measures were carried out on most of the lands of the amelioration fund of the humid zone (60.5%). Thus, in the Zakarpattia region almost 99% of the reclamation fund has been drained, 76% – in the Chernivetskyu region, and 84% in the Rivnenskyu region [2]. According to the indicator of land reclamation, the drainage zone corresponds to the level of such countries as the USA (60%), Germany (66%), the Netherlands (81%) [3; 6].

At the same time, modern climate changes create new conditions for growing crops, including on drained lands, which, accordingly, transforms the role of drainage systems, the economic, ecological, and social stability of the region depends on the efficiency of their use.

At the same time, most of the drainage systems of the humid zone of Ukraine are in an unsatisfactory technical condition, which is manifested in the physical and moral aging of the main reclamation funds, the low level of operation of the drainage network, failure, and in many cases the absence of hydromechanical equipment. Based on analytical and statistical sources, it was established that the technical condition of drainage systems is characterized by general depreciation of engineering infrastructure elements due to their long-term operation by an average of 60% (inter-farm network – 55% and intra-farm network – 65%) [6]. Consequently, the effectiveness of the use of drained lands and their role in the food and resource provision of the state has significantly decreased. Therefore, the current stage of the development of the water management industry of the humid zone is characterized by a complex of unresolved tasks, which are related to the peculiarities of the functioning of drainage systems in the complex and changing conditions of the humid zone.

Along with this, the determining condition for the possibility of implementing not only modern intensive technologies for growing agricultural crops, but also the formation and preservation of water resources, the creation of favourable living conditions, and the protection of the rural population and rural areas from harmful effects is the restoration of the effective functioning of the drainage systems of the drainage area [6; 7].

Analysis of the latest research and publications on the world experience of restoring drainage systems shows that in many countries (England, Belgium, the Netherlands, Germany, France, Denmark, etc.) permanent reconstruction is carried out [5; 8–10]. And the development of agricultural production on reclaimed land is proof that the greatest success was achieved by countries that implemented large-scale national programs for the development and restoration of both drainage and irrigation systems [11].

Abroad, much more attention is paid to evaluating the economic efficiency of land reclamation investments than in Ukraine [12]. The scientists' developments are aimed at creating economically profitable projects for the reconstruction of drainage systems, which consider the directions of their use and possible investment options [13].

The following Ukrainian scientists were involved in the assessment of economic efficiency in the field of water management and land reclamation: A.S. Gordiychuk, V. Ya. Humenyuk, E.A. Zin, N.E. Kovshun, L.F. L.F. Kozhushko, R.M. Kostyukevich, A.H. Kulibabyn, A.A. Stakhiv, V.M. Trehobchuk, M.A. Khvesyk, et al. [14–19]. Literary sources indicate the existence of a number of studies in the direction of a comprehensive assessment of the economic effectiveness of reclamation measures, taking into account the peculiarities of their implementation in modern market conditions. In the global practice of economic calculations, there are two main approaches to the economic assessment of project effectiveness of investments: static and dynamic [20–22].

In domestic practice, the "production" approach, based on the calculations of static indicators, prevailed. This approach focuses mainly on production efficiency (reducing costs and increasing labor productivity) and is poorly focused on investors and other stakeholders. Financial, economic, and other types of efficiency fade into the background [20; 23].

In modern conditions, a feature of approaches to the justification of investment projects, including in the field of restoration of drainage systems, is the calculation based on dynamic models. They have become widespread since the late 1980s. Almost 88% of enterprises in Europe (Germany, Austria, Switzerland, etc.) and the USA use dynamic models to evaluate the effectiveness of investments [24].

According to the above, to assess and analyze the economic efficiency of long-term capital-intensive investment projects, incl. such in scale as the restoration of the drainage systems of the humid zone of Ukraine, it is advisable to use primarily dynamic methods and indicators. This will allow you to make informed management decisions. [25; 26].

The purpose of the research is to evaluate the economic efficiency of the restoration of drainage systems as a comprehensive long-term project, which is based on the algorithm for calculating basic dynamic design indicators and

a scenario approach to assessing the effectiveness of investment decisions.

Research materials and methods. Research methods are based on the use of a system approach, a monographic method (summarization of scientific studies on the assessment of economic efficiency in the field of water management and land reclamation), dynamic methods, and indicators of pre-investment analysis of drainage system restoration projects, and a scenario approach to the assessment of the effectiveness of investment decisions.

Research methodology. The methodology for determining the economic efficiency of the restoration of drainage systems includes the calculation of economic indicators for the production of crops that are economically attractive for agricultural producers for two conditions: production without restoration and production during the implementation of the project for the restoration of drainage systems; using a scenario approach and an enlarged version of determining the payback of investment (capital) costs for the restoration of drainage systems (with an analysis of possible financing options, discount rates, volumes and rates of cost recovery and other factors of systemic and non-systemic impact, alternative cost). The assessment of the effectiveness of the restoration of drainage systems is carried out according to the developed general conceptual scheme by the tasks set in the "Irrigation and drainage strategy in Ukraine for the period up to 2030" (approved by the order of the Cabinet of Ministers of Ukraine dated August 14, 2019, No. 688-r.), Plan measures for its implementation (approved by the order of the Cabinet of Ministers of Ukraine dated October 21, 2020, No. 1567-r.), which notes the need to expand the functionality of drainage systems in the current conditions of their operation and provides for priority measures for restoration (modernization) (Fig. 1) [27; 28].

In the framework of this study, the focus is on the justification of the approach to assessing the financial and economic efficiency of the restoration (modernization) of drainage systems.

The main indicators for evaluating the project efficiency of restoration (modernization) of drainage systems, the use of which is justified by the concept of changing the value of money over time and which are key in making investment decisions, regardless of the type of investment project and sources of obtaining financial resources, are: net present value of the project (NPV), internal rate of return/return (IRR), return on investment (PI), payback period (PP) and discounted payback period (DPR) [24].

The calculation and forecasting of the profitability of the implementation of the project of restoration (modernization) of drainage systems is carried out according to the standardized approach of pre-project analysis, which consists in comparing the income during the implementation of the project with all incurred costs (including the costs of raw materials and materials, wages of employees, fuel and energy, depreciation, administrative costs, taxation, etc.) and taking into account the factor of change in the value of money over time.

The cash flow accumulated over the entire period of future project activity (the difference between the present value of the net cash flow for the period of project operation and the reduced amount of investment costs for its implementation) is determined by the net present value indicator according to the formula:

$$NPV = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n} = \sum_{k=0}^{n} \frac{CF_k}{(1+r)^k}, \quad (1)$$

where, CF_i – the project's net cash flow (the difference between the project's income and expenditure in monetary units) in the *i*-th year; n – number of years; $CF_к$ – net cash flow of the project; CF_0 – the amount of initial investment in the project; r – the discount rate in the *i*-th year.

An investment decision is made if the net present value (NPV) indicator for an individual project is greater than or equal to zero; among several alternative projects, the one with a higher NPV is accepted [24].

When calculating project efficiency, both the traditional scheme for evaluating the effectiveness of an investment project and the equity capital scheme can be used. The difference between them is determined by the calculation of the discount rate and the construction of the project's cash flow. All things being equal, the equity scheme is more visible, flexible, and reliable for investors, and reflects the financial stability and ability of the enterprise. When applying the equity scheme, the discount rate is the cost of equity, and when forecasting cash flows, both interest payments and repayment of the body of credit funds are considered.

The justification of the discount rate is one of the most difficult tasks in the process of making an investment decision. In the scientific literature and business practice, several methods are used to justify the discount rate: WACC, CAMP, cumulative construction method, normative, market extraction, expert evaluation, etc. [25].

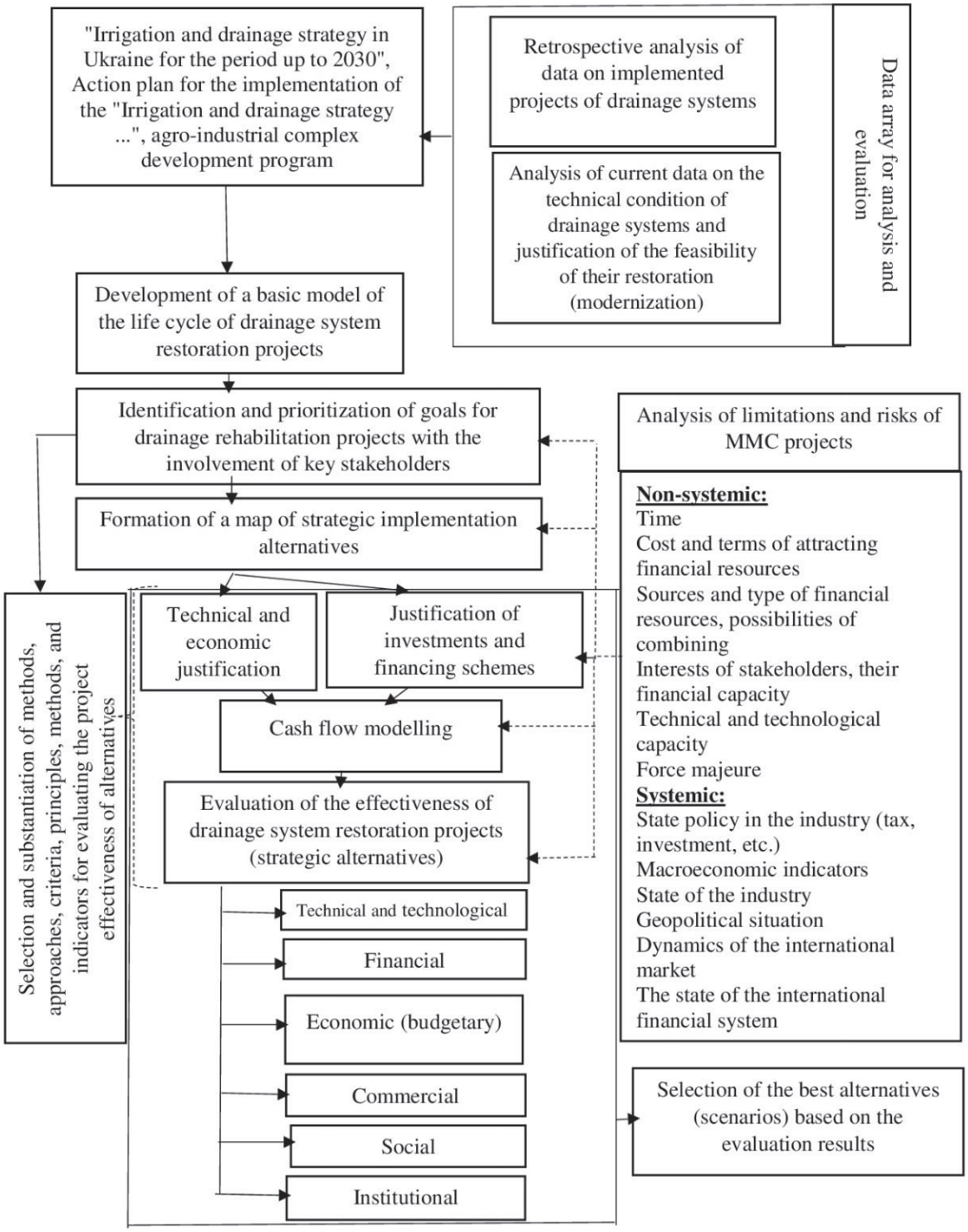

Fig. 1. Conceptual scheme for evaluating the effectiveness of restoration (modernization) of drainage systems

In the traditional scheme for evaluating the effectiveness of an investment project, the discount rate when financing a project from various sources (own, borrowed, borrowed) is taken as the weighted average cost of capital WACC (Weighted Average Cost of Capital).

The calculation of the discount rate using the WACC method is carried out according to the formula [25]:

$$WACC = k_e w_e + k_d (1-t) w_t, \qquad (2)$$

where k_e is the cost of equity; w_e – the share of equity capital in the capital structure; k_d – the cost

of loan capital; t – the tax rate; w_t – the share of loan capital in the capital structure.

The cost of capital for companies whose securities are not quoted on the stock market can be determined through the ratio of the company's annual profit to the number of its funds accumulated up to the period under consideration, that is, through the return on equity (ROE).

In the capital asset pricing model (CAMP), the discount rate consists of the rate of return on a risk-free investment and an additional rate that compensates for the uncertainty associated with investing in a particular asset. Therefore, the discount rate is calculated by the formula [25]:

$$r^* = r_j + \beta\left(r_m - r_j\right), \quad (3)$$

where r_j – risk-free investment rate of return; r_m – average market return; β – risk factor.

Attention also deserves the approach to calculating the discount rate, which is based on considering such main components: risk-free income, inflation premium, and risk premium (provides additional compensation for project risks associated with an investment decision). The use of such an approach to determining the discount rate is expedient when inflation is "homogeneous". [25].

$$r_i = (1 + r)(1 + i) - 1, \quad (4)$$

де r_i – discount rate (coefficient) adjusted for inflation; r – discount rate (ratio) excluding inflation (risk-free); i – average annual inflation index (coefficient).

As a risk-free rate, deposits for legal entities in the national currency of the most reliable banks are most often accepted (contains a risk-free component and a risk associated with investments in Ukraine) or in currency [29].

If the project is financed by borrowed funds, the discount rate is taken to be the bank's credit rate chosen to attract investment funds. The base of choice is also the rates of official statistics, in particular, the National Bank of Ukraine, taking into account the terms, region, currency, types and sizes of enterprises. These data characterize the weighted average market rates for secured loans, including country risk.

According to the recommendations of the Ministry of Finance of Ukraine, the discount rate when attracting credit funds can be calculated according to the following components: interest rate on borrowed funds; interest rate of credit risk; expected inflation rate [30].

When financing projects by raising funds in European markets, it is recommended to use the LIBOR (London Interbank Offered Rate) method, according to which the discount rate is calculated using the formula [31]:

$$r^* = LIBOR + \beta_k\left(1\ldots2\%\right), \quad (5)$$

where $LIBOR$ – the weighted average interest rate on interbank loans provided by banks to each other in different currencies or the so-called benchmark rate or cost of selling money in European currency markets; β_k – country risk level.

The internal rate of return/return (IRR) is one of the key indicators for making investment decisions. This is, in its way, an indicator of the "margin of safety" or, in other words, the "margin of return" of the project. This is the value of the discount rate at which the present value of the investment is equal to the present value of the cash flow from the investment, which provides a "0" value of NPV.:

$$\sum_{j=1}^{n} \frac{CF_j}{(1 + IRR)^j} = INV\ , \quad (5)$$

where CF_j – incoming cash flow in the j-th period, INV – the amount of investment.

If the internal rate of return is equal to the cost of capital, then the project should be accepted. If it is smaller, the project should be rejected. In the first case, we have a margin of safety for the return of invested investments and the return of funds, in the second case, the volume of funds is insufficient.

The investment profitability index (PI) is a relative indicator that reflects the level of profitability (profitability) of the project or the return on funds invested in the project, which allows you to compare investment projects that are different in scale, complexity, and conditions and is calculated by the formula:

$$PI = NPV / CF_0, \quad (6)$$

where NPV – the net present value of the project; CF_0 – the amount of initial investment in the project.

If $PI > 1$, the project is profitable and should be considered for investment; in the case of $PI = 1$, the project must be evaluated based on a set of performance indicators to make a rational investment decision, and if $PI < 1$, the project is unprofitable and it is not advisable to invest in it. If investment funds are distributed over time, the calculation of RI takes the form:

$$DRI = \sum_{t=1}^{n} \frac{CF_t^n}{\left(1 + r\right)^t} / \sum_{t=0}^{n} \frac{CF_t^n}{\left(1 + r\right)^t}\ , \quad (7)$$

where DPI – discounted project's profitability.

Another way to calculate the return on investment is to determine the payback period (PR) or the time required for the revenues from the project to ensure reimbursement of costs

(investments) for its implementation. Calculation of the payback period with uniform project revenues for the corresponding period is carried out by dividing the number of initial investments (expenses) by the average annual cash receipts.

With uneven cash flows, it is more appropriate to calculate the cumulative discounted or non-discounted payback period. The first takes into account the change in the value of money over time (DPP).

It is calculated from the initial (investment) costs of the project (CF_0), successively subtracting the discounted cash receipts until the payback point (obtaining a positive cumulative cash flow). Similarly, however, without discounting, the second indicator considers the uneven cash flows of the project.

The methodology for determining the economic efficiency of the restoration of drainage systems also includes the rationale for budgetary efficiency, taking into account forecasting changes in yield, volumes and profitability of sales from the standpoint of the "Irrigation and drainage strategy in Ukraine for the period up to 2030", and the Action Plan for its implementation [27; 28], programs for the development of agricultural production in the regions, additional revenues of the budgets of the corresponding levels. When determining budget efficiency, specific forms of participation of budgetary funds in project financing are taken into account, including the provision of budgetary resources in the form of an investment loan or on a gratuitous basis; provision of budget subsidies related to the implementation of a certain price, structural, sectoral policy; development programs and enforcement of established social and environmental priorities; provision of state (regional) guarantees of investment risks for certain types of activities.

Research results. To carry out calculations of the economic efficiency of the restoration of drainage systems, the generalization results regarding their technical condition obtained based on the analysis of patent research materials on constructive solutions of drainage systems, many years of experience in their operation, and inventory data of the State Water Agency of Ukraine (2011), were used. The conducted analysis shows that the technical condition of the drainage systems of the humid zone of Ukraine is characterized by satisfactory (the systems are in working (operable) condition and can perform their functions in the design mode) and unsatisfactory (the functionality of the drainage systems is possible only thanks to the implementation of measures to restore them) [6; 7]. Therefore, the restoration of drainage systems in the drainage area is carried out according to two options:

– modernization of working drainage systems;

– restoration of non-working drainage systems [27].

Taking into account climate changes, the priority measures for the modernization of drainage systems include work on expanding their functional capabilities with the ability to regulate the water regime of the soil during the growing season of crops [7; 27; 37].

The conducted studies and the scientific and practical results obtained on their basis made it possible to substantiate the directions and scope of modernization of working and restoration of non-working drainage systems. Calculations of costs for the restoration (modernization) of drainage systems were carried out based on the results of a preliminary assessment of the cost of restoration works for various types of drainage systems based on the reduced costs for restoration of the intra-farm and inter-farm network, which are adopted in the "Irrigation and Drainage Strategy…", (Table 1) [7; 27].

Modernization of working drainage systems is carried out taking into account their division into draining, drying-moistening, polder and water circulation systems [6]. The set of modernization measures is determined on the basis of inventory data and will include various types of work on different types of drainage systems.

1. Volumes and cost of restoration works for different types of drainage systems

System type	Total area, thousand ha	The need for repair and restoration works		The cost of restoration of 1 ha (up to the project level), c.u.		
		thousand ha	%	Inter-farm network	On-farm network	Total 1 ha
Drainage	1649.4	1072.1	65	160	800	960
Drainage-irrigation	1113.1	679.0	61	190	1300	1490
Polder	306.6	113.4	37	300	2000	2300
Water-circulation	205.0	98.4	48	350	2300	2650
Total	3274.1	1962.9	60	250	1600	1850

On drainage systems of one-way action, the basis of modernization measures is the installation of irrigation systems on them; drainage-irrigation ones – to ensure the possibility of implementing a guaranteed two-way regulation of the water regime of the soil. Modernization of polder and water circulation systems to the level of drainage and irrigation is carried out by building irrigation systems (drip irrigation or sprinkler systems) on them. The total area of such systems is 1311.2 thousand hectares. According to the "Strategy of Irrigation and Drainage…" the total area of drainage systems of various types, on which measures to modernize and expand their functional capabilities should be carried out as a priority, is 350 thousand hectares (Table 2).

For non-working drainage systems, restoration of their performance to the design level is carried out mainly by carrying out repair and restoration works on intra-farm and inter-farm networks. These works include cleaning canals and culverts; restoration of water control structures (gates, lifts, etc.); washing of collectors and drains, partial restoration of drainage; the arrangement of wells-filters for removal of surface water; an arrangement of existing dams, strengthening of mouths of drainage collectors, etc [7; 27].

The total area of such systems is 1962.9 thousand hectares. First of all, the restoration of these systems is proposed to be carried out on an area of 632.0 thousand hectares (Table 3). Along with restoring the functionality of non-working drainage systems, the possibilities of these systems performing the function of protecting territories and settlements from inundation and flooding are taken into account. The calculation of the economic efficiency of the restoration (modernization) of drainage systems includes the calculation of the economic indicators of the production of economically attractive crops for agricultural producers under the conditions of production before the restoration (modernization) and production during the implementation of the project of restoration (modernization) of drainage systems.

The selection of economically attractive crops is carried out based on research on the current state of use of drained lands. It was established that the modern structure of cultivated areas is subject to both climatic changes and the market situation, which dictates the cultivation of economically attractive crops. Since 1990, the cultivated area of sunflower has increased by 4.1; corn per grain – 4.5; rapeseed – 14.6; soybeans – 11.4 times, and their products today serve as the basis of exports. At the same time, 42 to 83 % of these crops are in the Forest Steppe and Polissia. Therefore, in agricultural production in the zone of drainage reclamations, grain corn, sunflower, rapeseed, and soybeans are grown. [32; 33].

The estimated yield levels of the specified crops during their pre-project cultivation and

2. Available areas, volumes and costs for modernization of working drainage systems

Type and area of reclamation systems, thousand ha	Type of system after modernization	Recommended area, thousand ha	Cost of modernization, c.u./ha	Modernization costs, million c.u.
1. Drainage – 577.3	drainage-irrigation	200.0	2000.0	400.0
2. Drainage-irrigation – 434.1	drainage-humidification-irrigation	100.0	2000.0	200.0
3. Polder – 193.2	drainage-irrigation	30.0	2000.0	60.0
4. Water-circulation – 106.6	drainage-irrigation	20.0	1700.0	34.0
Total 1311.2		350.0		694.0

3. Available areas, volumes and costs for restoration of operational efficiency of non-working drainage systems

Type and area of reclamation systems, thousand ha	Type of system after modernization	Recommended area of modernization, thousand ha	Cost of modernization, c.u./ha	Modernization costs, million c.u.
1. Drainage – 1072.1	drainage	200.0	960.0	192.0
2. drainage-irrigation – 679.0	drainage-irrigation	300.0	1490.0	447.0
3. Polder – 113.4	polder	112	2300.0	257.6
4. Water-circulation – 98.4	water-circulation	20.0	2650.0	53.0
Total: 1962.9		632.0		949.6

the implementation of the project of restoration (modernization) of drainage systems on drained lands were adopted based on the results of the analysis of statistical data and research by scientists of the IWP&LR of NAAS of Ukraine (Table 4) [33; 34].

We consider in detail options for determining the payback of investment (capital) costs for the restoration (modernization) of drainage systems. To do this, first of all, we calculate the economic indicators of the pre-project and after the implementation of the project production of the main crops (Tables 5, 6).

A comparative analysis of the production of the main crops before and after the implementation of the drainage system restoration (modernization) project was carried out, the results of which are presented in Table 7.

When determining the discount rate and calculating project indicators directly for the restoration (modernization) of drainage systems, we determine possible financing options:

– budgetary on the inter-farm network (agreed programmatically from the state, regional, municipal budgets and donor in the ratio agreed by the government and donors) and private or mixed on the intra-farm network (land users of different forms of ownership: owner funds, credit, donor funds, etc.);

– private financing by land users or mixed (donor and land users).

The option of full state financing is not considered taking into account the changes in the legislation and the "Irrigation and Drainage Strategy…", which states that the financing of investment projects will be carried out in stages, taking into account priority and economic indicators of cost effectiveness and a wide range of potential investors [27]. In addition, this option is difficult to implement due to a significant budget deficit.

4. Yield levels of pre-project cultivation of crops and during the implementation of the project of restoration (modernization) of drainage systems on drained lands

Type of crop	Pre-project yield, t/ha	Yield under the implementation of the restoration (modernization) project, t/ha
Corn for grain	7.0	12.0
Soybean	2.0	4.0
Winter wheat	5.0	8.0
Sunflower	2.5	4.0

5. Economic indicators of pre-project production of major crops on drained lands

Crops	Share in the structure of crops, %	Productivity, t/ha	Total production costs, thousand UAH/ha	Sales price (without VAT), thousand UAH/ha	Cost of gross production, thousand UAH/ha	Gross profit, thousand UAH/ha	Profitability of production, %
Winter wheat	20	5.0	16.0	4.1	20.5	4.5	28.13
Corn	35	7.0	18.3	3.7	25.9	7.6	41.53
Sunflower	10	2.5	14.0	8.0	20.0	6.0	42.86
Soybean	35	2.0	10.4	8.0	16.0	5.6	53.85
	100	-	14.6	5.7	20.6	6.12	41.79

6. Economic indicators of the production of the main agricultural crops on drained lands during the implementation of the project of restoration (modernization) of drainage systems

Crops	Share in the structure of crops, %	Productivity, t/ha	Total production costs, thousand UAH/ha	Sales price (without VAT), thousand UAH/ha	Cost of gross production, thousand UAH/ha	Gross profit, thousand UAH/ha	Profitability of production, %
Winter wheat	20	8.0	19.2	4.1	32.8	13.6	70.83
Corn	35	12.0	22.0	3.7	44.4	22.4	101.82
Sunflower	10	4.0	16.8	8.0	32.0	15.2	90.48
Soybean	35	4.0	12.5	8.0	32.0	19.5	156.00
–	100	–	17.6	5.7	36.5	18.9	107.45

7. Project indicators of the production of the main agricultural crops on drained lands during the implementation of the drainage system modernization project

Crop	Increase in yield, t/ha	Sale price (without VAT), thousand UAH/ha	Total production costs, thousand UAH/ha (20%)	Cost of gross production, thousand UAH/ha	Gross profit, thousand UAH/ha	Net profit, thousand UAH/ha	Share in the crop structure, %
Winter wheat	3	4,1	3,84	12,3	8,46	6,94	0,2
Corn	5	3,7	4,4	18,5	14,1	11,56	0,35
Sunflower	1,5	8	3,36	12	8,64	7,08	0,1
Soybean	2	8	2,5	16	13,5	11,07	0,35
–	–	–	3,52	15,74	12,22	10,02	1

The option of full private financing is possible for implementation in the presence of significant state benefits and guarantees, effective credit policy in the field of agro-industrial complex (APC) for land users, including water user associations.

That is, for the project of restoration (modernization) of drainage systems, the sources of investment can be the funds of landowners, donors, creditors, budget funds, etc. Accordingly, it is possible to use the traditional scheme for calculating project indicators, where the discount rate is calculated as the weighted average cost of capital (WACC).

Under certain conditions, namely: significant variability and uncertainty of the current sources of financial resources and investment conditions; gradual introduction of changes in legislation; continuation of evaluation works on reclaimed territories; the crisis state of Ukraine's economy; specifics of the project of restoration (modernization) of drainage systems and its duration, for the discount rate for the preliminary pre-investment analysis we choose:

– weighted average interest rate for long-term loans for legal entities, taking into account the inflation component;

– weighted average interest rate on deposits (risk-free) for legal entities, taking into account the inflation component;

– the value of equity capital of enterprises of the agro-industrial complex.

We compare the results at different rates in 2021 and at the beginning of 2022.

The average weighted rate on loans in the national currency for non-financial corporations as of December 31, 2021 amounted to 9.1%, and as of February 2022, 10.6%. The weighted average rate in Ukraine on long-term deposits for non-financial corporations in the national currency as of December 31, 2021 was 5.8%; as of February 23, 2022 – 8.0% [35].

The National Bank of Ukraine expected inflation at the level of 5.5% at the end of 2021, and the average annual forecasted rate at the level of 5.8% [36]. In fact, the inflation index in 2021 was 110.0% [37]. The inflation index as of March 2022 was 104.5% [37], and for the year it was forecast at the level of 107.6%. For calculations for 2022, we use the forecasted annual indicator.

Discount rate for restoration (modernization) projects of drainage systems for calculating the effectiveness of an investment project in national currency with a credit source of funds for a period of more than 5 years ($r_{1к}$ та $r_{2к}$) is:

$$r_{1к,\ 2021} = (1 + 0{,}0901)(1 + 0{,}1) - 1 \approx 20\%;$$

$$r_{2к,\ 2022} = (1 + 0{,}106)(1 + 0{,}076) - 1 \approx 19\%.$$

The discount rate for the project of restoration (modernization) of drainage systems according to the data of 2021 and the beginning of 2022($r_{1д}$ та $r_{2д}$) based on the average rate for long-term deposits for legal entities:

$$r_{1д,\ 2021} = (1 + 0{,}058)(1 + 0{,}10) - 1 \approx 16\%;$$

$$r_{2д,\ 2022} = (1 + 0{,}080)(1 + 0{,}076) - 1 \approx 16\%.$$

Taking into account the relatively stable projected rates of inflation recently, this calculation approach is justified, and the discount rates (r_1, r_2) take into account the main risks for investors.

Investment costs for the project of restoration (modernization) of drainage systems (for drainage and moisturizing) in national currency are: 56.54 thousand UAH/ha (2020); 54.79 thousand UAH/ha (2021); 58.52 thousand UAH/ha (beginning of 2022).

We build the cash flow taking into account the design yield when implementing the restoration (modernization) of drainage systems, the dynamics of prices for priority agricultural crops grown on drained lands, at discount rates at levels r_1 and r_2. To determine the net profit in the calculations, we accept the rate of taxation of the profit of enterprises according to the general taxation system. The cash flow includes depreciation deductions during the 8 years of

project implementation (the term corresponds to the late payback period calculated according to the "Irrigation and Drainage Strategy…"). The liquidation value at the stage of project completion is assumed equal to 0.

According to the conditions adopted in this study and the analytical data obtained, we have the design efficiency indicators given in Table. 8.

The results indicate that all calculation options give positive indicators of the financial efficiency of the investment project for the restoration (modernization) of drainage systems, which indicates the feasibility of its implementation. In addition, the internal rate of return shows a sufficient margin of safety (24–26%). The return on investment is sufficient and corresponds to market indicators and its dynamics. This indicator is the highest for options with sources of funds from long-term deposits (34 and 25%, respectively, for 2021 and at the beginning of 2022) and the equity capital of agribusiness enterprises (43%). At the same time, the calculated non-discounted (PP) and discounted (DPP) payback periods of the option with sources of funds from long-term deposits are 3.2 and 4.9 (for 2021) and 3.5 and 5.5 years (at the beginning of 2022), which is more profitable compared to the option with long-term loans. The most economically expedient, of course, is the option with a source of equity capital of agribusiness enterprises, for which the non-discounted (PP) and discounted (DPP) payback terms are 3.4 and 4.7 years.

Profit can be reinvested by land users to ensure further economic development by introducing innovations, including the acquisition of modern equipment, and the development of new varieties of crops and technologies for their cultivation. Part of the funds can be reinvested in research and development in the field of agro-industrial complex, which will speed up the introduction of innovations into production practice.

When calculating project efficiency, land users, donors, and representatives of state or regional authorities need to operate at a decisive rate precisely taking into account the specifics of investment, interests of stakeholders, state policy in the field of agriculture, and regional and municipal development investment programs. The rate of taxation of the profit of agricultural producers may also vary depending on the taxation system and the availability of tax benefits. The norms and peculiarities of taxation of agrarians are being revised, including reimbursement of value-added tax (VAT), the amount of which is in the range from 20 to 14%; reduction of personal

8. Indicators of the effectiveness of the project for the restoration (modernization) of drainage systems using different discount rates

The discount rate is the weighted average rate for long-term loans for legal entities, considering the inflation component		
Project efficiency indicator	**At discount rate $r_{1к.\ 2021}$ = 20 %**	**At discount rate $r_{2к.\ 2022}$ = 19 %**
NPV, thousand UAH	9.94	8.91
IRR, %	26	24
PI, %	18	14
PP, years	3.2	3.5
DPP, years	5.8	6.2
The discount rate is the weighted average rate for long-term deposits for legal entities, considering the inflation component		
Project efficiency indicator	**At discount rate $r_{1д.\ 2021}$ = 16 %**	**At discount rate $r_{2д.\ 2022}$ = 16 %**
NPV, thousand UAH	18.49	14.45
IRR, %	26	24
PI, %	34	25
PP, years	3.2	3.5
DPP, years	4.9	5.5
Discount rate – the cost of equity of agribusiness enterprises (data for 2021 and 2022 are not available)		
Project efficiency indicator	**At discount rate $r_{1вк.2020}$ = 13 %**	
NPV, thousand UAH	24.42	
IRR, %	25	
PI, %	43	
PP, years	3.4	
DPP, years	4.7	

income tax (PIT); taxation of the income of agricultural producers, land, etc.

Municipal and regional authorities receive direct and indirect effects from the implementation restoration (modernization) of drainage systems projects, particularly, in terms of ensuring the growth of budget efficiency, and indicators of social and environmental efficiency. The state ensures the preservation and increase of the export potential of the agricultural industry.

An important role in accelerating the implementation of the projects under study is also played by the introduction of the Law "On water user organizations and stimulation of hydro technical land reclamation" (dated February 17, 2022 No. 2079-IX), incl. from the standpoint of stimulating the inflow of investments, regulatory harmonization of land reclamation issues [38].

These and other regulatory, technical, technological, and organizational measures will speed up the process of involving the World Bank and other interested foreign financial institutions in the investment process. Accordingly, we can predict that soon, hydro-technical reclamation in Ukraine will acquire a programmatic and systemic character, which will allow combining the efforts of both national and foreign stakeholders, creating conditions for long-term growth in the agricultural sector.

According to analytical data, the government continues to work on programs for the agricultural sector development, where reclamation occupies a prominent place. In general, in 2021-early 2022, the government continued work on the following development programs: support for insurance of agricultural products; compensation for losses from damage to crops as a result of man-made and natural emergencies; support for agricultural producers who use reclaimed land; support for producers of organic products; support of potato producers; support of agricultural producers by allocating budget subsidies per unit of cultivated land (buckwheat) [39].

Conclusions. The assessment of the economic efficiency of the restoration of the drainage systems of the humid zone of Ukraine is proposed to be carried out according to a conceptual scheme that determines the stages of the assessment, the sources of the input array of information, the strategic orientation and invariance of restoration projects, involves considering risks and limitations of a systemic and non-systemic nature when assessing the design effectiveness of strategic ones.

It is determined that the basis of the assessment should be:

– the results of studies on establishing the technical condition of drainage systems, the restoration of which in the drainage area is carried out according to two options: modernization of working and restoration of non-working systems;

– data on the preliminary assessment of the cost of restoration works for different types of drainage systems (drainage, drainage-irrigation, polder, and water circulation systems) based on the reduced costs for the restoration of intra-farm and inter-farm networks;

– economic indicators of the production of agricultural crops that are economically attractive for agricultural producers (grain corn, sunflower, rapeseed, soybeans) under the conditions of their production before and after the implementation of the project of restoration (modernization) of drainage systems.

Indicators of the project effectiveness of restoration (modernization) of drainage systems were established using the scenario approach based on the consolidated version of determining the payback of investment costs. It is proven that the options at the discount rates r_1 (for 2021) and r_2 (for the beginning of 2022), as well as the discount rate for the equity scheme, give positive indicators of the investment project, which indicates the feasibility of its implementation and economic efficiency. The internal rate of return for the three options shows a sufficient margin of safety (24–26%). The most economically expedient is the option with a source of financing from the equity capital of agro-industrial complex enterprises, for which the non-discounted (PP) and discounted (DPP) payback terms are 3.4 and 4.7 years, respectively.

References

1. Halbac-Cotoara-Zamfir R. (2015). A history of agricultural land drainage. *Proceedings of the 43rd International Symposium on Agricultural Engineering, Actual Tasks on Agricultural Engineering*, Opatija, Croatia, 24-27 February. P. 19–29.

2. Tekrony R.G., & Sanders G.D. (2004). History of drainage in the bureau of reclamation. *Journal of Irrigation and Drainage Engineering*, Vol. 130. Iss. 2. P. 265–279.

3. Kozhushko, L.F., & Velesyk, T.A. (2015). Formuvannia rynku osushenykh semel silskohospodarskogo prysnachennia – [Formation of the market for agricultural agricultural land] : monograph. Rivne : NUVHP. [in Ukrainian]

4. Baljuk, S.A., Romashhenko, M.I., & Truskavetskyi, R.S. (2015). Melioratsiia gruntiv (systematyka, perspektyvy, innovatsiyi) – [Soil reclamation (systematics, perspectives, innovations)] : a collective monograph. Kherson : Grin D.S. [in Ukrainian]

5. Hadzalo, Ia.M., Stashuk, V.A., & Rokochynskyi, A.M. (2017). Melioratsiia i oblashtuvannia Ukrainskoho Polissia – [Land reclamation and arrangement of Ukrainian Polissya]. Kherson : OLDI-PLUS, 1, 923. [in Ukrainian]

6. Voropay, G.V., Yatsyk. M.B., & Mozol, N.V. (2019). Suchasnyy stan ta perspektyvy rozvytku osushuval`nykh melioratsiy v umovakh zmin klimatu – [Current state and the prospects of development of drainage reclamation in a changing climate]. *Melioratsiia i vodne hospodarstvo*, 2, 31–39. [in Ukrainian]

7. Voropay, G.V. (2021). Suchasni aspekty naukovoho zabezpechennia vidnovlennia drenazhnykh system humidnoyi sony Ukrayiny – [Modern aspects of scientific support of restoration of drainage systems humid zone of Ukraine]. *Melioratsiia i vodne hospodarstvo*, 1, 39–51. [in Ukrainian]

8. Giulia S. (2014). Modification of artificial drainage networks during the past half-century: Evidence and effects in a reclamation area in the Veneto floodplain (Italy). *Anthropocene*. Vol. 6. P. 48–62.

9. Minaev, I.V., & Maslov, B.S. (2009). History of Land Improvement. In Agricultural Land Improvement: Amelioration and Reclamation. Encyclopedia of Life Support Systems (EOLSS); Eolss Publ. Co. Ltd.: Oxford, UK, 1, 95–116.

10. Maslov, B.S. (2008). Voprosy istoriyi melioratsiyi torfianykh bolot I rasvitiye nauki – [Questions of the history of reclamation of peat bogs and the development of science]. *Vestnyk TGPU*, 4(78). 64–69. [in Russian]

11. De Wrachien D. (2003). Drainage and Land Reclamation in a Changing Environment: Overview and Challenges. *International conference on land reclamation and water resources development*. P. 234–238.

12. Ryskulov, D.M. (1988) Zarubezhnye metody ekonomicheskoy ozenki effektivnosti meliorativnykh I vodokhoziaystvennykh proektov – [Foreign Methods of Economic Evaluation of the Efficiency of Land Reclamation and Water Management Projects]. *Melioratsiia i vodnoe khosiaystvo. Ekonomika i upravleniye v meliioraziyi i vodnom khoziaystve: obzornaia informatsia.* TsBNTI Minvodkhoza SSSR. Moskva, 2, 1–48. [in Russian]

13. Adamonite, I. (2005). Issledovaniye tekhnicheskikh investitsionnykh reshenii rekonstruktsii osushitelnykh system v Litve – [Study of technical investment solutions for the reconstruction of drainage systems in Lithuania]. *Povysheniye effektivnosti melioratsii selskokhoziaistvennykh zemel. Doklady mezhdunarodnoi nauchno-prakticheskoi konferentsii*. Minsk, 19–23. [in Russian]

14. Hordiychuk, A.S., & Stakhiv, O.A. (2000). Ekonomika i orhanizatsia diialnosti vodohospodarskykh pidpryemstv – [Economics and organization of activities of water management enterprises]. Rivne : RDTU. [in Ukrainian]

15. Kozhushko, L., Okorskyi, V., & Kostjukevych, R. (2001). Stratehichni problem menedzhmentu u vodnomu hospodarstviv umovakh zemelnoyi reformy – [Strategic problems of management in water management in the conditions of land reform]. *Vodne hospodarstvo Ukrayiny*, 3–4, 18–24. [in Ukrainian]

16. Trehobchuk, V. M. (1990). Ekonomiko-ekologicheskie problem gidromelioratsii – [Economic and environmental problems of hydromelioration]. AN USSR. Institut ekonomiky. Kiev : Naukova dumka. [in Russian]

17. Khachaturov, T.S. (1979). Effektivnost kapitalnykh vlozheniy – [Efficiency of capital investments]. Moskva : Ekonomika. [in Russian]

18. Khvesyk, M., & Kovshun, N. (1996). Do pytannia metodolohii vyznachennia ekoloho-ekonomichnoyi efektyvnosti osushuvalnykh melioratsiy – [To the issue of the methodology of determining the ecological and economic efficiency of drainage reclamations]. *Ekonomika Ukrayiny*, 4, 83–87. [in Ukrainian]

19. Khvesyk, M.A., & Radkevych, N.M. (2003). Kompleksnyi analiz rozvytky vodnykh melioratsiy v Ukraini – [Comprehensive analysis of the development of water reclamation in Ukraine]. Kyiv : RVPS Ukrayiny NAN Ukrayiny. [in Ukrainian]

20. Vatamanjuk, Z.H., & Styrskyi, M.V. (1998). Roblemy zastosuvannia dynamichnykh metodiv otsinky investyziynykh proektiv – [Problems of applying dynamic methods of assessment of investment projects]. *Finansy Ukrayiny*, 5, 5–10. [in Ukrainian]

21. Komarov, A.G., & Rogova, E.M. (2001). Investizionnoe proektirovanie : uchebnoe posobie – [Investment design : textbook. allowance]. 3-ye izd. SPb. : SPbGUEF. [in Russian]

22. Kommercheskaia osenka investitsionnykh proektov. Osnovnye polozhnia metodiki – [Commercial evaluation of investment projects. The main provisions of the methodology]. *altrc.ru*. Retrieved from www.altrc.ru/common/art64-3.shtml

23. Pokasznyky efektyvnosti investytsiynoho proektu za modellju prostykh ta skladnykh protsentiv – [Performance indicators of the investment project based on the model of simple and compound interest]. *pidru4niki.com.* Retrieved from: https://pidru4niki.com/15100827/investuvannya/pokazniki_efektivnosti_investitsiynogo_proektu_modellyu_prostih_skladnih_protsentiv

24. Hadzalo, Ia.M., Stashuk, V.A., & Rokochynskyi, A.M. (2017). Melioratsiia i oblashtuvannia Ukrainskoho Polissia – [Land reclamation and arrangement of Ukrainian Polissya]. Kherson : OLDI-PLUS, 2, 854. [in Ukrainian]

25. Koval, N.V. (2010). Obgruntuvannia velychyny dyskontnoi stavky dlia rozrakhunku prognoznoyi efektyvnosti investytsiynykh proektiv v Ukraini – [Justification of the value of the discount rate for calculating the forecast efficiency of investment projects in Ukraine]. *Investytsiyi: praktuka ta dosvid*, 9, 9–13. [in Ukrainian]

26. Metodychni recomendatsiyi z rozrobky biznes-planiv investytsiynykh proektiv – [Methodological recommendations for the development of business plans for investments projects]. 2010. Nakaz Derzhavnoho ahent·stva Ukrayiny z investytsiy ta rozvytku 31.08.2010 № 73 – [Order of the State Agency of Ukraine for Investments and Development dated August 31, 2010 No. 73]. Retrieved from: http://econom.chnu.edu.ua/wp-content/uploads/2016/09/met-rekom-mbi.pdf

27. Stratehia sroshennia ta drenazhu v Ukraini na perid do 2030 roku – [Irrigation and drainage strategy in Ukraine for the period until 2030] (2019). Skhvaleno Kabinetom Ministriv Ukrainy 14.08.2019. № 688-r. [in Ukrainian]

28. Pro zatverdzhennia planu zakhodiv z realizatsii Stratehii. Retrieved from zakon.rada.gov.ua/1567-2020-p. [in Ukrainian]

29. Pernarivskyi, O.V. 2017. Modelyuvannya stavky dyskontuvannya z urakhuvannyam investytsiynykh ryzykiv – [Discount rate modeling taking investments risks into account]. Abstracts of the 4th International scientific and practical conference "*Formation of an effective model of enterprise development in the conditions of a market economy*". Retrieved from: https://conf.ztu.edu.ua/wp-content/uploads/2017/01/477.pdf

30. Vyznachennya stavky dyskontuvannya: svizhi porady vid Minfinu – [Determination of the discount rate: fresh advice from the Ministry of Finance]. 2020. *Debet-Kredyt*. Retrieved from: https://news.dtkt.ua/accounting/individual-transactions/63917

31. Fedonin, O.S., Repina, I.M., & Oleksjuk, O.I. (2006). Potenzial pidpryemstva: formuvannia ta otsinka : navchalnyi posibnyk – [Enterprise potential: formation and assessment : education. manual]. Kyiv : KNEU. [in Ukrainian]

32. Voropay, G.V. (2020). Silskohospodarske vykorystannia osushuvanykh zemel humidnoi zony Ukrainy v umovakh reformuvannia agrarnoho sektoru ta zmin klimatu – [Agricultural use of drained lands of the humid zone of Ukraine in the conditions of agricultural sector reform and climate change]. *Visnyk agrarnoi nauky*, 11, 62–73. [in Ukrainian]

33. Silske, lisove ta rybne hospodarstvo. Retrieved from ukrstat.gov.ua/druk/publicat/kat_u/publ7_u

34. Romashhenko, M.I., & Tarariko, Ju.O. (2017). Otsinka ta ratsionalne vykorystannia agroresursnoho potentsialu Ukrainy (zony zroshennia i osushennia) – [Reclaimed agroecosystems. Assessment and rational use of agricultural resource potential of Ukraine (irrigation and drainage zones)]. Nizhyn : PP Lysenko M.M., 696. [in Ukrainian]

35. Retrieved from https://bank.gov.ua/files/4-Financial_markets.xls

36. Osnovni makropokaznyky ekonomichnoho i sotsialnoho rozvytku Ukrainy na 2021 rik: ekspertnyi ogliad – [The main macro indicators of economic and social development of Ukraine for 2021: expert review]. Retrieved from https://decentralization.gov.ua/news/12690

37. Tablytsia indeksiv infliatsii sa 2011–2022 – [Table of inflation indices for 2011–2022.]. Retrieved from: https://buhgalter.com.ua/dovidnik/norma-robochogo-chasu/tablitsya-indeksiv-inflyatsiyi

38. Pro organizatsii vodokorystuvachiv ta stymuljuvannia hidrotekhnichnoi melioratsii zemel – Про організації водокористувачів та стимулювання гідротехнічної меліорації земель LIGA:ZAKON (ligazakon.net). Retrieved from https://agro.me.gov.ua/ua/news/uryad-rozshiriv-derzhavnu-pidtrimku-agrariyiv-na-2021-rik.

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ОЦІНЮВАННЯ ЕКОНОМІЧНОЇ ЕФЕКТИВНОСТІ ВІДНОВЛЕННЯ ДРЕНАЖНИХ СИСТЕМ ГУМІДНОЇ ЗОНИ УКРАЇНИ: ПРИЙНЯТТЯ ІНВЕСТИЦІЙНИХ РІШЕНЬ

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Анотація. *Обґрунтовано підходи до оцінювання економічної ефективності відновлення дренажних систем гумідної зони України. Розроблено концептуальну схему, яка визначає етапність оцінювання, джерела вхідного масиву інформації, стратегічну орієнтацію та інваріантність проєктів відновлення, передбачає врахування низки ризиків та обмежень системного й несистемного характеру при оцінюванні проєктної ефективності стратегічних альтернатив. Основою оцінювання є результати аналізу матеріалів щодо технічного стану дренажних систем, відновлення яких у зоні осушення виконується за двома варіантами: модернізація працюючих (на площі 1311,2 тис. га) та відновлення непрацюючих (на площі 1962,9 тис. га) дренажних систем. Враховуючи кліматичні зміни, до першочергових заходів із модернізації дренажних систем віднесені роботи з розширення їх функціональних можливостей здатністю регулювати водний режим ґрунту протягом періоду вегетації вирощування сільськогосподарських культур. У розрахунках витрат на відновлення (модернізацію) використано результати попередньої оцінки вартості відновлювальних робіт для різних типів дренажних систем (осушувальні, осушувально-зволожувальні, польдерні та водооборотні) на основі приведених витрат на відновлення внутрішньогосподарської та міжгосподарської мережі, які прийняті у «Стратегії зрошення та дренажу…». Розраховано економічні показники виробництва економічно привабливих для агровиробників сільськогосподарських культур (зернової кукурудзи, соняшника, ріпаку, сої) за умов їх виробництва до та за реалізації проєкту відновлення (модернізації) дренажних систем. Обґрунтовано застосування традиційної схеми розрахунку проєктних показників, за якої ставку дисконтування визначали як середньозважену вартість капіталу (WACC). Враховуючи специфіку проєктів відновлення (модернізації) дренажних систем та їх тривалості, за ставку дисконтування для здійснення попереднього передінвестиційного аналізу обрано середньозважені ставки за довгостроковими кредитами і депозитами (безризикова) для юридичних осіб з урахуванням інфляційної складової та вартістю власного капіталу підприємств АПК. На основі розрахунку проєктної ефективності відновлення (модернізації) дренажних систем з використанням сценарного підходу за укрупненим варіантом визначення окупності інвестиційних витрат доведено, що варіанти при ставках дисконтування r_1 (за 2021 р.) та r_2 (на початок 2022 р.), а також ставці дисконтування для схеми власного капіталу дають позитивні показники інвестиційного проєкту, що свідчить про доцільність його реалізації та економічну ефективність. Внутрішня норма рентабельності для трьох варіантів показує достатній запас міцності (24–26%). Найбільш економічно доцільним є варіант з джерелом фінансування за рахунок власного капіталу підприємств АПК, для якого недисконтований (PP) та дисконтований (DPP) терміни окупності становлять, відповідно, 3,4 і 4,7 роки.*

Ключові слова: *дренажна система, відновлення дренажних систем, економічна ефективність, сценарний підхід, інвестиційний проєкт*