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RESULT OF IMPLEMENTATION OF RESOURCE-SAVING SYSTEM IN AGRO-INDUSTRIAL COMPLEX

Об'єктом дослідження є результат впровадження ресурсозбереження в агропромисловому комплексі (АПК), зокрема в першій його сфері – машинобудівництві для сільського господарства. Одним з найбільш проблемних місць є системність впровадження ресурсозбереження в АПК. Для подолання даної проблеми авторами запропонована схема вибору ресурсозберігаючого проекту сфери технічного обслуговування агропромислового комплексу, для того щоб оцінити ефективність технологій ресурсозбереження.

Авторами ставилося за мету проаналізувати ефективність впровадження ресурсозберігаючих заходів у комплексі першої сфери АПК. Для деталізації мети було поставлене завдання апробації схеми вибору ресурсозберігаючого проекту сфери технічного обслуговування АПК для аналізу ресурсоефективності на підприємствах, та визначення ефективності ресурсозберігаючих заходів. В результаті була оцінена модель багатокритеріального обґрунтування підвищення ресурсозбереження підприємств АПК як така, що є адекватною для оцінки ефективності виробництва і рівня ресурсозбереження.

Проаналізована та обґрунтована технологія оптимізації паливо-повітряної суміші, що на оптимально збідненій паливно-повітряній суміші з коефіцієнтом надлишку повітря $a \geq 1{,}1-1{,}15$ *забезпечує роботу бензинового двигуна з мінімальним вмістом шкідливих складових у вихлопних газах. Зокрема концентрація* NO_x *суттєво нижча, ніж при згорянні суміші близької до стехіометричної.*

Розрахована економічна ефективність ресурсозберігаючої технології висівного апарата з резервним дозатором. Середній річний приріст прибутку від впровадження модернізованого висівного апарата точного висіву для основних просапних культур (кукурудза, соняшник, соя, буряк) складає 1216,45 у. о. на посіві одного гектару. Загальний річний прибуток на сівалку за рік – 956 тис. у. о. На прикладі посіву однієї з культур найбільший економічний ефект дає кукурудза – 1,6 млн. у. о. на рік, найменший – соняшник (266 тис. у. о.). Водночас найкращим чином дослідний зразок показав себе при сівбі сої, зменшивши втрати у вартісному виразі на 99 %.

Ключові слова: *ресурсозберігаючий тип агропромислового комплексу, двигун з регулюванням потужності шляхом відключення окремих робочих циклів.*

1. Introduction

The new paradigm of the evolutionary economy, according to which the trajectory of development is determined by the interaction of technological structures, more likely describes the current processes of the national economy. The organizational and economic development of the agro-industrial complex (AIC) is a process of continuous improvement of the organizational and technological structure and economic parameters of the functioning of production systems. Thus, the concept of the formation of a system of resource-saving functioning of agroeconomy continues and develops the existing scientific positions in the field of effective use of resources and solves the most important socio-economic problem for the state in the interaction of the agribusiness sectors.

According to this concept, the formulation of a new scientific problem of the formation of a resource-saving type of agro-industrial complex was justified as a result of the systemic action of the components of an active resource-saving policy. This task was accomplished through the creation of socio-economic, organizational and legal conditions for effective reproduction, development and use of the resource-saving potential of agro-industrial production. The main areas of increasing the efficiency of resource use are:

– formation and implementation of state, sectoral, regional and local resource-saving programs;
– creation of a regulatory and legal framework and economic mechanisms to support and stimulate the adaptation of innovative resource-saving activities;
– the readiness of the Ukrainian AIC to use the best practices of effective resource conservation and resource use.

An effective method for identifying new sources of resource savings in the development of technical means for the spheres of the agro-industrial complex, as well as projects for the manufacture or restoration of individual parts of agricultural and processing machinery is mathematical modeling. The basis of model constructions is based on the mathematical systems presented in [1]. When manufacturing or restoring parts of agricultural and processing machines, it is necessary not only to lay down the parameters of optimum reliability, but also to strive to achieve minimum resource costs while respecting the conditions for their reproduction and environmental sustainability.

The effectiveness of resource-saving in agrarian-processing production is inextricably linked with the use of innovative methods, technologies, means of labor. The need to solve theoretical and practical problems aimed at identifying and using the reserves of efficiency growth of agro-industrial enterprises by reducing the resource intensity of production determined the relevance of the investigated problem.

2. The object of research and its technological audit

The object of research is the implementation of resource-saving systems in the agro-industrial complex, in particular in the first area – machine building for agriculture. As the most characteristic for achieving the aim of the research, technologies were chosen for optimizing the fuel-air mixture for the internal combustion engine and the technology of the seeder with a reserve dosing device. The choice of these facilities was conditioned by the fact that, according to the structure of agricultural production costs in 2017, fuel costs ranged from 11.6 to 28.7 %, seed costs from 11.1 to 21.2 %, depending on culture.

One of the most problematic places is the systematic implementation of resource-saving in the agro-industrial complex. To overcome this problem, the authors propose an algorithm for selecting a resource-saving design of the service sector in order to evaluate the effectiveness of resource-saving technologies.

3. The aim and objectives of research

The aim of research is analysis of the effectiveness of implementing resource-saving measures in the complex of the first sphere of the agro-industrial complex. To detail the aim, the task is set to create an algorithm for determining reserves of resource efficiency at the enterprises necessary to achieve competitive advantages. This will allow developing flexible scenarios for structuring strategic decisions, assessing the economic and environmental efficiency of implementing resource-saving technologies.

To achieve this aim, it is necessary to solve the following tasks:

1. To assess the adequacy of the proposed multi-criteria rationale for increasing the resource efficiency of agro-industrial enterprises to assess the efficiency of production and the level of resource-saving and to justify priority areas of resource conservation.
2. To substantiate the choice of resource-saving optimization technology of the fuel-air mixture to ensure the operation of the gasoline engine with a minimum content of harmful constituents in exhaust gases, in particular nitrogen oxides, taking into account the fuel economy of the engine.
3. To calculate the economic efficiency of the resource-saving technology of the sowing device with a backup dosing device.

4. Research of existing solutions of the problem

Various aspects of the resource-saving strategy were investigated by scientists in [2–4]. The founder of resource saving can be considered the current president of Kazakhstan, who did not start a given direction of the economy in a word, but started a business [5]. Ukrainian scientists thoroughly pursued the issue of resource conservation, although with a smaller scale. Each of the authors had his own vision and vector of effort. Thus, the author of [6] considered resource saving in the context of the recycling of industrial waste. Purely agricultural resource saving analyzed by the author of [7], but in the future this direction did not develop. Separate aspects of resource conservation in the context of innovative development were investigated by the authors of [8]. Most of the studies, in which the topic of resource-saving was considered, concerned the global aspect [9–13]. In particular, the author of the work [9] analyzed resource savings like the author of [5], within the framework of the structural transformation of the national economy. The author of the work [10] made a detailed analysis of resource saving in the context of the regional aspect. The authors of [11–13] analyzed resource saving in the aspect of its influence on the economic development of Ukraine.

At the same time, in order to more fully disclose the aim of this research, in particular, for the purposes of analyzing the first sphere of the agro-industrial complex, besides direct research on resource conservation, theories and fields of science, including technical ones, were considered. To select a resource-saving optimization technology for the fuel-air mixture to ensure the operation of a gasoline engine with a minimum content of harmful constituents in exhaust gases, in particular nitrogen oxides, taking into account the fuel economy of the engine, papers [14] were analyzed.

To solve the problem of calculating the economic efficiency of the resource-saving technology of the sowing device with the reserve dosing unit, the development of scientists [1] was used, such as that of all alternative options, the most can be applied in Ukrainian realities.

The idea of modern problems of reducing the content of toxic components, including in the field of agro-industrial complex, is formed by studies [15]. It was noted that the toxic effect of NO_x on the human body is ten times more dangerous when compared with CO, as well as the complexity of the neutralization process of nitrogen oxides. Further development of internal combustion engines (ICE) is impossible without reducing their harmful impact on the environment, which is stimulated by the increase in global toxicity standards.

At the same time, many issues of effective organization of material and technical support for agricultural production, creation of an effective system of resource saving as a priority direction for realizing the potential of the agrarian sector on an innovative basis require further study and justification.

5. Methods of research

The scheme of the model for selecting a resource-saving project for the first sphere of the agro-industrial complex is shown in Fig. 1.

As economic indicators, labor intensity, metal consumption, energy intensity, capital intensity and other specific costs for the i-th manufacturing or recovery technology were used. As technical indicators – the resource (the operating time from the beginning of the operation of the machine to reach its limit state), the time to failure, the quality of the obtained product (the operation performed by the machine), and the productivity of the work process.

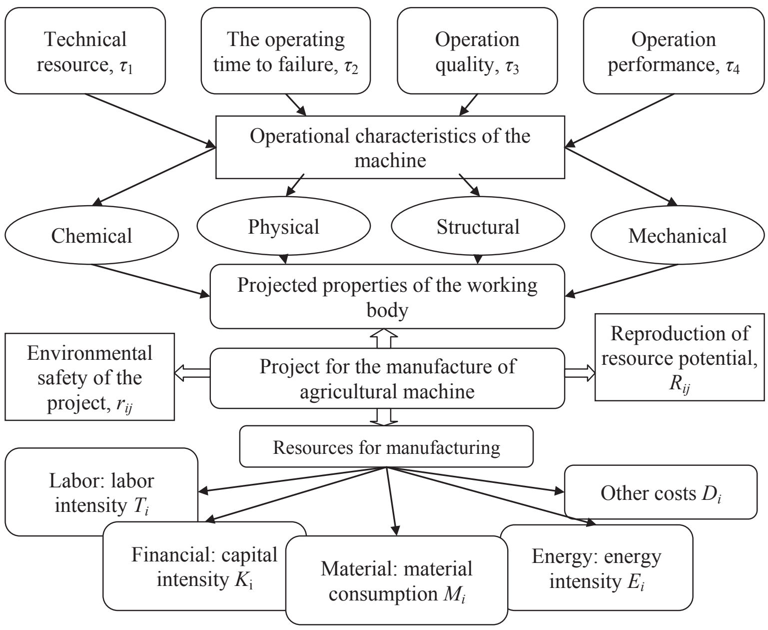

Fig. 1. Scheme for selecting a resource-saving project for the sphere of technical maintenance of the agro-industrial complex [16]

Agricultural and processing machines must have the optimum technical resource and operating time to failure, while ensuring the required quality of the products and the productivity of the work process. To measure the achievement of specified characteristics, a complex coefficient g_i is proposed and which is determined from the relation:

$$g_i = \frac{\tau_{i1}}{\tau_{n1}} \cdot \frac{\tau_{i2}}{\tau_{n2}} \cdot \frac{\tau_{i3}}{\tau_{n3}} \cdot \frac{\tau_{i4}}{\tau_{n4}}. \qquad (1)$$

To select a resource-saving project for manufacturing (restoring) parts of agricultural and processing machines, the general mathematical model of optimization of agricultural production, described in [3], is transformed taking into account the introduction of the following parametric designations:

i – the kind of technology for manufacturing (restoring) an agricultural or processing machine;

X_i – intensity of application of the i-th technology of manufacturing (restoration), changes;

T_i – labor intensity of the i-th technology with a single intensity, man-hours;

M_i –metal consumption and the i-th technology with a single intensity, kg;

E_i – energy intensity and the i-th technology with a single intensity, kWh;

K_i – the capital intensity of the i-th technology with a single intensity, c. u.;

D_i – other unit costs for i-th technology with a single intensity, c. u.;

a_i – productivity of i-th technology with a single intensity, pcs;

τ_{i1}, τ_{n1} – technical resource of the machine, manufactured according to i-th technology and normative;

τ_{i2}, τ_{n2} – the operating time to failure of the new machine according to i-th technology and normative;

τ_{i3}, τ_{n3} – an indicator of product quality (operation), received on a new machine and on the normative basis;

τ_{i4}, τ_{n4} – productivity of the new machine and according to the normative;

V – program for the manufacture (recovery) of machines, pcs.

6. Research results

6.1. Motor researches of the internal combustion engine with the switching off of the working cycles and automatic gas valve. Problems of environmental pollution and energy conservation have acquired significant importance in recent years. Road transport takes a dominant role in the emergence and resolution of these problems. Pollution of the atmosphere by toxic emissions prompts scientists and specialists in the engine building industry to work on creating low-toxic power plants for vehicles.

It is known that 70 % of all piston internal combustion engines, operated on vehicles in Ukraine, are gasoline ones. Their significant drawbacks include the deterioration of environmental performance and low fuel efficiency in their operation compared to other engines, such as diesel engines [14]. Therefore, in the near future, a significant reduction in air pollution and a reduction in fuel consumption is a priority task that can be solved by designing less toxic petrol engines.

The main directions for reducing the toxicity of gasoline ICE, which are promising at present are:

– improvement of the combustion process in the internal combustion engine cylinder by changing the design of its systems and introducing new methods of power regulation;
– application of devices for cleaning and neutralization of exhaust gases (EG);
– use of alternative fuels;
– regulation and adjustment of ICS control systems;
– legitimate limitation of exhaust gas toxicity.

Among these many scientific directions, which are devoted to the solution of the problem of atmospheric pollution with toxins, a fundamentally new method of regulating the power of switching off individual operating cycles (IOC) should be identified [15]. This modification reduces the toxicity of exhaust gases and improves the fuel efficiency of an internal combustion engine.

The essence of the method of power regulation by switching off individual operating cycles is that the change in power is due to the reduction (or increase) in the number of operating cycles by stopping the supply of fuel to the combustion chamber, thereby ensuring the necessary power. IOC does not require significant changes in the design of a standard gasoline engine, and the use of electromagnetic injectors with electronic control makes it possible to carry out the regulation in this way quite simply and reliably.

Compared with the serial petrol engine in the IOC there is no throttle, and the process of throttling with its inherent disadvantages, especially at partial loads. Throttling at the inlet eliminates the possibility of intensive turbulence of the working mixture, which is necessary to improve the subsequent combustion process in the engine cylinder. A deactivated (purge) cycle clears the cylinder of the residual gases and promotes a better flow of the working process in the operating cycle following the disconnected cycle.

Improving the fuel economy of the IOC is ensured with a constant filling ratio regardless of the load. High values of the indicator efficiency are achieved due to a higher use of heat and a small heat capacity of the combustion products of the lean mixture compared to the standard method of power regulation.

As shown by the studies [15], the use of IOC on gasoline internal combustion engines, in addition to reducing fuel consumption by 20–30 % in operating conditions, and up to 40 % in the idling mode, allows to reduce the concentration of toxic products when fuel combustion is 1.5–3 times.

When the IOC is operated on a depleted fuel-air mixture and the constant air excess ratio ($\alpha\approx1.0-1.2$), the concentrations of CO and C_mH_n in the EG are at a sufficiently low level, whereas the NO_x concentrations have the maximum values precisely at $\alpha\approx1{,}05-1.15$. Therefore, a more detailed study of the formation of nitrogen oxides in the engine cylinder, in this case IOC, and the search for optimal control parameters of the IOC supply system are promising. Also, until now, the working cycle of the IOC, following the deactivated (purge) cycle, remains investigated for the parameter «toxicity». The prospectivity of this study has also been affected by the great complexity of neutralizing nitrogen oxides.

A number of authors offer their variants of finding the equilibrium coefficient, the values of which have some differences, to influence the results of calculating atomic oxygen and, accordingly, nitrogen oxide as a whole. For accurate calculations of the concentration of atomic oxygen and NO, it is necessary to introduce the most acceptable equation of the equilibrium coefficient, which in turn is expressed in terms of volume concentration in mol/cm^3. Therefore, in this work, appropriate calculations have been made to determine the refined formula for the atomic oxygen equilibrium coefficient K_0 in the equation.

A large number of gas-valve diagrams are known for obtaining a sample of gas from the engine cylinder: mechanical, hydraulically driven, pneumo-electric, pyrotechnic, based on movable disks and others. Due to a number of drawbacks of the above schemes, in particular when used in high-speed engines, they can't be used in engines with the disconnection of individual operating cycles. Gas valves with mechanical and hydraulic drive, considering the compliance of the system of levers, drafts and high pressure pipelines are bulky enough, structurally complex, is an obstacle when installing them on the engine.

When testing the gas valve and the entire gas-fired system, a number of requirements for their operation were taken into account:

– to ensure that a sample of the gas valves is taken from the engine cylinder, which is necessary to obtain reliable information on the presence of nitrogen oxides in the exhaust gas;
– to ensure regulation and control of the duration of gas sampling phases when the valve is operated on a running engine at the combustion stage;
– to clearly maintain the compliance of the opening and closing moments of the valve with the specified operating conditions at different engine speeds of the crankshaft (CS);
– to ensure the reliability of the valve in the combustion chamber at a temperature of 1900–2700 K, taking into account also that the pressure in the cylinder at the expansion stroke varies within the limits of 0.1–7 MPa;
– to ensure complete gas tightness of the gas-fired system and exclude the penetration of gases and air from the atmosphere.

On the basis of these criteria, a gas-sampling system with an electromagnetic gas valve (EMGV) was developed, which satisfies the requirements.

The main component of the electrical circuit of the electronic control unit (ECU) is a programmable microcontroller PIC16F84A (USA). The device was programmed to take a sample of gas from the cylinder of the operating cycles on the expansion stroke after the combustion process was completed until the exhaust valve was opened. The duration of the combustion process in gasoline engines is in the range of 40–100° of the crankshaft rotation angle (CRA) after the top dead center (TDC) at the compression stroke. Therefore, at the time of the discovery of the EMGV, let's accept the CRA point equal to 400–460°, and its duration in the open state will be 50–100°, which for $n_{cs}=1000-2000$ min^{-1} will be 5–20 ms.

The choice of the operating mode of the IOC was based on the following conditions:

1. The concentration of nitrogen oxides in the exhaust gas should be sufficient so that the relative error does not affect the research results.

2. The amount of fuel-air mixture in the engine cylinder must be large enough to ensure the necessary volume of gas at a single sampling.

3. The frequency of CV rotation remains constant and consistent with the speed of the gas-gusher valve. The duration of the selection should be within the established limits: the beginning of the selection corresponds to the end of the combustion process, and the closing of the valve, respectively, at the beginning of the discharge process:

– constant coefficient of excess air $\alpha=1.0-1.15$;
– constant cyclic fuel supply Q_c=const;
– speed of CS rotation of $n_{CV}=1500\pm50$ min^{-1};
– ignition advance angle θ_i – 15° CRA to TDC;
– throttle valve fully open. The thermal regime of the engine, the pressure and temperature of oil and exhaust gases are constant.

To determine the concentration of nitrogen oxides in the working cycles of the IOC chemically, four methods for the determination of NO_x were recommended, which are recommended in the chemical industry for air quality control.

These are colorimetric methods with the Griess-Ilosval reagent, potassium iodide and salicylic acid, as well as spectral analysis in the gaseous medium, from which the chosen colorimetric method with salicylic acid was used to determine nitrogen oxides in the gas sample. This method of accuracy is not inferior to the method of spectral analysis.

The relative error in determining the NO_x content of the sample using the colorimetric method with the use of salicylic acid is within 13.5 % when determining the NO_x content of the sample for the range of nitrogen oxide changes at 100–3000 ppm.

Concentrations of carbon monoxide CO at all load conditions of the IOC will be significantly lower compared to the serial engine 8Ч 9.2/8.

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Concentrations of unburned C_mH_n hydrocarbons have lower values. The only exception is the operating mode of the IOC with the switching off of the operating cycles and a somewhat enriched duty cycle following the disabled cycle.

The concentration of NO_x oxides during IOC operation is much less than for the serial system, except for the maximum load regime.

6.2. Resource-saving technologies of the sowing device with a reserve dosing device. Any sowing machine in comparison with the ideal sowing introduces its shortcomings in the form of gaps and doubles. The best among the devices should be considered one that performs closer to the ideal, and the economic effect of its work is the difference in economic performance compared with the basic (serial).

Thus, with the same impact of all other factors, the difference in the efficiency of the experimental and serial sowing apparatus becomes the basis of the economy. It is necessary to consider two aspects that determine the final result: the first is the direct fulfillment of the technological process of sowing and the second is the obtaining of crop yields during harvesting. With this formulation of the problem, the total losses from the operation of the sowing apparatus in comparison with the ideal sowing for all crops grown can be represented by the sum:

$$C_\Sigma = \sum_{i=1}^{k} C_i, \tag{2}$$

where C_i – losses from the operation of the apparatus, are obtained during the cultivation of the i-th culture; k – number of crops.

The savings for each crop in the work of an improved research apparatus in comparison with the standard serial is:

$$E = L_a - L_s, \tag{3}$$

where S_i – losses from the experimental apparatus for the i-th culture; L_s – losses from a serial device for a certain culture.

In the general damage consists of both expendable and profitable parts, that is, it is possible to write:

$$L = D - C, \tag{4}$$

where D – the revenue part; C – loss part.

Disadvantages in the operation of the sowing machines are possible gaps when the seed isn't sown, as well as the appearance of doubles, when two or more seeds are simultaneously sown into the nest.

From the point of view of direct savings, gaps reduce seed costs Q_o. The amount of seed material saved on permits can be calculated by the formula:

$$Q_g = \zeta_g \cdot Q, \tag{5}$$

where Q_g – the planned amount of sowing of a particular crop; ζ_g – probability of gaps.

The planned amount of seeding is determined by the achievement:

$$Q = S \cdot q, \tag{6}$$

where S – the area allocated for sowing the crop; q – the set seed rate.

Thus, the savings of seed material due to the formation of gaps are:

$$Q_g = \zeta_g \cdot S \cdot q, \tag{7}$$

and the savings expressed in monetary units are:

$$D_g = Q_g \cdot P_{sm}, \tag{8}$$

where P_{sm} – sowing material price.

Substituting the components of (8):

$$D_g = \zeta_g \cdot S \cdot q \cdot P_{sm}. \tag{9}$$

Doubles when sowing produce direct losses in the additional cost of seed. By analogy, these losses can be calculated as follows:

$$Q_d = \zeta_d \cdot Q. \tag{10}$$

Substituting the components of expressions (7) and (9):

$$Q_d = \zeta_d \cdot S \cdot q \tag{11}$$

or

$$B_d = \zeta_d \cdot S \cdot q \cdot P_{sm}, \tag{12}$$

where ζ_d – the probability of doubles; B_{ac} – direct losses in the additional cost of seed.

The next stage after sowing is the development and maturation of plants, which eventually form the future crop.

Gaps due to lack of seeds lead to direct losses of a possible crop, which are defined as follows:

$$Q_g = \zeta_g \cdot S \cdot Y, \tag{13}$$

where Y – the crop yield.

In monetary units, these losses are

$$B_g = \zeta_g \cdot S \cdot Y \cdot P_{sm}. \tag{14}$$

Thus, when sowing, gaps result in seed savings, can be calculated from formula (9), and doubles – additional costs, which are determined according to the expression (12).

The peculiarity of the passes is that, because of the absence of seeds at their proper place, the feeding area for neighbors grows and their yield increases by ΔY. Since two adjacent seeds correspond to each pass, then:

$$\Delta Y = 2 \cdot \zeta \cdot K_{ip} \cdot Y, \tag{15}$$

where K_{ip} – coefficient of increase in productivity of neighbors of the gap, $K_{ip} = 0.15$.

In monetary terms, the profit is:

$$D_{ny} = \Delta Y \cdot S \cdot P_{sm}. \tag{16}$$

After substituting the components:

$$D_{py} = 2 \cdot \zeta_g \cdot K_{ip} \cdot Y \cdot S \cdot P_{sm}. \tag{17}$$

The appearance of doubles reduces the level of possible yield [1]. This means that as a result of the appearance of doubles, the yield is lost:

$$\Delta Y_d = \zeta_d \cdot K_{dy} \cdot Y, \quad (18)$$

where K_{dy} – the coefficient of yield increase in neighboring plants, between which a gap is formed, $K_{dy}=0.3$.

Or in monetary units:

$$B_{dy} = \Delta Y_d \cdot P_{sm} \cdot S.$$

So

$$B_{dy} = \zeta_d \cdot K_{dy} \cdot Y \cdot P_{sm} \cdot S. \quad (19)$$

Thus, such drawback in the operation of the sowing apparatus as the appearance of doubles brings double economic damage: additional seed costs, and shortage of crops.

Proceeding from the foregoing and returning to equation (4), the losses of the sowing apparatus when growing a particular crop using a serial or research seeder can be represented by the sum of income and expenditure parts:

$$L = D_g - L_g + D_{gy} - L_{ac} - L_{acy}, \quad (20)$$

where D_g – economy of a sowing material owing to formation of admissions; L_g – direct losses of a possible crop due to a pass; D_{gy} –income due to increased yields of neighboring plant of the gap; L_{ac} – direct losses in additional costs of seed; L_{acy} – costs due to shortage of crops.

Each of the devices is not completely perfect design that performs the crop without disadvantages. Disadvantages, as is known, are gaps and doubles. The machine, which has less flaws, will give better results in growing the crop. At the same time, economic efficiency is formed as the difference between losses from the operation of the apparatus. Therefore, based on (3), the economic efficiency of the introduction of the research apparatus for each of the crops is calculated.

The overall economic efficiency of using the seeder with a reserve dosing device for all tilled crops is calculated as the sum:

$$E_{\Sigma} = \sum_{i=1}^{n} E_i. \quad (21)$$

An example of calculation may be the determination of economic efficiency from the production of a research apparatus. The calculation is given per 1 hectare of sown area ($S=1$), the data for the calculation are given in Table 1.

The results of the calculations are summarized in Table 2.

Summarizing the obtained economic efficiency data for the crops (Table 2), the overall economic efficiency from the introduction of the research results is determined. The average value of economic efficiency per 1 hectare using a research apparatus is 1216.45 c. u. To determine the economic efficiency of a seeder per year, it is necessary:

$$N = E_i \cdot S_c, \quad (23)$$

where E_i – the economic efficiency of a particular crop; S_c – total area of sowing of one seeder per year, which is determined by the formula:

$$S_c = P \cdot T, \quad (24)$$

where P – the seeder productivity, which is 4.8 ha/h; T – annual loading of one seeder, which is 160 h.

Table 1

Data for calculating the economic efficiency of the implementation of research results

Indicator	Value
Productive capacity CTBT-12/8M	
Annual seeder loading, h	160
Seeder productivity, ha/h	3–5
Sowing area, thousand ha	800
Seed flow *q*, pcs/ha (kg/ha)	
Soybean	500000 (130)
Corn	80000 (25)
Sunflower (at a row spacing of 70 cm)	150000 (8)
Sugar beet	100000 (3,5)
Sowing material price P_{SM}, c. u./ha (c. u./kg)	
Soybean	1950 (15)
Corn	500 (20)
Sunflower	280 (35)
Sugar beet	1400 (400)
Yield *Y*, t/ha	
Soybean	2.16
Corn	6.16
Sunflower	1.94
Sugar beet	47.65
Price per ton of yield P_y, c. u./t	
Soybean	4650.9
Corn	1744.7
Sunflower	3842.7
Sugar beet	494.2

Table 2

Results of calculation of economic efficiency of introduction of the research sowing device with reserve dosing device on 1 hectare

Crops	Economic efficiency, c. u.
Soybean	1198.11
Corn	2087.58
Sunflower	346.79
Sugar beet	1232.11
Average value	1216.15

Then, from (24):

$$S_c = P \cdot T = 4{,}8 \cdot 160 = 786 \text{ ha}. \quad (25)$$

Based on preliminary calculations, one can record the economic efficiency of one seeder (N) for the crops under consideration:

$$Nsoy = 1198.11 \cdot 786 = 920145.89 \text{ c. u.}$$

$$Ncorn = 2087.585 \cdot 786 = 1603259.94 \text{ c. u.}$$

$$Nsun = 346.79 \cdot 786 = 266334.6 \text{ c. u.}$$

$$Nsug = 1232.11 \cdot 786 = 946259.15 \text{ c. u.}$$

$$Nav = 1216.45 \cdot 786 = 955891.95 \text{ c. u.}$$

As the above calculations show, the greatest economic efficiency of using a seed drill in corn sowing, which makes it possible to obtain 1.6 million USD profit per year from one seeder.

7. SWOT analysis of research results

Strengths. Since the largest percentage in the cost of agricultural products is the cost of fuels and lubricants and seeds, the authors analyzed the available resource-saving technologies.

In particular, after analyzing the results of theoretical calculations and experimental studies of IOC, it was determined that when the engine is running on an optimally depleted fuel-air mixture with $a \geq 1.1-1.15$, the NO_x concentration is significantly lower than when the mixture is close to stoichiometric.

The technical efficiency of the seeder with a duplicate seed dispenser is due, first of all, to a significant reduction in the gaps from 1.2 to 3.3 times.

Weaknesses. Since new technologies require initial financing, most innovators are stopping to implement separate resource-saving technologies. This generally gives a slight effect on the entire production system causing over-expenditure of resources and compromises the whole idea of resource-saving, in general.

Opportunities. The proposed mechanism for supporting resource-saving processes in the agro-industrial complex on the basis of the technological chain of resource costs allows one to search for the most appropriate areas of resource conservation. The proposed model is aimed at increasing the efficiency of agro-industrial enterprises, creating horizontal production links, which include the main and auxiliary units with the aim of reducing production costs through resource costs.

Threats. The main negative factor, accompanied by resource-saving technologies, is the insufficient analysis of the synergistic influence of resource-saving technologies in the system of their use. Thus, in the examples of the use of an internal combustion engine with disconnection of individual cycles, fuel efficiency was obtained, but with a lower engine power.

8. Conclusions

1. In the process of this research, a system was created to assess the efficiency of production and the level of resource saving in the agricultural sector. For the detailed elaboration of this system, a scheme of the algorithm for determining reserves of resource efficiency at enterprises has been developed, and it is possible to assess the economic efficiency of introducing resource-saving technologies.

As a result, the multi-criteria rationale for increasing the resource efficiency of agribusiness enterprises was assessed as such, which is adequate for assessing the efficiency of production and the level of resource saving.

Practical implementation of the resource-saving system in the agro-industrial complex due to the synergistic combination of interactive indicators of resource efficiency makes it possible to effectively use the mechanism of balanced innovation-resource-saving development. Responding to different stages of industrial and processing cycles of agro-industrial complex enterprises in the form of controlled flow (diffusion) of different types of resources into the sector with the most efficient development. The introduction of this system will create optimal conditions for production efficiency and resource-saving level.

2. The technology of fuel-air mixture optimization has been analyzed and justified. On an optimally depleted fuel-air mixture with an excess air factor $a \geq 1.1-1.15$ the operation of the gasoline engine with the minimum content of harmful constituents in the exhaust gases is ensured. In particular, the NO_x concentration is significantly lower than when the mixture is mixed with a stoichiometric mixture.

3. The economic efficiency of the resource-saving technology of the sowing device with the reserve dosing device is calculated. The average annual increase in profit from the introduction of a modernized precision seeding machine for the main tilled crops (corn, sunflower, soybeans, beets) is 1216.45 c. u. on sowing one hectare. The total annual income for a seed drill for the year is 956 thousand c. u. On the example of sowing one of the crops, maize yields the greatest economic effect – 1600,000 in a year, the smallest – sunflower (266 thousand c. u.). At the same time, the best prototype shows itself when soybean was sown, reducing losses by 99 % in value terms.

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RESEARCH OF THE ESSENCE OF SOCIAL RISK MANAGEMENT

Об'єктом дослідження є сутність соціального ризик-менеджменту з точки зору визначення його основних рис. Показано, що об'єкт дослідження багатовимірний і складається з:

1) факторів, що спонукають соціальні ризики;

2) самих ризиків, як віддзеркалення негараздів у науковій думці;

3) організаційних, економічних і творчих процесів, що супроводжують ризик-менеджмент і становлять його сутність.

До недоліків об'єкту дослідження віднесені неточність визначень і відсутність єдиного підходу до питань управління ризиками в загальнодержавних органах і в приватних, корпоративних і громадських організаціях.

У дослідженні використовується метод узагальнення на основі абстрагування. Такий підхід пов'язаний з наявністю розрізненої інформації з заявленої теми. Шляхом узагальнення шукаються інваріанти, що вміщують сутність соціального ризик-менеджменту.

У результаті дослідження були виявлені, логічно ув'язані і сформульовані основні риси об'єкту досліджень. Виявлена загальна природа невизначеності ризиків, яку неможливо мінімізувати людськими зусиллями. Зусилля людини має бути спрямовано на вироблення потоку конкретних (хоча і не зовсім коректних, а то і помилкових) рішень в умовах невизначеності і непередбачуваності. З'ясовані характерні відмінності установ, які займаються соціальним ризик-менеджментом. Запропоновано відповідну класифікацію на прикладі українських інституцій. Зроблений висновок про необхідність посилення наявних інституцій соціального ризик-менеджменту в Україні та підвищення фахової підготовки існуючих менеджерів.

Робота становитиме інтерес для науковців, які досліджують проблеми соціального ризик-менеджменту, та представників органів влади всіх рівнів.

Ключові слова: *управління соціальними ризиками, оптимізація соціальних ризиків, соціальний ризик-менеджмент, інституції управління ризиками в Україні.*

1. Introduction

Risk management, in particular social, is a long-standing direction in the practice of business and public administration. Social protection at the state level was, perhaps, for the first time only in the 19th century in Germany after the unification of its «land». The German Kaiser in 1881 promulgated a message on the right of workers to social protection, on the basis of which the Reichstag issued three laws on social insurance: in case of illness, accident, disability and old age [1]. Soon, the Council of People's Commissars in 1918 issued a decree «Regulations on the social security of workers» [2].

In the twenty-first century, the practice of managing social risks received a new impetus. Against the backdrop of the global financial crisis in 2009, the World Bank issued the international standard «Risk management – Principles and guidance» [3]. The document is devoted to the risks of humanity in general; social problems indicated there indirectly.

The issues of risk management with the features inherent in the social sphere are explored in this work. The relevance of the topic at the global level is conditioned by:

1) increased risk of technogenic factors;
2) so-called globalization, which led to impoverishment of the population in many countries of the «third» and «second» world;
3) hunger and wars, which never subsided;
4) accelerated spread of epidemics and epizootics;
5) severe global and regional economic crises and the like.