

Methodological characteristics for the efficient evaluation of investments in updating the technical basis of agricultural organizations dedicated to planting

Características metodológicas para la evaluación eficiente de inversiones en la actualización de la base técnica de las organizaciones agrícolas dedicadas a la siembra

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ABSTRACT:

Low technological level of domestic agricultural producers, reducing the supply of machinery to the village, increasing the load on the unit base mechanization does not allow to increase productivity in crop production, to reduce costs of implementation of mechanized operations, etc. In the course of research the method of estimation of economic efficiency of innovation and investment projects on updating and development of technical base of crop production of agricultural producers is specified.

Keywords: Crop production, technical and technological base, renewal, investment

RESUMEN:

El bajo nivel tecnológico de los productores agrícolas rusos, sumado a la reducción en el suministro de maquinarias al pueblo y aumentando la carga en la mecanización de la base de la unidad no permite aumentar la productividad en la producción de cultivos ni reducir los costos de implementación de operaciones mecanizadas. En el transcurso de esta investigación se utilizó el método de la estimación de la eficiencia económica de innovación y los proyectos de inversiones sobre la actualización y el desarrollo de la base técnica de la producción de cultivos de los productores agrícolas.

Palabras clave: producción de cultivos, base técnica y tecnológica, renovación, inversión

1. Introduction

Machine-tractor fleet of agricultural producers is an important element of their production potential. Insufficient availability of tractors, combines and other machinery, high degree of their physical and moral wear and tear lead to violation of agricultural technologies of cultivation and, as a consequence, to large losses of crop and income. Therefore, timely updating and replenishment of the fleet of machines taking into account the development of modern innovative resource-saving mechanized technologies is a prerequisite for improving the efficiency of crop production, increasing the volume and competitiveness of products.

Well-known scientific publications of this research area reveal the main theoretical and methodological provisions of the problem under consideration. However, some of its aspects require further deepening, development and adaptation to constantly changing internal and external technical, technological and organizational and economic conditions of agricultural production.

The aim of this work was to clarify and develop methodological provisions for assessing the effectiveness of investments in the renewal of the machine and tractor fleet of agricultural organizations, taking into account the transition to innovative mechanized technologies in crop production. The achievement of this goal involved the development of an assessment methodology, as well as its testing on the example of agricultural organizations in one of the regions of the South of Russia.

2. Materials and methods

The research was carried out using the methods of comparative analysis, monographic, economic-statistical and computational-analytical.

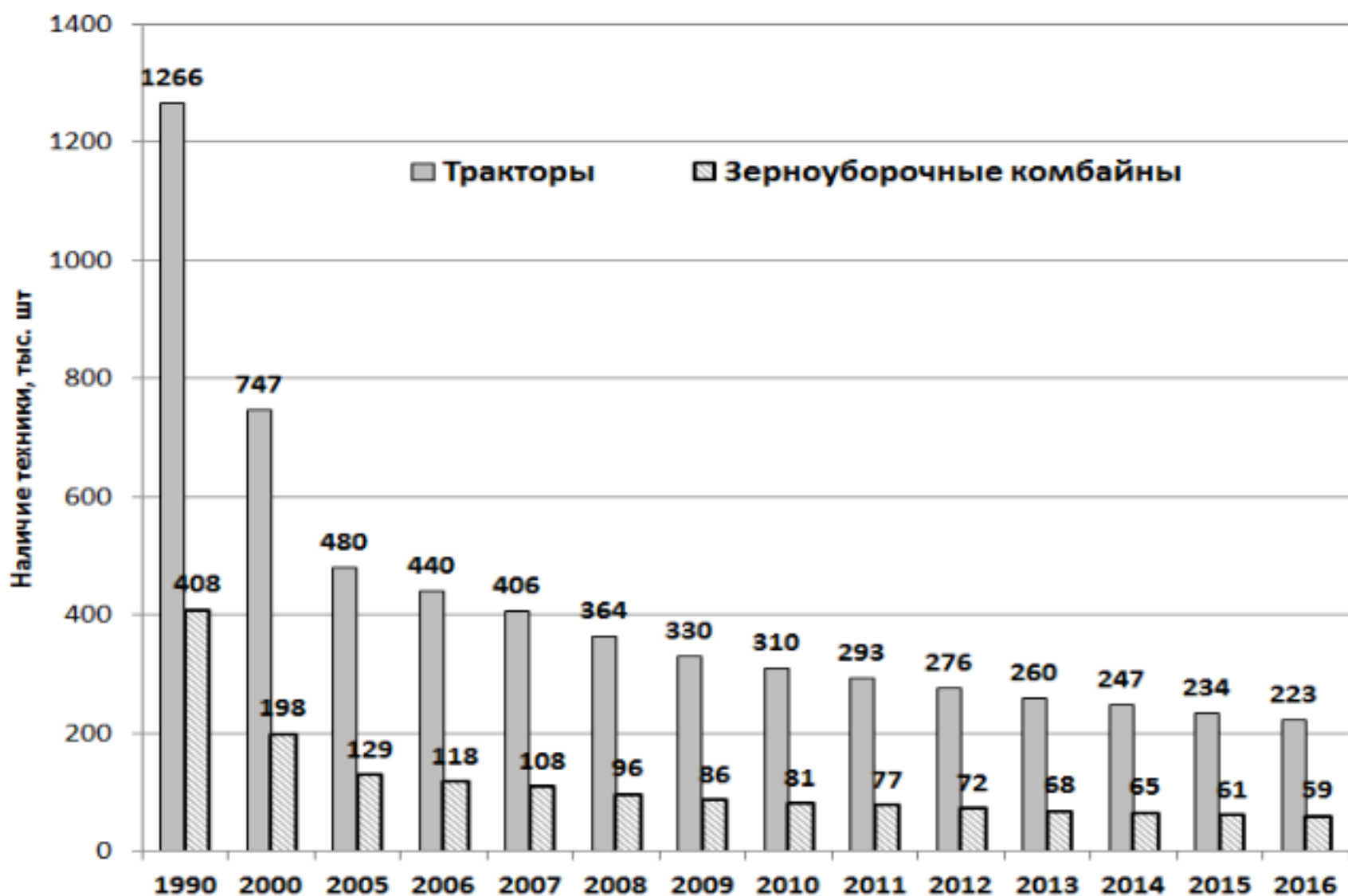
3. Discussion

Proceeding from economic essence of reproduction process, reproduction of technical base of plant growing should be understood as process of constant renewal of quantity, quality, structure of the machine and tractor Park exposed to physical and moral wear for the purpose of preservation or increase of volumes of production of agricultural products at increase of productivity of work and decrease in specific production costs. At the same time, the reproduction process can be carried out in two ways: by major repairs of worn-out machines and their further use, or by replacing the old equipment with a new one. In the latter case, the reproduction process is innovative, since the updating of technology, as a rule, occurs with the simultaneous improvement of its composition and quality through the introduction of technical and technological innovations.

The analysis showed that the quantitative composition of basic mechanization in agricultural organizations in Russia has decreased significantly over the past two and a half decades (Figure 1). Among the main reasons for this is the weakening of state support for the agricultural sector, the nonequivalence of cross-sectoral exchange, high price and low availability of debt capital.

Figure 1

Availability of basic means of mechanization of plant growing in agricultural organizations of Russia



Source: Prepared by the authors.

Violation of the reproduction processes of the technical base of producers caused an increase in the load per unit of basic mechanization, which only over the past 6-7 years increased by almost 30% (Table 1). In the existing Park of agricultural machinery of Russia 60% of tractors and 45% of combine harvesters are operated for more than 10 years (Bershitsky, 2014). This is one of the causes of significant crop losses, and, as a consequence, a decrease in the efficiency of crop production.

In the current conditions, the issues of technical re-equipment of the crop sector with the transition to modern resource-saving agricultural technologies are of particular importance. The introduction of technical and technological innovations in production requires significant investment, so it is important to correctly assess their effectiveness and riskiness.

Table 1
Indicators of technical equipment of plant growing industry of the Russian Federation.

Years	Availability of equipment		Load per unit of agricultural machinery, hectares	
	we have 1000 hectares of arable land tractors, pcs.	there are 1000 hectares of crops of grain combine harvesters, pcs.	On the tractor	On the combine harvester
2010	4,2	3,1	236	327
2011	4,1	2,8	247	354
2012	3,9	2,7	258	369
2013	3,6	2,5	274	399

2014	3,5	2,4	290	408
2015	3,3	2,4	307	422
2016	3,3	2,4	305	425

Source: Prepared by the authors.

As indicators of efficiency of investments are most often used are dynamic indicators, such as net present value, internal rate of return and discounted payback period (Chetyrkin, 1998). However, the methodology for calculating these indicators should be adapted to the characteristics of the subject area under consideration. In assessing the effectiveness of investments, it is necessary to take into account the structure of the invested capital and the price of its various sources (Kuzmenko, 2014), as well as the price dynamics in calculating the expected cash flows generated by the project.

Given the above, the net present value of the innovative-investment project of the renovation of the technical base of plant producers is to be calculated using the following expression:

$$NVP = \sum_{t=1}^{n_1} R_t(1 + ACC)^{-t} - I_c - \left[A + \frac{s \cdot AP}{(1+ACC)^{1+m}} + \sum_{t=2+m}^{n_2-s+1} AP(1 + ACC)^{-t} \right] \quad (1)$$

where: **NPV**– net present value, rubles; **R_t** – projected annual net cash income, rubles; **ACC**– weighted average cost of invested capital, relative units; **I_c** – own funds of the organization, rubles; **A** – advance payment, rubles; **AP** – amount of the annual payment to repay the debt, rubles; **s** – multiplicity of increase in the first payment; **m** – payment deferral period, years; **n₁**– period of receipt of income, years; **n₂** - maturity of debt, years.

Negative cash flows in this expression represent investment costs of the producer for acquisition of new equipment. These costs can be of a one-time nature (for the conditions of self-financing of investments) and distributed over time (using borrowed financial resources). In the latter case, formula (1) takes into account the possibility of debt repayment with deferred payment, advance payment and increased payment in the first years of the project:

$$AP = \frac{K-A}{\frac{s-1}{(1+r)^{1+m}} + \frac{(1+r)^{-m} - (1+r)^{-n_2+s-1}}{r}} \quad (2)$$

where: **K** – amount of debt, rubles; **r** – interest rate on Bank loans (leasing).

The annual expected cash income of **R_t** in terms of (1) represents the annual economic effect of the introduction of technical and technological industry innovations. It is determined by comparing the performance of existing and innovative mechanized technologies implemented by appropriate means of mechanization.

At the same time, the economic effect of the transition to new agricultural technologies consists of saving operating costs for field mechanized work and the cost of additional products obtained through the use of new technology.

The reduction of operating costs in the transition to new technologies is achieved through the use of multi-operational combined machines and tools, increasing the productivity of new equipment and reducing the cost of maintaining it in working order.

The economic effect of saving operating costs due to the introduction of sectoral technical and technological innovations can be calculated using the following formula:

$$E_c = \Delta C_{cr} + \Delta C_{lub} + \Delta C_{sal} \quad (3)$$

where: **E_c** – effect of saving operating costs, rubles; **ΔC_{cr}** – reduction of costs for current repair and maintenance of new equipment, rubles; **ΔC_{lub}** – reducing the cost of fuel and lubricants, rubles; **ΔC_{sal}** – reduction of expenses on a salary of machine operators, rubles.

Another component of the economic effect is formed by reducing crop losses due to the possibility of performing the most important field mechanized work in the optimal agrotechnical terms, as well as by increasing the yield of crops due to the transition to innovative technologies for their cultivation and harvesting.

The General economic effect of the production of additional products due to the improvement of the technical and technological base of crop production can be calculated using the following expression:

$$E_{pr} = E_{ts} + E_i \quad (4)$$

where: E_{pr} – economic effect of the production of additional crop production, rubles; E_{ts} – the effect of reducing crop losses due to the implementation of mechanized field work in the recommended of tight schedule, rubles; E_i – economic effect of increasing crop yields through the development of innovative agricultural technologies, rubles.

The first component of this effect represents an additional income of the company resulting from the formation of the optimal composition of the tractor fleet, which allows to reduce the time of performing the essential field work to the recommended. For each type of technological operation, this economic effect in formalized form can be represented by the following expression:

$$E_{ts} = \sum_{i=1}^I Y_i \cdot \int_{t_n}^{t_a} L_i(t) dt \cdot S_i \cdot (P_i - C_i) \quad (5)$$

where: I – many types of agricultural crops; Y_i – average annual yield of the i -th crop, tons/hectare; $L_i(t)$ – function of losses of the i -th culture from the breach of a tight schedule; t_n – recommended tight schedule, days; t_a – actual period of implementation of mechanized operations, days; S_i – sown area of the i -th culture, processed or cleaned in violation of agricultural workers, hectare; P_i – price of the i -th culture, rubles/ton; C_i – cost of growing and harvesting 1 ton of the extra production of the i -th culture, rubles/ton.

The second component of the economic effect obtained from the growth of crop yields due to the transition to innovative agricultural technologies can be determined by the formula:

$$E_i = \sum_{i=1}^I (Y_i^n - Y_i^b) \cdot S_i \cdot (P_i - C_i) \quad (6)$$

where: Y_i^n, Y_i^b – yield of the i -th crop under the new and basic variant of technologies respectively, tons/hectare.

The technique described above was tested on the example of agricultural organizations in the South of the Rostov region. Agro-climatic and soil features of this zone are characterized by insufficient and unstable moisture, which requires the use of innovative water-saving technologies of tillage, implemented zonal system of machines adapted to the conditions of the zone placement. This requires an appropriate update of the composition of the machine and tractor fleet of agricultural organizations of the zone.

Using as initial data the developed structure of the sown areas of the agricultural organizations of the zone, characteristics of innovative agrotechnologies and average for a number of the last years of productivity of the main crops, calculations on determination of optimum structure of machine and tractor Park of agricultural producers of the investigated zone by means of the author's mathematical model (Bershitsky, 2010) and the computer programs developed for its practical implementation were executed (Bershitsky, Katsko & Kastidi, 2012; Bershitsky, Katsko & Krepyshev, 2012; Bershitsky & Kastidi, 2012). The lack of means of mechanization of producers, as well as the amount of necessary investment to eliminate it was determined by the results of a comparative analysis of the optimal and available (at the beginning of 2016). the composition of the machine and tractor fleet (Table 2). Taking into account the high degree of wear and tear of equipment, in the process of updating the machine and tractor fleet, the possibility of selling worn-out equipment at a liquidation cost of 5% of the original carrying price was taken into account.

Table 2

Indicators of renewal of machine and tractor Park of producers of the South of the Rostov region taking into account transition to innovative agrotechnologies.

Type of equipment	Presence, pcs.		Acquisition		
	total	beyond the amortization term	quantity, pcs	cost, million rubles	liquidation value of worn-out equipment,

					million rubles
Tractors	18564	10893	5813	4818	424
Combine harvester	4916	2494	2992	14641	262
Truck	7531	3546	215	387	319
Multi-operational tillage machines and tools	-	-	2600	1087	-
Total	31011	16933	11620	20933	1005
Required investments, million rubles	19928				

Source: Prepared by the authors.

Calculations have shown that technical re-equipment of crop production of producers of the considered zone will require about 20 billion rubles of investments

In table 3 calculated indicators of economic effect from updating of machine and tractor Park of producers of the considered zone at the expense of reduction of operational expenses with application of an author's technique are resulted.

Table 3

Calculated indicators of the economic effect of the renewal of the machine and tractor fleet of producers of the South of the Rostov region.

Indicators	Existing technology	Innovative technology	Effect
Tractors are required, thousand pieces	12,6	12,2	0,4
Agricultural machineries are required, thousand pieces	102,3	74,7	27,6
Cost of the fleet, million rubles	51727	49654	2073
Machine operators are required, people	9100	8500	600
Operating costs, million rubles	16516	15442	1074

Source: Prepared by the authors.

The calculations also showed that the transition to innovative technologies of soil treatment and reduction of duration of the grain harvest will allow you to get more crop production in the amount of 4.2 billion rubles.

In total, as a result of technical and technological modernization of crop production, producers of the considered zone can get an annual economic effect in the amount of 5.3 billion rubles.

Table 4 shows the estimated performance of investments in the implementation of this innovative project.

Tables 4

Calculated indicators of economic efficiency of investments in technical and technological modernization of crop production in the South of the Rostov region.

Indicator	Value
Investment costs, million rubles	19928
Expected annual economic effect, million rubles	6646
Discount rate, %	13,3
Net present value, million rubles	8,2
Internal rate of return, %	26,7
Discounted payback period, years	5,0

Source: Prepared by the authors.

The positive value of net discounted income and short payback period of investments indicate the economic feasibility of the project implementation of technical and technological innovations in crop production in the South of the Rostov region.

The effectiveness of the introduction of sectoral innovations largely depends on the financial conditions of their implementation, including the solvency of producers, which determines the possibility of their self-financing, as well as the conditions for attracting external financial resources.

Calculations have shown that the most effective way to finance innovative projects to update the technical and technological base of rural organizations are currently the conditions of Federal leasing, allowing agricultural producers to carry out technical re-equipment of production without large capital costs.

When using Bank loans as a source of financing for innovation and investment projects, state support in the form of subsidizing part of their interest rate is necessary.

4. Conclusions

The conducted researches allow to draw the following main conclusions:

1. The volume of investments in updating the technical base of crop production of agricultural organizations should be determined by the results of a comparative analysis of the existing and optimal composition of the machine and tractor fleet. At the same time, the optimal composition should be formed taking into account the transition to modern resource-saving mechanized technologies of cultivation of crops.
2. When calculating the performance indicators of investments in technical re-equipment of agricultural producers, it is proposed to use the author's methodology that allows for taking into account the sources and price of invested capital, as well as methods of repayment of financial debt. The technique also allows to calculate the expected economic effect from the renewal of the machine and tractor fleet, formed by reducing the cost of mechanized work in the field, as well as by increasing the volume of products from reducing the duration of these works and improve their quality.
3. The developed technique was tested in assessing the effectiveness of updating the technical base of crop farming organizations of the South of the Rostov region. The calculations made allowed to substantiate the recommended optimal composition of the machine and tractor fleet of manufacturers, to calculate the volume of required investments in the amount of 20 billion rubles, to determine the indicators of their efficiency. Proven economic feasibility of implementing this innovative-investment project, internal rate of return which is equal to 26.7% and the discounted payback period shall not exceed 5 years.
4. As a result of researches it is established that the most effective form of financing of investment projects of renewal of technical base of agricultural producers now is the

financial leasing allowing to carry out modernization of production on the innovative basis without attraction of large investments.

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