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METHODICAL APPROACH TO COMPLEX EVALUATION OF TECHNOLOGICAL SUPPORT OF PRODUCTION IN AGRICULTURAL ENTERPRISES

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A B S T R A C T

The purpose of the article is to develop a methodology for comprehensive assessment of technological support of production in agricultural enterprises by determining the system of indicators of production and economic activity of these enterprises, the efficiency and intensity of the use of main types of resources. In the process of research the following methods were used: statistical and economic, comparison, tabular, grouping, formalization, sociological and monographic. The article studies the problems of assessing technological support of production of enterprises as one of the aspects of their innovation activities. The content, purpose and algorithm for the use of a comprehensive assessment of technological support of production in agricultural enterprises in the context of innovativeness are substantiated. The developed method allows the management of agricultural enterprises by the results of the assessment to determine the level of technological support of production at each individual enterprise and take effective management decisions concerning the further policy of innovation development.

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1. INTRODUCTION

One of the main goals of agricultural enterprises, as well as economic entities of other sectors of the economy, is to focus on achieving effective results by providing competitive advantages in domestic and foreign markets, given the specific economic character of farmers and the possible use of innovative management mechanisms. The search for ways to function effectively in modern conditions can be ensured through innovative changes and requires the formation of appropriate proposals for the intensification of agricultural production, in which technological renewal plays an important role. Ensuring the technological renewal of agricultural production is a complex process accompanied by financial difficulties, and with an insufficient level of technological support, there will be a reduction in the economic efficiency of production. Elements of technological renewal of production are compliance with scientifically sound production technologies, protection of the natural

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environment, ensuring the system of rational use of land resources, preservation of quality parameters of agricultural lands, protection of property rights, improving the ecological environment to ensure food security of the country in general. Renewal is usually made through innovation or supporting components. It is quite difficult in the system of technological renewal of production to understand the essence of this process, its effectiveness in agricultural enterprises, the mechanism of technological renewal of production, and methods of its evaluation. That is why it is important to form a holistic, theoretically sound system of technological renewal of production in agricultural enterprises. Such renewal should be included in the roadmap of enterprise activity, because it allows achieving higher indicators compared to competitors (Boryshkevych & Iwaszczuk, 2020).

The basis for making managerial decisions concerning the innovativeness of production, the justification of possible vectors of development in the current period and in the future, in particular, the feasibility of technological upgrading of production in agricultural enterprises, is the assessment of the existing technological support of the production process.

The purpose of the article is to develop a methodology for comprehensive assessment of technological support of production in agricultural enterprises by determining the system of indicators of production and economic activity of these enterprises, the efficiency and intensity of the use of basic types of resources.

2. LITERATURE REVIEW

The activities of the enterprise in modern conditions should be competitive. The category of competitiveness is not irrelevant and stable and is assessed only in comparison with the performance of other enterprises of the industry. The issue of increasing the competitiveness of agricultural enterprises is studied by scientists from different countries, including: Ukraine and Poland N. Pavlenchyk, F. Horbonos, A. Pavlenchyk, R. Skrynkovskyy, G. Pawlowski (Pavlenchyk et al., 2021), Ł. Chryniewicz, D. Kyryliuk, M. Wojtaszek (Chryniewicz et al., 2017), M. Matyja (Matyja, 2016), China S. Chang (Chang, 2017), D. Huo, Y. Chen, K. Hung, Z. Song, J. Guan and A. Ji (Huo et al., 2020), America I. M. Sheldon (Sheldon, 2017) and others.

Carrying out the analysis of recent studies, it is necessary to highlight the scientists who reveal the problems of innovative development of agricultural enterprises in different regions of the world, taking into account their inherent specific constraints and conditions. A. Koraus, K. Haviernikova, M. Gombar, F. Cernak, F. Miroslav (Koraus et al., 2020) identified the key elements covered by three main dimensions (technological, non-technological and organizational) that affect the innovative activities of agricultural small business entities in Slovakia regarding their sustainable development and investigate the perception of these elements by the agricultural industry. S. Jercinovic, N. Dadacek empirically analyzed the development trend of permanence-oriented innovative agricultural enterprises in Croatia regarding their marketing efficiency. The authors conducted a regression analysis in order to establish a statistically significant influence of some independent variables on the marketing efficiency of agricultural enterprises as a dependent variable (Jercinovic & Dadacek, 2016).

Thus, the methods of environmental and economic management and mechanisms for their implementation to ensure the safe development of agribusiness in the region according to the innovation scheme through the development and support of organic production are considered by M. Bahorka (Bahorka, 2019). The author considers agricultural enterprises as an economic and ecological system, which is based on rational and environmentally justified methods of production by ensuring the quality of products and raw materials and in this he sees the possibility of increasing competitiveness.

We consider technological renewal of production as a key factor in ensuring the competitiveness of enterprises in the market, an integral part of the policy of innovation development of economic entities, which consists in the process of replacing production technology with new, more perfect, and this, causes changes in other elements of the production process and directs to achieve more effective activity of enterprises.

Agricultural enterprises must find new optimal methods of activity management in order to adapt to the constantly changing external factors (Yakubiv et al., 2019; Yakubiv et al., 2020; Yakubiv & Poliuk, 2019; Balaniuk et al., 2021; Sofina & Dyachkov, 2022).

Therefore, a comprehensive assessment of the technological support of production will allow the management of the enterprise to develop possible options for action on the technologies used in the current period and in the future, as well as to determine the need for technological upgrading of the production process.

The existing approaches to assessing the level of technological development of production in the vast majority (Horizon, 2020; The Law of Ukraine, 2011; Resolution of the Verkhovna Rada of Ukraine, 1999; Order of the State Statistics Committee, 2016; Order of the State Statistics Committee, 2014; Spivak, 2017; Mikołajczyk, 2014; Baruk, 2016; Motyka, 2016; Ermakov et al., 2018):

1) concern the innovation activity of the enterprise as a whole;
2) do not take into account the peculiarities of the activity of enterprises in different sectors of the economy;

3) as a rule, provide the calculation in the dynamics of a certain list of indicators characterizing various aspects of the activity of the enterprise, but are not reduced to a comprehensive assessment using the appropriate methodology.

Thus, M. Banaś (Banaś) considers a number of general and more specific indicators and criteria of activity of enterprises with the purpose of measurement and analysis of innovation activity, referring to A. Pomykalski, Community Innovation Survey and innovation indicators according to Boston Consulting Group.

M. Oszmiańska (Oszmiańska) in order to evaluate innovations on farms proposes to use indicators of the number of innovations, their type, the level of spending on innovation in the total value of the household or the relative advantage that is achieved through the introduction of innovation.

T. Kraśnicka for the purposes of research and comparative analysis of innovation, uses indicators proposed by OECD experts in the Oslo Manual (Oslo Manual, 2018), as well as synthetic indicators for assessing the innovation economy developed by international organizations (OECD, World Bank and EU), paying considerable attention to the Sumary Innovation Index (SII), formed on the basis of more than 20 detailed indicators concerning education, R&D costs, patents, innovation, small and medium business and innovation financing (Kraśnicka, 2013).

P. Litwa points out the possibility of using the balanced scorecard as a comprehensive tool for measuring the level of innovation in an enterprise (Litwa, 2017).

P. Łukasik (Łukasik, 2017) considers rating and aggregate assessment based on calculated indicators to be an interesting way to measure the innovativeness of enterprises. The calculation of return on investment in innovations is considered to be one of the significant indicators of innovation performance.

I. Yepifanova, V. Dzhedzhula (Yepifanova & Dzhedzhula, 2020) proposed a scientific and methodological approach based on the Harrington criterion to assess the level of innovation potential, which allows to generalize diverse criteria and factors that determine the innovation potential of an enterprise.

Thus, most researchers note the complexity of measuring and assessing innovation, taking into account the multidimensionality of the concept of innovativeness in general, but consider it appropriate to derive a synthetic assessment of this process.

Given the above, as well as the importance of technological innovation for the development of the enterprise, our goal is to form an approach to the integrated assessment of the technological component of innovation activities of agricultural enterprises, in particular, the technological support of production, taking into account the specifics of activity in agriculture.

3. MATERIALS AND METHODOLOGY

In the process of research the following methods were used: statistical and economic, comparison, tabular – in order to collect, summarize and present statistical information; grouping – to form a ballot measure of indicators of complex evaluation of technological production support; formalization – to present methods of complex evaluation of technological production support through formulas; sociological – to interview respondents during the research of technologies used in agriculture – to visualize the process of technological renewal of production in the form of tables and figures and visualization of the research object; monographic – in order to calculate a comprehensive assessment of technological support of production of the farm.

The information base of the study consisted of scientific works of domestic and foreign scientists, data of the State Statistics Service of Ukraine, materials of the State Employment Service of Ukraine, financial and statistical reports of the studied enterprise, the results of a questionnaire survey.

The proposed method of comprehensive assessment of technological support of production in agricultural enterprises is based on the approach proposed by E. Gail for marketing assessment of goods (Gail, 1994) and is formed taking into account the weight coefficients, criteria and indicators of production and economic activity of the enterprise, efficiency and intensity of production, determined by expert method, and scoring, reflecting the relative level of indicators during the period selected for observation (Sas, 2019; Sas, 2020).

The rationale for the choice of indicators for assessing the technological support of production is reflected in our previous publications (Sas, 2018).

The weighting coefficients were determined by a questionnaire survey. The experts were 50 people, including scientists from different regions of Ukraine, heads and specialists of agricultural enterprises, employees of the Department of Agroindustrial Development and Agroindustrial Productivity Center. The list of questions that respondents received and the summary results of the survey (weighting coefficients) are presented in Table 1.

Table 1. Weight of general and partial criteria and indicators of comprehensive assessment of the effectiveness of technological support of production in agricultural enterprises (in accordance with the results of expert evaluation based on the questionnaire)

Criteria	Criteria and indicators weight					
	general criteria	partial criteria			indicators	
1. General criteria of production and economic activity of the enterprise	0.3					
1.1. Product manufacturing			0.5			
1.1.1. Agricultural production per 100 UAH the value of non-current and current assets, UAH					0.5	
1.1.2. Agricultural production per 100 hectares of agricultural land, thousand UAH					0.5	
Total					1.0	
1.2. Product sales			0.2			
1.2.1. Agricultural production per 100 UAH of the value of non-current and current assets, UAH					0.3	
1.2.2. Agricultural production per 100 hectares of agricultural land, thousand UAH					0.3	
1.2.3. Export of agricultural products per 100 UAH of the value of non-current and current assets, USD					0.2	
1.2.4. Export of agricultural products per 100 hectares of agricultural land, thousand USD					0.2	
Total					1.0	
1.3. Investments			0.3			
1.3.1. Capital investments per 100 UAH of the value of non-current assets, UAH					0.4	
1.3.2. Capital investments per 100 hectares of agricultural land, thousand UAH					0.2	
1.3.3. Foreign investments per 100 UAH of the value of non-current assets, USD					0.2	
1.3.4. Foreign investments per 100 hectares of agricultural land, thousand USD					0.2	
Total			1.0		1.0	
2. Performance criteria	0.5					
2.1. By type of performance		0.5				
2.1.1. Economic			0.3			
2.1.1.1. Net profit (loss) per 100 UAH of non-current and current assets, UAH					0.2	
2.1.1.2. Net profit (loss) per 100 hectares of agricultural land, thousand UAH					0.2	
2.1.1.3. Profitability of operations, %					0.6	
Total					1.0	
2.1.2. Technological			0.3			
2.1.2.1. Crop yield:					0.5	
2.1.2.1.1. Cereals and legumes, c/ha						0.2
2.1.2.1.2. Factory sugar beets, c/ha						0.1
2.1.2.1.3. Sunflower, c/ha						0.2
2.1.2.1.4. Rapeseed and colza, c/ha						0.1
2.1.2.1.5. Soybeans, c/ha						0.1
2.1.2.1.6. Potato, c/ha						0.1
2.1.2.1.7. Vegetable crops, c/ha						0.1
2.1.2.1.8. Fruit and berry crops, c/ha						0.1
Total						1.0
2.1.2.2. Animal performance:					0.5	
2.1.2.2.1. Average daily gain in growing and fattening cattle, g						0.3
2.1.2.2.2. Average daily growth of pigs on growing and fattening, g						0.2
2.1.2.2.3. Average egg production of laying hens, pcs.						0.2
2.1.2.2.4. Average annual milk yield from one cow, kg						0.2
2.1.2.2.5. The average annual wool removals from one sheep, kg						0.1
Total					1.0	1.0

2.1.3. Environmental			0.2			
2.1.3.1. Hazardous waste generation per 100 UAH of non-current and current assets, kg					0.3	
2.1.3.2. Hazardous waste generation per 100 hectares of agricultural land, tons					0.3	
2.1.3.3. Emissions of harmful substances from stationary sources of pollution per 100 UAH of the value of non-current and current assets, g					0.2	
2.1.3.4. Emissions of harmful substances from stationary sources of pollution per 100 hectares of agricultural land, kg					0.2	
Total					1.0	
2.1.4. Social			0.2			
2.1.4.1. Internal				0.7		
2.1.4.1.1. Ratio of wages to the minimum wage, times					1.0	
Total					1.0	
2.1.4.2. External				0.3		
2.1.4.2.1. Number of new jobs created per 100 UAH of non-current and current assets value					0.5	
2.1.4.2.2. Number of new jobs created per 100 hectares of agricultural land					0.5	
Total			1.0	1.0	1.0	
2.2. By resources		0.5				
2.2.1. Efficiency of use of labor resources			0.1			
2.2.1.1. Labor productivity per employee, thousand UAH					0.2	
2.2.1.2. Production labor intensity, man-hours.					0.2	
2.2.1.3. Power equipment of labor, kW					0.2	
2.2.1.4. Staff profitability, %					0.1	
2.2.1.5. Staff turnover rate, %					0.2	
2.2.1.6. Working time utilization rate, %					0.1	
Total					1.0	
2.2.2. Efficiency of use of financial resources			0.2			
2.2.2.1. Return on assets, %					0.1	
2.2.2.2. Return on equity, %					0.2	
2.2.2.3. Profitability of production, %					0.2	
2.2.2.4. Return on sales, %					0.2	
2.2.2.5. Coefficient of economic efficiency of financial resources, %					0.1	
2.2.2.6. Capital intensity of production, UAH					0.1	
2.2.2.7. Profitability of capital investments, %					0.1	
Total					1.0	
2.2.3. Efficiency of use and technical condition of fixed assets			0.1			
2.2.3.1. Return on assets, UAH					0.2	
2.2.3.2. Stock-intensity, UAH					0.1	
2.2.3.3. Labour efficiency, thousand UAH					0.1	
2.2.3.4. Equipment, UAH ths.					0.1	
2.2.3.5. Return on fixed assets					0.1	
2.2.3.6. Fixed assets depreciation rate					0.2	
2.2.3.7. Fixed assets renewal ratio					0.2	
Total					1.0	
2.2.4. Efficiency of use of current assets			0.1			
2.2.4.1. Turnover rate					0.3	
2.2.4.2. Load factor					0.2	
2.2.4.3. Length of one turnover, days					0.1	
2.2.4.3. Production equipment, thousand UAH					0.2	
2.2.4.4. Return on current assets					0.2	
Total					1.0	
2.2.5. Efficiency of use of current costs			0.1			
2.2.5.1. The volume of products sold per 1 UAH costs, UAH.					0.3	
2.2.5.2. Material intensity of production, UAH					0.4	
2.2.5.3. Material output, UAH					0.3	
Total					1.0	
2.2.6. Efficiency of land use			0.2			

2.2.6.1. Crop profitability: Cereals and legumes, %						0.2
2.2.6.2. Factory sugar beets, %						0.1
2.2.6.3. Sunflower, %						0.2
2.2.6.4. Rapeseed and colza, %						0.1
2.2.6.5. Soybeans, %						0.1
2.2.6.6. Potato, %						0.1
2.2.6.7. Vegetable crops, %						0.1
2.2.6.8. Fruit and berry crops, %						0.1
Total						1.0
2.2.7. Efficiency of livestock production			0.2			
2.2.7.1. Profitability of livestock production: Cattle for meat, %						0.2
2.2.7.2. Pigs for meat, %						0.2
2.2.7.3. Sheep and goats for meat, %						0.1
2.2.7.4. Poultry for meat, %						0.1
2.2.7.5. Milk,%						0.2
2.2.7.6. Chicken eggs, %						0.1
2.2.7.7. Wool, %						0.1
Total		1.0	1.0			1.0
3. Intensity criteria	0.2					
3.1. Intensity of fixed assets use			0.2			
3.1.1. Cost of fixed capital per 100 hectares of agricultural land, thousand UAH						0.5
3.1.2. The cost of fixed capital per conceptual livestock, thousand UAH						0.5
Total						1.0
3.2. Intensity of use of current assets			0.2			
3.2.1. The amount of energy capacity consumed for production needs per 1 hectare of arable land, kW					0.2	
3.2.2. Quantity of mineral fertilizers per 1 hectare of arable land, kg					0.3	
3.2.3. The amount of organic fertilizer per 1 hectare of arable land, kg					0.2	
3.2.4. Fodder consumption per livestock, kg fod. unit.					0.3	
Total					1.0	
3.3. Intensity of current costs use			0.2			
3.3.1. Current production costs per 1 hectare of arable land, thousand UAH					0.5	
3.3.2. Current production costs per livestock, thousand UAH					0.5	
Total					1.0	
3.4. Intensity of labor use			0.2			
3.4.1. Land load per employee (hectares of agricultural land per employee)					1.0	
Total					1.0	
3.5. Land use intensity			0.1			
3.5.1. Degree of economic use of land (the ratio of the area of agricultural land to the total land area)					1.0	
Total					1.0	
3.6. Intensity of animal use			0.1			
3.6.1. The density of livestock per 100 hectares of agricultural land, heads					1.0	
Total	1.0	-	1.0		1.0	

Source: developed and summarized by the authors on the basis of the results of a questionnaire survey.

The algorithm for the development of a comprehensive assessment of technological support of production in agricultural enterprises includes the following stages:

1. definition and justification of criteria and characteristics that characterize the process of technological support of production. These include:

1) general criteria of production and economic activity of the enterprise concerning the production of products, sales of products, investments and characterizing their indicators;
2) criteria of efficiency of technological renewal of production on the basis of their distribution by types of efficiency and resources and characterizing their indicators;

3) criteria of intensity of the process of technological renewal of production and characterizing their characteristics.

2. Conducting an expert evaluation and establishing the coefficient values for the criteria and indicators – weights of their importance, which within each of the groups (production and economic activity, efficiency and intensity) should be equal to 1.

3. Calculation and grouping of indicators of technological support of production with assigning those scores – from 1 to 10, reflecting the minimum and maximum limits of values of selected indicators in agricultural enterprises during the period selected for observation.

If a positive value of the indicator is an increase at the enterprise, points are assigned in the order of its growth, if vice versa – in the order of decrease.

As for the profitability indicators, which can acquire a positive (profitability) or negative (unprofitability) value, the positive value of the profitability indicator, according to the points assigned, is added, and the negative one is subtracted.

In addition, some indicators (hazardous waste generation, labor intensity, personnel turnover rate, capital intensity of production, capital intensity, depreciation rate of fixed assets, working capital utilization rate, duration of one turnover of working capital, material intensity of production) points are assigned in reverse order, given that a positive at the enterprise is considered a decrease in their value.

4. Multiplication of the number of points corresponding to the value of the indicator by the weighting factor in order to determine the sum of points of each group of indicators. The summation of the values of the three groups of indicators makes it possible to obtain a comprehensive indicator indicating the appropriateness of the technologies used in agricultural enterprises in the relevant year (Sas, 2019; Sas, 2020).

A generalized reflection of the proposed methodology for the comprehensive assessment of technological support of agricultural enterprises is presented in Table 2.

Table 2. Methodological approach to the comprehensive assessment of technological support of production in agricultural enterprises

Eof TU =	0.3 × CG =	0.5 × PP =	0.5 × Pa + 0.5 × Ps		
		0.2 × RP =	0.3 × Pra + 0.3 × Prs + 0.2 × Ea + 0.2 × Es		
		0.3 × I =	0.4 × CIa + 0.2 × CIs + 0.2 × FIa + 0.2 × FIs		
	0.5 × CE =	0.5 × ET =	0.3 × EE =	0.2 × NPa + 0.2 × NPs + 0.6 × PFo	
			0.3 × TE =	0.5 × CC =	0.2 × CCc + 0.1 × CCb + 0.2 × CCsf + 0.1 × CCr + 0.1 × CCs + 0.1 × CCp + 0.1 × CCv + 0.1 × CCf
				0.5 × PVa =	0.3 × ICa + 0.2 × IPa + 0.2 × LHa + 0.2 × MУa + 0.1 × CWa
			0.2 × ECE =	0.5 × HWa + 0.5 × HWs	
			0.2 × SE =	0.7 × SEi =	1.0 × Wmw
				0.2 × WP =	0.5 × Wpa + 0.5 × WPs
		0.5 × ER =	0.1 × EP =	0.2 × PLp + 0.2 × CPl + 0.2 × EL + 0.1 × PFp + 0.2 × STp + 0.1 × CWt	
			0.2 × EFR =	0.1 × Pfa + 0.2 × PFeq + 0.2 × PFp + 0 × 2PFr + 0.1 × Cfr + 0.1 × CIp + 0.1 × PFci	
			0.2 × EFA =	0.2 × FRfa + 0.1 × CIp + 0.1 × LSl + 0.1 × SEfa + 0 × PFfa + 0.2 × DFfa + 0.2 × UFfa	
			0.1 × EWC =	0.3 × TRwc + 0.2 × DFwc + 0.1 × DTwc + 0.2 × STp + 0.2 × PFwc	
			0.2 × EL =	0.2 × PFc + 0.1 × PFb +0.2 × PFsf + 0.1 × PFr + 0.1 × PFs + 0.1 × PFp + 0.1 × PFv + 0.1 × PFf	
			0.2 × EA =	0.2 × PFcm + 0.2 × PFpm + 0.1 × PFshm + 0.1 × PFchm + 0.2 × PFm + 0.1 × PFe + 0.1 × PFw	
	0.2 × CI =	0.3 × IFA =		0.5 × CFCs + 0.5 × CFCa	
		0.3 × IWC =		0.2 × ECs + 0.3 × FMs + 0.2 × FOs + 0.3 × FCa	
		0.2 × IP =		1.0 × ELp	
		0.1 × IL =		1.0 × ULs	
		0.1 × IA =		1.0 × SAs	
		0.1 × IA =		1.0 × SAs	

Source: the authors' own development.

Eof TU – indicator of the comprehensive assessment of technological support of production in agricultural enterprises;
numerical values – significance of the indicators determined by the method of expert evaluations;
CG – general criteria of production and economic activity of the enterprise;

CE – efficiency criteria;
CI – intensity criteria. General criteria of production and economic activity of the enterprise (CG):
PP – production, in particular: Ra – agricultural production per 100 UAH of the value of non-current and current assets, UAH; Ps – agricultural production per 100 hectares of agricultural land, thousand UAH;
RP – sales of products, in particular: Pra – agricultural production per 100 UAH of the value of non-current and current assets, rubles; Prs – agricultural production per 100 hectares of agricultural land, thousand UAH; Ea – export of agricultural products per 100 UAH of non-current and current assets, dollars; Es – export of agricultural products per 100 hectares of agricultural land, thousand USD.
I – investment, in particular: Cla – capital investment per 100 UAH of non-current asset value, UAH; Cls – capital investment per 100 ha of agricultural land, thousand UAH; Fla – foreign direct investment per 100 UAH of non-current asset value, USD; Fls – foreign direct investment per 100 ha of agricultural land, thousand USD.
Efficiency criteria (EC): ET – efficiency by types, ER – efficiency by resources.
Efficiency by type (ET):
EE – economic efficiency, in particular: NPa – net profit (loss) per 100 UAH of non-current and current assets, rubles; NPs – net profit (loss) per 100 hectares of agricultural land, thousand UAH; RFo – profitability of operating activities, %;
TE – technological efficiency, in particular: CC – crop yield, c/ha (CCc – grain and legume crops; CCb – sugar beet; CCsf – sunflower; CCr – rape and colza; CCs – soybean; CCp – potato; CCv – vegetable crops; CCf – fruit and berry crops); PVa – animal productivity (ICa – average daily gain of cattle, g; IPa – average daily gain of pigs, g; LHa – average egg production of laying hens, pcs; MYa – average annual milk yield from one cow; – average annual wool from one sheep, kg;
ECE – environmental efficiency, where HWa – hazardous waste generation per 100 UAH of the value of non-current and current assets, kg; HWs – hazardous waste generation per 100 ha of agricultural land;
SE – social efficiency: SEi – internal, where Wmw – ratio of wages to its minimum level, times; WP – external, where WPa – number of created new jobs per 100 million UAH of non-current and current assets value; WPs – number of created new jobs per 1000 ha of agricultural land.
Efficiency by resources (ER):
EP – efficiency of use of labor resources, where PLp – labor productivity of one worker, thousand UAH; CPI – labor intensity of production, pers. hour; EL – energy intensity of labor, kW; PFp – personnel profitability, %; STp – personnel turnover rate; CWt – working time use factor;
EFR – efficiency of the use of monetary resources, where PFa – return on assets, %; PFeq – return on equity, %; PFp – return on production, %; PFr – return on sales (sales), %; Cfr – coefficient of economic efficiency of the use of financial resources; Clp – production capital intensity, rubles; PFci – return on capital investments, %;
EFA – efficiency of use and technical condition of fixed assets, where FRfa – return on assets, rub; CIp – stock-intensity, rub; LSl – armament of labor, thousand UAH; STfa – stock equipment, thousand UAH; PFfa – profitability of fixed assets, %; DFfa – fixed asset wear coefficient; UFfa – fixed asset renewal coefficient;
EWC – efficiency of use of current assets, where TRwc – turnover ratio; DFwc – load factor; DTwc – duration of one turnover, days; SEp – capital equipment of production, thousand UAH; PFwc – profitability of current assets;
EL – efficiency of land use, where the profitability of crops, %: PFc – cereals and legumes; PFb – sugar beet; PFsf – sunflower; PFr – rape and colza; PFs – soybean; PFp – potato, PFv – vegetable crops; PFf – fruit and berry crops.
EA – efficiency of livestock production, where profitability of livestock production, %: PFcm – cattle for meat; PFpm – pigs for meat; PFshm – sheep and goats for meat; PFchm – poultry for meat; PFm – milk; PFe – chicken eggs; PFw – wool.
Intensity criteria (CI):
IFA – intensity of use of fixed assets, where CFCs – cost of fixed capital per 100 hectares of agricultural land, thousand UAH; CFCa – cost of fixed capital per conditional livestock, thousand UAH;
IWC – intensity of use of circulating assets, where ECs – amount of power consumed for production needs per 1 ha of arable land, kW; FMs – amount of mineral fertilizers per 1 ha of arable land, kg; FOs – amount of organic fertilizers per 1 ha of arable land, kg; FCa – consumption of feeds per 1 ha of arable land, kg of feed unit;
IP is the intensity of labor use, where ELp is the land load per employee (hectares of agricultural land per employee);
IL – intensity of land use, where ULs – degree of economic use of land;
IA – intensity of animal use, where SAs – density of conventional livestock per 100 hectares of agricultural land, heads.

The value of the complex assessment of 1-3 points reflects a low level of effectiveness of technological support of production, 4-7 points – average level, 8-10 points – high level. The maximum possible value of the indicators of the first block of the complex assessment – 3 points, the second – 5 points, the third – 2 points (Sas, 2019; Sas, 2020).

4. RESULTS

In the course of the study the calculation and grouping of indicators of comprehensive assessment of technological support of production in agricultural enterprises of Ukraine for five years (2016-2020) has been carried out and scores from 1 to 10 have been assigned to them. However, due to the large volume of calculations and limited volume of the publication it was not possible to display the intermediate calculations within this article (Sas, 2020).

The calculation of the comprehensive assessment of technological support of production according to the proposed methodology was carried out for agricultural enterprises as a whole (Table 3), as well as for an individual private farm. In order to conduct the comparison, the calculations were done within two time frames. The results of the calculations are shown in Table 4.

Table 3. Calculation of the complex assessment of technological support of production in agricultural enterprises in 2020

1,92+ 2,73+ 1,71= 6,4	0,3× 6,39 =1,92	0,5×6,5 = 3,25	0,5×3+ 0,5×10=6,5		
		0,2×7,9= 1,58	0,3×7 + 0,3×10+0,2×4+0,2×10=7,9		
		0,3×5,2 = 1,56	0,4×6 + 0,2×10+0,2×1+0,2×3=5,2		
	0,5× 5,46= 2,73	0,5×6,5= 3,25	0,3×4,8 =1,44	0,2×3+0,2×6+0,6×5=4,8	
			0,3×8,25 =2,48	0,5×9,2 =4,6	0,2×10+0,1×10+ 0,2×10+0,1×4+0,1×10 + 0,1×9+0,1×9+0,1×10=9,2
				0,5×7,3=3,65	0,3×10+0,2×10+ 0,2×1+0,2×10+0,2×1=7,3
			0,2×10 =2	0,5×10+0.5×10=10	
			0,2×2,9=0,58	0,7×2 =1,4	1,0×2=2
				0,2×7,5=1,5	0,5×5 + 0,5×10=7,5
		0,5×4,41= 2,21	0,1×6,9=0,69	0,2×10 + 0,2×10 + 0,2×3 + 0,1×4 +0,2×7 +0,1×5=6,9	
			0,2×4,7 =0,94	0,1×5+0,2×4+ 0,2×5 + 0,2×6 + 0,1×2+ 0,1×6+ 0,1×4=4,7	
			0,2×6,5=1,3	0,2×1+0,1×1 + 0,1×10 + 0,1×10 +0,1×4 + 0,2×10+ 0,2×9=6,5	
			0,1×6=0,6	0,3×6+0,2×8+0,1×8 + 0,2×4+ 0,2×5=6	
			0,2×3,9=0,78	0,2×6+ 0,1×(-5)+ 0,2×5+ 0,1×7+ 0,1×5+ 0,1×3+0,1×5+0,1×2=3,9	
			0,2×0,5 =0,1	0,2×(-5)+0,2×5+0,1× (-4)+0,1×4+0,2×6+0,1×2+0,1×(-9)=0,5	
	0,2× 8,56= 1,71	0,3×10=3		0,5×10+0,5×10=10	
		0,3×8,2=2,46		0,2×1+0,3×10+ 0,2×10+0,3×10=8,2	
		0,2×10 =2		1,0×10=10	
		0,1×10=1		1,0×10=10	
		0,1×1=0,1		1,0×1=1	

Source: calculated by the authors (State Statistics Service of Ukraine).

Table 4. The calculation results of the complex assessment of technological support of production in agricultural enterprises, points

Criteria and indicators	Agricultural enterprises of Ukraine		PFG "Potochishche"	
	2016	2020	2016	2020
1. General criteria of production and economic activity of the enterprise	1,84	1,92	1,82	1,39
1.1. Product manufacturing	3,5	3,25	5,0	3,5
1.2. Product sales	1,26	1,58	0,9	0,96
1.3. Investments	1,38	1,56	0,18	0,18
2. Performance criteria	1,66	2,73	2,62	3,05
2.1. By type of performance	1,48	3,25	2,62	3,33
2.1.1. Economic	1,02	1,44	1,44	1,98
2.1.2. Technological	0,98	2,48	1,65	2,0
2.1.3. Environmental	0,3	2,0	2,0	2,0
2.1.4. Social	0,66	0,58	0,14	0,68
2.2. By resources	1,83	2,21	2,62	2,76
2.2.1. Efficiency of use of labor resources	0,37	0,69	1,0	1,0
2.2.2. Efficiency of use of financial resources	0,86	0,94	1,36	1,34
2.2.3. Efficiency of use and technical condition of fixed assets	0,9	1,3	1,38	1,32
2.2.4. Efficiency of use of current assets	0,7	0,6	0,28	0,32
2.2.5. Efficiency of land use	1,24	0,78	0,7	0,53
2.2.6. Efficiency of livestock production	-0,42	0,1	0,52	1,0
3. Intensity criteria	0,58	1,71	1,1	1,52
3.1. Intensity of fixed assets use	0,3	3,0	0,3	2,4
3.2. Intensity of use of current assets	1,29	2,46	3,0	3,0
3.3. Intensity of labor use	0,2	2,0	0,2	0,2
3.4. Land use intensity	0,1	1,0	1,0	1,0
3.6. Intensity of animal use	1,0	0,1	1,0	1,0
Total	4,1	6,4	5,5	6,0

Source: calculated by the authors (State Statistics Service of Ukraine; Forms of financial and statistical reporting of PFG "Potochishche" for 2016-2020).

Based on the analysis of the obtained values of comprehensive assessment components it is possible to conclude how the applied technologies affect the formation of individual results of agricultural enterprises (according to the criteria of production and economic activity, efficiency and intensity of production). The proposed comprehensive assessment reflects the averaged values of the indicators at the enterprises of the industry for five years and can serve as a basis for comparison with the latter performance indicators of a particular enterprise.

As a result of the calculation of comprehensive assessment of the effectiveness of technological support of production in the agricultural enterprises of Ukraine in 2016 and 2020, the values of 4.1 and 6.4 points, respectively, have been obtained, which indicates the average level of effectiveness of the technologies used. In 2020, the value of the comprehensive assessment of the effectiveness of technological support of production compared to 2016 increased by 2.3 points, indicating positive changes in the relevant process. Thus, the increase in the comprehensive assessment of the effectiveness of technological support of agricultural enterprises in 2020 compared with 2016 indicates that the applied technologies contributed to the growth of efficiency criteria (in general by 1.07 points), in particular efficiency by type - by 1.77 points (mainly due to the increase in technological efficiency by 1.5 points, environmental - by 1.7 points, economic - by 0.42 points) and resource efficiency - by 0.38 points, among which the greatest growth is characterized by effective use of main funds (by 0.4 points), work force (by 0.32 points) and cattle farming production efficiency (by 0.52 points).

The resource use intensity criteria have increased significantly - by 1.13 points, including fixed assets - by 2.7 points, current assets - by 1.17 points, work force - by 1.8 points, land - by 0.9 points.

Formulating of more detailed conclusions and introducing proposals in order to improve the efficiency of technological support of agricultural enterprises with the purpose of making managerial decisions requires a comprehensive assessment of the effectiveness of technological support of the production of a particular agricultural enterprise. Calculation of the complex assessment of technological support of production of a particular agricultural enterprise and comparison with a generalized assessment in the industry allows us to conclude about the level of technological support of production at this enterprise relative to the industry average value, and, accordingly, to make managerial decisions on further policy of innovative development.

To calculate the comprehensive assessment of technological support of production we used the data of a typical (by area of agricultural land and livestock), medium-sized agricultural enterprise - PFG "Potochyshche" (Gorodenkivsky district, Ivano-Frankivsk region). Calculation of the comprehensive assessment of the efficiency of technological support of production in PFG "Potochyshche" showed an average level in 2016 and 2020. - 5.5 points and 6.0 points, respectively. The increase in the integrated assessment indicates certain positive changes in the activities of the enterprise under investigation, but its growth rate was inferior to the growth rate of relevant indicators in the agricultural enterprises of Ukraine as a whole.

The growth of comprehensive assessment of technological support of production at Potochische PFG was provided: in crop production - the introduction of intensive technologies that involve the introduction of a significant amount of mineral and organic fertilizers, the use of plant protection products, plant varieties of high reproductions and conventional tillage with integrated multifunctional machines "Compactomat" and "Khorsh"; in livestock farming - breeding Ukrainian red-motley breed of dairy cattle, the use of intensive feeding technologies, which include, in addition to silage and haylage, the selection of concentrated feed, milking process using a milk pipeline; box housing of pigs and intensive technology of their feeding (concentrated feed and premixes).

Comparison of technologies used in farming in 2016 and in 2020 showed that changes took place due to the introduction of complex multifunctional units for replacement tractors and trailers in crop production and the use of a milk pipeline in livestock production instead of milking machines. This, in our view, led to an insignificant difference in the values of the comprehensive assessment of the effectiveness of applied technologies in 2020 compared to 2016 and a lower value compared to the average industrial one.

4. CONCLUSION

Calculation of the comprehensive assessment of the efficiency of technological support of production in agricultural enterprises of Ukraine in 2016 and 2020 showed the average efficiency level of technologies used (4.1 points and 6.4 points, respectively). Its growth indicates the development and improvement of technological support of production in agricultural enterprises.

The proposed methodical approach to the integrated assessment of technological support of production in agricultural enterprises involves determining the system of indicators of production and economic activity of these enterprises (production and sale of products, attracting investment), efficiency and intensity of the use of basic types of resources.

The relevant indicators are summarized in a comprehensive assessment, taking into account the weight significance of individual indicators established by expert judgment and the assigned score calculated by

grouping the actual performance of agricultural enterprises, reflecting the relative level of the selected indicators during the period chosen for observation.

The calculation of the comprehensive assessment of technological support of production of a particular agricultural enterprise and comparison with the generalized assessment in the industry allows us to conclude about the level of technological support of production at this enterprise relative to the industry average value, and, accordingly, to make managerial decisions on further policy of innovation development.
The methodological basis for making managerial decisions on the future policy of innovation development on the basis of the established level of technological support of production at the agricultural enterprise relative to the industry average value was further developed. The proposed methodology is based on the approach of E. Gail for marketing assessment of goods and is formed taking into account the weight coefficients and point estimation.

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