

The Methodical Approach of the Substantiation of the Evaluation Indicators System of the Agro-Industrial Complex Development

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Abstract In this study, the authors propose a methodological approach to substantiate the evaluation indicators system of the regional development of the agro-industrial complex. The methodological basis for establishing the evaluation indicators system is determined, which is based on the principles of systematization, universality and consistency of evaluation indicators. Based on the generalized list of prior evaluation indicators, the evaluation indicators system is substantiated using the expert method. For each indicator, its approval by experts is determined, as an example, the agreement of experts on capital investment in agriculture, hunting and related services, as a percentage of total investment in the region. The structural-logical scheme of the structure of the evaluation system formation of the agro-industrial complex of the regions is offered. The proposed system of evaluation of the agro-industrial complex provides for the definition of such areas as follows: industries that produce means of production for agriculture and other industries that provide services to agriculture; Agriculture; industries for processing and preservation of agricultural products; production and social infrastructure.

Keywords Agro-industrial Complex, Region, Regional Development, Agriculture, Sustainable Development

1. Introduction

Modern problems of sustainable development and growing unsatisfied consumer demand require research on the development of agro-industrial complex. The agro-industrial complex plays an important role in the development of the state. Each country, as well as its regions, has specific features due to many circumstances. Ukraine is no exception and this requires research and substantiation of methodological bases for the formation of evaluation indicators of the agro-industrial complex. The study of publications allows the authors to conclude that there is no single unified system for assessing the development of the agro-industrial complex, and there is no single point of view on their justification. The difficulty of assessing the development of the agro-industrial complex is due to the fact that it combines

a large number of different industries.

The purpose of the article is to substantiate the evaluation indicators system of the regional development of the agro-industrial complex of Ukraine. To achieve this goal, the authors set and solved the following tasks:

- methodologically substantiated principles of the selection of estimated indicators of the regional development of the agro-industrial complex;
- a general list of evaluation indicators for further systematization and selection has been established;
- the evaluation indicators system was coordinated using the expert-statistical method.

Many scientific works of domestic and foreign scientists are devoted to the development of the agro-industrial complex. Scientists [1-2] emphasize that the processes taking place in the modern economic community require new solutions and approaches related to integration processes in the agricultural sector. The author of the article [3] analyzes the reforms in the field of the agro-industrial complex and evaluates their effectiveness; based on the study, conclusions are formulated on the main most optimal and necessary areas of state regulation.

The study [4] evaluates and analyzes the gross domestic product (GDP) of agribusiness for 63 countries and the rest of the world and demonstrates the results and links with the Human Development Index (HDI). The aim of the article [5] is to study the decriminalization of the agro-industrial complex as the most important factor of food security, as well as a way to solve problems affecting the state of food security, the problem of legal support of national priorities related to food independence. The article [6] presents the results of the study of the state of the innovation stimulation in the agro-industrial complex, and based on these results, the authors proposed a conceptual and logical model of innovation in the agro-industrial complex, which ensures the development of agricultural enterprises based on science-intensive technologies.

The authors of articles [7-11] with the help of comparative analysis and calculation of differentiation coefficients characterize the degree of difference in the development of the region's agro-industrial complex in the conditions of sanction pressure and in the conditions of sustainable development. In the articles [12-17], the authors consider the peculiarities of the functioning of the agro-industrial complex in digital economy. The article examines the largest market participants in the agro-industrial complex who have joined forces to digitize agriculture. The authors [18] present the main characteristics of the sustainability of the agro-industrial complex, which allows providing a comprehensive assessment of its condition to justify a certain structural model of the strategy of sustainable development of agriculture with changing the level of environmental parameters.

The authors of the articles [19-21] assess the impact of

negative factors and suggest the development of engineering, social and transport infrastructure and the improvement of the situation on the labor market in rural areas as one of the solutions. It is proved within the article that the support of the agro-industrial complex is important and will provide an opportunity to solve existing problems. Articles [22-26] are based on the definition of key principles for building a system of efficiency of innovation activities of agro-industrial companies and the study of economic security in conditions of intensified competition.

However, despite the considered researches of leading scientists it should be noted that the methodical approach of the substantiation of the evaluation indicators system of the agro-industrial complex development needs the further studying and the analysis.

2. Materials and Methods

The substantiation of evaluation indicators is preceded by the determination of the methodological basis for their establishment, which includes the principles of criterion selection of evaluation indicators. The main principles that must be met by evaluation indicators are:

- the principle of systematization - provides for the separation of the general set of evaluation indicators that can fully and comprehensively characterize the subject of research, namely the process of development of agro-industrial complex of regions, reflect specific features and represent a certain systemic structure of grouping indicators;
- universality - provides an opportunity to use a system of evaluation indicators for all regions of the country and fully describe the development of all areas of the agro-industrial complex. In addition, the principle of universality provides for the availability of quantitative measurement and the possibility of their rationing and comparison with statistics and estimates of international observations;
- consistency, which provides for the content of each indicator and its logical relationship with the evaluation indicators system in the absence of duplication, which can also be detected by correlation calculations.

The principle of systematization, universality and coherence of the estimated indicators of development of the agro-industrial complex makes it possible to make accurate calculations and to compare them, to eliminate the errors associated with the primary data entered for evaluation.

3. Results and Discussions

The conducted research on the assessment of the development of the agro-industrial complex made it possible to form an initial list of evaluation indicators, which is presented in Table 1.

Table 1. Initial list of evaluation indicators for assessing the level of the regional development of agro-industrial complexes

Indicators for assessing the level of the regional development of agro-industrial complexes	Scope of evaluation
Capital investment in agriculture, hunting and related services, % of total investment in the region	<i>The sphere of industries that produce means of production for agriculture</i>
Purchase of new agricultural machinery by agricultural enterprises, pcs.	
Innovatively active enterprises, in total, units	
Sale of compound feeds to agricultural enterprises, thousand centners	
Purchase of energy materials by agricultural enterprises, million m ³	
Purchase of mineral fertilizers by agricultural enterprises, thousand c.	
Purchase of plant protection products by agricultural enterprises, thousand tons (thousand liters)	
Availability of tractors, combines and agricultural machinery at agricultural enterprises, at the end of the year, pcs.	
Sale of petroleum products to agricultural enterprises, thousand	
Agricultural production indices, in % to the previous year	
Livestock production indices, in % to the previous year	
Meat production (in slaughter mass), thousand tons	
Milk production, thousand tons	
Egg production, mln	
Purchase of plant protection products by agricultural enterprises, thousand tons (thousand liters)	
Availability of tractors, combines and agricultural machinery at agricultural enterprises, at the end of the year, pcs.	
Sale of petroleum products to agricultural enterprises, thousand	
Agricultural production indices, in % to the previous year	
Livestock production indices, in % to the previous year	
Meat production (in slaughter mass), thousand tons	
Milk production, thousand tons	
Egg production, mln	
Livestock products (at constant prices in 2010), UAH million	
The level of profitability of beef production for meat, in%	
The level of profitability of pork production for meat, in%	
The level of profitability of poultry production for meat, in%	
The level of profitability of milk production, in%	
The level of profitability of chicken egg production, in%	
Crop production indices, in% to the previous year	
Production of cereals and legumes, thousand tons	
Production of sugar beets (factory), thousand tons	
Sunflower production, thousand tons	
Potato production, thousand tons	
Vegetable production, thousand tons	
Production of fruits and berries, thousand tons	
Crop products (at constant 2010 prices), UAH million	
The level of profitability of production of cereals and legumes, in%	
The level of profitability of sugar beet production (factory), in%	
The level of profitability of sunflower seed production, in%	
The level of profitability of potato production, in%	
The level of profitability of open-ground vegetable production, in%	
The level of profitability of fruit production, in%	

Table 1. Continued

Production of sausages, thousand tons	<i>Sphere of processing industry</i>
Production of fatty cheeses, thousand tons	
Production of unrefined sunflower oil and its fractions, thousand tons	
Production of processed liquid milk (pasteurized, sterilized, homogenized, rendered, peptized), thousand tons	
Production of yogurt and other fermented or fermented milk and cream, thousand tons	
Flour production, thousand tons	
Production of bread and bakery products, short-term storage, thousand tons	
Production of white crystalline sugar, thousand tons	
Production of food, beverages and tobacco, in% to the previous year	
Textile production, production of clothing, leather, leather products and other materials, in% to the previous year	
Commissioning of housing in rural areas, thousand m ² of total area	<i>Sphere of production and social infrastructure</i>
Capital investment in transport, warehousing, % of total investment in the region	
Capital investment in temporary accommodation and catering, % of total investment in the region	
Capital investment in information and telecommunications, % of total investment in the region	
Capital investment in education, % of total investment in the region	
Capital investments in health care and social assistance, % of total investments in the region	
Capital investments in professional, scientific and technical activities, % of total investments in the region	
Retail trade, except of motor vehicles and motorcycles, mln. UAH	
Internal current expenses for scientific and scientific-technical works performed by own organizations of scientific organizations, in actual prices, thousand UAH	
Capital investments in wholesale and retail trade, repair of motor vehicles, % of total investments in the region	
Capital investment in transport, warehousing, postal and courier activities, % of total investment in the region	

Source: compiled and summarized by the authors

According to the initial list of evaluation indicators, their choice is substantiated and systematized using the expert method. Seventeen highly qualified specialists in the field of agro-industrial production were involved in the examination. The number of specialists was determined using the formula:

$$0.5 \cdot \left(\frac{3}{e} + 5 \right), \quad (1)$$

where, e– change in the estimate corresponding to e = 0.11, it is a constant value that is determined according to the Saati scale and makes it possible to determine the number of experts. The rating scale for experts is from 0.006 to 0.060 with a gradation of 0.006. In our case,

given that the experts involved seventeen people, we have:

$$0.5 \cdot \left(\frac{3}{0.11} + 5 \right) = 16.136.$$

Each of the presented indicators given in Table 1 is coordinated. In the form of a detailed sample, we give an example of approval by experts of the assessment for the evaluation indicator "Capital investment in agriculture, hunting and related services, % of total investment in the region", which belongs to the industries that produce means of production for rural farms (Table 2).

Table 2. Substantiation of coordination by experts of a choice of an estimation indicator of development of an agro-industrial complex of region

Value	Expert assessments																	Explanation	
Experts in decision-making in the order of ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Seventeen experts were elected	
Expert assessments to substantiate the evaluation indicator	0,006	0,024	0,012	0,024	0,030	0,012	0,006	0,012	0,024	0,012	0,030	0,036	0,012	0,024	0,012	0,042	0,054	Built dependence on the rank of the selected expert	
Rank correlation		+	+	+	+	+	+	+	0	+	+	+	+	+	+	+	+	If Rx is more than 0.3 modulo, the examination is accepted as positive (agreed evaluation)	
			-	0	-	+	-	-	0	-	+	-	+	0	-	+	+		
				+	+	0	-	0	+	0	+	+	0	+	0	+	+		
					-	-	+	-	-	0	+	+	-	0	+	-	+		
						-	-	-	0	-	-	+	-	+	-	+	-		
							-	0	+	+	0	+	+	0	0	+	+		
								+	+	+	+	+	+	+	+	+	+		
									+	0	+	+	0	+	0	+	+		
										-	+	-	+	-	0	+	+		
													-	+	+	+	0		
														-	-	+	-		+
															+	+	0		+
																+	-		+
																	+		+
																	+		
where the value of the rank correlation: "+" - agreed assessment, "-" - inconsistent assessment, "0" - indefinite assessment, i.e. one expert "yes", another - "no", in the future such assessments are rejected as not having a definite benefits.																			

The estimated indicator, namely capital investment in agriculture, hunting and related services, % of the total investment in the region, which was selected for approval by the experts, is accepted because:

$$R_x = \frac{(N+) + (N-)}{N} \quad (2)$$

where, $N = 136$ - the total number of compounds from 17 to 2 (scale of experts 0.006-0.060);

$(N+)$ - number of positive agreements (in this case 80);
 $(N-)$ - number of negative agreements (in this case 33).

Thus: $R_x = (80-33)/136 = 0,346$ – the estimated value is accepted because the calculated value of $R_x \geq 0.3$.

In this case, the value of $R_x \geq 0.3$ is determined according to the rank correlation, which is carried out according to Kendel.

According to the same principle of calculation of coherence, the examination for other estimation indicators of the regional development of the agro-industrial complex is carried out.

In accordance with the expert coordination of the evaluation indicators of the development of the agro-industrial complex, the indicators for evaluation were singled out and systematized (Fig. 1).

Thus, the separation of methodological principles for estimating the regional development of the agro-industrial complex and clarifying its list using the expert-statistical method, the estimated indicators of each area were chosen, which are presented in Table 3-6. All indicators are given in Table 3-6 were agreed by highly qualified specialists in accordance with the example given above (see Table 2, Formulas 1-2). It should be noted that in Tables 3-6 the indicators are presented according to how they received the largest number of agreed expert assessments. That is, for example, the index x_1 received a better value of R_x than the indicator x_{10} . However, it is possible to determine whether x_1 has a greater impact on the agricultural sector and other industries that provide agricultural services than x_{10} only by calculating the correlation between the normalized values of evaluation indicators and finding the coefficients of their impact.

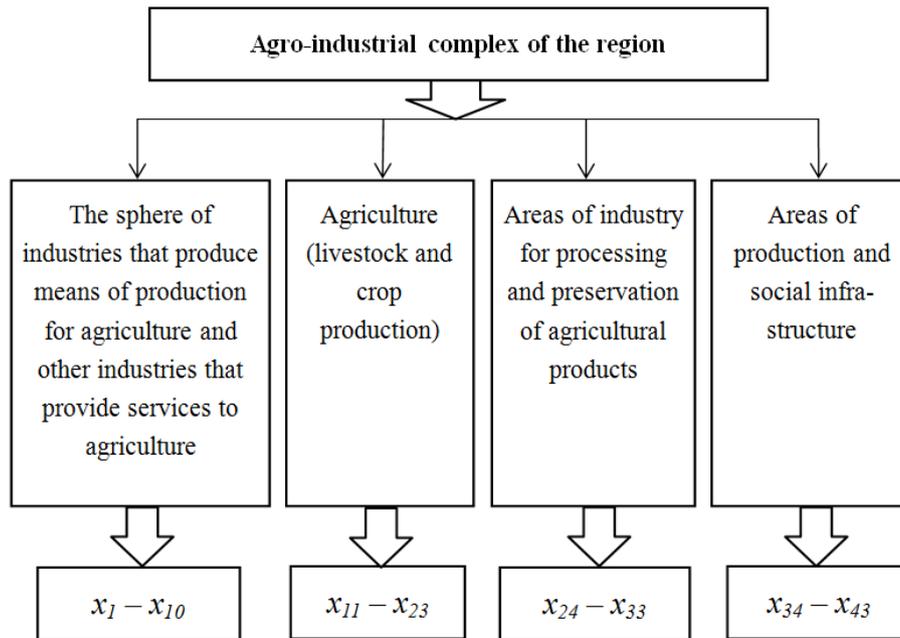


Figure 1. Block diagram of the structure of the evaluation system formation of the agro-industrial complex of regions

Table 3. Estimates of the sphere of industries that produce means of production for agriculture and other industries that provide services to agriculture

№	Indexes
x_1	Capital investment in agriculture, hunting and related services, % of total investment in the region
x_2	Innovatively active enterprises, in total, units
x_3	Purchase of new agricultural machinery by agricultural enterprises, pcs.
x_4	Availability of tractors, combines and agricultural machinery at agricultural enterprises, at the end of the year, pcs.
x_5	Sale of compound feeds to agricultural enterprises, thousand centners
x_6	Purchase of energy materials by agricultural enterprises, mln
x_7	Sales of petroleum products to agricultural enterprises, thousand tons
x_8	Purchase of mineral fertilizers by agricultural enterprises, thousand centners
x_9	Purchase of pesticide plant protection products by agricultural enterprises, thousand tons
x_{10}	Purchase of other chemical plant protection products by agricultural enterprises, thousand liters

Source: substantiated by the authors

Table 4. Estimates of agriculture (livestock, crop production)

№	Indexes
x_{11}	Meat production (in slaughter mass), thousand tons
x_{12}	Milk production, thousand tons
x_{13}	Egg production, mln.
x_{14}	Livestock products (at constant prices), UAH million
x_{15}	Financial results of livestock enterprises, net profit (loss), thousand UAH
x_{16}	Production of cereals and legumes, thousand tons
x_{17}	Production of sugar beets (factory), thousand tons
x_{18}	Sunflower production, thousand tons
x_{19}	Potato production, thousand tons
x_{20}	Vegetable production, thousand tons
x_{21}	Production of fruits and berries, thousand tons
x_{22}	Crop products (at constant prices), UAH million
x_{23}	Financial results of livestock enterprises, net profit (loss), thousand UAH

Source: substantiated by the authors

Table 5. Estimates of the sphere of industries for processing and preservation of agricultural products

№	Indexes
x_{24}	Production of sausages, thousand tons
x_{25}	Production of processed milk (pasteurized, sterilized, homogenized, rendered, peptized), thousand tons
x_{26}	Production of fatty cheeses, thousand tons
x_{27}	Production of unrefined sunflower oil and its fractions, thousand tons
x_{28}	Flour production, thousand tons
x_{29}	Production of bread and bakery products of short-term storage, thousand tons
x_{30}	Production of white crystalline sugar, thousand tons
x_{31}	Production of yogurt and other fermented or fermented milk and cream, thousand tons
x_{32}	Production of food, beverages and tobacco, in% to the previous year
x_{33}	Textile production, production of clothing, leather, leather products and other materials, in% to the previous year

Source: substantiated by the authors

Table 6. Estimates of the sphere of production and social infrastructure

№	Indexes
x_{34}	Capital investment in education, % of total investment in the region
x_{35}	Capital investments in professional, scientific and technical activities, % of total investments in the region
x_{36}	Retail trade, except of motor vehicles and motorcycles, UAH mln
x_{37}	Capital investments in wholesale and retail trade, repair of motor vehicles, % of total investments in the region
x_{38}	Capital investment in transport, warehousing, postal and courier activities, % of total investment in the region
x_{39}	Capital investment in temporary accommodation and catering, % of total investment in the region
x_{40}	Capital investments in health care and social assistance, % of total investments in the region
x_{41}	Commissioning of housing in rural areas, thousand m ² of total area
x_{42}	Capital investment in transport, warehousing, % of total investment in the region
x_{43}	Capital investment in information and telecommunications, % of total investment in the region

Source: substantiated by the authors

It should be noted that the indicators are certain evaluation indicators, namely: x_3 , x_4 , x_8 , x_9 , x_{10} , - are total indicators and include several or more components.

For example, the indicator x_3 - the purchase of new agricultural machinery by agricultural enterprises includes the purchase of the following vehicles: tractors of all types; plows; cultivators; harrows; drills; manure and fertilizer spreaders; water pumps and pumping stations; mowers; rollers; repackers; grain harvesters; grain cleaning machines, milking machines and devices; machines and mechanisms for feed preparation; manure conveyors; agricultural trailers and semi-trailers; trucks with diesel and semi-diesel internal combustion engines.

Indicator x_4 - the presence of tractors, combines and agricultural machinery in agricultural enterprises, at the end of the year, includes: tractors; grain and corn harvesters; beet harvesters; sprinkler systems and units; watering machines and devices; water pumps and pumping stations.

Indicators x_8 - purchase of mineral fertilizers by agricultural enterprises, contains: nitrogen, phosphate, potassium and complex fertilizers.

Indicators x_9 , x_{10} - purchase by agricultural enterprises of plant protection products, in thousands of tons and thousands of liters, includes: insecticides; fungicides; herbicides; plant growth regulators and other pesticides.

3. Conclusions

The scientific novelty of this study is the substantiation of the evaluation indicators system of the agro-industrial complex of regions, which, unlike the existing ones, is based on a methodological basis, which provides for the selection of evaluation indicators and coordination of groups of indicators using expert evaluation.

The grouping of indicators taking into account the principles of systematization, universality and coherence makes it possible, in addition to assessing the development of the agro-industrial complex of regions,

also to assess individual areas, namely:

- firstly, industries that produce means of production for agriculture and other industries that provide services to agriculture;
- secondly, agriculture;
- thirdly, the spheres of industries for processing and preservation of agricultural products;
- fourthly, the sphere of production and social infrastructure.

The practical significance of this study is that a sound system of indicators can be used at the national and regional levels to calculate the development of the agro-industrial complex, and develop measures to improve its efficiency.

Further research requires calculations of the regional development of the agro-industrial complex, taking into account a sound system of evaluation indicators.

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