Model of diagnostics of the efficiency of using the resource potential of the agricultural sector economy

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Abstract. The article examines the problem of the effective use of resource potential in agriculture. It is argued that the reasons for increasing the efficiency of resource use at the current stage of development are closely related to the digital transformation of the industry. The aim of the study is to develop a model for diagnosing the efficiency of using the resource potential of the agricultural sector of the economy, which is based on a regional industry approach that takes into account the current trends of large-scale transformations, the driver of which is the dependence on innovation and the rapid penetration of new technologies. The developed integrated territorial-industrial model allows us to link logically occurring structural changes in agriculture associated with digitalization and technical modernization of its sub-sectors, to identify the specifics of the spatial development of the agricultural sector, to determine the vector of effective management decisions. The criteria for identifying the degree of digitalization of economic resources are justified, the main of which is the percentage of: digitalization of agricultural land; employees with an IT specialty; automation and computerization of the management of the main production assets; agricultural machinery provided with the Glonas and GPS system.

1 Introduction

In recent years, the trends of the global agri-food market are characterized by large-scale changes, the driver of which is the dependence on innovations and the rapid penetration of new technologies into all sub-sectors of agricultural production, which allows you to significantly increase labor productivity, maintain full comprehensive control over costs, reducing them to a minimum, significantly improving the quality of products.

As part of the implementation of the May decrees of the President of the Russian Federation of 07.05.2018, a special role belongs to the structural reset of the national economy, which provides a breakthrough in the scientific, technological and socio-economic development of its priority sectors. The economic mechanism that takes place in the modern conditions of management in the agricultural sector of the Russian economy is aimed at creating appropriate conditions that orient agricultural producers to use the

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existing production potential more efficiently and efficiently, by introducing modern achievements of scientific and technological progress into the production process.

Breakthrough technologies, turning agriculture into a high-tech industry, make it possible to combine the resources used by actively replacing one with another (labor and land with capital), which stimulates the positive dynamics of economic growth in the agricultural sector of the economy on the basis of increasing the efficiency of using the resource potential [1, 2, 3] .

The uneven distribution of innovations in the agricultural production of certain regions of Russia is due to a number of factors of their territorial differentiation.

Studies have shown that in domestic practice, the diagnosis of the economic efficiency of using the resource potential of the agricultural sector of the economy is carried out mainly in the context of two main areas: based on the assessment of factor productivity, for example, when calculating output indicators per 1 employee and per 100 hectares of agricultural land; using factor models. However, the available methods do not take into account the vector of modern structural changes [5, 6, 7].

We propose to determine the efficiency of resource use in the agricultural sector of the economy on the basis of a comprehensive territorial-industrial model. The tools proposed by us for the territorial-sectoral approach to assessing the effectiveness of the use of resource potential may vary depending on the specifics of the sectoral and sub-sectoral orientation of the agricultural sector in a particular region.

2   Research methodology

The methodological basis of the study was a set of methods of economic analysis. In particular, the spatial and sectoral analysis was used to study the production potential of the agricultural sector in the region. A comparative analysis of the economic efficiency of the use of production resources was carried out according to the data of the ministry of agriculture and food of the Rostov region.

3   Research results

In the era of civilizational and scientific-technological transformations, the sustainable and planned development of economic entities in rural areas is directly dependent on the key components of the production process, such as labor, land, basic production assets and technical resources. At the same time, the territorial and sectoral aspect of the diagnostics of the efficiency of the use of resource potential allows us to assess the level of competitive advantages of the region and to form the appropriate organizational and economic conditions for the sustainable development of its industries [8, 9, 10].

Therefore, we consider it appropriate to develop a methodology for diagnosing the effectiveness of the use of resource potential, adequate to the structure of the industry of a particular region (Fig 1), an example of which can serve as one of the leading agricultural regions of Russia-the Rostov region.

The advantage of this method of diagnosing the economic efficiency of the use of resource potential is that the regional sectoral approach allows us to link logically occurring structural changes in agriculture associated with digital transformation and technical modernization of its sub-sectors, to identify the specifics of the spatial development of the agricultural sector, to determine the vector of effective management decisions [11, 12, 13, 14].
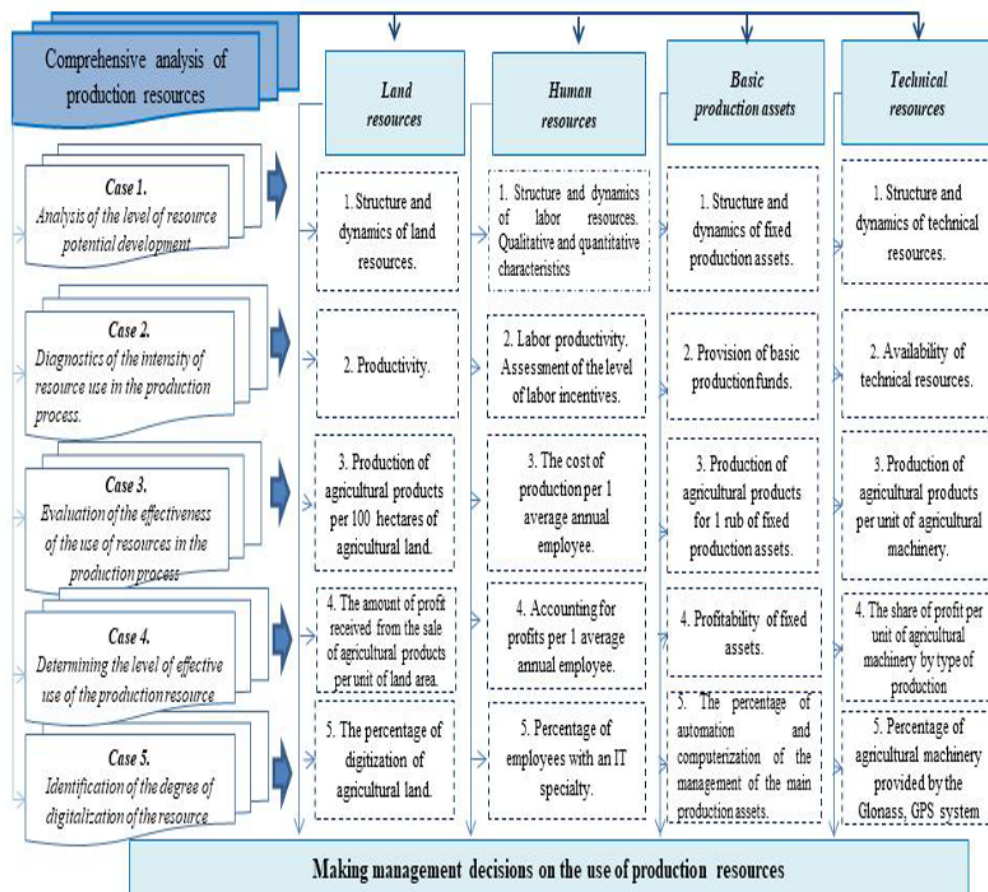
Fig. 1. Integrated territorial and sectoral model for assessing the efficiency of resource use in agriculture
Developed by the author

Land resources. The starting point for the stable development of agricultural production is the availability and effective use of land resources, the potential of which determines the general line of development of the agricultural industry as a whole. Studies have shown that the land resource of the Rostov region is characterized by a large area with no uncultivated land plots.

For the period 2014-2019 in agriculture of the Rostov region, there is an increase in the share of arable land in the structure of agricultural land. At the same time, the structure of agricultural land of large and medium-sized enterprises of the Rostov region has not undergone significant changes. Thus, the ploughing of agricultural land in the region during the study period averaged more than 80.0 % due to the plowing of pastures and hayfields, the share of which decreased from 19.0% to 15.8% during the study period.

The Southern zone, in the course of its economic development, specializes both in the production of the main types of crop production, including cereals, oilseeds, vegetables, and in the production of dairy and meat cattle breeding, since favorable climatic conditions and fertile soils allow the development of priority agricultural production sectors.

The results of our research have shown that for the period 2014-2018 in the Rostov region, there is a tendency to increase the efficiency of land use in the crop production

industry in all categories of farms. In particular, the yield of grain per 100 hectares of arable land increased from 109.8 tons in 2014 to 165.8 tons in 2019 (or 52.1 %), sunflower seeds from 8.6 tons to 20.5 (2.4 times), vegetables from 7.1 tons to 8.5 tons (or 19.8 %).

The yield of cultivated crops is one of the key criteria for evaluating the efficiency of agricultural land use. Our analysis showed that in the region for the period 2014-2019 there is a steady growth in crop yields, with the exception of sugar beet, for all categories of farms.

The high yield rates of the main types of agricultural crops per unit area are due to the high agricultural culture, which corresponds to a scientifically based structure, as well as the use of highly productive seeds, soil fertility.

In the dairy industry, the production of products per 100 hectares of agricultural land was constant and amounted to 2.7 tons (Figure 5). The negative trend of reducing the efficiency of land use per 100 hectares in the meat livestock industry decreased from 12.7 tons in 2014 to 9.2 tons in 2019, due to the bankruptcy of a large poultry complex, LLC "EuroDon", which accounted for the lion's share of poultry production.

The use of modern high-tech equipment in various categories of farms in the region made it possible to reduce labor costs per 100 hectares of agricultural land by 15.6% during the study period (Fig. 2).

The analysis of the dynamics of profit per 100 hectares of arable land showed a decrease in profit per 1 hectare from 4036,1 rubles in 2014 to 1292,8 thousand rubles in 2019 due to the unfavorable macroeconomic situation in the country, which negatively affected the efficiency of land use.

The author's approach to developing a methodology for evaluating the effectiveness of resource use is that in the period of breakthrough scientific and technological revolutions, digital technologies become a key factor in successful and competitive activities.
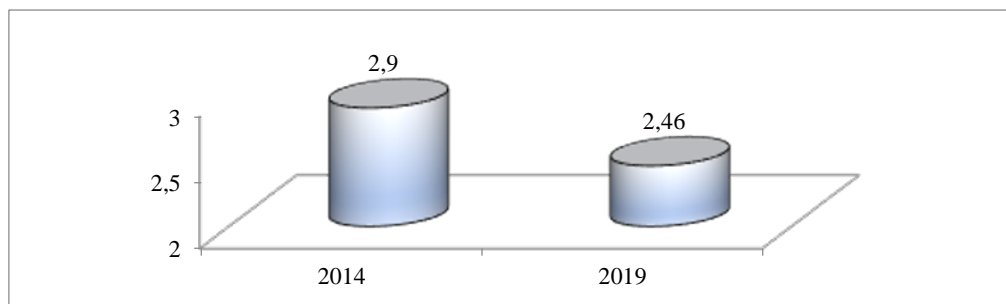
Fig. 2. Dynamics of man-hours worked per 100 hectares of agricultural land in the agriculture of the Rostov region for 2014-2018.
Developed by the author based on the annual reports of agricultural enterprises of the Rostov region [4]

The use of digital technologies in the use of land resources at the management level is considered appropriate to consider through a system of digital maps for monitoring agricultural land. The creation of digital maps of agricultural land in the region is the initial requirement for the formation of artificial intelligence in the field of land use. Therefore, the indicator of the share of digitized agricultural land should be considered when diagnosing the use of land resources in the context of digitalization of production resources. Thus, the Rostov region is a leading region in the digitization of agricultural land. In 2014, all agricultural land was converted to digital format.

Labor resources. The analysis of the number of people employed in the agricultural sectors showed that for the period 2014-2019, the number of employees in the agricultural sector significantly decreased from 49,313 people to 45,249 people, or by 8.24 %. This

trend can be traced both in the field of crop production and in animal husbandry. Today, agricultural producers acquire energy-saturated modern agricultural machinery, which replaces and displaces manual labor. Thus, the use of modern high-performance equipment in the crop production industry led to a significant reduction in the share of tractor drivers from 22.7 % in 2014 to 20.8 % in 2019.

The financial and economic situation in the country has a significant impact on both the level of profitability of agriculture and the amount of net profit per employee. Thus, in 2019, the amount of net profit per employee amounted to RUB 129.5 thousand, which is 1.8 times lower than in 2014, which negatively affects the level of resource potential utilization.

The use of modern machinery and equipment not only reduces the level of employment in the industry as a whole, but also significantly affects the level of hours worked by 1 employee during the year. So, if in 2014 there were 2196.0 people - hours per employee per year, then in 2019 this indicator was 1884.0 people-hours.

It should be noted that the material component seriously affects the level of efficiency of the use of labor resources in agriculture, determining its prestige among young highly qualified specialists. The analysis of the key motivating factor showed that, despite the significant increase in wages of employees of agricultural organizations in the region in the period 2014-2019 from 17,651. 1 rubles to 25,845. 9 rubles (or by 46.4 %) with inflation of 11.5 % in 2014 and 12.9 % in 2015, there is no need to talk about improving the well-being of rural workers. In addition, the share of labor costs in the cost structure tended to decrease and did not meet its regulatory limit (30.0 %).

In our opinion, the level of professional qualification of the staff will be the criterion of the effectiveness of the use of labor resources of the Rostov region. The low level of qualification of the personnel of agricultural organizations (Fig. 3) indicates the presence of a potential factor that hinders the active introduction of innovative and advanced technologies in the industry. Thus, a significant part (41.8 %) of workers in mass professions have no education, 29.8 % of employees have primary vocational education, 24.1 % - secondary education, respectively. More than 90.0 % of managers and specialists have a professional higher or secondary education. At the same time, a significant part of specialists (7.7 %) have only primary vocational education, and 5.0% do not have any vocational education at all. This fact not only significantly reduces the level of labor productivity in agricultural organizations in the region, but also creates serious barriers to the introduction of modern digital technologies in agriculture.
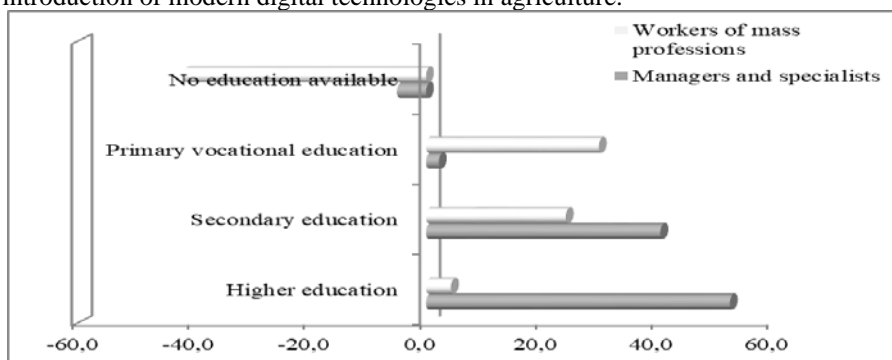
Fig. 3. Qualitative characteristics of the labor resources of agricultural organizations in the Rostov region in 2019, %
Developed by the author according to [3]

The low level of qualification of the labor resources of agricultural organizations is explained by unsatisfactory living conditions in rural areas, the lack of prestige of

agricultural labor and the low level of its payment, as the main element of the motivational mechanism.

But do not forget that the current challenge for the agricultural sector of the region is the introduction of IT technologies in various sectors of agriculture, signaling that in the age of digital technologies there is a significant need for competent specialists, whose mobility and flexibility of professional skills will allow them to respond in a timely manner to threats to the internal and external environment.

The low level of "computer literacy" does not allow small and medium-sized organizations to use most of the advantages of modern information technologies, which affects the quality of management of the resource potential of farms.

The criterion for digitalization of labor resources in agriculture will be the percentage of the industry's availability of IT specialists. Currently, a significant part of the workers and employees of the agricultural sector (over 40.0 %) cannot use the achievements of modern information and communication technologies due to the lack of the necessary qualifications and formed competencies in this area. The share of IT specialists in the region's agriculture is less than 1.0 % [3].

Basic production assets. In the process of studying the resource potential of agricultural organizations in the Rostov region, it was found that the cost of fixed production assets necessary to obtain added value in agriculture through the implementation of industrial economic activities tends to increase. In the structure of the main production assets of agricultural organizations, the largest share is occupied by the categories: "Machinery and equipment", "Buildings and structures", "Vehicles".

The main indicators of the efficiency of the use of fixed production assets of agricultural organizations in the region allow us to determine the level of intensity of their use in the production process. Studies have shown that the positive dynamics of the indicators of the capital-to-equipment ratio and the capital-to-equipment ratio of the production potential (Table 1) had a positive impact on the level of efficiency of the use of fixed production assets in agricultural organizations in the region.

Table 1. Indicators of the availability of basic production funds in agriculture of the Rostov region in 2014, 2019

Indicator	2014	2019	Regulatory restrictions on the level of resource potential use		
			low	average	high
capital equipment, thousand rubles/ha	25,51	45,20	20 <…	20<…<60	…> 60
labor capital ratio, thousand rubles /person	1108,0	2217,6	1000 <…	1000<…<5000	…> 5000
fund profitability, %	12,2	3,7	10<…	10<…<20	…> 20

Developed by the author based on the annual reports of agricultural enterprises of the Rostov region [4]

This fact is confirmed by the indicators of capital productivity, capital intensity and capital profitability that exceed their minimum regulatory limits (Table 2).

The level of automation and computerization of key management decisions in large, medium and small farms will be the criterion for digitalization of the main production assets of the Rostov region (Fig. 4).

The introduction of IT technologies is the most important condition for the successful implementation of key management tasks based on working with large amounts of data. For example, to automate management decisions, large agricultural holding structures, medium

and small agricultural organizations use special platforms for accounting, statistical and management reporting on a large scale.

Table 2. Indicators of the efficiency of the use of fixed production assets in agriculture of the Rostov region in 2014, 2018.

Indicator	2014	2018	Regulatory restrictions on the level of resource potential use		
			low	average	high
- return on funds	1,3	1,1	1 <…	1<…<2	…> 2
- capital intensity	0,8	0,9	**<… 0,5**	0,5<…<1,0	…> 1

Developed by the author based on the annual reports of agricultural enterprises of the Rostov region [4]
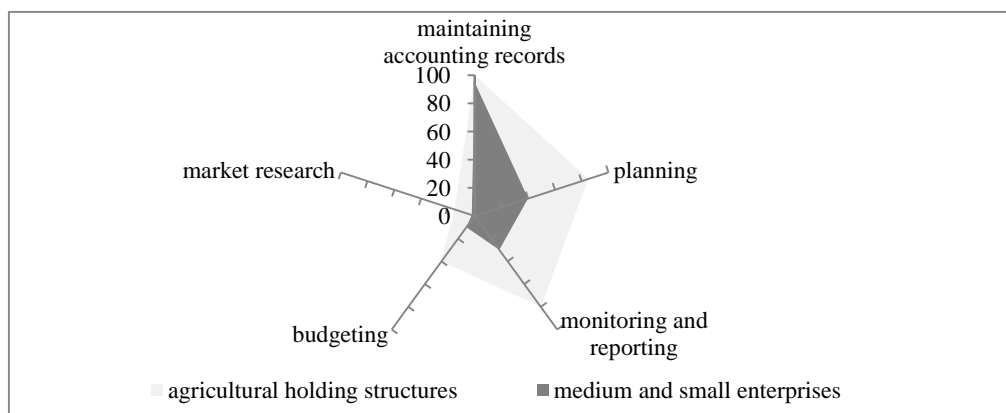
Fig. 4. Criteria for digital transformation of labor resources in large, medium and small farms of the Rostov region in 2018
Developed by the author according to [3]

Technical resources. The study of the structure of the equipment park in the Rostov region – one of the largest agar regions of the country, the leader in the production of cereals and oilseeds, indicates that the insufficient level of mechanization and the extreme wear of technical means remains an important problem for the agricultural sector.

So, in 2019, the farms of the Rostov region had 28,856 units of tractors, 10,380 units of combine harvesters. In 2019, the share of agricultural machines outside the amortization period remains high: 65.4% for tractors and 46.0% for combines, provided that the region produces modern agricultural equipment that is in high demand among agricultural producers not only in the region, but also throughout Russia.

The positive dynamics of recent years in terms of the number of modern, wide-range, multi-operational agricultural machinery purchased using satellite navigation can significantly reduce the consumption of fuel and lubricants and spare parts, reduce the time required for the implementation of agricultural measures and increase the economic efficiency of production.

Despite the positive dynamics of the coefficients of renewal of the technical park of agriculture in the region over the past 5 years with modern agricultural machines, their values remain below their regulatory limits. Thus, the coefficients of updating the technical fleet for tractors in 2019 amounted to 3.4 % at the rate of 6.6 %, for combines - 4.9 % (at the standard of 8.6).

The analysis of indicators of economic efficiency of the use of machine and tractor fleet in the farms of the Rostov region for the period 2014-2018 shows that in the region, taking

into account the movement of the area of arable land and the number of tractors over the past 5 years, the load of arable land per tractor increased from 121.8 hectares per machine to 142.6 hectares.

At the same time, the harvesting area per harvester increased by 5.6%. Despite the increased load on the harvesters, all harvesting operations in the region are carried out within the technological deadlines. This once again suggests that the old harvesters are being replaced by agricultural machines of new modifications with higher productivity.

From 2014 to 2019, grain production per tractor increased by 1.4 times, and per harvester by 15.3 %, which has a positive impact on the overall economic situation of farms and their solvency.

The criterion of digital transformation of the use of technical resources in the region is the level of provision of modern agricultural machines with the Glonass, GPS system. This system allows to increase the economic efficiency of the use of technical means, as well as to bring to a higher level all agrotechnological work in the industry. In the agricultural organizations of the Rostov region, this indicator for the period 2014-2019 exceeded the mark of 80,0 %.

4 Conclusion

The developed integrated model for assessing the efficiency of resource use in agriculture based on the territorial-sectoral approach allows us to identify bottlenecks in the development of economic entities in the region, accumulating the production potential of industries to increase the competitiveness of the agricultural sector of the economy as a whole.

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