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ALGORITHM FOR CALCULATING THE RESOURCE POTENTIAL OF AGRICULTURAL PRODUCTION

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Abstract

Resource potential, as a generalizing indicator of resource availability, reflects the volume and balance of production resources, expressed in their functional ability to carry out production activities. This economic category is the fundamental basis of any material production and, from our point of view, has to have a quantitative dimension. In the economic literature, even with a correct understanding of its essence, it rather has a descriptive form which does not allow determining an integral assessment of all production resources. We believe that a quantitative assessment of the resource potential shows the volume of products produced by an agricultural organization with an average efficiency of resource use. This problem is solved based on the use of the apparatus of production functions. The specificity of agricultural production does not allow building a mathematical model for a specific enterprise. Therefore, it is necessary to have a significant array of data on agricultural enterprises in the region, forming homogeneous groups using cluster analysis methods. After that, production functions are built for each of the selected clusters, and an estimate of the resource potential is proposed. The proposed algorithm is illustrated on a sample of several agricultural organizations of one of the regional clusters.

Keywords: Agriculture, clusters, economic growth, elasticity of production, production function

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1. Introduction

The question of the content of the category "resource potential of agricultural production" is still debatable, and it is often identified with production potential, while, in our opinion, they carry different semantic loads (Kulikov & Minakov, 2018; Smagin, 2015).

We believe that the resource potential is a generalizing indicator of the resource availability of agriculture. It includes a set of natural and material elements involved in the production process and for its assessment it is necessary to determine an integral assessment of all resources.

Some researchers note that in order to assess the resource potential, in addition to the volume, one should take into account the balance of resources (Kulikov & Minakov, 2018). The effect of their joint action, the initial production capabilities, determined by the mass of all available individual resources, their structure and quality. Agreeing with the above aspects, we note that their estimates are descriptive, so we made an attempt to quantify the resource potential and propose an algorithm for its calculation.

To solve this problem, you cannot evaluate a separate resource, because the results of production are formed under the influence of all production resources that are in unity. Obviously, in order to calculate the resource potential, it is necessary to assess the balance of resources, while answering the main question: what is meant by balance? We believe that the balance reflects the degree of satisfaction with the requirements of the technological process, reflected in the observance of certain proportions between the costs of production resources, which, in turn, is determined by the specialization of the given enterprise. Therefore, balance is understood differently for agricultural organizations with different sectoral structures.

On the other hand, if the volume and structure of resources must meet the requirements of the technological process, the result of which is the production of products, then the resource potential must be directly related to the volume of gross production. Whatever aspects are discussed (volumes of resources used, their balance, adaptation to changing environmental conditions, etc.), the production process is always analyzed. Consequently, the resource potential depends on the volume and intensity of the use of resources, balanced taking into account the specialization of an enterprise capable of carrying out production activities. In this case, it can be modeled using a logically grounded, adequate production function built on significant factors, i.e. a probabilistic-statistical model reflecting the relationship between the amount of resources expended and the volume of production (Kulikov & Minakov, 2020; Minakov & Nikitin, 2019; Nikitin et al., 2020a).

2. Problem Statement

Since the volume and structure of resources have to meet the requirements of the technological process, the result of which is the production of products, the resource potential has to be directly related to the volume of gross production. Whatever aspects are discussed (volumes of resources used, their balance, adaptation to changing environmental conditions, etc.), the production process is always analyzed. Consequently, the resource potential depends on the volume and intensity of the use of resources that are balanced taking into account the specialization of an enterprise capable of carrying out production activities. In this case, it can be modeled using a logically grounded, adequate production function built on significant factors, i.e. a probabilistic statistical model reflecting the relationship between the amount of resources expended and the volume of production (Antsiferova et al., 2019; Nikitin et al., 2019b).

3. Research Questions

The article addresses the following issues:

- the use of cluster analysis for the formation of homogeneous groups of enterprises, taking into account the volume of production resources, the intensity of their use and the level of specialization:
- building production functions for each selected cluster;
- development of an algorithm for calculating the resource potential for agricultural organizations in the region.

4. Purpose of the Study

The aim of the study is to develop an algorithm for calculating the resource potential in the agricultural sector of production.

5. Research Methods

We propose to consider the methodology for determining the resource potential, taking into account the degree of influence of production resources on the gross output. In this case, one should take into account the peculiarities of agricultural production, which impose a number of restrictions on the procedure for calculating this indicator (Nikitin et al., 2019a, 2019b).

First, in terms of gross output and the cost of each of the production resources, we have only one observation per year, which does not allow us to build a mathematical model for a specific enterprise. Consequently, it is necessary to have a significant amount of data on agricultural enterprises in the region. Second, the correct processing of statistical data can be carried out only for a homogeneous group of observations. The data on agricultural organizations in the region differ in their heterogeneity, therefore, for an adequate analysis, it is necessary to form the appropriate groups using the methods of cluster analysis. At the same time, in different clusters (different homogeneous aggregates) there are different relationships between the amount of spent production resources and the volume of gross output. Homogeneity should be ensured by those factors that determine the effective indicator (in this case, it is the volume of gross output), i.e. the volumes and intensity of resource use, balanced taking into account the specialization of the enterprise, should be used as cluster features. The operation preceding the cluster analysis is the standardization of all variables. This procedure is necessary, since all characteristics must be brought to a comparable form by excluding units of measurement. The standardization process is carried out according to the formulas (Nikitin & Smykov, 2019):

$$z_{ik} = \frac{x_{ik} - \overline{x}_k}{s_k},$$

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where x_{ik} is the value of the attribute k for the i-object; $\overline{x}_k$ is the arithmetic mean of the attribute k; sk is the standard deviation of the attribute k.

The clustering was based on the following factors: x_1 is agricultural land area, ha; x_2 is the average annual cost of fixed assets, thousand rubles; x_3 is the average annual cost of production working capital, thousand rubles; x_4 is the average annual number of employees, people, as well as resource costs per 100 hectares of agricultural land; q_1 is the cost of fixed assets per 100 hectares of agricultural land, thousand rubles / 100 hectares; q_2 is the cost of working capital per 100 hectares of agricultural land, thousand rubles / 100 hectares; q_3 is the number of employees per 100 hectares of agricultural land, people / 100 hectares.

To assess the specialization of agricultural organizations, clustering should be based on the structure of marketable products,%: z_1 is the proportion of grain in the composition of marketable products; z_2 is the share of sunflower in the marketable product; z_3 is the share of sugar beet in the marketable product; z_4 is the proportion of fruits and berries in the composition of marketable products; z_5 – the share of vegetables in the composition of marketable products; z_6 is the specific gravity of potatoes in the composition of marketable products; z_7 – specific gravity of cattle meat in the composition of marketable products; z_8 is the proportion of pig meat in the marketable product; z_9 is the proportion of milk in the composition of marketable products; z_{10} is the share of sheep breeding products in the composition of marketable products.

6. Findings

Thus, using 17 features, we carried out a cluster analysis using the Wards method of 256 agricultural organizations in the Tambov region, which resulted in three representative clusters.

As an example, we consider the first cluster, the production function of which is:

$$Y = 8,273 \cdot x_1^{0,201} \cdot x_2^{0,145} \cdot x_3^{0,447} \cdot x_4^{0,294}$$

where Y is the volume of gross agricultural production, thousand rubles.

All factors are significant, the model is adequate with a reliability level of at least 99.9%. Multiple correlation coefficient is R = 0.9617 ($R^2 \approx 0.925$). The elasticity coefficients for agricultural land, fixed assets, working capital and labor resources are 0.201, 0.145 and 0.447, 0.294 respectively. Thus, with an increase in the area of agricultural land, the average annual cost of fixed assets, working capital and the average annual number of employees by 1%, the volume of gross production increases by 0.201; 0.145; 0.447 and 0.294%, respectively. The sum of all elasticity coefficients, i.e. the elasticity of production is 1.087.

Table 1 shows the calculation of the resource potential for 12 enterprises of the first cluster (calculated using the above production function), where Y_k is the actual volume of gross production at the k-enterprise, R_k is the resource potential of the k-enterprise, i.e. theoretical (calculated by the production function) volume of production; E_{Rk} is the efficiency of using the resource potential at the k-enterprise with an average efficiency of using resources in this cluster (the ratio is Y_k / R_k).

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Table 1. Cost estimate of the resource potential of 12 enterprises of the 1st cluster

k	X_1	X_2	X_3	X_4	Y_k	R_k	E_{Rk}
1	7 651	116 016	33 404	34	92239	80360	114.8
2	5 756	123 685	188 612	211	260167	284022	91.6
3	7 603	64 642	108 412	95	149333	168809	88.5
4	6 363	109 809	264 606	51	204144	218283	93.5
5	5 871	61 184	43 495	130	135336	115909	116.8
6	9 117	158 153	216 524	43	189122	215115	87.9
7	3 580	18 061	22 683	13	23392	33398	70.0
8	5 076	42 759	46 143	65	87228	89500	97.5
9	5 374	6 880	51678.5	13	42562	45525	93.5
10	3 472	11 443	24582.5	12	31397	31456	99.8
11	5 969	48 816	58591.5	43	100843	92880	108.6
12	6 166	69 051	73137.5	45	106395	110014	96.7

We believe that it is possible to offer a point estimate of the resource potential, the calculation algorithm for which can be as follows.

1. We form homogeneous aggregates of agricultural organizations using the methods of cluster analysis.

2. We build production functions for each cluster.

3. We calculate the coefficients of elasticity $E_1, E_2, \ldots, E_n$:

$$E_j = \frac{\partial Y}{\partial x_j} \cdot \frac{x_j}{Y}.$$

4. We determine the shares of each resource:

$$W_i = \frac{E_i}{\sum_{j=1}^{n} E_j}.$$

For the first cluster of the above production function, we get:

$$W_1 = \frac{0,201}{1,087} \approx 0,185; W_2 = \frac{0,145}{1,087} \approx 0,133; W_3 = \frac{0,447}{1,087} \approx 0,411; W_4 = \frac{0,294}{1,087} \approx 0,270.$$

5.

Fixing this cluster, we determine the resource potential of the k-enterprise:

$$\overline{R}_k = \sum_{i=1}^{n} W_i \cdot X_i^{(k)},$$

where $X_i^{(k)}$ is the volume of the i-type resource at the k-enterprise.

Table 2. Point assessment of the resource potential of 12 enterprises of the 1st cluster

k	X_1	X_2	X_3	X_4	R_k	$\overline{R}_k$	$R_k / \overline{R}_k$
1	7 651	116 016	33 404	34	80360	30584	2.63
2	5 756	123 685	188 612	211	284022	95091	2.99
3	7 603	64 642	108 412	95	168809	54587	3.09
4	6 363	109 809	264 606	51	218283	124549	1.75
5	5 871	61 184	43 495	130	115909	27135	4.27
6	9 117	158 153	216 524	43	215115	111724	1.93
7	3 580	18 061	22 683	13	33398	12391	2.70
8	5 076	42 759	46 143	65	89500	25608	3.49

9	5 374	6 880	51678.5	13	45525	23153	1.97
10	3 472	11 443	24582.5	12	31456	12271	2.56
11	5 969	48 816	58591.5	43	92880	31690	2.93
12	6 166	69 051	73137.5	45	106395	40396	2.63

The score is difficult to interpret, so the last column shows the ratio of the cost to the score (as shown in Table 2), showing the price of one point; on average, for these enterprises, 1 point of resource potential costs 2.52 thousand rubles.

7. Conclusion

Resource potential, reflecting the volume and balance of production resources, expressed in their functional ability to carry out production activities, is the fundamental basis of any material production. Its quantitative assessment shows the volume of products produced by an agricultural organization with an average efficiency of resource use in a given cluster. The efficiency of using the resource potential, being the most important direction of economic growth in the agricultural sector of the economy, is the ratio of the actual volume of gross output to its theoretical level.

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