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# Using Cluster Analysis To Justify The Priority Areas Of Agricultural Organizations Innovative Development.

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**ABSTRACT**

The most important condition for a qualitative and quantitative breakthrough in the production of agricultural products, an increase in efficiency is the activation of its innovative component. However, it should be noted that the sustainable development of the studied sector depends on the correct choice and adequate zonal distribution of innovations. In this regard, the paper proposes a methodological approach based on the application of the cluster analysis method, adapted to the features of the object of study by substantiating the essential indicators used in the clustering process of milk producers, which include the productivity of the dairy herd taking into account the actual fat and protein content milk, cost of production and profitability. The substantive characteristics of the cluster analysis of milk production are substantiated, the number of clusters and the geographical location is determined. On the basis of the obtained results, a matrix of classification of organizations in a regional system based on observable classes is presented.

**Keywords:** milk-producing subcomplex, region, cluster analysis, matrix.

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## INTRODUCTION

Dairy cattle breeding is one of the most difficult sub-sectors of agriculture. This is due to the high capital intensity and laboriousness of technological processes, as well as a long period of the reproduction cycle. It should be borne in mind here that more than half of milk in Russia is produced in personal subsidiary farms. If at present, according to experts, in the agricultural organizations of Russia a modern scientific and technical level of production is equivalent to the level of the 1970s. in the individual sector, the current lag is deeper and does not exceed the level of the 50s. The twentieth century [1].

When analyzing the performance of 191 agricultural organizations of the Krasnodar Territory engaged in the production and sale of milk in 2017, a large variation of their technological and economic indicators was noted. In our opinion, one of the most adequate tools for such an analysis is the cluster method, which allows for the classification of heterogeneous statistical aggregates, combining them into groups that are homogeneous in several indicators (cluster).

M.S. Aldenderfer and R.K. Blashfield [2] believes that "... the goal of cluster analysis is to search for existing structures.

Evaluating cluster analysis as a research method, A.Ya. Boyarsky [3] identifies two of his essential methodological features: the justification of a single measure covering a number of signs, and a purely quantitative solution of the question of grouping objects of observation.

IN AND. Nechaev and E.I. Artemova [4] believe that cluster analysis allows solving the problem of organizing various indicators characterizing the innovation activities of commodity producers into visual structures, i.e. to conduct a taxonomy, involving systematization, hierarchical construction of a group of objects according to a definite attribute or set of attributes.

## MATERIAL AND METHODS

In determining the priorities for the integrated development of dairy cattle breeding in the region, cluster analysis can be used in several aspects. The first field of application is the identification of problems and the formation of a group of farms with low development indicators that need reorganization and investment assistance. The second aspect of the analysis is the assessment of the potential and the selection of agricultural organizations that can become "flagships and locomotives" of development, an example of skillful management, as well as a rational allocation of investment funds and their innovative use.

To simplify the procedure for determining the factors that most fully reflect the state of milk producers, a scheme was drawn up (Figure 1), where all indicators are conventionally divided into two parts – economic and technological.

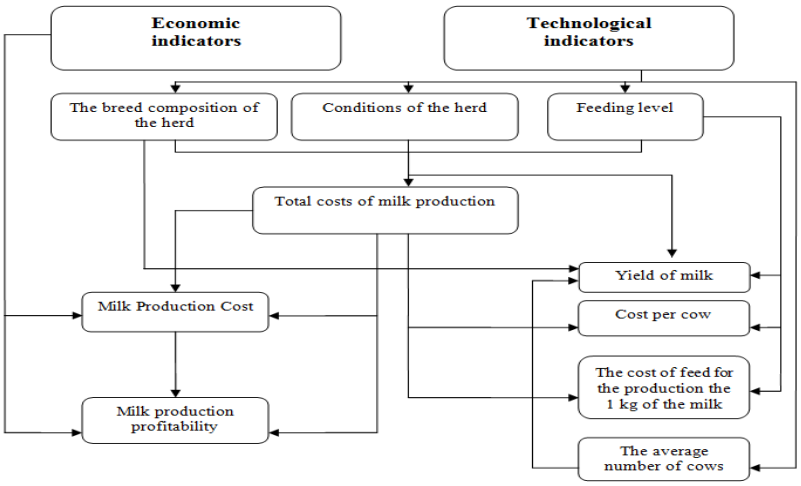


**Figure 1: Grounding the essential characteristics of the milk production cluster analysis**

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## RESULTS AND DISCUSSION

To divide the aggregate into clusters, an application package was used for statistical processing and visualization of Statistica 10.0 data. The dendrogram of 191 agricultural enterprises of the Krasnodar Territory engaged in the production of milk is shown in Figure 2. It can be seen from the figure that the studied set of enterprises initially form three large clusters, which are then divided into five, etc.

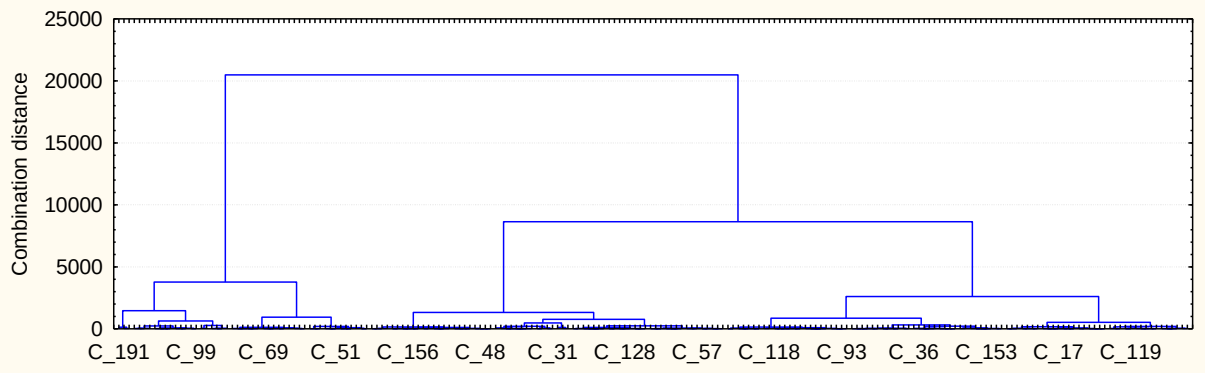


**Figure 2: Agricultural organizations dendrogram of the Krasnodar Region (association rule - Ward method, proximity measure - Euclidean distance, 191 observation)**

At this stage of the study, the task was to obtain a multidimensional classification of agricultural enterprises of the Krasnodar Territory according to the level of development of dairy cattle breeding. The resulting division into five clusters (groups) allows for some comparative analysis of the average values of clusters and to chart ways for further innovation and investment development of enterprises. However, it should be noted that due to the relatively large number of groups, further analysis is rather cumbersome and difficult to see. Therefore, for the further analysis, three integrated clusters were selected.

As a result of the division of agricultural enterprises into three classes (amalgamation distance of 5,000) using the k-average method, 61 enterprises were included in the first cluster, 67 enterprises entered the second cluster, 63 - the third.

In the third class, all average values of indicators exceed the corresponding values of the second and first class (Table 1).

**Table 1: Average values of variables in the formation of three clusters of agricultural enterprises engaged in milk production in the Krasnodar Region**

| Variable | Average value | | |
|---|---|---|---|
| | cluster 1 | cluster 2 | cluster 3 |
| Milk content with basic fat and protein content, c | 43,16 | 55,19 | 62,92 |
| The number of cows per 100 hectares of farmland, goal. | 6,82 | 8,31 | 9.55 |
| Production costs per cow, thousand rubles | 71,8 | 80,61 | 87,01 |
| Feed consumption for the production of 1 centner of milk with basic content of fat and protein, centner feed units | 1,33 | 1,08 | 1,01 |
| The cost of 1 kg of milk with basic fat and protein, rub./kg | 1457 | 1222 | 1151 |
| Profitability of production,% | -2,33 | 17,98 | 30,92 |

95-% confidence intervals for average values of indicators convincingly show a steady order of quality of classification of agricultural organizations of the Krasnodar Territory for all indicators: 3 cluster, 2 clusters, 1 cluster.

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Using the resulting classification using discriminant analysis allows you to find the classification function of new objects belonging to one of the classes according to the highest value of the corresponding function. We will select the grouping - "cluster" and independent variables, according to which the classification was made. Table 2 reflects the resulting linear classification functions.

**Table 2: The classification functions for the grouping - "cluster"**

| Variable | Classification functions | | |
|---|---|---|---|
| | G_1:1 P=0,1635 | G_2:2 P=0,4135 | G_3:3 P=0,4231 |
| Milk yield with basic fat and protein content, c | 3,820 | 3,652 | 3,844 |
| The number of cows per 100 hectares of farmland, goal. | 0,354 | 0,295 | 0,344 |
| Production costs per cow, thousand rubles | 3,103 | 2,909 | 3,104 |
| Feed consumption for the production of 1 centner of milk with basic content of fat and protein, centner feed units | 14,719 | 15,538 | 15,601 |
| The cost of 1 kg of milk with basic fat and protein, rub./kg | 0,354 | 0,300 | 0,291 |
| Profitability of production,% | 0,518 | 0,525 | 0,623 |
| Constant | 225,128 | 167,068 | 160,284 |

The classification matrix shows that almost 93.3% of enterprises are classified correctly (Table 3).

**Table 3: Enterprise Classification Matrix**

| Observable class | Correctness percentage | Predicted class | | |
|---|---|---|---|---|
| | | G_1:1 P=0,1635 | G_2:2 P=0,4135 | G_3:3 P=0,4231 |
| G_1:1 | 91,176 | 31 | 3 | 0 |
| G_2:2 | 96,512 | 0 | 83 | 3 |
| G_3:3 | 90,909 | 0 | 8 | 80 |
| Total | 93,269 | 31 | 94 | 83 |

The graphical depiction of classes also indicates a good classification of enterprises - Figure 3. The first canonical root discriminates all 3 classes, which illustrates the adequacy of the classification.

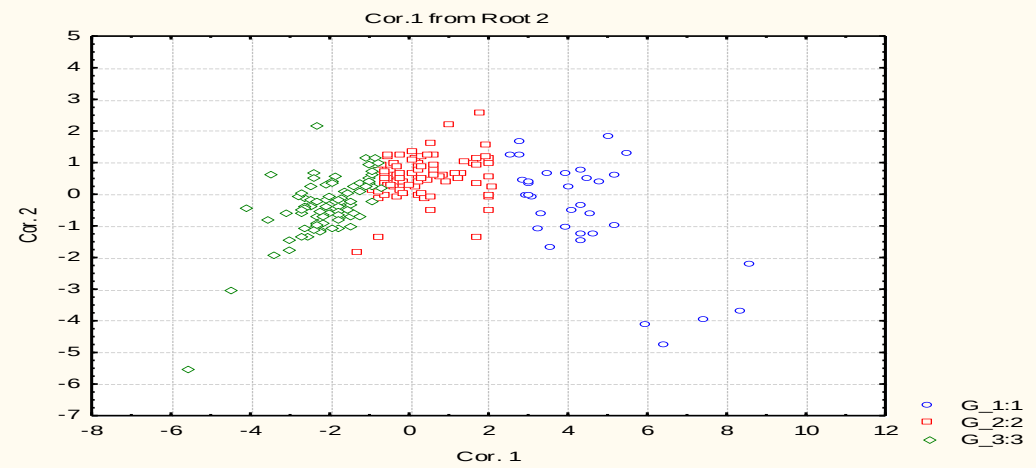


**Figure 3: Cluster Graphic**

The matrix of the factor structure (the table of correlation coefficients between the parameters and factors - canonical roots) of the solution obtained makes it possible to estimate the contribution of variables to the classification obtained through connection with canonical roots: the first root is most strongly associated with the cost price of a unit of basic milk and feed consumption for the production of 1 c of milk, the second - with production costs per cow and milk yield (Table 4). Thus, we can assume that the available data are mainly due to the above factors.

**Table 4: Matrix of factor structure**

| Variable | Canonical root | |
|---|---|---|
| | root 1 | root 2 |
| Milk yield with basic fat and protein content, c | -0,185834 | 0,151444 |
| The number of cows per 100 hectares of farmland, goal. | -0,084298 | 0,079786 |
| Production costs per cow, thousand rubles | 0,151885 | 0,308387 |
| Feed consumption for the production of 1 centner of milk with basic content of fat and protein, centner feed units | 0,247291 | -0,241151 |
| The cost of 1 kg of milk with basic fat and protein, rub./kg | 0,982843 | -0,132286 |
| Profitability of production,% | -0,711626 | -0,442928 |

## CONCLUSION

Now the issues of data analysis and dependency search can be solved in each of the classes separately. When a new enterprise appears with the help of classification functions, it should be attributed to one of the three classes, and then, using regression dependencies, to evaluate the necessary performance indicators.

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