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# Economic Evaluation of the Efficiency of Supply Chain Management in Agricultural Production Based on Multidimensional Research Methods

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*Abstract*-- **The article studies the system of indicators characterizing the efficiency of supply chain management in agricultural production. The hierarchical classification of the subjects of the Russian Federation according to the indicators characterizing the results of the activity of the agricultural sector has been carried out. Clusters with high, medium and low levels of supply chains management's efficiency have been identified. Regions for selected clusters are set. A comparative analysis of the regions on the performance of the agricultural sector has been carried out. Regularities are revealed, prospects for further development are defined. For each cluster promising areas of effective development of agriculture were identified.**

*Keywords*: *agriculture; production efficiency; indicators; multidimensional classification; evaluation; clusters; supply chain management.*

## 1. Introduction

Agriculture is one of the most strategically significant economic activities in terms of providing the population with their own food. In view of the current economic situation in the world, the study of the effectiveness of its functioning and development is relevant.

The review of the scientific literature allows us to conclude that there are numerous studies of the efficiency of supply chains management in agricultural production at the level of different samples, including regions, countries, enterprises of various forms of ownership and production scale, using various methods and indicators of various types of efficiency [1-4].

Today, a comparative analysis of efficiency and environmental performance is not enough [3]. Analysis of various types of agricultural production efficiency (supply chain management, operational, environmental and standardized) using the example of 18 countries in Latin America and the Caribbean showed that not all countries achieve efficiency in all dimensions [3, 5]. We agree with the authors and confirm that often indicators of various types of efficiency change inconsistently and do not have a definite pattern depending on the resource supply of the industry. Also there is the necessity in the information base of the condition and environmental protection precisely by types of economic activity.

The necessity and significance of the inclusion of environmental indicators in the efficiency study is confirmed by the results of the analysis of the technical efficiency of vegetable growing in Cameroon by the method of evaluating non-parametric data. No study has measured the technical efficiency of vegetable farmers in Cameroon's forestry [1]. And in our opinion, in the future it is necessary to consider in the aggregate agriculture and forestry as one type of economic activity, from the standpoint of sustainable development of territories.

Along with the need to take into account the environmental friendliness of production, it is important to talk about the efficiency of using lean production technologies, which allow us to put production in order with virtually no capital expenditures [2]. The research is also conducted on

the efficiency of supply chain production in agriculture on the basis of financial ratios [6-7].

When studying the relative efficiency of agriculture in the European Union, it was concluded that, on average, for movement at the border of efficiency, it is necessary to reduce both costs and simultaneously increase the yield of crop and livestock products [8]. Thus, in different countries agricultural producers face the same problems and the need to solve almost the same tasks.

Issues of increasing the efficiency of agricultural production are analyzed at the level of the Russian Federation and its regions. There are many unsolved problems and tasks of improving management tools, monitoring and diagnostics of the functioning of agricultural enterprises. Using the example of one of the leading regions - the Stavropol Territory - the author suggests ways to improve the mechanism of state support for agriculture based on the results of a differentiated assessment of the efficiency of agricultural production, adapted to modern business conditions and relationships between organizational communication and supply chain risk perceptions, explored after decision makers were allowed to adjust their supply chain strategies [9]. The assessment was performed on clusters with regard to various indicators of production efficiency.

Given the importance of both the organizational and individual perspectives in supply chain management risk decision making, it is important to reconcile the two by identifying the influence of organizational communication on individual decision making. Recent research has indicated that supply chain managers' risk perceptions are a major consideration in developing risk management strategies and has suggested that future researchers should explore the determinants of such risk perceptions (e.g. [10])

Studies of the current stage of agricultural development suggest that the subjects of the agricultural sector are moving to digital, intellectual and robotic technologies. For informational reflection of this process, an index of agriculture robotization is proposed. In the Russian Federation, it is at the level of 0.78 units per 10,000 agricultural workers according to the data of 2016 [11]. Conducting this study and characterizing the indicators related to fixed assets and technologies [12-13], we also come to the conclusion that it is necessary to develop an indicator to assess the effectiveness of digital technologies.

On the basis of this research, specific directions are proposed for increasing the efficiency of agricultural production: modernization of agricultural production technologies, creation of highly qualified information and analytical services, etc. [14]. Thus, it is again about improving the information-analytical, technological and analytical support of the industry. Presentative of this group of authors also conducted studies on the efficiency of using fixed capital in agriculture using multidimensional data analysis methods [15]. The agricultural production can be more effective with a proper strategy of supply chain management and if properly organized [16].

Supply chain management studies suggest that product integration with customers and suppliers can increase a firm's effectiveness in its product development efforts, and thus lead to increased sales [17].

Speaking about the use of analysis methods, one can note the analysis of the agricultural production of Ghana from the position of agribusiness by the methods of time series analysis and panel data [18].

It is necessary to apply a variety of methods in the study of production efficiency, including multidimensional statistical methods. New issues related to the analysis of large amounts of data can not be effectively addressed by traditional methods of statistical analysis. The use of big data is aimed at a real practical problem, rather than a theoretical explanation. It is necessary to apply the cluster method as well. Science has gained experience in its use in analyzing various economic issues [19]. The use of cluster analysis is of particular importance and practical need in the case of incomplete data [20]. Cluster analysis found its application in the study of energy efficiency in agriculture, which emphasizes the importance of an integrated structure for understanding trade-offs and interaction of efficiency indicators [21].

In modern conditions of development of the Russian economy, clustering is a relatively new approach of organizations of the economic system from the standpoint of the territorial location of interrelated enterprises, combining the capabilities of the state, business and science. The practical experience of creating and implementing clusters shows their ability to improve labor efficiency, reduce transaction costs and stimulate innovation [22].

Analysis of research results suggests that there is a problem of improving the efficiency and sustainability of agricultural production, its

measurement, the use of various effective methods of analysis to obtain scientifically based conclusions and recommendations of agriculture, to ensure the food security of countries. Also in modern conditions there is the task of updating the system of production efficiency indicators (in terms of developing and analyzing indicators characterizing current trends in the industry's digitalization, joint accounting for agriculture and forestry) and the information base for analysis (in terms of information and analytical support for environmentally friendly production and environmental protection).

The purpose of this study is to study the level of efficiency of agricultural production in the regions of the Russian Federation and the development of recommendations for its improvement.

## 2. Methods

In order to study the level of efficiency of agricultural production, a multidimensional grouping of regions of the Russian Federation was carried out using the cluster analysis method.

Cluster analysis is a method that allows to classify multidimensional observations which uses a polythetic group formation approach, i.e. when classifying observation in one group or another, all grouping characters are simultaneously involved [15].

Scientists using this method note that cluster analysis aims to identify groups of related features that reflect a certain side of the studied objects [19-22].

In this study, this method of multidimensional classification is used which allows to create scientifically based groups (clusters) and identify internal links between regions of Russia.

In this case, the classification is not carried out sequentially according to individual characteristics, as in the case of combination grouping, but simultaneously according to the whole complex of indicators. The task of multidimensional classification is to isolate the condensations of points in the attribute space, forming homogeneous in some respects groups [15]. The assessment of the similarity or difference between objects to a certain extent depends on the absolute values of the signs, units of measurement and the degree of variation in the aggregate.

In the process of theoretical substantiation of the inclusion in the model of indicators directly or indirectly characterizing the efficiency of agricultural production and based on the availability of informative base on them and agreeing with the developers of the methodological recommendations [23], in this study, the economic efficiency is represented by gross agricultural output indicators at current prices per hectare of agricultural land, per a worker engaged in agriculture, by profitability of plant growing and livestock breeding. Technological efficiency is characterized by indicators: in crop production - the yields of grain and legume crops (grains are the main crop and export products for the Russian Federation, are produced in most regions), in livestock breeding - milk production per cow (also typical for the country). Social production efficiency is represented by indicators of the physical mass of grain and milk sold per employee employed in agricultural production, as well as the marketability of grain and milk as indirect indicators of product quality. Ecological efficiency was presented by an indicator characterizing the effectiveness of environmental activities, namely, reforestation per unit of harvested wood [24-25] (based on the availability of information base and the absence of other indicators by activity). However, the inclusion of this indicator drastically changes the distribution of regions into groups and distorts the results. As a result, it was excluded from further analysis.

Agricultural productivity at the regional level also represents the gross agricultural output per inhabitant [23, 26], which was also included in the study.

Thus, 12 indicators were selected that characterize the efficiency of agricultural production:

X1 - gross output per 1 ha of agricultural land, thousand rubles;

X2 - gross output per 1 average annual agricultural worker, thousand rubles (labor productivity);

X3 - profitability of sold goods, products (works, services) of crop production,%;

X4 - profitability of sold goods, products (works, services) of livestock,%;

X5 - gross agricultural output per 1 inhabitant of the region, thousand rubles

X6 - the yield of grain and legumes crops, c per 1 ha;

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X7 - milk yield per 1 cow, kg;

X8 - sold grain per 1 average annual agricultural worker, c / person;

X9 - marketability of grain and legumes,%;

X10 - application of mineral fertilizers per 1 hectare of sowing in farm crops, kg %;

X11 - sold milk per 1 average annual agricultural worker, c / person;

X12 - marketability of milk,%.

For building clusters according to the level of efficiency of agricultural production, the sources of information were official statistics presented in the publications of the Federal State Statistics Service of the Russian Federation [27].

The cluster analysis was carried out using the "STATISTICA 6.0" software and due to the fact that when classifying regions, indicators measured in incompatible units were used, not the absolute values of variables, but their standardized coefficients calculated using the formula were used [14]:

$$x_{il}^{H} = \frac{x_{il} - \overline{x_l}}{s_l},$$

$$(1)$$

where $x_{il} -$ the value of the l feature of the i object;

$\overline{x_l} -$ arithmetic average value of the l characteristics;

$$s_l = \sqrt{\frac{1}{n} \sum_i \left( x_{il} - \overline{x_l} \right)^2} -$$ standard deviation of l characteristics.

The hierarchical dendrogram was built for 59 regions of the Russian Federation, where the most stable merger results were obtained using the full connection method using the Euclidean distance metric.

## 3.  Research results

When choosing grouping characteristics for multidimensional grouping by the level of efficiency of supply chain agricultural production, it is necessary to consider and characterize with indicators various types of production efficiency, both economic and regional, technological, social, ecological, education [23, 28], since the role of the agricultural sector is reduced not only at least to cost recovery, but is also very important for the sustainable development of territories, strategic importance for the provision of food security of the country and its development.

From the total number of regions of the Russian Federation, regions that were not typical for the industry, in particular, the northern territories, as well as regions with low specific weight of the industry in gross value added (less than 3%), were excluded. Further, in the process of building and analyzing various variants of the multidimensional grouping, 3 outliers were eliminated. Thus, the analyzed statistical aggregate is represented by 59 regions of the Russian Federation. Information array was analyzed for 2017.

Clustering showed a general picture of the integration of regions into clusters, varying in terms of the efficiency of agricultural production (Figure 1).

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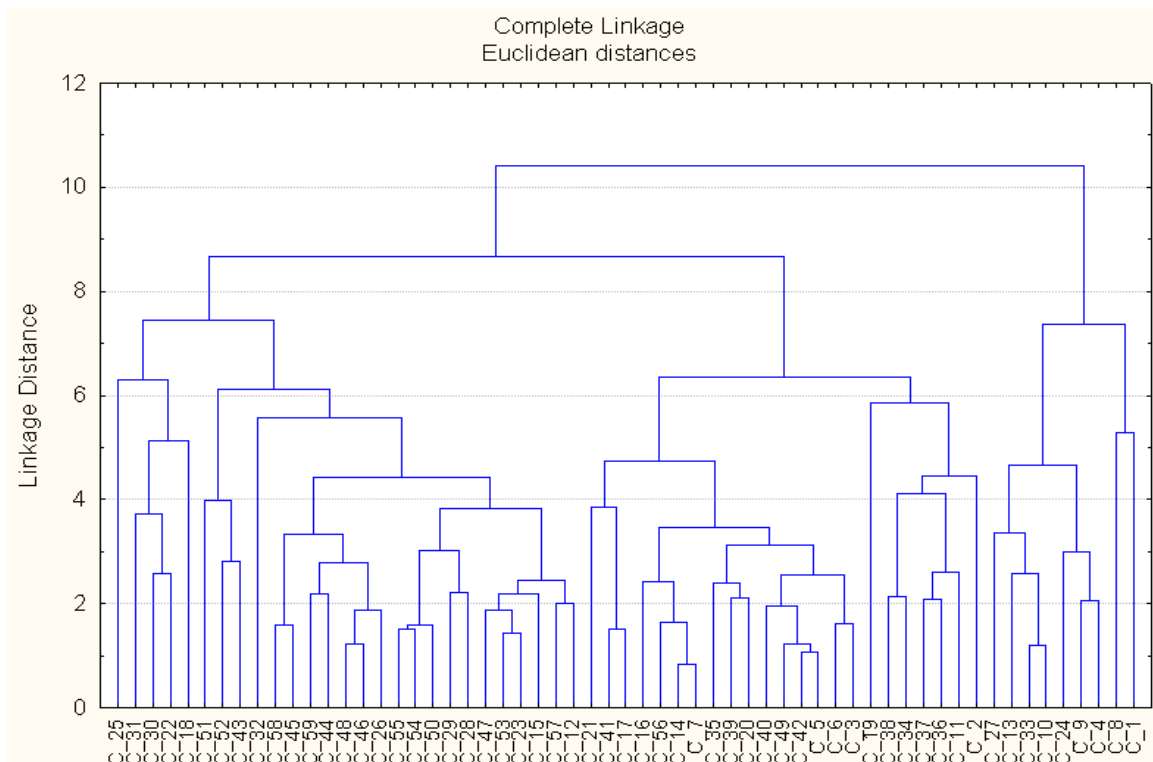
**Figure 1**. Dendrogram of the supply chain of the regions of the Russian Federation

As a result of the study, the division of the totality of regions into three clusters was obtained, which can be conditionally defined as follows:

1. The group of regions with the highest level of efficiency of agricultural production, characterized by high rates of output, the most efficiently organized production process.
2. The group of regions with an average level of agricultural production efficiency.
3. The group of regions with lower level of efficiency of agricultural production, characterized by lower rates, characterized by low-profitable agricultural production (taking into account the climatic conditions).

The clustering of Russian regions in terms of the efficiency of agricultural production is presented in Table 1.

**Table 1**. Characteristics of clusters of regions of the Russian Federation by the level of efficiency of agricultural production

| Cluster | Cluster composition |
|---------|---------------------|
| I | Regions: Rostov, Tambov, Oryol, Lipetsk, Belgorod, Voronezh, Kursk; territories: Stavropol, Krasnodar. |
| II | Regions: Pskov, Kirov, Yaroslavl, Vologda, Novosibirsk, Tver, Kostroma, Novgorod, Sverdlovsk, Nizhny Novgorod, Ivanovo, Kaluga, Vladimir, Leningrad, Ryazan, Bryansk; Republics: Mari El, Chuvash, Udmurt, Bashkortostan, Mordovia, Tatarstan; Perm territory. |
| III | Regions: Astrakhan, Kaliningrad, Orenburg, Tomsk, Samara, Amur, Penza, Kurgan, Saratov, Volgograd, Irkutsk, Kemerovo, Chelyabinsk, Ulyanovsk, Tula, Omsk, Smolensk; Republics: Karachay-Cherkessia, Kabardino-Balkaria, Adygea, Altai, Chechen, Dagestan, Ingushetia, Crimea; territories: Altai, Krasnoyarsk. |

The first cluster is represented by 9 regions, which is 15.3% of the total number of the studied integrity, the second cluster contains 23 regions (39.0% of the total), the third cluster is the most representative and contains 27 regions, which is 45.8% of study regions.

**Figure 2** shows the distribution of standardized averages of agricultural production efficiency indicators.
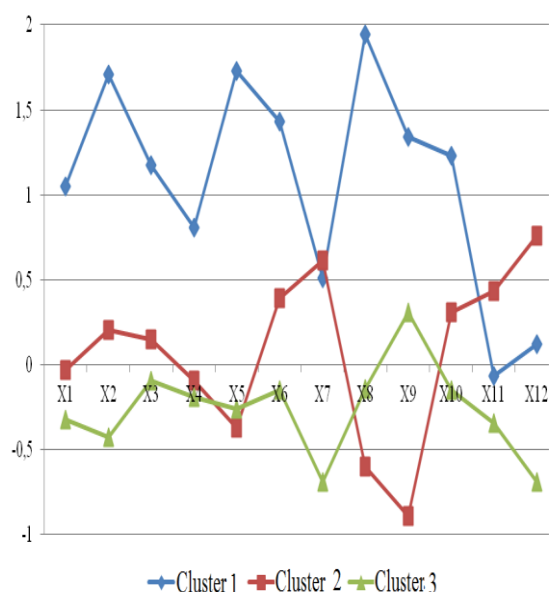
**Figure 2.** Distribution of average values of indicators characterizing the efficiency of agricultural production (based on standardized coefficients)

The characteristics and the name of the cluster elements by regions are given in Table 2. They are presented as the values of grouping characteristics and some of the productive indicators of the industry and its resources for a more complete description of the selected groups.

**Table 2.** Results of a multidimensional grouping of regions of the Russian Federation according to 2017 data.

| Indicators | Total and average | Cluster 1 | Cluster 2 | Cluster 3 |
|---|---|---|---|---|
| The number of regions in the cluster, units | 59 | 9 | 23 | 27 |
| Gross output per 1 hectare of agricultural land, thousand rubles | 35.44 | 52.14 | 30.03 | 24.17 |
| Gross output per employee, thousand rubles (labor productivity) | 2330.99 | 3160.95 | 2365.87 | 1466.15 |
| Profitability of sold goods, products (works, services) of crop production, % | 26.6 | 38.2 | 26.8 | 14.7 |
| Profitability of sold goods, products (works, services) of livestock,% | 11.1 | 15.4 | 9.2 | 8.6 |
| Gross agricultural production per 1 inhabitant of the region, thousand rubles | 55.50 | 90.46 | 36.65 | 39.40 |
| Productivity of grain and legumes, c from 1 hectare | 33.8 | 44.8 | 29.9 | 26.6 |
| Milk yield per cow, kg | 5006 | 5469 | 5594 | 3956 |
| Sold grain per 1 average annual agricultural worker, c / person. | 430.3 | 953.4 | 102.4 | 235.1 |
| Marketability of grain and legumes,% | 60.8 | 82.6 | 41.0 | 58.8 |
| The application of mineral fertilizers per 1 ha of sowing in the agricultural sector. | 78.1 | 110.3 | 79.1 | 44.7 |
| Milk sold per 1 average annual agricultural worker, c / person. | 79.1 | 75.8 | 97.6 | 63.8 |
| Marketabilit | 71.3 | 72.3 | 84.1 | 57.4 |

| y of milk,% | | | | |
|---|---|---|---|---|
| Gross output for 1 rub. the cost of fixed assets, RUB. (capital productivity) | 1.13 | 1.19 | 0.94 | 1.26 |
| Capital-labor ratio, thousand rubles / person. | 1770.8 | 2738.9 | 1367.4 | 1206.2 |
| Power supply, hp / person. | 34.1 | 56.5 | 24.7 | 21.2 |
| Investment intensity, rub. | 9.23 | 12.51 | 8.81 | 6.45 |
| The level of depreciation of fixed assets of agriculture, % | 38.5 | 37.9 | 38.6 | 39.2 |
| The proportion of fully worn out fixed assets of agriculture, % | 8.3 | 7.9 | 9.0 | 8.1 |
| The share of crop production in agriculture, % | 48.1 | 59.8 | 35.1 | 49.4 |
| The proportion of livestock in agricultural products,% | 51.9 | 40.2 | 64.9 | 50.6 |
| The share of agriculture in gross value added,% | 11.9 | 17.2 | 7.8 | 10.9 |
| Milk produced on 1 hectare of agricultural land, c | 2.12 | 1.74 | 2.76 | 1.86 |

| Indices of agricultural production in comparable prices,% to prev. | 102.8 | 104.3 | 101.9 | 102.2 |
|---|---|---|---|---|
| The share of unprofitable organizations of agriculture, % | 22.6 | 16.9 | 24.9 | 26.1 |

The data of table 2 allow us to conclude that the transition from group to group tends to decrease in gross output per hectare of agricultural land from 52.14 thousand rubles to 24.17 thousand rubles.with an average of 35.44 thousand rubles in the sample, labor productivity decreases from 3,160.95 thousand rubles. up to 1,466.15 thousand rubles per employee. The profitability of the goods sold in the branches of plant growing and livestock breeding also decreases when moving from the first cluster to the third. The gross agricultural output per capita of the region takes the greatest value in cluster 1 and varies with insignificant differences in clusters 2 and 3.

The highest power supply was in 1 cluster.

Cluster 1 included the reference agricultural regions of Russia, as evidenced by the most significant indicators of grain and legume crop yield in this group, grain sales per person employed in agriculture, marketability of grain and legume crops, and the dose of fertilizer applied to the area of agricultural crops. Regions of this cluster produce 41.0% of the total gross crop production. The strongest regions in this group are the Belgorod Region, Krasnodar and Stavropol Territories.

The 2nd cluster includes regions in which, along with crop production, livestock breeding is developed. This is confirmed by the greatest milk yield per cow among all the clusters, the largest volume of milk sold per agricultural worker and a higher level of milk marketability. The indicator of marketability of grain crops in the regions of the 2nd cluster is the smallest - 41.0%, which is explained by the need to create food supply, cultivation and allocation of land for forage crops. The cluster produces 39.8% of all gross livestock production. The regions of this cluster are characterized by a fairly high population density, so

the gross agricultural output per capita is slightly lower than in the regions of the 3rd cluster. The strongest regions of the 2nd cluster are the Republics of Tatarstan, Mordovia, Bashkortostan, Bryansk region. The dendrogram also allows to select a subcluster of the most powerful regions of this group.

The third cluster includes regions with a significant geographical location, but in which there are similar conditions and results of agricultural production. Here we can talk more about the social efficiency of agricultural production in order to provide the population of the regions with food and to develop territories. The cluster, numerous in terms of the number of regions, produces about 37% of the value of the total gross crop production and 32% of livestock production. The strongest regions of this cluster are the Republics of Adygea and Kabardino-Balkaria, the Samara region. The variety of regions included in the cluster according to climatic conditions, scales also allows to single out subclusters within the cluster, which is also demonstrated on the dendrogram.

For a complete analysis of production efficiency, it is not enough to consider only performance indicators. It is necessary to compare them with indicators of the availability of production resources. As a result, we will analyze additional indicators for clusters, the values of which are also presented in Table 2, along with the indicators laid down in the basis for dividing the population into clusters. Indicators of the capital-labor ratio and the energy-intensity ratio are most important in cluster 1 and tend to decrease when moving from group to group, which is generally consistent with economic laws. A similar pattern is observed in the indicator of the share of unprofitable organizations of agriculture.

One of the indicators of economic efficiency is the indicator of gross production in the calculation of the ruble of the value of basic production assets, the indicator of capital productivity [23]. It takes the highest value in cluster 3, where the level of efficiency of supply chain management in production is the lowest. This situation, in our opinion, is explained precisely by technical equipment, the introduction of digital technologies in agricultural production, which is developing today both in crop production - elements of precision farming systems, parallel driving, etc., and in livestock breeding - animal chipping, creation of electronic systems maintenance of animals and others. The indicator of investments in

the calculation of gross agricultural output (investment intensity) shows the introduction of these technologies. It takes the largest value in cluster 1 and the smallest - in cluster 3. Thus, there is a rise in the cost of fixed assets, a decrease in their depreciation and a share of fully worn out fixed capital, hence the decline in capital productivity, but at the same time there is an increase in the efficiency of production as a whole. This is a vivid confirmation of the need to equip agricultural production with modern technologies. Here we come to the need to develop and introduce into the methodology an analysis of the efficiency indicator of digital technologies. Perhaps this will be a transition period, therefore, it is necessary to continue this study in dynamics.

Indicators of the share of crop and livestock production by clusters take the expected values - the largest share of crop production is in cluster 1, and livestock - in cluster 2. The indicator of the share of agriculture in gross value added takes the highest value in cluster 1 - 17.2%, the smallest in the 2nd cluster - 7.8%. Regions of the 2nd clusters with the current level of efficiency and the level of livestock production, the possibility of creating and developing a sustainable food supply have the potential to develop agricultural production.

Regions of all three clusters on average tend to increase production in dynamics, which is characterized by agricultural production indices in comparable prices.

## 4. Discussion of the results

The results obtained during the study showed that cluster analysis is a fairly informative method for studying the efficiency of supply chain agricultural production. Efficiency is characterized by various indicators, so it is impossible to single out one of them, which would fully reflect the performance of the industry. Also, clustering indicators were based on performance indicators, without resource availability indicators, since resources can be used in different ways, as the results obtained demonstrated. At the same time, the allocation of clusters using various metrics, methods of combining even from a scientifically based sample does not give a clear distribution of regions in terms of the efficiency of agricultural production. The first, the best, cluster of main agricultural regions is clearly distinguished. This suggests that the process of supply chain agricultural production is

influenced by various factors operating in different directions. Further studies need to be supplemented by a study of the closeness of connection and analysis of smaller structures - subclusters, which are partially manifested in clusters.

These findings are consistent with the results obtained by other researchers [3]. It is also necessary to take into account in the analysis of efficiency indicators of environmental protection, environmental friendliness of production, supply chain production, to expand the information base of the study [1].

The evolution of the bioeconomy emphasizes the importance of designing supply chains management that use as much of the feedstock as possible, including residues and byproducts, profitably. Livestock producers use residues for animal feed, pet food, and production of materials (e.g. gelatin, bone meal). The profitability of biofuels is benefited from creative use of its residues [29].

It is necessary to continue research in order to increase the efficiency of supply chain management in agricultural production. Discussions of conference participants on agriculture and food issues suggest that economic and social sciences in agriculture will continue to face problems when it comes to resolving the conflict between resource efficiency, food production and society's expectations [30].

We view the design of a supply chain management as a constrained optimization problem. Many insights about supply chain management design can be obtained from static profit maximization problems subject to relevant constraints. For example, when an innovation is capital-intensive (e.g., a facility to process biofuels), and the entrepreneur faces credit constraints, the credit constraints may lead to heavy reliance on external suppliers, who can finance the production of the feedstock rather than produce the feedstock in-house [31]- [37].

We adhere to the same position, because in conducting research on the effectiveness of agriculture, we are confronted with a mismatch of available resources and production results.

In general, the results obtained and the conclusions drawn from them are consistent with the results of other researchers.

Analysis of various types of agricultural production efficiency shows that not all countries achieve efficiency in all dimensions [3]. The results of our study also allow us to conclude that the

performance indicators do not always change consistently, often do not have a certain pattern depending on the resource supply of the industry by region.

It is necessary to expand the information base and study the production efficiency with the use of financial ratios, which is confirmed and consistent with global studies [6]. It is always relevant (this is confirmed by the results of the study) to reduce costs and at the same time increase the output of industries [8].

The analysis revealed the need to develop an indicator to assess the effectiveness of digital technologies. Suggestions for it are also found in other researchers [11].

In general, it is necessary to further improve the information-analytical, technological, analytical support of the industry. On the basis of scientific research, directions for increasing the efficiency of agricultural production are already partially proposed: the modernization of agricultural production technologies, the creation of highly qualified information and analytical services, etc. [14].

There is a lot of research in individual regions [3, 8, 11, 18]. However, in a country that is very diverse in climatic conditions, population density, with its vast territories, in the prevailing political conditions, general research is needed, summarizing the calculations. Such studies allow us to determine the industry development strategy.

## 5. Conclusions

The analysis performed using multidimensional research methods yielded scientifically based results.

Cluster 1 includes the basic agricultural regions of Russia, which produce 41.0% of the total gross crop production. These regions are characterized by a high level of production equipment, the introduction of technological innovations, a high level of supply chain management of production and sales of crop products. In this cluster, it is necessary to place further strategic emphasis on improving the quality of products, including those for exporting grain.

1.  The 2nd cluster includes regions in which, along with crop production, livestock breeding is developed. The cluster produces 39.8% of all gross livestock production. For the regions of this cluster, it is necessary to further

implement state support measures for scientifically-based reduction of feed consumption per cattle head, create a sustainable feed base, provide technical equipment for the industry, improve product quality and marketability of products. Under the prevailing conditions of agricultural production and the provision of resources, the regions of this cluster have the potential to increase efficiency. Special attention and support should be given to a stronger sub-cluster within this group.

2. The third cluster includes regions with a significant geographical location, but in which there are similar conditions and results of agricultural production. Agriculture in this cluster has a more pronounced social orientation, which makes it possible to provide vast territories with high-quality food.

3. Taking into account the results obtained, it should be noted that vocational education in the field of agriculture should also be aimed at the development of the existing trends, the strategic development of the most effective directions for certain regions and clusters as a whole.

4. In order to improve the analysis methodology, it is recommended to use performance indicators for a greater number of types of products, taking into account the specialization of enterprises. Clusters are more precisely selected.

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