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**RATING OF AGRICULTURAL ENTERPRISES OF IRKUTSK**  
**REGION BASED ON MULTIVARIATE ANALYSIS**

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*Abstract*

The article touches upon the issues of necessary assessment of the current state of the agricultural organizations' activity in the Irkutsk region; the indicators of the organizations' financial state are analyzed, the methodology of the integrated comparative rating assessment of the economic entities' activity is improved due to the usage of the multivariate analysis in the context of monitoring both in space (that is, in comparison with other organizations) and in time (for a number of time periods). To compile the ranking, the responsive computational algorithm is used that shows the capacity of the mathematical model of the multivariate comparative analysis, namely, the comparison of the business performance of the agricultural organizations in the Irkutsk region. The method involves the calculation of the Euclidian distances that allows taking into account not only the absolute values of every organization's indicators, but also the degree of their proximity (distance) to the indicators of the organization that is regarded as a benchmark on the strength of all the evidence. The criterion of the integrated assessment of the organizations' activity is defined; it is a classification criterion when ranking high-impact and low-impact organizations. The results obtained allow comparing the organizations with each other within the definite industry, ranking them, classifying them and projecting their capacity level for the nearest future.

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**Keywords:** Multivariate analysis, rating assessment, agricultural organizations.



## **1. Introduction**

The public goals when developing the agriculture involve the efficient, successful and correct economic policy implemented to achieve the socially significant objectives in the context of the food security problems. To make the economic development of the agriculture well-balanced, the public authorities work out the integrated measures of supporting and regulating the economic entities' activity; that is why the issues of monitoring and projecting the development of the agricultural organizations' activity in the region become really topical. The notion of "monitoring" itself is of interest from the perspective of its theoretical analysis as it does not have a precise single interpretation due to the fact that it is studied and used in different spheres of the scientific-practical activity. In the author's opinion, monitoring is integration of collecting, processing, analyzing the information and interpretation of the results. If monitoring is used for practical goals, then with the usage of the multivariate comparative analysis, it is possible, on the one hand, to characterize the level and dynamics of the agricultural organizations' activity and, on the other hand, to present the comparative analysis of this development and to define the priorities of the future development of the definite organization.

## **2. Problem Statement**

At the current stage of economic development characterized by its crises, it is necessary to look for some new methods of management, new approaches to collecting, processing, analyzing the economic information about the complex research objects rapidly changing over time. International experience shows that these approaches and methods are implemented by means of monitoring supported by information technologies and computer equipment and they make the analysis of perspectives and forecasting publicly available.

## **3. Research Questions**

The scientific hypotheses formulated by the author are proved and justified by the corresponding logical and analytical conclusions. The theoretical and methodological foundation of the research is the studies of the multivariate analysis carried out by Hidalgo and Goodman (2013), Anderson (2003), Kumar, et al., (1986), Schervish (1987), euclidean distance (Linares-Mustarósa, Coendersb, & Vives-Mestres, 2018) and cluster analysis (Capece, Cricellib, & Pillo, 2010, Gupta & Huefner, 1972, Salmi, Dahlstedt, Luoma, & Laakkonen, 1986, Boillat, Skowronski, & Tuchschimid, 2002). Financial performance and distress profiles are from classification according to financial ratios relatively compositional classification.

The periodical publications and annual financial reports of the agricultural organizations of the Irkutsk region were used for analysis. On this basis, the theoretical and practical hypotheses were introduced; they are accurate, scientifically based, representative and aimed at the increased efficiency of the agricultural organizations' management in the region in the context of the current economic situation. It is possible and efficient to use the original recommendations in actual practice when managing the agricultural organizations.

#### 4. Purpose of the Study

The purpose of the study is to improve the methodology of the integrated comparative rating assessment of the economic entities' activity on the basis of the multivariate analysis in the context of monitoring that allows taking into account not only the absolute values of every organization's indicators, but also the degree of their proximity (distance) to the indicators of the organization that is regarded as a benchmark on the strength of all the evidence. The results obtained allow comparing the organizations with each other within the definite industry, ranking them, classifying them (high-impact, low-impact) and projecting their capacity level for the nearest future.

The object of monitoring is financial state and performance of the agricultural organizations of the Irkutsk region.

#### 5. Research Methods

The efficient method of the comparative analysis of agricultural organizations is the integrated rating assessment based on the multivariate analysis; it allows, on the one hand, characterizing the level and dynamics of the agricultural organizations' activity and, on the other hand, presenting the comparative analysis of this development and defining the priorities of the future development of the definite organization (Tyapkina, 2004, pp. 48).

1. The first stage involves creating the information database of the agricultural organizations' indicators and collecting these data for the retrospective analysis. Industrial specificity of the agriculture, duration of the production cycle, capital intensity of the industry influence performance indicators of the organizations. At this stage, the data of accounting financial reports of 115 agricultural organizations for 2011-2016 were collected.

2. The second stage includes the correlative analysis according to which  $n$  indicators for each of  $m$  compared agricultural organizations are calculated, where:  $i = 1, 2, 3, \dots, m$ ;  $j = 1, 2, 3, \dots, n$ .

In order to assess the performance of a company, the financial ratio analysis is a fundamental starting point (Schönbohm, 2013, pp. 21). All the indicators were checked for multicollinearity (strength of relationships with each other) and the indicators influencing each other in the least way were defined: bank-liquidity ratio, equity ratio, costs return ratio, market share. These selected ratios are extremely informative, consistent, have the same orientation (positive correlation, that is, the growth of the ratio means the improvement of the state), the numeric ratios of the minimal satisfactory level or of changes rate are calculated only on the basis of the public accounting of organizations and give the possibility to rank them both in space (that is, in comparison with other organizations) and in time (for a number of time periods). It is an important means of assessing past performance and in forecasting and planning future performance (Ravinder & Anitha, 2013).

For each indicator, the best and the worst values were defined and assigned, correspondently, to the best ( $m+1$ ) and to the worst ( $m+2$ ) reference organizations. The obtained data were standardized according to their relation to the difference between the best and worst values of the corresponding indicators, where  $Di,j$  are standardized indicators of  $i$  organization [ $0 \leq Di,j \leq 1$ ], which define the rate of  $j$ -indicator deviation from the reference (best) one, expressed by ratios of the difference between the best and worst values in the group of compared organizations;  $Pi,j$  are financial indicators  $j$  reflecting the business performance of  $i$ -

organization. For each (*i*) of the compared organization, the rate of its deviation from the reference is defined, where *Rdi* is a rate of the deviation of *i* compared organization from the reference.

3. The third stage involves the classification of organizations via cluster analysis methods, that is, the set of organizations is divided into groups depending on their financial state; the average values of indicators in every group are defined. Then ranking of the compared organizations is carried out: the highest rank is attributed to the organization having the maximum value, where *Ri* is an integrated comparative rating assessment, *Rd(m+1)* and *Rd(m+2)* are the best and the worst rates of deviation in the group of compared organizations.

4. The fourth stage includes the rating assessment of organizations according to their financial state during several (six) years, where *Rai* is the distance of the results of the *i* year from those of the reference (best) period.

5. The fifth stage involves forecasting the organizations' rating. With the knowledge of the auto-rating dynamics, it is possible to describe it via the first-order regression equation, where *Ra* is the organization's auto-rating for every year when comparing the results of one organization for several years; *K* is a regression ratio characterizing the average annual growth rates of the organization; *T* – serial number of the analyzed period; *C* – initial ordinate of the regression equation. Then sustainability of an increase is assessed; it takes into account the entire set of indicators on the basis of residual variance of auto-rating, where *Rari* is the value of auto-rating for *i* year calculated from the regression equation:  $Rari = KT_i + C$ , *T* – the number of years of the organization's monitoring (Tyapkina, 2004, pp. 48).

Assessment of the sustainability of functioning and development of the agricultural organization in the context of the negative influence of natural, economic and political processes is of importance. It implies that the organization's financial state is not sensitive to the fluctuations of the natural-climatic and market conditions. Sustainability is assessed via the indicators variance calculated for several years (2011-2016). The less the variance is, the higher the sustainability of the organization's performance is. If one does not take into account the sustainability of the average annual increase rates, the differentiation of the agricultural enterprises can be done using two criteria and four groups: high-impact (low-impact) with positive and negative average annual rates of growth.

Regarding all the above-mentioned conditions, the mathematical model of assessing the financial state is developed.

$$\left\{ \begin{array}{l} D_{i,j} = (P_{m+1,j} - P_{i,j}) / (P_{m+1,j} - P_{m+2,j}) \\ Rd_i = 10 \sqrt{D_{i1}^2 + D_{i2}^2 + \dots + D_{in}^2} \\ R_i = (Rd_x - Rd_i) / (Rd_x - Rd_n) * 100 \\ Ra_i = (1 - Rd_i / 100) \\ D = \sum_{i=1}^N (Ra_i - Rari [KT + C])^2 / N \\ \dots\dots\dots \\ (m+1) \max \text{ и } (m+2) \min \\ P_{i,j}, \text{ where } i = 1, 2, 3, \dots, n \\ [0 \leq D_{i,j} \leq 1] \end{array} \right.$$

Criteria values for different groups of organizations located in the corresponding octants are shown in Table 01.

**Table 01.** Limits of the indicator values for different groups of agricultural organizations

Criterion	Groups of Organizations			
	1	2	3	4
	High-impact with positive average annual rates of growth	High-impact with negative rates of activity	Low-impact with positive rates of growth	Low-impact with negative rates of activity
$R$	$>Rz$	$>Rz$	$<Rz$	$<Rz$
$K$	$>0$	$<0$	$>0$	$<0$

$$R=Rz; K=0,$$

where  $Rz$  – a criterion of the integrated assessment of the financial state in the group of compared agricultural organizations.

Given that the public support of the agriculture in the Irkutsk region involves the development of the favorable conditions for the agricultural organizations (including economic ones), endogenous (calculated) and exogenous (forecasting) indicators were included in the methodology.

One of the methods of avoiding uncertainty related to the imprecise knowledge of the limits of the possible performance of the agricultural enterprises when differentiating them is implementation of the indicators of state. These indicators include the common parameters of performance state of the agricultural organizations which have the well-known values. Going beyond these values causes the instability and the possible shift to another quality or it may lead to the dissolution. A certain value of an indicator can mean a positive activity for a certain company, but a negative activity for another. A pertinent diagnosis can be made only after analyzing as many financial indicators as possible, for multiple periods and when there is a standard to which one can report to (Suciu & Barsan, 2013). The analysis of the economic literature concerning innovative activity of the enterprises considering a risk component showed that nowadays there is no uniform interpretation of such concepts as the innovative activity risks, the efficiency of innovations considering the risks, the life cycle of innovations in the presence of a risk. In its turn, it does not allow defining more effective ways of the enterprises innovative activity risks management for the purpose of their minimization and neutralization, and directed to the improvement of the economic stability of the enterprises engaged in an innovative activity as a whole (Nechaev & Prokopyeva, 2014).

To define the industrial peculiarities, the following indicators were used: ratios indicating the organization's inability to pay, such as ratios of bank-liquidity and availability of the own working capital (given that during the correlative analysis these indicators have the high degree of interrelation, the ratio of availability of the own working capital is excluded from the further calculations); equity ratio that is sensible to the industrial peculiarities of the agricultural companies' activity and characterizes the different stages of crisis; costs return ratio as a lot of agricultural organizations have the negative financial result (losses) (Tyapkina, 2007).

Thus, it is enough to use only several indicators to assess the economic terms of the agricultural organizations' activity; if the additional indicators are taken into account, the multivariate analysis becomes more complicated.

## 6. Findings

The set of the studied objects included the collective agricultural organizations of any ownership form of the Irkutsk region, as they defined the trends of economic development of the regional agriculture. Later, auto-rating was calculated for every organization, that is, its performance rating for the last six years.

The basic indicators of the agricultural companies' activity have characteristic values of the definite indicators recognized in the scientific literature. In order to implement the public valid and task-oriented policy aimed at supporting the regional agricultural organizations, it is necessary to differentiate the following set of the studied organizations on the grounds of the development indicators:

Group 1. High-impact and developing organizations which have rather high economic indicators and positive annual growth rate.

Group 2. High-impact organizations having the negative rates of performance. Their results may be high, though a bit decreased during the last years.

Group 3. Low-impact but developing organizations which have rather low economic indicators but positive annual growth rate.

Group 4. Low-impact organizations which have the negative rates of performance; they have rather low economic indicators and decreasing rates of performance.

In the author's opinion, the development of the criterion  $Rz$  allows tracing the differences between the high-impact agricultural enterprises (which ensure the expanded reproduction) and low-impact ones (which have simple and contracted reproduction). So another reference organization  $m+3$  with the normal  $n$  restrictions is included in the initial set: bank liquidity ratio = 2; equity ratio = 0.5; costs return ratio = 1.25; market share = 0.01 (average per totality). The criterion of the integrated comparative rating assessment of the reference organization equaled  $R = 48.76$ ; the regression ratio characterizing the average annual rates of its performance was  $K = 0.004$ . The agricultural enterprises that had the indicators higher than the value of the integrated comparative rating assessment ( $R = 48.76$ ) were categorized as Group 1 or Group 2. If the indicators were lower, they were classified as Group 3 or Group 4. The agricultural organizations having the regression ratio (that characterizes the average annual rates of the organization's growth) higher than  $K = 0.004$  were classified as Group 1 or Group 2. If the ratio was lower, they were classified as Group 3 or Group 4.

Group 1 included 50% of the high-impact and developing agricultural organizations with 12.56% return on costs; they had rather high economic indicators and positive average annual rate of growth. The enterprises of this group continue to perform their production activity and improve the indicators. The following organizations were included in the group: Belorechenskoye PJSC, Parizhskoye LLC, Sayanski Broiler LLC, Agrosmolenskoye LLC, Angarskaya Ptitsefabrika CJSC, Okinsky PC, Angara LLC, Bolsheelanskoye JSC, Zheleznodorozhnik CJSC, Usolski Svinokompleks PC and others. These organizations' revenues were 19777 mln roubles and gains – 1846 mln roubles in 2016.

Group 2 was introduced by 2.5% of the high-impact organizations with the negative rates of performance. They might have high results that decreased during the last years. They still remain high-impact with 10.1% return on costs: Alarskaya MTS LLC, Maiskoye CJSC, Rassvet LLC. These organizations' revenues were 78 mln roubles and gains – 11 mln roubles in 2016.

Group 3 included 39% of the low-impact but developing agricultural organizations of the Irkutsk region that had rather low indicators with the positive annual average rate of growth. Their return on costs was 0.06%: Irkutskie Semena CJSC, Barki LLC, Sibirskaya Niva PJSC, Bratskaya Ptitsefabrika CJSC, Tyretski PC, Urozhai LLC and others. These enterprises' revenues were 2503 mln roubles and gains – 3.6 mln roubles in 2016.

Group 4 comprised 8.5% of low-impact agricultural organizations with the negative rates of performance; they had rather low economic indicators and decreasing rates of performance with 98.5% return on costs: Kompleks Zverevo LLC, Verkholskoye LLC, Kimiltei CJSC, Dalnyaya Zakora MAP, Selkhozstanar LLC, Zaslavskoye LLC, Krasoyar LLC, Buzykanovskoye MUE, Berezovskoye LLC, Sheragulskoye LLC. These enterprises' revenues were 155 mln roubles and losses – 2 mln roubles in 2016. These organizations are important for the regional economy but they require special concern of the public, as they have experience of agricultural activity, create job opportunities for rural people, give support to private farms (rural people buy feeding stuff, calves and they need veterinary services).

The agricultural development of the region is carried out in accordance with the public program of the Irkutsk region “Development of Agriculture and Regulation of Markets of Agricultural Products, Raw Materials and Food” for 2014-2020 approved by Irkutsk region government decree № 68-pp of 9 December 2013. In the agro-industrial sector, the measures of the public support of the agricultural producers are developed and implemented. They are aimed at solving problems of technical re-equipment and modernization of the agricultural production, ensuring the food security of the Irkutsk region and creating job opportunities for the population.

Experience shows that the implementation of the investing projects in the agro-industrial sector in 2011-2016 gives positive feedback when supported by the regional budget of the Irkutsk region. The Ministry of Agriculture selects the economically significant projects in agriculture where agro-industrial economic entities develop and implement investing projects of growth in the context of these subsidies; the projects are assessed by the government in accordance with the target indicators of the development sub-programs. Thus, during the previous years due to the implementation of investing projects, more than 1500 workplaces were created, tax payments and insurance premiums to non-budget funds increased three times, the volumes of production and sales of agricultural goods became higher.

In 2016 there was selection of economically significant investing projects in the field of agricultural development of the Irkutsk region. At the early stage, the selection of the agricultural enterprises that are going to take part in the contest was performed. At the next stage, the agricultural enterprises presented their projects in accordance with the requirements. Then the projects were assessed; some of them were selected for receiving the public support. It is necessary to note that the selection comprised several aspects: production of milk, crop, bovine meat, vegetables, rape, porcine as well as sheep and goat breeding, drove breeding of horses and creation of agricultural cooperation.

The agricultural companies took part in several contests related to different public grants and subsidies. As they presented several projects at one time, they totally had higher financing because on the basis of monitoring they were considered high-impact and developing organizations having rather high economic indicators and positive annual growth rate. That allowed forecasting their perspectives. So on the basis of the rating assessment, Belorechenskoye PJSC was classified as Group 1 and had great potential for the implementation of several (four) investing projects simultaneously: production of milk, bovine meat, field vegetables and rape. Urozhai LLC was categorized as Group 3 as a low-impact but developing company having rather low indicators with positive annual growth rate. This organization has insufficient financial, technical, technological resources; that is why, it can apply for the public support of one economically significant project.

Competitive selection of the investing projects was carried out with regard to the organization's ranking concerning several criteria: the rates of growth of agricultural production (Fig. 02) and of the average monthly wage, the quantity of new workplaces, payback period, share of the own capital, return on costs, efficiency of tax payments and contributions from one rouble of the invested budget funds.

As a result of the selection, the proposed projects received high final weighted average scores and got the public support in the form of grants and subsidies. When selecting projects, one of the important factors was taken into account: investing projects were analyzed and selected regardless of the size of the organization.

Every economically significant project got the great share of the target financing for 2016. So in Belorechenskoye PJSC, 130813 ths roubles from the budget funds (out of 213592 ths roubles) were given to the project of milk production, and to the meat production project – 30172 ths roubles out of 70800 ths roubles.

The result of implementation of economically significant projects by Belorechenskoye PJSC will be as follows: the gains will increase to 80 mln roubles or 10.2%. The acreage share of oil plants (rape) will increase from 500 ha to 110 ha (2.2 times) and the company's acreage will equal 28.6% of the total rape acreage in the Irkutsk region. The volume of vegetables production will increase 1.6 times including through the higher yield (24.8%). The company will produce 50% of the vegetables grown by all agricultural companies of the Irkutsk region. In meat production, the reduction of the prime cost is projected (4.2%) due to ensuring the upload of the production processing capacities. In milk production, there will be renewal of the number of breeding stock and an increase of cows' productivity from 6575 kg to 7177 kg or by 9.2%.

## 7. Conclusion

Therefore, the research of auto-rating in the context of multivariate analysis allows, on the one hand, characterizing the level and dynamics of the agricultural companies' state and, on the other hand, presenting the comparative analysis of this development, as well as defining the priorities of the further development of the definite enterprise. In the end, the multivariate analysis of the economic entity's activity has the main function – it determines the reserves of efficiency increase, potential of the organization's economic growth. Thus, it should be mentioned that unbiased assessment of the financial activity is of high importance not only for improving the state of the definite company but of the entire economy.

In case of practical application of monitoring as a system of observing, analysis and assessment of activity, one can get complete information about the economic performance of the organization and define the current problems.

In the author's opinion, the practical application of the research results will influence the development and improvement of the organizations' activity in a positive way. The results allow comparing the agricultural organizations with each other within the industry, ranking them according to the degree of their financial stability, classifying them on a reasonable basis and projecting their capacity level for the nearest future.

The integrated comparative rating assessment is necessary for the organizations themselves as it allows defining the possibilities of their improvement or decline, current trends, changes of the external environment of the company, minor adjustments of the internal policy without attracting significant external investments. However, it is also important for the public authorities implementing the agricultural policy, for instance, for selecting organizations that can be included in the regional investing programs, low-interest loan programs, as well as in programs of the prior development of the regionally important productions, debt restructuring, social support, support of development of alternative occupations in socially disadvantaged areas, etc.

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