Statistical analysis as a management tool of AIC innovative development

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Abstract. In the agro-industrial complex (hereinafter AIC), innovative development is manifested in the introduction of new technologies for processing agricultural products, the use of elite sowing materials, the use of unconventional, yet efficient management practices, high-tech technology and equipment, and in the use of intangible assets in all their forms. However, the introduction of innovations in agro-industrial complex has its own specificity related to the heterogeneity of the vast territory of the country. The Russian Federation is characterized by the heterogeneity of regions in the area of socio-economic, climatic and geographical factors, which imposes its imprint on the development of national agro-industrial complex. In this article we will present the results of a statistical study of Russia's agriculture development level depending on its territorial location in order to further develop recommendations on optimal investing in innovative development of a specific direction.

1 Introduction

Opportunities for innovation in agro-industrial complex are wide because it includes several interrelated activities that perform certain technological and economic functions and differ in the type and the purpose of products, requirements for staff qualifications, means of production, necessary resources, technologies and other characteristics. In the context of the national project implementation for the agriculture development with strong state support, effective spending of both budget and private investment for innovation has a significant impact [1]. With this background, the role of statistical studies that allow to cluster the agro-industrial complex of the country on certain signs, to analyze and reveal the close connection between its territorial location and financial results of activities, identify opportunities to invest in innovation, predict the results of returns [2].

2 Materials and methods

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The public data of the State Statistics Service of the Russian Federation for 2005-2018 are used as materials [3]. Methods: Cluster analysis by Nearest Neighbor, Far Neighbor, Centroid, Median method, Group Mean and Ward, Grouping, Analysis, Benchmark.

3 Results and discussion

For research of agro-industrial complex development level of the Russian Federation regions, interspecies assessment of the management efficiency level was used. As a key factor determining the state of agro-industrial complex of the region, we have selected shipment of goods of own production, showing the degree of its development in absolute expression. The regions rating construction is made on the basis of a number of relative indicators characterizing the level of agro-industrial sector development of the region and its potential for further agro-industrial segment development in the region [4] . To weigh the influence degree of the investigated factors, they were divided into 5 groups, each of which has a certain weight based on expert assessments of the National Rating Agency. The study groups of factors included: 1) labor resources of the region (weight — 17.3%); 2) regional infrastructure (weight — 20.0%); 3) market volume (demand potential) (weight — 22.7%); 4) production potential of the regional economy (weight - 21.3%); 5) financial stability of the regional budget and enterprises of the region (weight - 18.7%) [5]. In order to bring of all studied indicators in absolute terms to the relative appearance, weighting on the number of employed in segments of agro-industrial complex in the region per 1 cash resident in the region per 1 ruble of gross regional product was applied, depending on the nature of indicator [6]. In order to bring the type indicators of agriculture, food and processing industry to an integrated form, the weighting of the investigated factors on the volume of own-produced shipped products by activities of the regional agro-industrial complex was performed. Thus it was revealed that during the whole period the production and shipment of agricultural products has clearly expressed regional and demographic specificity. In 2005, enterprises of the Central Federal District shipped products of their own production in the amount of 612.0 billion rubles, i.e. 35.8% of the all-Russian shipment; enterprises of the North-West Federal District -261.0 billion rubles of AIC products (15.3%), Volga Federal District shipped products for 302.2 billion rubles or 17.7%; Southern Federal District -214.6 billion rubles or 12.6% of of all-Russian significance. The share of the remaining federal districts is less than 10% [7]. That is, the trend has become noticeable that the share which the federal district takes in the total volume of agricultural products shipment depends primarily on the population size, its solvency. A large population and a high proportion of the middle class are the key to the successful development of AIC enterprises in the region.

In the next phase of the study, cluster analysis was conducted by various methods on the factors mentioned above. The following were applied: cluster analysis using the method of nearest and far neighbor, centroid, median, group mean, and Ward. The results of the latter method should be emphasized. The essence of Ward's method is to construct a cluster structure with minimal increase in intergroup dispersion [8]. The number of "migrating" regions during the construction phase is 5%. The optimal number of clusters considering the distance between them, taking into account feature migration and simplicity of construction is 5. Moreover, Ward's method shows the greatest distance between clusters. Following the results of the construction, a model of 5 clusters was obtained, where the 1st group of regions was the leaders in the development of agro-industrial complex, and the 2nd group was the subjects of the Russian Federation with an average level of AIC development, as well as regions not having potential in this segment. Cluster 4 includes

regions that have neither developed agro-industrial complex nor potential in this segment, but show relatively high indicators of budgetary provision (Kaliningrad region is also referred to this group, yet inconsistently), group 5 consists mainly of regions of the Southern and North Caucasus federal districts, which are not characterized by high indicators of the level of AIC development, but have certain prospects in this direction (table 1, abbreviations in in table 1: oblast - obl., Republic - Rep., Krai - kr.). It was not possible to carry out further analysis using this regional structure (Table 1) in view of the clusters presence consisting of too heterogeneous regions, the reason being an inadequate set of features, largely having multicollinear properties of a set, therefore it is necessary to select the most informative ones among the traits. The research was continued with structurizing ratings. Based on the comparison results of ranking different ways of Russian Federation subjects, the most qualitative assessment was shown by the method developed by RAEX-Analytics publishing house, adapted for the system indicators of agro-industrial complex. It provided a system of indicators showing the best results in minimizing deviations from the "benchmark" [9].

Table 1- Cluster structure of regions of the Russian Federation, built by Ward Method by 32 factors

Region	cluster	Region	cluster	Region	cluster
Belgorod obl.	1	Murmansk obl.	2	Irkutsk obl.	2
Bryansk obl.	1	Novgorod obl.	2	Kemerovo obl.	2
Vladimir obl.	1	Vologda obl.	2	Novosibirsk obl.	2
Kaluga obl.	1	Volgograd obl.	2	Omsk obl.	2
Kursk obl.	1	Rep. of Dagestan	2	Tomsk obl.	2
Lipetsk obl.	1	Stavropol kr.	2	Primorsky kr.	2
Moscow obl.	1	Rep. of Bashkortostan	2	Khabarovsk kr.	2
Smolensk obl.	1	Rep. of Mari El	2	Amur obl.	2
Tambov obl.	1	Rep. of Mordovia	2	Moscow city	3
Tver obl.	1	Udmurtia	2	S aint Petersburg city	3
Vologda obl.	1	Chuvashia	2	Kaliningrad obl.	4
Leningrad obl.	1	Perm kr.	2	Rep. of Sakha (Yakutia)	4
Pskov obl.	1	Kirov obl.	2	Kamchatka kr.	4
Krasnodar kr.	1	Orenburg obl.	2	Sakhalin obl.	4
Rostov obl.	1	Penza obl.	2	Rep. of Adygea	5
Rep. of Tatarstan	1	Samara obl.	2	Rep. of Crimea	5
Nizhny Novgorod obl.	1	Saratov obl.	2	Sevastopol city	5
Ivanovo obl.	2	Ulyanovsk obl.	2	Rep. of Ingushetia	5
Kostroma obl.	2	Kurgan obl.	2	Kabardino-Balkarian Rep.	5
Oryol obl.	2	Sverdlovsk obl.	2	Karachay-Cherkess Rep.	5
Ryazan obl.	2	Tyumen obl.	2	Rep. of North Ossetia Alania	5
Tula obl.	2	Tyumen obl.	2	Astrakhan obl.	5
Yaroslavl obl.	2	Chelyabinsk obl.	2	Chechen Rep.	5
Republic of Karelia	2	Rep. of Buryatia	2	Rep. of Altai	5
Komi Republic	2	Altai Krai	2		
Arkhangelsk obl.	2	Krasnoyarsk Krai	2		

The minimum deviation from the benchmark according to this method of rating construction was 452 points, while the minimum error of scoring was 609 points, and the weight rating - 672 points (tab. 2).

Table 2- Comparison of regions rating calculation methods by AIC development level according to data of 2018, score

Region	RAEX rating	Deviation from the benchmark	Region	RAEX rating	Deviation from the benchmark
1	2	3	4	5	6
Kostroma obl.	52	11	Udmurtia	19	11
Orenburg obl.	53	8	Tula obl.	20	4
Rep. of Dagestan	54	6	Oryol obl.	21	16
Ivanovo obl.	55	4	Sverdlovsk obl.	22	3
Irkutsk obl.	56	10	Saratov obl.	23	5
Tyumen obl.	57	19	Ryazan obl.	24	10
Ulyanovsk obl.	58	1	Altai Krai	25	8
Yaroslavl obl.	59	10	Chelyabinsk obl.	26	10
Rep. of Crimea	60	12	Smolensk obl.	27	24
Kurgan obl.	61	0	Novosibirsk obl.	28	8
Karachay-Cherkess Rep.	62	0	Volgograd obl.	29	2
Chuvashia	63	8	Kaluga obl.	30	3
Sevastopol city	64	10	Pskov obl.	31	0
Continuation of table 2					
1	2	3	4	5	6
Rep. of Komi	65	1	Bryansk obl.	32	6
Arkhangelsk obl.	66	1	Tver obl.	33	1
Khabarovsk kr.	67	1	Rep. of Bashkortostan	34	9
Rep. of Karelia	68	1	Krasnoyarsk kr.	35	0
Arkhangelsk obl.	69	4	Kemerovo obl.	36	3
Murmansk obl.	70	0	Omsk obl.	37	9
Rep. of Khakassia	71	0	Rep. of Mari El	38	4
Rep. of Buryatia	72	6	Samara obl.	39	17
Astrakhan obl.	73	2	Sakhalin obl.	40	13
Rep. of Altai	74	3	Primorsky kr.	41	2
Zabaykalsky kr.	75	1	Kabardino-Balkarian Rep.	42	16
Rep. of Sakha	76	3	Tyumen obl.	43	1
Nenets AO	77	4	Rep. of Adygea	44	12
Khanty-Mansi AO	78	0	Novgorod obl.	45	2
Rep. of North Ossetia	79	7	Vologda obl.	46	6
Chechen Rep.	80	1	Amur obl.	47	3
Rep. of Kalmykia	81	1	Kirov obl.	48	7
Chukotka AO	82	1	Perm kr.	49	13
Yamalo-Nenets AO	83	3	Kamchatka kr.	50	2
Magadan obl.	84	3	Tomsk obl.	51	3
Rep. of Tuva	85	1	**Subtotal**	-	452
Rep. of Ingushetia	86	1	Leningrad obl.	1	6
Jewish Autonomous obl.	87	1	Saint Petersburg city	2	3
Moscow city	8	6	Moscow obl.	3	2
Nizhny Novgorod obl.	9	3	Voronezh obl.	4	2
Kaliningrad obl.	10	0	Krasnodar kr.	5	1
Vladimir obl.	11	4	Belgorod obl.	6	3
Tambov obl.	12	9	Lipetsk obl.	7	2
Kursk obl.	13	2	Stavropol kr.	16	3
Rostov obl.	14	0	Rep. of Tatarstan	17	9
Rep. of Mordovia	15	8	Penza obl.	18	11

The single-factor model of labor productivity showed a deviation from the benchmark of 1392 points, thus, labor productivity is not a sufficient factor to analyze the level of regional AIC development. The model based on the RAEX-Analytics system provides the number of regions with a deviation within three ranks from the position of the similar region in the benchmark model for 46 regions, and the model based on the point system - only for 32 regions. There is a noticeable coincidence of the trend in the RAEX-analytics model ranks on the basis of qualitative factors and rating of regions on the total shipment of AIC products, built on the basis of quantitative factor; and in the point model, the deviation of regions levels from the benchmark is rather chaotic (Table 2). Comparison of the obtained results with the reference rating of regions shows that the main factor predetermining the high level of regional AIC development is the shipment of own production products per 1 employed in the AIC. Labour productivity is a key factor in the intensive development of the national economy, it reduces the share of wages weight in the unit price, which entails wage growth, increases investor interest in the industry and enhances opportunities for innovation implementation. Among the regions that have a high level of labor productivity in AIC, there are no regions where the main producing segment is agriculture. Thus, the main driver of high level of labor productivity is the development of high value-added production (processing industry). Such products are divided into the production of tobacco products (Leningrad region (14.3 million rubles per 1 employed) - the leader of the indicator at the expense of tobacco factory Philip Morris, the shipment of tobacco products which in 2017 amounted to over 35% of the All-Russian), as well as the city of St. Petersburg (10.1 million rubles per 1 employed) (at the expense of tobacco factories Bat-SPB, Petro, Nevo tobacco) — about 50% of the all-Russian shipment, the production of beverages — city of St. Petersburg (10.1 million rubles), Nizhny Novgorod region (7.0 million rubles), Moscow region (6.1 million rubles), Kamchatka Krai (3.3 million rubles). Companies from these regions shipped over 50% of beverages in 2107. Production of food products amounted to - Moscow city (4.0 million RUB), Kaliningrad region (6.3 million RUB), Vladimir region (5.8 million RUB), Kamchatka Krai (3.3 million RUB). *Equally important* indicator is stock returns, which is closely related to productivity. The largest stock returns are observed in export-oriented regions, where the most of shipped products are food: Kaliningrad region and St. Petersburg city (3.7 RUB per 1 RUB of fixed assets, hereinafter FA), Primorsky Krai (3.4 RUB per 1 RUB. FA), then goes Vladimir region (3,3 rubles), Republic of Udmurtia, Tver region and Moscow city (3.2 rubles) [3]. The most cost-effective direction of food sales is export through sea transportation reducing logistical costs. We note that the level of stock returns is distributed across regions fairly evenly. *The next factor* characterizing the agricultural development level of the subject of the Russian Federation is the food self-sufficiency coefficient, showing how own needs of the region for basic food products (grain, meat, milk, potatoes, vegetables, eggs and fruits) are satisfied at the expense of local producers. In the calculation of this indicator, the distance of the region from the main transport hubs has weight, since cheaper logistics give imported products more competitive advantages and vice versa. In terms of food self-sufficiency integral level, the highest rating is the Republic of Mordovia, the subject fully provides itself with all necessary types of food (157.7%) excluding fruit (54%). High level of self-sufficiency is observed in Kabardino-Balkarian Republic (132.4%); overproduction of fruits (236.5%) is noted in the region, but the region is not able to fully self-support itself in eggs (98.2%), potatoes (87.1%). Next go the oblasts of: Lipetsk (124.6%), Volgograd (121.8%) and Tyumen (without autonomous districts) (120.4%).

An important role is played by the share of overdue liabilities in the AIC, characterizing the liquidity of enterprises and being an indicator of its economic condition. In most regions

the indicator does not exceed 10%, in regions that differ by large quantity of shipped AIC products the indicator is 0 (Belgorod, Kaluga, Lipetsk and other regions). *The next indicator* is the volume of shipped products per 1 ruble of investment (investor return). The highest investment return was shown by regions where the food and processing industry occupies a large share of the AIC shipment, or regions with increased yields, considering that crop production is the most highly profitable activity after the production of tobacco products — Belgorod oblast (19.9 RUB/1 RUB), Moscow oblast (18.4 RUB/1 RUB), Krasnodar Krai (9.9 RUB/1 RUB). *An important indicator* is the return per 1 ruble of state support for agriculture, the only indicator which in the rating is directly related exclusively to rural economy. First in the ranking are Moscow (the indicator is taken according to the calculation of the city of St. Petersburg) and St. Petersburg city (45.9 rubles per 1 rubles of state support). Such a high level of return on state support is associated with the high level of solvent demand in the region, as well as the high profitability of investment direction (production of eggs, fruits, vegetables), similar situation is also in the Leningrad (27.5 rubles) and Moscow (20.9 rubles) oblasts, which is connected with their solvent main markets (cities of St. Petersburg and Moscow). Next are the main agricultural regions with high fertility level and high quality cattle — Krasnodar Krai (26.8 rubles), Belgorod (24.5 rubles), Lipetsk (19.9 rubles) oblasts. Last are indicators related to solvent domestic demand. The main indicator that characterizes negatively the domestic consumption is the proportion of the population with an average per capita income below the subsistence wage. Among the regions with the lowest proportion of poor population are all regions with highly productive agricultural complex and high levels of yield — Republic of Tatarstan (7.7%), Belgorod oblast (7.9%), Moscow oblast (8.1%), Lipetsk oblast (9.0%), Krasnodar Krai (11.6%). For comparison — Irkutsk oblast (20.0%), Chechen Republic (20.6%), Krasnoyarsk Krai (18.7%) and others. *The latest indicator* characterizes the rate of inflation on food products. In most of the agricultural regions, the price of products has hardly changed — Krasnodar Krai (100.6%), Belgorod oblast (100.5%), Republic of Tatarstan (101.3%), Lipetsk oblast (101.4) %). For comparison — Kaliningrad oblast (106.9%), Republic of Kalmykia (105.1%), Tyumen oblast (without autonomous districts) — 103.6%. Consequently, the balance of supply and demand in the most agrarian regions is fairly stable and does not require government interventions, subsidies and fiscal support measures to stabilize prices and has wide opportunities for innovation.

4 Conclusion

It is revealed that the budget provision of the region and infrastructure features have a slight impact on the regional AIC development level and the introduction of innovations. Since the export of natural resources is critical in Russia, and the specificity of the tax legislation allows the use of a significant part of the proceeds in the interests of regional budget, there is a situation that regions with the highest level of budgetary provision in addition to large urban agglomerations become regions of Siberia, the Urals, in which the AIC development is difficult due demographic and climate characteristics [10] . These regions can become leaders of AIC innovative development, as there are all necessary prerequisites for this.

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