International Journal for Quality Research 13(4) 947–966
ISSN 1800-6450

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Article info:
Received 06.06.2019
Accepted 27.08.2019

UDC – 005.6
DOI – 10.24874/IJQR13.04-14

QUALITY MANAGEMENT IN THE AGRO-INDUSTRIAL COMPLEX ON THE BASIS OF TERRITORIAL-SECTORAL PLACEMENT AND SCIENTIFIC & TECHNICAL DEVELOPMENT

Abstract: *The article seeks the goal of studying the modern experience of quality management in the AIC in view of the distinguished categories of countries and approaches and developing a scientific concept of quality management in the AIC according to the regulation approach, which allows for high level of national food security. For studying the modern experience of quality management in the AIC the author uses the method of regression analysis, and the resulting variable is the index "Quality and safety", which is calculated within the Global Food Security Index. Also, analysis of variation and correlation and scenario analysis are performed. It is determined that countries that do not specialize in the AIC (e.g., Singapore, Ireland, the UK, and the USA) use the deregulation approach to managing the quality of products in the AIC. Though in 2018 there was high quality of the AIC products in these countries, the deregulation approach does not allow guaranteeing preservation of the achieved quality in the long-term. In countries that specialize in the AIC (e.g., Albania, Republic of Moldova, North Macedonia, and Montenegro) use the regulation approach, which ensures high manageability of quality of products in the AIC. However, the level of quality of these products in 2018 was low. It is substantiated that the optimal scenario is the one envisaging the systemic quality management in the AIC on the basis of the territorial-sectoral placement and scientific& technical development. For the most effective practical implementation of the regulation approach in the countries of the both categories, a scientific concept of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development, which allows ensuring high level of national food security, was developed.*

Keywords: *Quality management; Agro-industrial complex (AIC); Territorial-sectoral placement; Scientific & technical development.*

1. Introduction

Adoption of the global goals in the sphere of sustainable development stimulated the reconsideration of the paradigm of provision of national food security. According to the previous paradigm, it was treated as provision of population with food products. The new paradigm envisages consideration of national food security through the prism of the economic system's ability for independent provision of domestic needs for

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food products and through the prism of quality (benefit) and security of these products for human health.

The key condition of provision of national food security according to the new paradigm is high quality of products of the agro-industrial complex (AIC). That's why a current task on the path of transition to the new paradigm is development of a scientific concept of quality management in the AIC, which allows ensuring high level of national food security. An important aspect during development of this concept is consideration of specifics of the AIC in the modern economic systems, which could be classified according to the criterion of the role of the AIC in the national economy. Two categories of countries are distinguished.

The first category includes the countries that do not specialize in agriculture; the AIC in these countries develops only for provision of national food security. As a rule, they do not have competitive advantages in agriculture and are peculiar for industrial (with foundation on industry) and post-industrial (with foundation on the service sphere) economies. Import of agricultural and other food products for them is often more effective than organization of own production of these products. From the positions of the new paradigm, it is very difficult for them to ensure national food security, as the development of own AIC contradicts the idea of rationalization of economic activities and reduces its effectiveness.

The second category includes the countries that specialize in agriculture and in which the AIC is an important structural element of GDP. They have competitive advantages and manufacture agricultural and other food products not only for satisfying the domestic demand but also for conducting foreign economic (export) activities. Provision of national food security according to the new paradigm harmonizes with their interests of maximization of effectiveness of economic activities, as development of own AIC is rational for these countries.

Both categories of countries could use for quality management in the AIC the deregulation approach or the regulation approach. According to the deregulation approach, the state has minimum interference with the market processes and uses indirect methods of quality management in the AIC: adoption and control over observation of national standards of agricultural products (including its marking and certification of quality), propaganda of healthy living and healthy food, and stimulation of corporate responsibility of the AIC companies.

The advantage of this approach is low load on the state budget and high effectiveness of sectorial markets of the AIC. At the same time, a serious drawback is low manageability of the AIC and impossibility to guarantee high quality of agricultural and other food products. High scatter of the AIC companies on the territory of a country complicates control of quality of the manufactured products. Also, the low level of scientific& technical development set before the AIC company a choice between high efficiency and high quality, and efficiency is more preferable for them from the commercial positions, as it ensures higher profit.

The regulation approach offers large state interference with the activities of companies in sectorial markets of the AIC with the usage of direct methods of quality management. One of these methods is optimization of the territorial-sectoral placement of the AIC companies. The essence of this method consists in concentration of companies of the same sphere or adjacent spheres (e.g., agricultural manufacturers, companies of the agricultural machine-building, and suppliers of fertilizers) on the same territory with the possibility of creation of favourable conditions for economic activities and cooperation, with simplified control over the quality of the issued products.

Optimization of territorial-sectoral placement of the AIC companies could be aimed at reduction of territorial gap between production and consumption of agricultural and other food products. This allows reducing the risks of supply of these products and reducing the transport and logistics costs, including costs of transportation and storing of products (as a rule, perishable) and losses due to products' damage (reduction of quality).

Another perspective method, which is applied within the regulation approach, is scientific & technical development of the AIC. Modernization of equipment and transition to better technologies allows the AIC companies to show high efficiency with guarantee of high quality of the products. This method is in high demand in countries that do not specialize in agriculture, where the conditions for it are unfavourable – technological development allows levelling the negative influence of the natural and climatic factors on agricultural production and developing it on any territories.

The regulation approaches more preferable, as it ensures high manageability of the AIC and allows guaranteeing high quality of agricultural and other food products. The problem of this research consists in adapting the regulation approach to specifics of countries from different categories and provision of high effectiveness of its practical application for stimulating the implementation of the global goals in the sphere of sustainable development. The work seeks the goal of studying the modern experience of quality management in the AIC in view of the distinguished categories of countries and approaches and developing a scientific concept of quality management in the AIC according to the regulation approach, which allows ensuring the high level of national food security.

2. Literature review

As a result of an overview of the scientific literature on the selected topic, three blocks of publications are distinguished. 1st block: quality management in the AIC. Bogoviz et al. (2019a) determines quality of agricultural products in the unity of its ability to allay hunger (nutrition value – calorific capacity), to have positive influence on human's health (vitamins and minerals and energy value), and to preserve human's health (absence of harmful additives, balance of protein, fat, and carbohydrates – for preventing obesity).

Félix and Duarte (2018) notes that quality and security of agricultural and other food products determine the quality of human's life, and this increase of this quality is the primarily task of the state. Sitorus and Yustisia (2018) writes that quality of products of AIC determines the loyalty of consumers and could be a marketing tool of managing the competitiveness of the AIC companies.

Jin and Wang (2019) offers to solve the problem of strategic provision of transparency and quality control and security of agricultural products on the basis of its certification. Cortés et al. (2019) sees a perspective technical solution as usage of visible and near-infrared spectroscopy. El-Mesery et al. (2019) offers using the non-destructive technologies for controlling the quality of agricultural and other food products. Ping et al. (2018) thinks that it's necessary to use the Internet of Things during monitoring of quality and security of agricultural products. Shen et al. (2018) notes that control of the quality of the supply chain of agricultural products should be performed on the basis of "Internet+".

Biao et al. (2018) writes that monitoring of quality and security of agricultural products should be performed in real time, which is enabled by the network (web-) technologies. The works Sergi et al. (2019a) and Sergi et al. (2019b) express the opinion that increase of the quality of agricultural and other food products is the most optimal scenario of development of the modern AIC, though its practical implementation is complicated due

to differences of interests of companies and their interested parties.

2nd block: optimization of the territorial-sectoral placement of the AIC companies. Petrenko et al. (2018) comes to the conclusion that transaction costs have significant influence on the results of activities of the companies (including the AIC) and states the necessity for their reduction on the basis of optimization of territorial-sectoral placement of companies. Popkova et al. (2017a) thinks that it is necessary to solve the problem of optimization of spatial and sectoral placement of companies at the level of regional economy with the help of modernization of entrepreneurship.

The priority of reduction of transport and logistics costs for development of entrepreneurship (including in the AIC) is emphasized in the work de Camargo et al. (2018). Kusi-Sarpong et al. (2018) notes that selection of a supplier is a very important direction of decision making of modern companies of the AIC. The perspectives of optimization of territorial-sectoral placement of the AIC companies with the help of clustering on the basis of cases that reflect successful experience of various countries of the world are substantiated in D'Urso et al. (2019) by the example of Sardinia, in Chiapparino and Morettini (2018) by the example of Italy, in Zhang et al. (2017) by the example of China, and in Chatterjee and Ganesh-Kumar (2016) by the example of India.

Speranza et al. (2014) emphasizes the expedience of usage of clustering for optimization of territorial-sectoral placement of the AIC companies that conduct precision farming. Bogoviz et al. (2019b) notes the necessity for using not only domestic but also foreign economic opportunities for optimization of territorial-sectoral placement of the AIC companies. The scholar considers transnational clusters as the organizational and economic mechanism of innovative infrastructure of the agro-industrial complex of the EAEU countries.

In Popkova et al. (2017) clustering is viewed as a "growth point" of entrepreneurship of the AIC. In particular, Pozdnyakova et al. (2017) notes a significant contribution of clustering into provision of sustainable development. Popkova et al. (2016) emphasizes a special type of clusters – ecological – and notes the perspectives of their usage as increase of ecological security in developing countries.

3rd block: scientific & technical development of the AIC. According to Sibirskaya et al. (2017), the investment and innovative activities in the AIC (by the example of food industry) create a synergetic effect, raising the effectiveness of entrepreneurship. Belenkova et al. (2018) shows the priority of development of human capital in the interests of scientific & technological development of the AIC, as human capital is a "socio-economic phenomenon of innovative society", which has a demand for innovative agricultural and other food products.

Polyakova et al. (2018) notes the necessity for systemic monitoring of socio-economic processes that are connected to technological development of the AIC, by the example of network analysis and Big Data. Van der Ploeg (2018) deems it necessary to perform regular modernization of agriculture as a central element of the AIC. Knickel et al. (2017) provides arguments in favour of the fact that modernization of agriculture raises its sustainability.

Emerick et al. (2016) writes about topicality and importance of technological innovations in agriculture and the urgent need for their modernization in developing countries. Huh and Kim (2016) notes high ecological costs of conducting agriculture – in particular, cattle breeding (by the example of carbon emissions in the composting process of swine manure) and the necessity for their reduction via scientific & technological development of AIC, which is seen by the scholar in the context of transition to AIC

4.0. In the work Bogoviz et al. (2018) the authors note wide opportunities for increasing the labour efficiency on the basis of scientific & technological development of the AIC.

The foundations of AIC 4.0 as a scientific concept that reflects the future of the modern AIC after its modernization on the basis of technologies of Industry 4.0 (AI, the Internet of Things, etc.) and the advantages of AIC 4.0 as a means of rationalization of agricultural production are emphasized in the works Weltzien, C. (2016), Butorin and Bogoviz (2019), and Altukhov et al. (2019).

The necessity for state stimulation of scientific& technical development as a means of increasing the effectiveness and competitiveness of the AIC on the basis of cases that reflect successful practical experience of various countries of the world is substantiated in the work Kansanga et al. (2019) by the example of Ghana and New Zealand and in Ogemah (2017) by the example of African countries.

As a result of the literature review, it is possible to conclude that though the separate distinguished blocks of scientific knowledge are rather elaborated, there's no systemic opinion on the problem of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development in the modern economic science. The methods of the regulation approach in theory and practice are considered through the prism of the interests of the AIC companies (reduction of costs, increase of profit, and growth of efficiency), and insufficient attention is paid to the interests of society and the state in the aspect of provision of national food security (increase of the quality of agricultural and other food products).

This article is to fill this gap and ensure the systemic vision of the problem of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development.

3. Materials and method

For studying the modern experience of quality management in the AIC the author uses the method of regression analysis. The author compiles the equations of multiple linear regression, which reflect the dependence of the index "Quality and safety", which is calculated within the Global Food Security Index, which reflects the quality and security of agricultural and other food products in the economic system (resulting variable) on the following indicators (factor variables):

- Agricultural infrastructure as the indicator of optimality of territorial-sectoral placement of the AIC companies from the positions of reduction of transport and logistics costs and risk – it is calculated within the index "Availability" in the Global Food Security Index;
- Number of clusters in the AIC as the indicator of optimality of territorial-sectoral placement of the AIC companies from the positions of reduction of transaction costs and usage of the possibilities of integration (in the form of clustering) – determined on the basis of the statistics data base of the European cluster collaboration platform as a total number of clusters (including incubator, accelerator, co-working space, investor, and technology center) in the sectoral industries "Agricultural Inputs and Services" and "Food Processing and Manufacturing" and the data base of the Map clusters of Russia, compiled by the Russian cluster observatory;
- Public expenditures on agricultural R&D as the indicator of scientific& technical development of the AIC – calculated within the index "Availability" in the Global Food Security Index.

The research is performed in view of two distinguished categories of countries. The countries that do not specialize in agriculture are the leaders of the global rating as to the level of national ood security for 2018:

- Singapore (1st position, 85.9 points out of 100);
- Ireland (2nd position, 85.5 points out of 100);
- UK (3rd position, 85.0 points out of 100);
- USA (4th position, 85.0 points out of 100);
- Netherlands (5th position, 84.7 points out of 100);
- Australia (6th position, 83.7 points out of 100);
- Switzerland (7th position, 83.5 points out of 100);
- Finland (8th position, 83.3 points out of 100);
- Canada (9th position,83.2 points out of 100);
- France (10th position, 82.9 points out of 100);
- Germany (11th position, 82.7 points out of 100).

This category also includes Russia (42nd position, 67.0 points out of 100). The examples of countries that specialize in agriculture are countries from top-10 of agrarian countries of Europe (as the most detailed statistical data in the data base of the European cluster collaboration platform are available for the countries of Europe) according to Latifundist (2019) for 2018 (positions and points in the global rating as to the level of national food security for 2018 are given):

- Albania (absent in the rating);
- Republic of Moldova (absent in the rating);
- North Macedonia (absent in the rating);
- Montenegro (absent in the rating);
- Serbia (53rd position, 59.8points out of 100);
- Bosnia and Herzegovina (absent in the rating);
- Bulgaria (47th position, points out of 100);
- Romania (38th position 64.5 points out of 100);
- Poland (68.9 points out of 100).

For the countries of the selection that are absent in the global rating of the countries as to the level of national food security for 2018 the values to the indices "Quality and safety", "Agricultural infrastructure", and "Public expenditure on agricultural R&D" are assigned by the expert method similarly to other countries of the rating.

For determining the level of dissemination of the approach to managing the quality in the AIC, the method of analysis of variation is used. Direct average of all distinguished indices, standard deviation (value of deviation from direct average in the initial measuring items), and coefficient of variation (value of deviation from direct average in %) are calculated. The lower the coefficient of variation, the more homogeneous the selection and the more popular the approach to managing the quality in the AIC.

Also, the method of correlation analysis is used for calculating the correlation coefficients, which reflect the dependence of the resulting variable from each factor variable separately.

It should be noted that due to existence of two approaches to managing the quality of products in the AIC the factors of territorial-sectoral placement and scientific& technical development are not the only ones to influence the quality of agricultural and other food products; it seems that dependence of the resulting variable with factor variables will be moderate and, probably, statistically insignificant.

That's why this paper shall not contain expended regression analysis (F-test and Student's t-test) and is limited by compiling the equation of multiple linear regression.

Though this equation is not applicable for precision modelling and forecasting, it could be used for conducting scenario analysis (qualitative method) and will be used for determining the quantitative characteristics of the scenarios of provision of national food security of modern countries depending on quality management in the AIC.

Due to this, the share of subjectivism during compilation of scenarios will be reduced. At the same time, high precision during compilation of these scenarios is not required, as they are compiled based on selection of countries on the whole – i.e., they are generalized and are aimed at reflecting the potential vectors of provision of national food security of modern countries depending on quality management in the AIC.

4. Results

4.1. The modern experience of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development

The initial selection of data that reflect the result and factors of quality management in the AIC in countries that do not specialize in agriculture, in 2018, is shown in Table 1. Results of analysis of variation of data of Table 1 are shown in Figure 1.

Table 1. The result and factors of quality management in the AIC in countries that do not specialize in agriculture, 2018.

Country	Quality and safety, %	Agricultural infrastructure, %	Number of clusters in the AIC	Public expenditure on agricultural R&D, %
	y_1	x_{11}	x_{12}	x_{13}
Singapore	78.1	100.0	0	12.5
Ireland	84.8	80.6	0	62.5
UK	80.4	89.8	5	100.0
USA	85.4	80.6	0	37.5
Netherlands	85.1	89.8	8	75.0
Australia	85.4	80.6	0	25.0
Switzerland	79.8	100.0	0	50.0
Finland	86.0	100.0	2	12.5
Canada	83.0	100.0	3	12.5
France	86.5	100.0	23	50.0
Germany	79.7	89.8	4	50.0
Russia	75.2	50.9	6	12.5

Source: compiled by the authors based on Global Food Security Index (2019), European cluster collaboration platform (2019), Russian Cluster Observatory (2019)

According to Figure 1, direct average of the index of quality and security of products of the AIC in countries that do not specialize in agriculture in 2018 constituted 82.45%, variation is low (3.69%). This shows that all countries of the selection have high quality and security of the AIC products (as a result of quality management).

Direct average of the agricultural infrastructure in countries that do not specialize in agriculture in 2018 constituted 88.51%, variation is moderate (14.36%). This shows that in most countries of the selection the territorial-sectoral placement of the AIC companies from the positions of reduction of transport and logistics costs and risks is optimal.

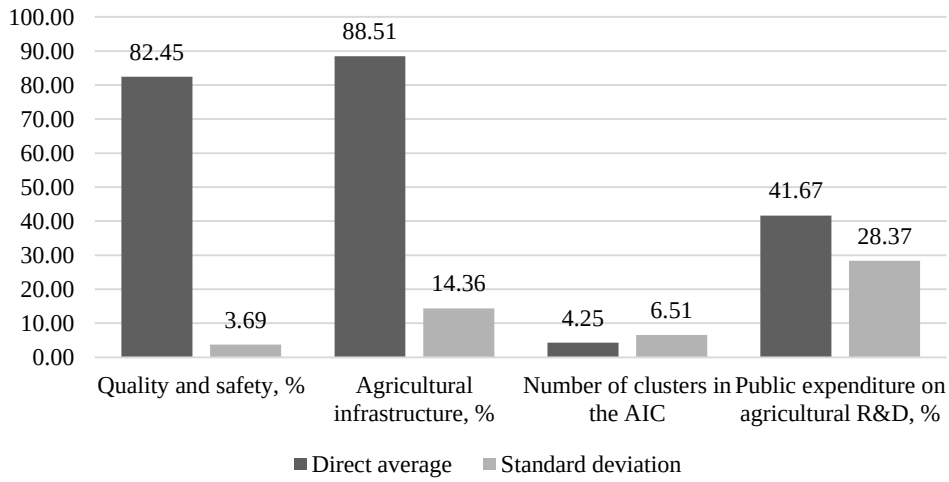


Figure 1. Analysis of variation of the result and factors of quality management in the AIC in countries that do not specialize in agriculture, 2018.
Source: calculated by the authors

Direct average of the number of clusters in the AIC in countries that do not specialize in agriculture in 2018 constituted 4.25 (т. (adjusted to 4), variation is very high (153.19%). This shows that cluster processes are too differentiated in the countries of the selection, but the level of clustering of entrepreneurship in the AIC is low. Therefore, territorial-sectoral placement of the companies of the AIC from the positions of transaction costs and usage of possibilities of integration (in the form of clustering) is not optimal.

Direct average of state expenditures for R&D in the AIC in countries that do not specialize in agriculture in 2018 constituted 41.67%, variation is high (68.09%). Therefore, the level of scientific & technical development of the AIC in the countries of the selection is too differentiated and rather low on the whole. Correlation coefficients (R^2) of the resulting variable with each factor variable separately are shown in Figure 2.

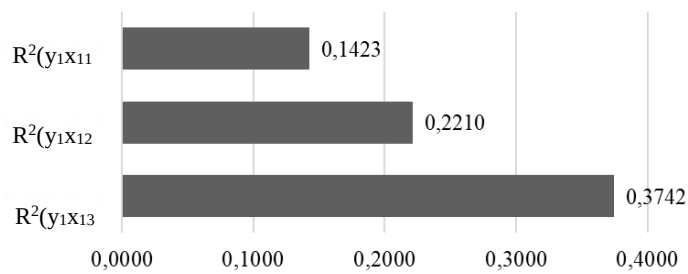


Figure 2. Coefficients of correlation (R^2) of the resulting variable with each factor variable.
Source: calculated by the authors

According to Figure 2, correlation of quality and security of agricultural and other food products in the countries of the selection is stronger (but low anyway) with state expenditures for R&D in the AIC: $R^2(y_1x_{13})=0.3742$. Correlation of the

resulting variable with the number of clusters in the AIC is low: $R^2(y_1x_{11})=0.2210$, as well as with the agricultural infrastructure: $R^2(y_1x_{12})=0.1423$. The results of the regression analysis of dependence of quality in the AIC on territorial-sectoral placement and scientific& technical development are shown in Table 2.

Table 2. Results of the regression analysis of dependence of quality in the AIC onterritorial-sectoral placement and scientific& technical development.

Regression statistics						
Multiple R	0.4208					
R-square	0.1771					
Adjusted R-square	-0.1315					
Standard error	3.9218					
Observations	12					
Dispersion analysis						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	26.4834	8.8278	0.5739	0.6480	
Leftover	8	123.0466	15.3808			
Total	11	149.5300				
	Coefficients	*Standard error*	*t-stat*	*P-Value*	*Lower 95%*	*Upper 95%*
Y-intercept	73.7370	7.4609	9.8831	0.0000	56.5321	90.9418
x_{11}	0.0895	0.0831	1.0772	0.3128	-0.1021	0.2812
x_{12}	0.0931	0.1874	0.4967	0.6327	-0.3391	0.5252
x_{13}	0.0095	0.0429	0.2206	0.8309	-0.0895	0.1084

Source: calculated by the authors

According to Table 2, the following equation of multiple linear regression is built: $y_1=73.7370+0.0895*x_{11}+0.0931*x_{12}+0.0095*x_{13}$. Therefore, increase of the agricultural infrastructure by 1% leads to growth of quality and security of agricultural and other food products by 0.0895%; increase of the number of clusters in the AIC by 1 leads to growth of quality and security of agricultural and other food products by 0.0931%; increase of state expenditures for R&D in the AIC by 1% leads to growth of quality and security of agricultural and other food products by 0.0095%.

Thus, the performed analysis showed that countries that do not specialize in agriculture used the deregulation approach to managing the quality in the AIC in 2018. The level of dissemination of this approach is low – therefore, the practice of its application in the studied countries is too differentiated; in certain countries (e.g., France) the regulation approach is used, and in certain countries (e.g., Switzerland) the mixed approach, which combines the elements of the regulation approach and the deregulation approach, is used.

Despite the high quality and security of agricultural and other food products in all countries of the selection, quality cannot be guaranteed in the long-term, as it is largely predetermined by the influence of the factors that are not subject to state management (e.g., corporate social responsibility, culture of consumption of the AIC products in society). That's why provision of sustainable development and provision of national food security in the long-term require transition to the regulation approach to managing the quality of products in the AIC.

The initial selection of the data that reflect the result and factors of quality management in the AIC in the countries that specialize in agriculture in 2018 is shown in Table 3.

Results of analysis of variation of data of Table 3 are shown in Figure 3.

According to Figure 3, direct average of the index of quality and security of products of the AIC in countries that do not specialize in agriculture in 2018 constituted 39.62%, variation is high (80.45%). This shows that quality and security of products of the AIC(as a result of quality management) in the countries of the selection are too differentiated, but is low on the whole.

Table 3. Result and factors of quality management in the AIC in the countries that specialize in agriculture, 2018

Country	Quality and safety, %	Agricultural infrastructure, %	Number of clusters in the AIC	Public expenditure on agricultural R&D, %
	y_2	x_{21}	x_{22}	x_{23}
Albania	6.4	6.8	1.0	1.4
Republic of Moldova	6.4	6.8	1.0	1.4
North Macedonia	6.4	6.8	1.0	1.4
Montenegro	6.4	6.8	1.0	1.4
Serbia	57.8	61.1	9.0	12.5
Bosnia and Herzegovina	63.2	61.1	0.0	25.0
Bulgaria	63.2	61.1	0.0	25.0
Romania	72.6	51.9	11.0	25.0
Poland	74.1	70.4	7.0	37.5

Source: compiled by the authors based on Global Food Security Index (2019), European cluster collaboration platform (2019), Russian Cluster Observatory (2019)

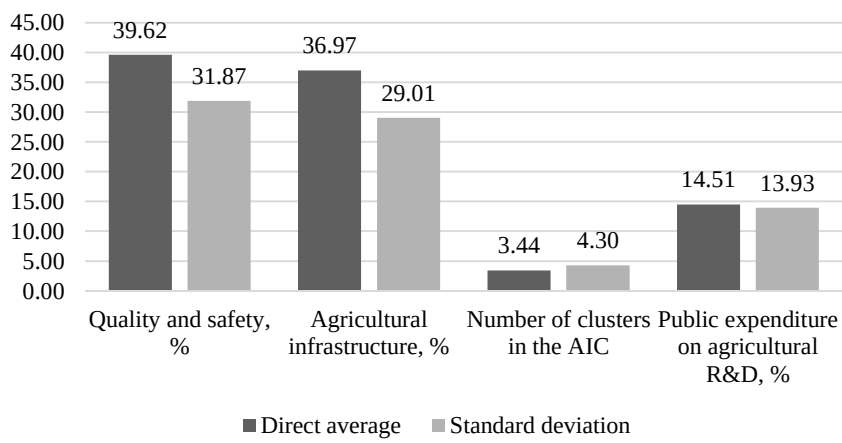


Figure 3. Analysis of variation of the result and factors of quality management in the AIC in countries that specialize in agriculture, 2018.
Source: calculated by the authors.

Direct average of the agricultural infrastructure in countries that do not specialize in agriculture in 2018 constituted 36.97%, variation is high (78.45%). This shows that the territorial-sectoral placement of the AIC companies from the positions of reduction of transport and logistics costs and risks in the countries of the selection is too differentiated and not optimal on the whole.

Direct average of the number of clusters in

the AIC in countries that do not specialize in agriculture in 2018 constituted 3.44 (adjusted to 3), variation is very high (124.97%). This shows that cluster processes are too differentiated in the countries of the selection, but the level of clustering of entrepreneurship in the AIC is low. Therefore, territorial-sectoral placement of the AIC companies from the positions of reduction of transaction costs and usage of the possibilities of integration (in the form of clustering) is not optimal.

Direct average of state expenditures for R&D in the AIC n countries that do not specialize in agriculture in 2018 constituted 14.51%, variation is high (96.00%). Therefore, the level of scientific& technical development AIC in the countries of selection is too differentiated and is rather low on the whole. Correlation coefficients (R^2) of the resulting variable with each factor variable separately are shown in Figure 4.

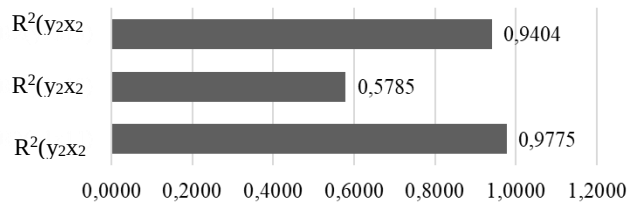


Figure 4. Coefficients of correlation (R^2) of the resulting variable with each factor variable.
Source: calculated by the authors

According to Figure 4, correlation of quality and security of agricultural and other food products in the countries of the selection is stronger (and very high) with state expenditures for R&D in the AIC: $R^2(y_2x_{23})=0.9775$. Correlation of the resulting variable with the number of clusters in the AIC is moderate: $R^2(y_2x_{21})=0.5785$, and with the agricultural infrastructure it is high: $R^2(y_2x_{22})=0.9775$. The results of the regression analysis of dependence of quality in the AIC on territorial-sectoral placement and scientific& technical development are shown in Table 4.

According to Table 4, the following equation of multiple linear regression is compiled: $y_2=0.3919+0.7027*x_{21}+1.0003*x_{22}+0.6759*x_{23}$. Therefore, development of the agricultural infrastructure by 1% leads to growth of quality and security of agricultural and other food products by 0.7027%; increase of the number of clusters in the AIC by 1 leads to growth of quality and security of agricultural and other food products by 1.0003%; increase of state expenditures for R&D in the AIC by 1% growth of quality and security of agricultural and other food products by 0.6759%.

Thus, the performed analysis showed that countries that specialize in agriculture in 2018 used the regulation approach to managing the quality in the AIC. The level of dissemination of this approach is low – therefore, the practice of its application in the studied countries is too differentiated; certain countries (e.g., Albania) use the deregulation approach, and certain countries (e.g., Bosnia and Herzegovina) use the mixed approach, which combines the elements of the regulation and the deregulation approaches.

Thus, the performed analysis showed that countries that specialize in agriculture in 2018 used the regulation approach to managing the quality in the AIC. The level of dissemination of this approach is low – therefore, the practice of its application in the studied countries is too differentiated; certain countries (e.g., Albania) use the deregulation approach, and certain countries (e.g., Bosnia and Herzegovina) use the mixed approach, which combines the elements of the regulation and the deregulation approaches.

Table 4. The results of regression analysis of dependence of quality in the AIC on territorial-sectoral placement and scientific& technical development.

Regression dependence						
Multiple R	0.9904					
R-square	0.9809					
Adjusted R-square	0.9694					
Standard error	5.5790					
Observations	9					
Dispersion analysis						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	7971.8423	2657.2808	85.3753	0.0001	
Residue	5	155.6235	31.1247			
Total	8	8127.4658				
	Coefficients	*Standard error*	*t-stat*	*P-Value*	*Lower 95%*	*Upper 95%*
Y-intercept	0.3919	3.2099	0.1221	0.9076	-7.8594	8.6433
x_{21}	0.7027	0.1789	3.9275	0.0111	0.2428	1.1626
x_{22}	1.0003	0.5289	1.8914	0.1172	-0.3592	2.3599
x_{23}	0.6759	0.3585	1.8853	0.1181	-0.2457	1.5974

Source: calculated by the authors.

Though domination of the regulation approach ensures high manageability of quality of agricultural and other food products in countries that specialize in agriculture, in most of them this quality is low. Therefore, the deregulation approach is applied with low efficiency, and the practice of its implementation requires improvement.

4.2. Scenarios of provision of nationalfood securityof the modern counties depending on quality management in the AIC

Depending on quality management in the AIC, we determined four scenarios of provision ofnationalfood securityof the moderncountries in view of two distinguished categories:

- Scenario "Loss of control", which envisages implementation of the deregulation approach and critical aggravation of the agricultural infrastructure, critical reduction of the number of clusters in the AIC and state expenditures for R&D in the AIC;
- Scenario "Single-vector management of territorial-sectoral placement", which is connected to improvement of the agricultural infrastructure and increase of the number of clusters with preservation of the current (as of 2018) state expenditures for R&D and AIC;
- Scenario "Single-vector management of technological development", which means significant increase of state expenditures for R&D in the AIC with preservation of the current (as of 2018) agricultural infrastructure and the number of clusters;
- Scenario "Systemic management", which ensures improvement of the agricultural infrastructure, increase of the number of clusters and significant increase of state expenditures for R&D in the AIC.

Characteristics of the above scenarios in the countries of the two distinguished categories are shown in Table 5. The values of factor variables are determined with the expert method, and the values of resulting variables – with putting the values of factor variables into the obtained equations of multiple linear regression.

Table 5. Scenarios of provision of national food security depending on quality management in the AIC.

Scenario		Characteristics of the scenario in countries that do not specialize in the AIC				Characteristics of the scenario in countries that specialize in the AIC			
		Quality and safety, %	Agricultural infrastructure, %	Number of clusters in the AIC	Public expenditure on agricultural R&D, %	Quality and safety, %	Agricultural infrastructure, %	Number of clusters in the AIC	Public expenditure on agricultural R&D, %
		y_1	x_{11}	x_{12}	x_{13}	y_2	x_{21}	x_{22}	x_{23}
Loss of control		78.09	44.26	2.13	20.84	20.01	18.49	1.72	7.26
Single-vector management	Only territorial-sectoral placement	83.64	97.36	8.50	41.67	69.04	73.94	6.88	14.51
	Only technological development	82.85	88.51	4,25	83.34	69.04	36.97	3.44	58.04
Systemic management		84.03	97.36	8.50	83.34	98.46	73.94	6.88	58.04

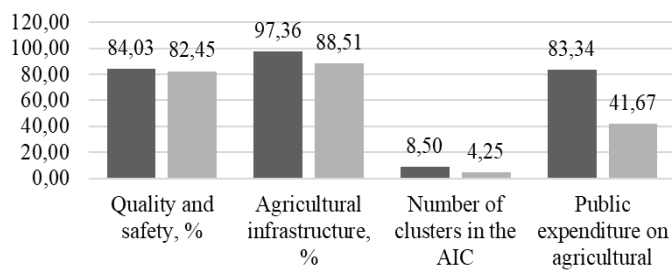
Source: calculated and compiled by the authors

According to Table 5, the highest values of the resulting variable (quality and security of products of the AIC) for both categories of countries are achieved within scenario "Systemic management". Therefore, this scenario is the most preferable.

Let us consider an example of calculations within scenario "Systemic management". In countries that do not specialize in AIC, with the set (Table 5) values of factor variables, the value of the resulting variable is calculated in the following way: y_1=73.7370+0.0895*97.36+0.0931*8.50+0.0095*83.34=84.03. In the countries that specialize in the AIC, with the set (Table 5) values of the factor variables, the value of the resulting variable is calculated in the following way:

y_2=0.3919+0.7027*98.46+1.0003*6.88+0.6759*58.04=98.46.

Let us compare the current (as of 2018) and optimal (according to scenario "Systemic management") values of variables in the distinguished categories of countries (Figures 5, 6).



Scenario "Systemic management" (darker) and Average (lighter)

Figure 5. Comparison of the current (as of 2018) and optimal values of variables in countries that do not specialize in the AIC

Source: calculated and compiled by the authors

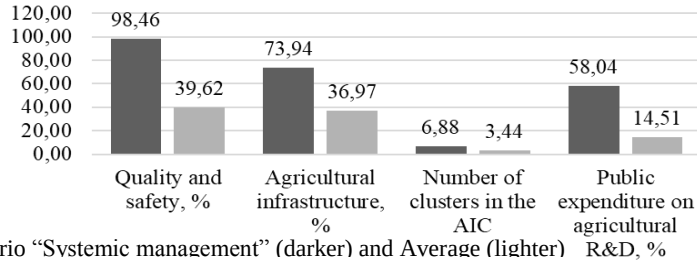


Figure 6. Comparison of the current (as of 2018) and optimal values of the variables in countries that specialize in the AIC
Source: calculated and compiled by the authors

Figure 5 shows that for practical implementation of the optimal scenario ("Systemic management")in the countries that do not specialize in the AIC they have to improve the agricultural infrastructure by 10%, increase the number of clusters in the AIC by 2 times, and increase state expenditures for R&D in the AIC by 2 times. This will ensure increase of the quality of agricultural and other food products by 1.92% and will allow guaranteeing high level of this quality – i.e., national food security in the long-term.

Figure 6 shows that for practical implementation of the optimal scenario ("Systemic management") in the countries that specialize in the AIC it is necessary to improve the agricultural infrastructure by 2 times, increase the number of clusters in the AIC by 2 times, and increase state expenditures for R& Din the AIC by 3 times. This will ensure increase of the number of agricultural and other food products by 1.5 times with preservation of stability of the level of this quality – i.e., this will stimulate the provision of national food security in the long-term.

4.3. The scientific concept of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development for provision of national food security

The determined differences between the countries from different categories belong to the scale of the measures of quality management of products in the AIC – i.e., they reflect quantitative characteristics of this management. From the scientific and theoretical (qualitative) point of view, the logic of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development for provision ofnational food security in both categories coincides (Figure 7).

Figure 7 shows that in a national economic system (country from any category) three types of territories could be distinguished, in which quality management of products in the AIC is different. The first type (territory 1) envisages that conditions for agriculture are favourable (from the positions of natural and climate conditions), and there's high (could be low) demand for agricultural and other food products (large population). It is recommended to create a territorial-sectoral cluster in the AIC on this territory, which will be based on agricultural production and which will include companies from the adjacent links of the added value chain in the AIC (e.g., companies of agricultural machine-building, suppliers of fertilizers, and agricultural research institutes).

The second type (territory 2) includes the territory on which conditions for agriculture are unfavourable, and there is high demand for agricultural and other food products (large population). Scientific and technological development of the AIC is recommended on this territory: R&D in the AIC, and production of the leading equipment for the AIC.

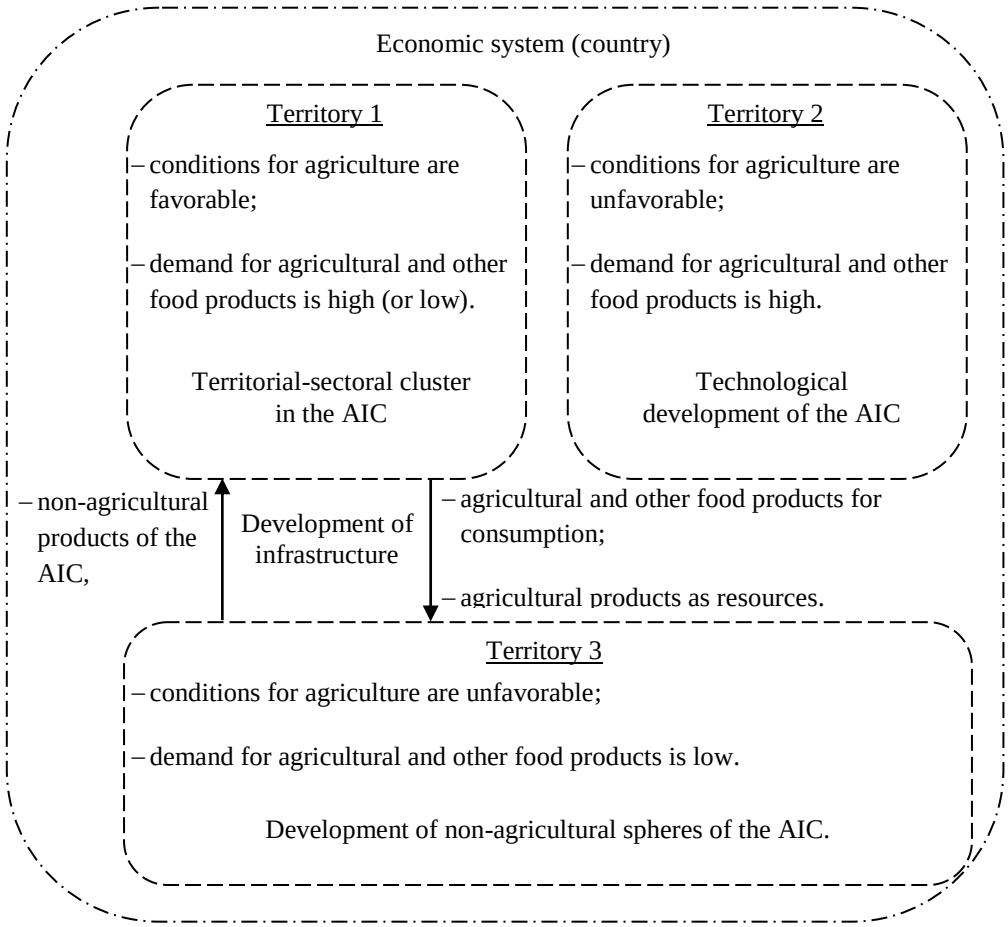


Figure 7. Scientific concept of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development.
Source: compiled by the authors.

In the territory of the third type (territory 3), the conditions for agriculture are unfavourable, and there's low demand for agricultural and other food products (small population). It is recommended to develop non-agricultural spheres of the AIC on this territory (e.g., companies of food industry).

Also, it is necessary to develop the transport and logistics infrastructure, which connects the territories of the first and third types. This infrastructure will be used for transportation of agricultural and other food products for consumption and agricultural products as resources from the territory of the first type to the territory of the third type. This infrastructure will be used for transportation of non-agricultural products of the AIC (e.g. food products).

The developed scientific concept of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development allows achieving high quality of agricultural and other food products and guaranteeing stability of this quality – i.e., supporting national food security. High effectiveness of entrepreneurship in the AIC will be achieved, and the risks of transportation and

sales of products will be reduced.

5. Conclusion

Thus, as a result of the research it is determined that counties that do not specialize in the AIC (e.g., Singapore, Ireland, the UK, and the USA) realize the deregulation approach to managing the quality of products in the AIC. Though in 2018 all countries had high quality of the AIC products, the deregulation approach does not allow guaranteeing preservation of the achieved level of quality in the long-term. Countries that specialize in AIC (e.g., Albania, Republic of Moldova, North Macedonia, and Montenegro) use the regulation approach. This ensures high manageability of the quality of products in the AIC in 2018, but the level of quality of these products is low.

The performed scenario analysis showed that transition to the deregulation approach will lead to critical reduction of quality of products in the AIC in the countries from the both categories. Single-vector management (or optimization of territorial-sectoral placement, or stimulation of scientific& technical development) allows for slight increase of quality of products in the AIC while preserving its moderate manageability.

The most preferable (optimal) scenario is the one that envisages systemic quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development – it ensures quality management of agricultural and other food products by 1.92% in countries that do not specialize in AIC, and by 1.5 times in countries that specialize in the AIC, and will allow guaranteeing high level of this quality – i.e., it will stimulate the provision of national food security in the long-term.

For the most effective practical realization of the regulation approach in countries of both categories, a scientific concept of quality management in the AIC on the basis of territorial-sectoral placement and scientific& technical development has been developed. It allows ensuring high level of national food security. This concept envisages differentiation of the management measures depending on the conditions for agriculture and demand for agricultural and other food products on the territories in a country.

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