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ECONOMIC SECURITY OF REGIONS AS A CRITERION FOR FORMATION AND DEVELOPMENT OF AGRICULTURAL CLUSTERS BY MEANS OF INNOVATIVE TECHNOLOGIES

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Abstract

The article provides an algorithm and development phases aimed at the creation of a complex economic security system for agricultural regions including an economic risk analysis and management system. In order to ensure the economic security of regions, the authors have developed a network model of cluster agricultural economy based on cooperation between small and medium-sized processing companies and suppliers of agricultural raw materials with due account for system requirements relating to economic security protection of business entities in the corresponding region. In this case, the cycle "Research — Production — Sales" remains within one cluster with the help of a corporate logistics system integrated into global networks, which allows all elements (business units) of the cluster to create a joint development framework and pricing strategy and establish fair distribution of profits among the units based on mutual competitive partnership principles, which, in their turn, promote economic security in the corresponding region. Classification and structure of clusters across the whole agricultural production of a region has been given. Apart from that, the authors have offered a methodology for defining economic potential of a cluster providing for synergetic effect of separate potentials and cumulative cluster potential achieved by integrating separate potentials. For the purpose of efficient cluster management, the authors suggest a model of cluster economy management, which includes management phases, goals, principles, and functions.

Key words: *economic security, cluster, agricultural region, info-communications, cloud technologies, Internet of things*

INTRODUCTION

In order to improve competitive performance of a region under acute shortage of resources, it is reasonable to consider priority areas of infrastructure development taking into account absolute and relative advantages, thus defining the specialization of the region and enhancing its investment appeal. The economic structure of most economically depressed regions in Russia can be described as a nonstructural specialization system [14]. It is necessary to pay attention to those regional industries which could, on the one hand, determine the competitive performance and economic security of the region and, on the other hand, improve the life quality of its population. Agriculture and processing industry can arguably perform these functions in many Russian regions, which means that the spheres in question should form a market for high-quality food and agricultural products. Therefore, work towards this goal should become the top priority task for the regional authorities.

Presently, the Russian Federation, which possesses 10% of the world's ploughland, continues to import around 35% of its food and agricultural products and remains to be on the edge of losing its own food security. In view of the current situation in the agricultural industry, the national project on import substitution and upsurge of agricultural production has been put into operation. In 2008, it was transformed into a state-supported program "Development of the Agricultural Complex".

However, this project cannot be deemed totally successful, since it has not only helped to solve problems connected with funding of the industry and investment inflow, but also contributed to the integration of the country into the global economy: there have been an increasing number of holding companies dealing with crop raising, dairy husbandry, pig and poultry farming with long-term land lease arrangements. There has been no increase in competitive performance of the Russian agricultural production because virtually the whole industry operates on a tolling basis, whereas the ploughland is cultivated by utilizing imported equipment and technologies. For example, the Swedish company Black Earth Farming admits the purchase and management of 300,000 hectares of land in the Central Black Earth Region of Russia through the connected company Agro-Invest, while the Danish company Trigon Agri declares its control over 100,000 hectares of land in Penza and Samara Regions, not to mention the 49-year lease of land in Primorye to the Chinese. This long-term strategy has been approved by the "New PRC Governmental Program" which encourages and subsidizes farmers who buy ploughland abroad [15]. This is an elaborate program with phased subsidizing: for instance, if a manufacturer cuts the production costs (e.g. due to the usage of alternative energy sources), the company will get gradual reimbursement for the cost of corresponding equipment and preferential taxation. As a result, the Chinese authorities also address the issue of production support and the need for a supply of agricultural raw materials as well as the reduction of unemployment in the countryside.

MATERIALS AND METHODS

The methodology of the complex economic security system (ESS) development should contain the following algorithm and phases:

– Analysis and review of specific features, business operations, market segment, management structure and business reputation of the main region's industry;
– Analysis of external and internal threats to the economic activity in the region and the degree of their influence;
– Modeling elements of the complex EES with direct and reverse connections for a particular business unit;
– Conducting an audit of the existing measures ensuring the economic security of the region and their correlation with the identified risks and threats;
– Finalization and approval of the complex ESS model and the required budget;
– Establishing the actual structures and regulations of the region's ESS;
– Expert efficiency evaluation of the introduced ESS and bringing its regulations to the required level.

As a rule, financial security is a matter of utmost importance as far as economic security is concerned, which is why both experts and scientists pay great attention to the detailed analysis of financial security in the course of program and project development. Besides, the teaching staff of educational institutions also incorporate topics connected with financial security into learning and teaching support kits for specialized subjects.

However, it constitutes only a small part of economic risks and conditions of uncertainty relating to external and internal organization environment, which should be regularly monitored and constantly controlled with respect to their dynamics. Thus, one should not get obsessed with the analysis of financial and operating performance [4], although it is a very important component and it is advisable to use such detailed analysis of 3-5 years dynamics as the basis for business analysis.

Nevertheless, talking of economic security as a complex system, one should represent such a system as a set of multiple variables, such as characteristics of a particular business unit,

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sub-industry and industry, within which it operates, and a number of elements in direct and reverse correlations with each other aimed at ensuring competitive performance of the business unit in question. A solution to such tasks implies that the organization should create unique analysis systems in order to reduce the influence of economic risks. Such systems are not only unique for each business unit but also individual in terms of risk priority ranking. At the same time, there have been attempts to create universal risk assessment solutions with the use of statistical data both on the global and microeconomic levels (that of separate business units) [11, 12, 13].

At the same time, specific operating characteristics of a particular organization will definitely serve as the main factor for risk prioritization.

The authors suggest the development of agricultural clusters by means of innovative technologies as a solution to the problem of providing the population with all necessary food products, which is one of the most important criteria for the economic security of any region. Scientific papers written by such academic economists as M. Porter, P.F. Drucker, I.V. Lipsitz, L.E. Mindeli and others should be considered and studied as the basis for the methodological instruments. "Cluster is a network of suppliers, producers, customers, elements of industrial infrastructure and research institutions interconnected in the process of creating new types of products and rendering services" [6].

The founder of cluster development theory is M. Porter who explored the issue by researching the competitive positions of over 100 industries in different countries. [6] M. Porter noticed that, as a rule, most internationally competitive companies from the same industry are located in the same region. This phenomenon can be explained by waves of innovation spread by the most competitive companies and affecting suppliers, customers and competitors of those companies.

High competitive performance of a region relies on the strong positions of separate clusters, whereas even the most developed economy without advanced clusters can produce mediocre results. In the modern economy, competitors are not separate companies or industries, but clusters.

RESULTS AND DISCUSSIONS

Clusters are formed around processing companies: sugar plants, butter and cheese making plants, oil mills, meat plants, flour mills, etc. Within one region there might be several clusters of the same type according to the number of processing facilities.

There are several factors that can both promote and hamper cluster development in Russia.

Specialists in the field name the following positive factors:

– existence of technological and scientific infrastructure;
– psychological readiness for cooperation.

The constraining factors include the following:

– low quality of business climate, low development level of associative structures (chambers of commerce, industrial associations), which cannot cope with the task of formation and promotion of priorities and interests of the regional business;
– short-term planning — real benefits from cluster development appear only 5-7 years later [9].

For the purpose of efficient cluster management, the authors suggest a model of cluster economy management which includes management phases, goals, principles, and functions (Fig.1).

Objects of management are clusters, which, as a rule, consist of several business units. Coordination and infrastructure issues should be dealt with by officials authorized as a regional administration. Objects of management and sub-systems of quality control are indicated in the model. In order to assess the efficiency and quality of cluster-produced goods, the authors have developed criteria and assessment levels, the most important among which is the utilization efficiency of financial resources).

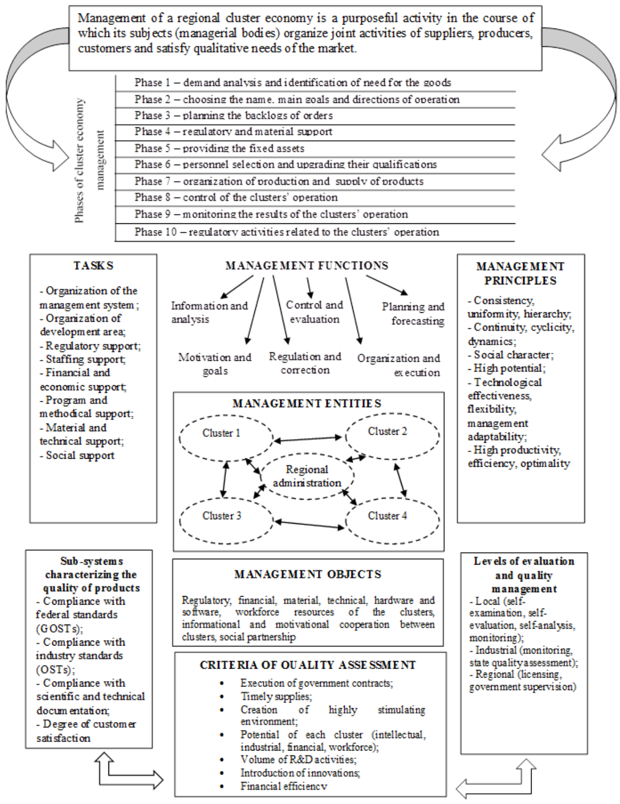

Fig.1. Model of regional cluster economy management
Source: Compiled by the authors

The authors have chosen the method of cluster formation based on specialization of raising and processing agricultural raw materials. The original method has been changed so that business units located not in one territory, but preferably in one region can become cluster participants. In this case, it is easier to choose the subject of research and assess the operational efficiency of a cluster.

Depending on the number of centers (nuclei) within a cluster it can be a simple network model (one center) or a complex network model (two and more centers).

The most important condition and advantage of economy clusterization for an agricultural region is integration of potentials:

– intellectual, $\sum Int$

$$\sum Int = Int1 + Int2 + \ldots + Intn; \quad (1)$$

– innovative, $\sum In$

$$\sum In = In1 + In2 + \ldots + Inn; \quad (2)$$

– investment, $\sum Inv$

$$\sum Inv = Inv1 + Inv2 + \ldots + Invn; \quad (3)$$

– industrial, $\sum Ind$

$$\sum Ind = Ind1 + Ind2 + \ldots + Indn; \quad (4)$$

– workforce, $\sum W$

$$\sum W = W1 + W2 + \ldots + Wn; \quad (5)$$

where 1,2…n is the number of business units participating in a cluster.

Then the common potential of the cluster, $\sum P$, will be equal to the sum of all the cluster potentials, which allows to conduct research and development activities (using the cluster's own resources or contracting other organizations), experimental design work aimed at development of new technologies and equipment, retraining of staff and other types of scientific, industrial and personnel activities within the cluster:

$$\sum P = \sum Int + \sum In + \sum Inv + \sum Ind + \sum W; \quad (6)$$

Joining the potential of all business units within a cluster allows getting the synergetic effect as a result of using all types of potential.

This approach also helps to ensure the economic security of the cluster and its separate elements (business units), regions and country as a whole. Under the current conditions of economic development implying unstable market environment, fierce competition for market segments, industrial espionage, benchmarking, implementation of innovations and bankruptcy threats resulting from different reasons, the necessity for economic security arises together with the need to ensure it by means of complex frameworks.

Judging from the analysis outlined above, it may be concluded that increase in labor productivity in the agricultural sphere is possible only due to the reduction of the living labor share (in its material form), which can be encouraged by the implementation of fundamental scientific discoveries and technological innovations, such as automatization and robotization.

In this case, a paradigm shift takes place as a result of using innovative approaches in agricultural activities.

Currently, infocommunication technologies and cloud services are penetrating the agricultural sphere. It is possible to identify several most progressive and advanced trends, which are likely to exercise great influence on the development of the whole agricultural industry in the coming years [1].

Development of robotic engineering and usage of big data and computer-aided learning in the agricultural sphere.

One of such examples is the invention of Australian scientists called Flow [7] — a fully automatic beehive. The design of the cells allows them to transform into channels, through which the honey flows into special containers. The main element of the design is a plastic frame which prevents violation of the beehive's integrity. Another example is the project 30Sec Milk [10] — a compact device, which performs the full cycle of milk production (including milking and pasteurization) and packaging. This invention allows shortening the chain of participants and speeding up the delivery of milk to the end consumer. Besides, various instruments and CRM tools for data collection, aggregation and analysis also regularly emerge. The AgCode software [8] was developed for vineyard companies and helps them to manage production: save data in a single database, monitor the crop yield, weather conditions, degree of ripeness and costs relating to each employee.

Usage of neural networks and artificial intelligence.

In the market, there are a number of standardized products from large-scale manufacturers, such as IBM, Google, or Monsanto. There are also targeted solutions: for example, OneSoil, a startup from Belarus — it is an online service, which monitors the condition of cultivated areas, crops increase and resources saving with the help of artificial intelligence. Drones, a "flying wing" and a helicopter are used for data collection.

Innovative solutions for plant treatment.

For example, the company Azotic uses a specially modified type of bacteria, which are able to extract nitrogen from the atmosphere and deliver it to plants as a fertilizer. Indigo uses the microbial coating on cotton seeds, which increases its crop yield by 10%. Scientists from the University of Queensland have received good results after treatment of plant leaves with ribonucleic acids. Another example — Sample6 system [3] — is used to detect food pathogen agents in plants. The Russian startup SBV24 — a solar bio-vegetarium — is a new generation of greenhouses accumulating solar energy several times better than its standard counterpart and regulating the temperature conditions thanks to the preserved heat. The bio-vegetarium uses the protected ground system, which regulates four factors affecting crops: light, temperature, water and fertilizers.

Tracking and control of production and transportation in real-time mode.

The system developed by SpensaTechnologies [2] allows farmers to track, trap and identify crop pests and receive daily reports. Startup Gamaya [15] provides a solution which allows saving a lot of time on examining the fields by identifying deviations in the soil parameters of separate plants. The program analyzes the images from the cameras carried by drones and, using the information about the necessary amount of chemical substances, soil characteristics and the cultivated crops draws a conclusion about any existing plant diseases and their causes. After that, the system sends a notification to the farmer indicating the location of the ill plants and lack of nutrients in the soil, which allows reducing the amount of fertilizers and other resources.

Development of the industrial Internet of things.

Over the last few years, the efficiency of irrigation has been substantially improved and water use has been reduced due to the data received from sensors installed on the ground, satellite images, weather forecasts and exploitation of drones. Edyn [3] is a solar-powered technology designed for monitoring the information about the condition of soil and air in order to calculate the necessary types and dosage of fertilizers and determine the appropriate time for planting and cropping, as well as increase the crop yield. The device is a system of solar-powered ground sensors, which send the information about the condition of soil, air temperature and humidity, light intensity and electrical conductivity to the farmer via a special application and give recommendations about the cultivation of particular plants. The irrigation system CropX [3], which has been developed in Israel, helps to reduce water and

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electricity usage by 20-30% as a result of division of the plot into separate irrigation zones (according to the soil type, humidity and terrain) and installation of sensors that analyze samples and calculate optimal amounts of water. The virtual agronomist Agrilyst [2] is a system of intellectual sensors used for data collection, analysis and visualization. It helps farmers to make informed decisions related to agricultural crops, animals, soils and other things. Bovcontrol [5] is a set of tools (ear rings, chips, smart scales etc.) for data collation and analysis aimed at boosting productivity in meat-and-dairy farming and genetic improvement in livestock breeding. The complementary program is designed for feeding, vaccination and inventory management.

The spread of urban hydroponic farms using polymer film.

One of the examples is BrightFarms [2] — the project of building greenhouses in urban conditions in close vicinity to the points of sale. Another project — Freight Farms [5] — has made farming possible in an urban setting offering shipping containers for growing agricultural products (due to their large size up to 4-5 thousand plants can be grown there). The company produces blocks ready for plant cultivation, which are equipped with all the necessary instruments for intensive and sequential cropping. The project employs innovative climate technologies based on hydroponics; it is possible to control lighting and regulate parameters remotely.

Quantitative and qualitative growth of data about the environment.

For example, AeroState [5] allows controlling the quality of air anywhere in the world. AeroState is a platform with interactive pollution heat map, which provides agricultural producers with the opportunity to add information about air quality to their product. Satellite systems, traffic data, information about emissions within cities including vehicle and industrial emissions are all used for analysis. Agri Eye [2] is a self-learning system able to assess the condition of soil and vegetation by means of multispectral field analysis and remote vegetation and soil sounding. The technology allows farmers to save up to 30% of resources used for crop treatment, keep soil in a good condition, calculate the indexes describing the condition of a plot and predict profit in a long-term perspective.

The innovative approach implies the creation of tools integrated into the key agricultural processes and allowing to monitor the changes in farming data in real-time mode. This information is used as the basis for forecasts and plans, making decisions and modifying logistic processes in order to optimize time and resources (Fig.2).

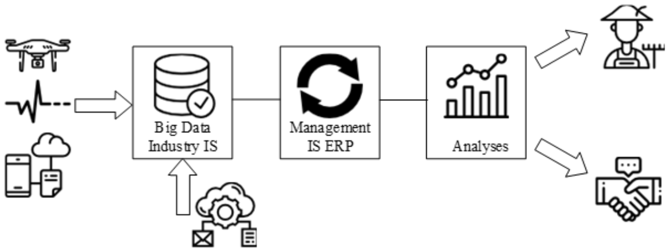

Fig.2. Usage of big data and ERP systems in agriculture
Source: Compiled by the authors

Analysis of this trend leads to the conclusion that over the last decades agricultural production has been undergoing revolutionary changes, from mechanization to robotization processes with the use of innovative technologies and artificial intelligence. In its turn, this allows not only reducing the labor input into production processes of the industry increasing labor productivity, efficiency and quality of products but also, as it has been mentioned earlier, it helps to reduce the share of living labor in the material product. Definitely, these developments can also have more serious consequences: industrial relations are changing, as well as the share of workforce taking part in the agricultural production of both raw materials and finished products.

One of the possible development patterns for regional markets is the production of ecologically clean agricultural products with the opportunity of clusterization of the regional economy for the purpose of reducing the costs of production.

Among the most important benefits that business will get as a result of cluster formation, the following ones should be mentioned:

– development of workforce potential thanks to training, retraining and exchange of experience between the staff of similar clusters;
– growth of separate and common potentials;
– civilized contractual relationships between suppliers, processors and sales companies;
– increase of manageability as far as separate industries and regional economy in general are concerned;
– creation of infrastructure for research and development and experimental design activities;
– cost minimization thanks to the scale of production, introduction of new technologies and equipment;
– identification of agricultural export opportunities in the international market;
– strict and constant quality control of raw materials and other products provided by suppliers;
– incorporation of know-how and innovative technologies into production without losing quality characteristics or useful properties of products.

The government of the Russian Federation provides agricultural industry with significant support, but, unfortunately, the main result of these efforts is favorable credit facilities for agricultural companies. In this connection in 2018, the total sum of credit resources allocated for companies and organizations in the agricultural sector amounted to 23.75 bln roubles: 15.58 bln was assigned for short-term credits and 8.17 bln — for preferential investment credits. As of the first half-year period of 2018, the Ministry of Agriculture of the Russian Federation has received 12,236 applications for preferential credits from the authorized banks for an overall amount of 907.01 bln roubles including the total subsidy amount of 19.21 bln roubles: 11.36 bln assigned for short-term credits and 7.91 bln — for investment credits. Insufficient collateral and unsatisfactory credit report remain the main reasons for preferential credit denial.

In the modern realia of market reforms in Russia, there are some priority areas and competitive industries favored by government support, which directly leads to the further disintegration of the population in terms of living standards. The situation is made even worse by the quality gap between the living standards of different regions and purchasing power of their population, immaturity of market infrastructure and small business and depressive state of the central Russian regions.

CONCLUSIONS

In view of the abovementioned conditions, it is necessary to create risk analysis and management systems in order to ensure regional economic security.

Such systems may consist of similar structural blocks:

– modeling of risky situations;
– assessment of losses resulting from risks;
– permissible limits for each risk category;
– development of algorithms aimed at avoiding risks or reduction of losses resulting from emerging risks;
– development of an action plan and its variants with the purpose of reducing negative effects of risks in order to avoid reaching the critical limits (bankruptcy risk);
– practical risk-preventing actions;
– control of risk-neutralizing measures and amendment of actions and decisions if necessary.

Assessment of risky situations can be implemented with the help of a set of analytical actions which allow predicting the possibility of receiving additional profit or amount of losses resulting from a risk, which emerged in a particular situation under the influence of certain external and internal factors. The most important parameter of this approach is possible damage and assessment of optimal investment necessary to reduce it to an acceptable level. As a rule, the possible damage is estimated by such methods as the statistical, expert or analytical approaches.

Endowing Russian food products with competitive advantages and revival of Russian agricultural production under governmental control will allow speeding up the process of socio-economic transformation of the territories. The growth of employment and income of the population will encourage the revival of the countryside and consumer cooperation, whereas high-quality nutrition at affordable prices will contribute to the general health of the population and national security of the country. In light of this, it is more important than ever to establish a thought-out support program for small and medium-sized business in the countryside, look for new development incentives for agricultural enterprises, reconsider the Russian and global agricultural experience and work out the optimal development path with due regard to national and regional specific features.

Establishing the cluster system of regional agricultural production management based on networking models allows achieving the following:

– increase the volumes of production and labor productivity in the agricultural sphere;
– receive higher incomes, which improves the financial capacity of the cluster's business units;
– set up venture funds within the cluster;
– create (purchase) and use innovations both in crop raising and livestock breeding;
– improve the quality of agricultural raw materials and food products and, as a result, promote the competitive capacity of such goods in the internal and external markets.

Production and distribution of ecologically clean products in necessary amounts will allow improving the quality of life in the country.

As far as the management of an agricultural region economy is concerned, clusters have the following advantages:

– constant demand for agricultural raw materials and their processing on a regular basis under long-term contracts for the supply of agricultural raw materials;
– growth of separate and common cluster potentials thanks to the integration of potentials belonging to all business units within the cluster;
– growth of volumes of agricultural products, development of food products market in the country thanks to long-term contracts for the supply of food products to the northern regions of the country;
– improvement of competitive performance of Russian ecologically clean food products, which, in its turn, boosts the competitive performance of the Russian regions.

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