Artículo de investigación

Management of integration formations in the AIC as food security tool

Управление Интеграционными Образованиями В АПК Как Инструмент Обеспечения Продовольственной Безопасности

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Abstract

The article presents the results of food security assessment; the decisive role in its provision is assigned to agricultural production. The analysis of the staple food supply to the population necessitated the buildup of domestic agricultural production. Despite the implementation of the state policy of import substitution, under the current conditions of agricultural enterprises operation, there is a risk of a further decrease in the food security of Russia. Strategic priority areas and tools for achieving food security are highlighted. It has been clarified that the creation of integration structures is one of the components of the mechanism of the food security at the macro, meso, and micro levels. The optimal parameters of integration agroindustrial structures have been determined for various investment scenarios. The study has found that the integration processes in agricultural production, on-farm industrial processing of milk and meat contribute to a higher value of net present value. The level of riskiness of creating an agro-industrial formation with a full production cycle based on simulation modeling has been justified.

Аннотация

В статье представлены результаты оценки продовольственной безопасности, определяющая роль в обеспечении ее отводится производству сельскохозяйственной продукции. Анализ обеспеченности населения основными продуктами питания обусловил необходимость наращивания отечественного сельскохозяйственного производства. Несмотря на реализацию государственной политики импортозамещения, при сложившихся условиях деятельности аграрных предприятий возникает риск дальнейшего снижения продовольственной безопасности России. Выделены стратегические приоритетные направления и инструменты достижения продовольственной безопасности. Уточнено, что создание интеграционных структур представляет собой одну из составляющих механизма взаимосвязи продовольственной безопасности на макро-, мезо- и микроуровне. Определены оптимальные параметры интеграционных агропромышленных структур при различных инвестиционных сценариях. В ходе

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Keywords: Food security, management, integration formations, AIC investments, state investment policy.

исследования установлено, что интеграционные процессы в сельскохозяйственном производстве, внутрихозяйственная промышленная переработка молока и мяса, способствуют получению более высокого значения чистого дисконтированного дохода. Обоснован уровень рискованности создания агропромышленного формирования с полным циклом производства на основе имитационного моделирования.

Ключевые слова: продовольственная безопасность, управление, интеграционные образования, АПК инвестиции, государственная инвестиционная политика.

Introduction

The problem of achieving food security has not lost its relevance for several decades. Russia, like other countries of the world, included food security in the concept of national security as one of the most important elements of social and economic policy. Achieving food independence is inextricably related to overcoming risks and threats of various kinds: migration outflow from rural areas, low incomes of the majority of the population, underdeveloped infrastructure, significant depreciation of fixed assets from producers, etc. At the same time, they continue to remain very controversial and require clarification of the area and tools to achieve food security.

Due to inconsistency of actions in the system of distribution of agricultural food products, a multicomponent relationship persists, there are a large number of intermediaries, and quantitative and financial "transparency" of commodity flows of agricultural products and processed products is not ensured. In order to solve this problem, an attempt was made to select the most effective forms of integration structures in agricultural production, taking into account the introduction of resource-saving technologies, the development of import-substituting and export-oriented industries using their own raw materials, and the production of environmentally friendly products.

Methods

The research is aimed at developing and substantiating scientific and practical recommendations for ensuring the food security of the country and regions by creating agroindustrial integration formations with a full production cycle. The research objectives are defined:

- to identify the current challenges and threats to food security in Russia;
- to highlight strategic priority areas and tools for achieving food security;
- to determine the optimal parameters of the integration agroindustrial structures in various investment scenarios; and
- to substantiate the level of riskiness in creating an agroindustrial formation with a full production cycle based on simulation modeling.

In the context of the globalization of agri-food markets, many researchers associate food security with the efficiency of agricultural production, security of food products, and the availability of processing in the supply chain. The works of Cole M. B. (2018), Alston J. (2000), Altieri M. A. (2012), Buks J. (2016), Pérez-Escamilla R. (2017), Charles H. (2014), Diouf J. (2009), Castro J. (2015), Fischer C. (2008) are dedicated to the problems of the developing the agroindustrial complex, and the creation of organizational and production structures within the framework of achieving food security. The practical implementation of food security technologies is presented in the works of Campbell H. (2009), Keyzer M. A. (2007), Pingali P. (2005).

In particular, Martin Barry Cole points to the need to stimulate the introduction of new technologies in agricultural production as part of achieving food security (Cole, 2018). Adhering to this opinion, the authors should add that the widespread introduction of technical and

technological innovations in production would allow for more efficient use of available resources. There are significant reserves for increasing the efficiency of agricultural production, which can be realized by optimizing the scale of production.

Results

Food security, which represents an unstable state depending on various combinations of institutions and mechanisms of their interaction, occupies the central place in the national security system of Russia. The problem is particularly relevant because of the ongoing geopolitical changes in the development of the country (Sekerin, 2018; Dudin, 2016; Sekerin, 2017). It is not surprising that in 2010 the Doctrine of Food Security of the Russian Federation was adopted (On approval…Decree of the President of the Russian Federation dated January 30, 2010 under No. 120). The document states that the "food security is the state of the economy, in which food independence is ensured, implying physical and economic access for the country's population to the agri-food products that meet the requirements of technical regulations in volumes not lower than rational consumption standards required for active, healthy lifestyle."

The level of food security is calculated as the proportion of domestic agricultural products in the total volume of commodity resources of the domestic market. It is considered that when supplying the population with domestic food, the indicator should be more than 85 % for meat and meat products, 90 % for milk and dairy products, and 95 % for potatoes (Table 1).

Table 1. Balance of agricultural products in Russia (Dudin, 2016)

Indicator	Milk and dairy products, million tons					Meat and meat products, million tons				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Resources	41.9	40.8	40.3	39.0	38.0	11.9	11.7	11.8	12.2	12.2
Opening stocks	2.0	2.1	1.9	1.7	1.6	0.9	0.8	0.8	0.8	0.9
Production	30.8	30.8	30.8	30.2	30.6	9.1	9.6	9.9	10.3	10.6
Import, including import	9.2	7.9	7.5	7.1	5.7	2.0	1.4	1.1	1.1	0.8
Use	41.9	40.8	39.7	39.0	38.9	11.9	11.7	11.9	12.2	13.2
Production consumption	3.5	3.3	3.2	2.9	2.7	0.1	0.0	0.0	0.0	0.0
Losses	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.0
Export, including export	0.6	0.6	0.6	0.6	0.6	0.1	0.1	0.2	0.3	0.4
Personal consumption	35.7	34.9	34.2	33.9	33.1	10.9	10.7	10.8	11.0	11.0
Closing stocks	2.1	1.9	1.7	1.6	1.6	0.8	0.8	0.8	0.9	0.8
Proportion of imports in commodity resources, %	21.8	19.4	18.7	18.3	15.0	16.4	11.6	9.5	9.0	6.5
Level of self-sufficiency, %	78.6	80.4	82.3	82.0	83.2	82.8	88.8	91.1	93.3	87.7

The analysis of the staple food supply to the population necessitated the buildup of domestic agricultural production. In 2018, self-sufficiency in meat and meat products as the ratio of production to domestic consumption taking into account losses amounted to 88 %. Russia has achieved self-sufficiency in meat and meat products mainly due to the production of poultry meat. Beef imports account for 19 % of its total consumption. To replace this amount, it is necessary to increase production by 450 thousand tons over the next seven years. The level of self-sufficiency in milk and dairy products, despite the growth trend, is significantly lower than the threshold value (in 2018 – 83 %).

The level of national staples self-sufficiency is growing. In particular, the indicator for meat increased by 4.9 percentage points in 2014 – 2018. This trend is due to the government policies aimed at replacing imports due to the embargo imposed in response to the sanctions of the EU countries and the USA.

For many socially significant products (animal oils, powdered milk and cream, sugar), an unstable tendency to decrease is observed. The share of imported food in most commodity resources tends to decrease (Figure 1). Nor has it yet been possible to substitute such a product as fish, the share of imports of which in 2018 amounted to 34 % (the indicator increased by 4.4 pp over the last three years). The response to the imposed foreign sanctions and the ban on the import of certain types of products further aggravate the problem of food security.

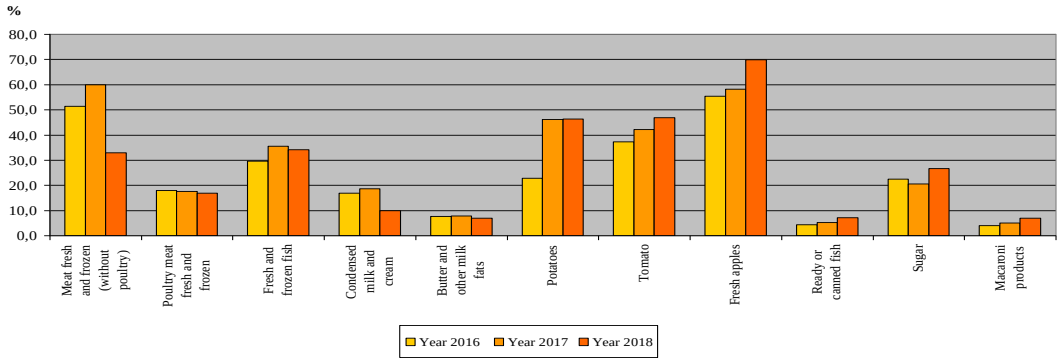


Figure 1. Share of imports of individual goods in their commodity resources (Federal State Statistics Service, n.d.)

Over the last decade, key links in the agricultural production chain, including processing, storage, and marketing, have been significantly changed in the Russian agricultural sector (Trubilin, 2017a; Gaiduk, 2017a). Under these conditions, a set of imbalances is inevitably manifested:

1. The existing raw material base does not provide a full load of food and processing industries. An increase in the production of all types of agricultural products, in particular livestock, is required.
2. The insufficient level of the production infrastructure development is caused by the shortage of modern vegetable stores, fruit stores, logistics complexes, as well as trade and procurement and service centers that ensure the coordination of agricultural producers with distribution networks.
3. Lack of greenhouse complexes providing year-round supplies of agricultural products, lack of enterprises for the industrial processing of livestock products and crop production.

Under the conditions of economic sanctions, restrictions on imported products contribute to the expansion of the market niche of Russian agricultural producers in the domestic market due to an increase in production volumes. In the framework of ensuring food security, the need for institutional and infrastructural transformations should be noted:

- Creation of financial and guarantee mechanisms;
- Development of social, industrial, and market infrastructure (Dudin, 2017);
- The need to introduce innovative technologies (Trubilin, 2017b);
- Reduction of dependence on imported agri-food products; and
- Greening of production processes against the background of a decrease in anthropogenic impact on the environment.

The most important area of ensuring food security should include the reformation of the infrastructure support system for the AIC based on the active development of resource-saving technologies and technical and technological updating (Gaiduk, 2018; Gayduk, 2017b). The authors consider it economically feasible to invest in agricultural complexes, which will contribute to increasing the concentration of capital and increasing efficiency due to the scale effect, improving the structure of relations between enterprises in the industry.

The backwardness of organizational and economic relations within the AIC, the aggravated disparity in prices, the problem of the balanced development of production and technological infrastructure, and the increasing

rise in prices for means of production make it difficult to implement investment innovative projects in the AIC. Therefore, an own raw material base and an established sales system will make it possible to level out the market imperfection caused by the dictate of prices from the largest domestic and foreign agricultural processors. Own raw materials base should provide cost savings, an increase in the quality of products. Closed-cycle enterprises are successfully occupying market niches and are gradually expanding their product range.

The creation of integration structures is one of the components of the mechanism for the interconnection of food security at the macro, meso, and micro levels. After all, the formation of integrated agroindustrial structures can be considered as the most important condition for the stable functioning of the AIC at the level of the country, region, or economic entity. After all, agro-industrial integration contributes to the adaptation of all participants to transformational economic conditions, decrease in production costs, and attraction of additional investment.

Discussion

A. Assessment of the effectiveness of the formation of integrated structures in the AIC

The multidirectional nature of the economic interests of economic entities within the agro-industrial complex necessitates the creation of multidisciplinary agroindustrial formations that contribute to reducing investment risks and solving the problems of inequivalence of exchange-distribution relations.

The paper evaluates the economic efficiency and riskiness of organizing an integrated complex for the production, processing, and marketing of agricultural products using the example of the agricultural enterprise of Vesna AF OJSC in the Krasnodar Territory. The purpose of the investment project is to organize a cost-effective import-substituting environmentally friendly production of meat and dairy products based on the cultivation of high-yield breeds of dairy and beef cattle using modern technology for animal management and feeding. The planned economic effect can be obtained through the introduction of modern resource and energy-saving technologies, which can reduce the average consumption of labor costs and electricity.

When assessing the effectiveness and riskiness of the investment project of the organization of integrated agricultural formation, several situations have been analyzed. The first scenario with an eight-year planning period assumes a dairy products line; cattle fattening complex of cattle and pigs, fodder production. The necessary volume of investments in construction, the acquisition of production lines, the coverage of the need for working capital is 12,538 thousand dollars.

The activity of dairy products line involves the cultivation of cattle of high-yield meat and dairy breeds. The complex will be equipped with a high-performance foreign-made milking parlour (De Laval), loose-housing boxes, and a veterinary control system. Premises for livestock are equipped with a water piping, manure removers, and a system for heating young stock. A necessary part of the project is the acquisition of high-yield Holstein cattle.

The cattle fattening complex with a daily output of 1.2 tons of live weight of the product is aimed at providing the killing and sausage manufacturing rooms with raw materials. It is planned to build houses, loafing areas, and a manure removal system. The conditions for the maximum comfortable animal management will correspond to the modern requirements for the placement of animals, ventilation, and the use of a loose-housing system. Optimum conditions of managing and fattening will contribute to obtaining high average daily weight gain due to better absorption of feed, and, consequently, reduction of days of fattening and cost reduction. As part of the project, it is planned to use an optimized fodder production system, namely, to use fodder distributor mixers. Mobile fodder distributor mixers provide fast preparation and distribution of precisely balanced own-produced feed mixtures, which is a great advantage when creating a competitive livestock division. At the same time, each feed group of animals receives a diet with the exact weight dosing of the individual components. Feed milling production will allow producing feed for livestock line as well as compensate for the lack of quality feed for third-party farms of the region.

Along with the cattle fattening complex, it is also planned to organize a commercial pig farm with a daily supply of products up to 1.7 tons of live weight of pigs. The pig-breeding complex is intended for fattening pigs using modern Danish technologies, feed production systems, automatic feeding, ventilation, and manure removal systems. To obtain pigs at a commercial farm, it is supposed to raise 208 productive yielding sows

of the Yorkshire and Landras breeds with improved productivity indicators.
Along with the organization of a dairy products line, a cattle and pig fattening complex, the second investment scenario provides for investments in dairy production using produced raw milk and raw materials from third-party enterprises in the region; slaughtering and killing of cattle and pigs; and production of sausage products. As part of creating a closed production cycle, the second investment scenario provides for the construction of a dairy factory with daily design capacity of more than 5 tons of milk. The planned activity of the enterprise will be the production and subsequent sale of high-quality dairy products: pasteurized milk, sour cream, kefir, cheese, cottage cheese, and butter. It is planned to erect a milk factory building with a total area of 2,000 m2. For the storage and processing of raw materials, production is equipped with its own warehouses and refrigerators. Quality control of dairy products is planned to be carried out at all technological stages. The Gascoine Mellote LLS company, which has a research center for the development of systems and technologies for the production and processing of milk, has been selected as the supplier of equipment for the production of dairy products. The work of the unit is possible both with its own and with customer-owned raw materials (milk from farms and enterprises of the region).

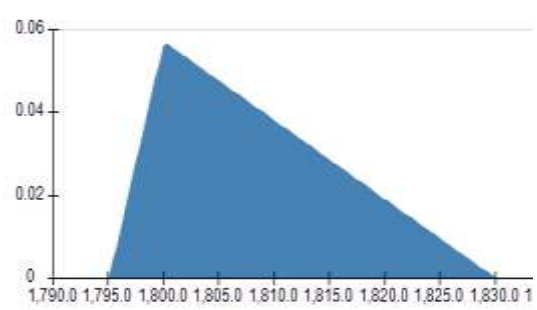
The second investment scenario was supplemented by the organization of a killing room with an annual capacity of 1,500 tons, which will allow obtaining high quality chilled semi-finished meat products as well as fresh raw materials for premium sausages. The planned room will carry out the killing and slaughter of cattle and pigs supplied both from own livestock farming and other enterprises of the Southern Federal District. To implement the investment project, the construction of the building of the sausage room and the purchase of domestic and foreign equipment will be required. Currently, the company has nonfunctioning killing premises, in which the necessary communications will allow organizing the killing technological process. The technological cycle will be located on a single industrial site with a high degree of blocking of buildings and facilities, optimization of commodity and transport flows, strict observance of veterinary and sanitary standards, and environmental requirements. The room is planned to be equipped with modern high-tech equipment with killing, slaughter, primary cutting, straight (lump) cutting lines, and an industrial refrigerator.

Based on government objectives for the accelerated development of AIC industries and taking into account the expected growth in demand for high-quality dairy and sausage products, the existing processing enterprises do not fully cover the growing needs. The project planned for implementation is aimed at the annual processing of about 8,400 tons of milk and the production of 2,544 tons of sausage products.

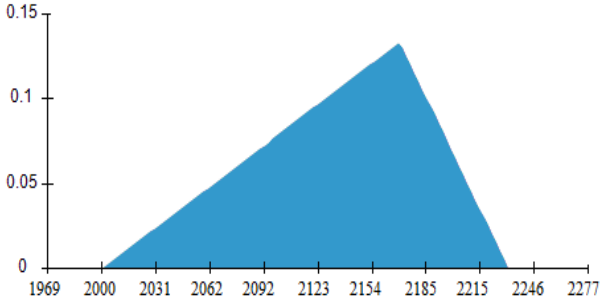
Under the second project, the volume of investments in the implementation of construction and installation works, the acquisition of technological equipment and floating assets will increase up to $15,277 thous. Significant investments require an assessment of effectiveness, taking into account the impact of uncertainties in the internal and external environment. The greatest riskiness of the project is due to the influence of manufacturing expenses and product prices. Risks should include errors in assessing the level of demand for fodder and dairy products, inaccurate release dates, production output; fluctuations in the prices of raw materials used, etc. The analysis of the risks that affect technical and economic indicators will help to adjust the magnitude of the integral economic effect.

B. Justification of the level of riskiness of agricultural formation based on simulation modeling

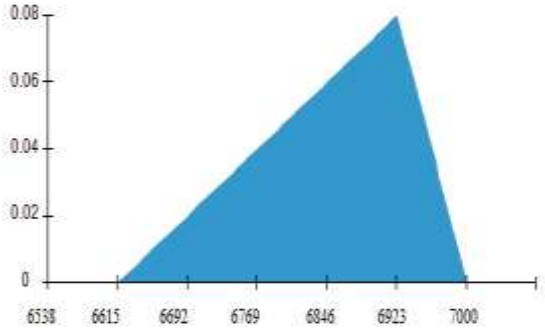
To clarify the role of creating integrated structures as an element of ensuring the interconnection of food security at the macro, meso, and micro levels, the effectiveness and riskiness of the second investment project, supplemented with the industrial processing of milk and meat, were assessed. When assessing investment risks, the Monte Carlo method has been used, which allows predicting the studied economic area taking into account the most important dependencies between the elements. The following risk factors were selected in the project: sales prices for agricultural and food products, prices for raw materials used; level of demand for manufactured dairy and sausage products, production costs (Figure 2).



1) Demand for dairy products, t. Mathematical expectation – 1,800, maximum – 1,830, minimum – 1,795.



2) Prices for dairy products, USD/t. Mathematical expectation – 2,154, maximum – 2,231, minimum – 2,000.



3) Prices for cheeses produced, dollars/t. Mathematical expectation – 6,923, maximum – 7,000, minimum – 6,615.

Figure 2. Distribution of probability when changing individual parameters of the investment project for the creation of an agroindustrial formation

When analyzing the probability of net present value, the authors used the normal and triangular distribution of key parameters. The expected value of the indicator is the average value under the results of all experiments. The risk assessment analysis provides an assessment of the standard deviation of the possible value of the effectiveness from the expected level.

Table 2 presents the indicators of economic efficiency and riskiness of the second investment scenario.

Table 2. Economic efficiency and riskiness of investments in organizing a vertically integrated complex on the basis of an agricultural organization

Indicator	Value
Investments for construction and installation works, floating assets, acquisition of production technological lines, thousand dollars	
Share of the borrowed capital for the project, %	20
Net discounted income for all simulation experiments, thousand dollars	1,357
Discount rate, %	20
Probability of income under the project, %	81
Probability of losses under the project, %	19
Coefficient of variation, %	46
Investment profitability index	1.3
Discounted payback period, years	3.4
Internal rate of return, %	38

An assessment of the economic efficiency and riskiness of the investment project indicates that in 2020 – 2028 the average net present value for all simulation experiments will amount to 1,357 thousand dollars (Figure 3)

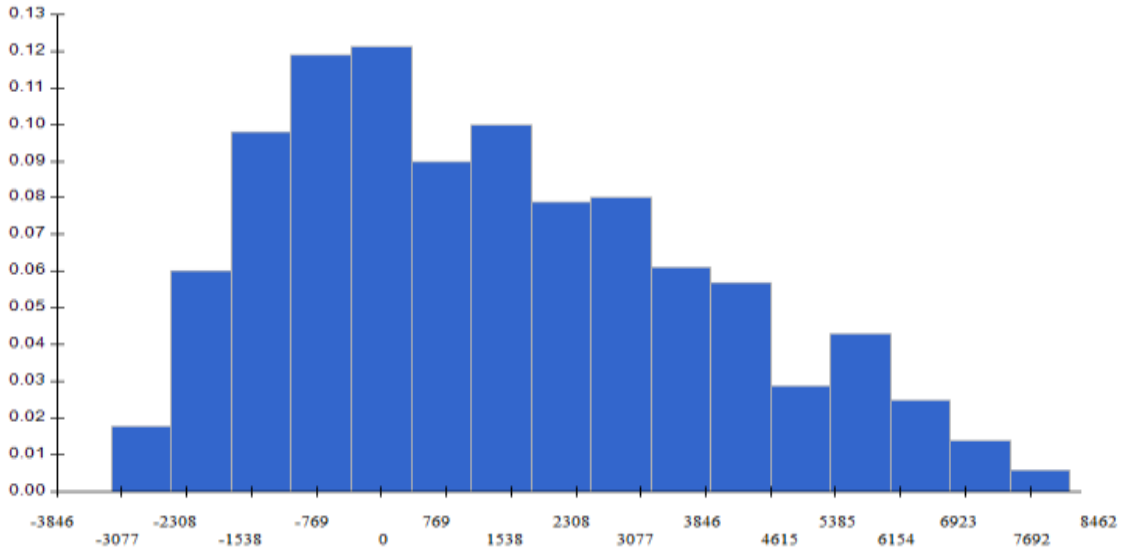


Figure 3. Frequency of distribution of net present value for the project

When investing in the organization of a vertically integrated complex for the production of agricultural products, the industrial processing of milk and meat, the coefficient of variation was 46 %. The probability of obtaining an economic result above zero under the investment project reaches 81.4 %. The probability of obtaining a negative net present value is 18.6 %.

The studies have shown that integration processes in agricultural production, namely the addition of industrial processing of milk and meat, contribute to a higher net present value (Gaiduk, 2017a; Gaiduk, 2018; Gayduk, 2017b). In the industry under study, risk level forecasting should be carried out using simulation modeling.

Conclusion

The conducted studies allow drawing a number of the following important conclusions.

1. In recent years, agricultural production has been developing. The introduced economic sanctions under the conditions of insufficient state support had impact on the development of the agri-food sector in several areas. This dependence was especially evident in the unstable growth in production volumes of the main groups of food and agricultural products, a sharp drop in the consumer demand, a rise in the prices of food, and an increased level of import dependence of agricultural producers on imported equipment, seeds, and materials. The creation of a single, organized, and stably functioning national agri-food market capable of producing a significant multiplier effect is a complex process of forming a system of new institutions and relations, accompanied by the search for their optimal forms and contents as well as methods and tools.
2. It has been established that the formation of integration structures can be considered as the most important condition for the stable and effective functioning of the AIC at the level of a country, region, or economic entity. The creation of integration structures is one of the components of the mechanism for the interconnection of food security at the macro, meso, and micro levels. After all, agroindustrial integration contributes to the adaptation of all participants to transformational economic conditions, decrease in costs, and attraction of additional investment.
3. To clarify the role of creating integrated structures as an element of ensuring the

inter-connection of food security at the macro, meso, and micro levels, the effectiveness and riskiness of the investment project, supplemented with the industrial processing of products, were evaluated. When assessing investment risks, the Monte Carlo method was used, which allowed predicting the studied economic area taking into account the most important dependencies between the elements. Using the proposed methodological apparatus, it is possible to solve a number of problems related to determining the efficiency of investments in the formation of integrated structures in the AIC, which ensure a sufficient income level for reproduction.

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