

Inno-Diversification Approach to Regulating the Dairy Industry Transformation Into the Digital Economy

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Abstract—The necessity of developing and forming a system of state regulation of the agro-industrial complex on the basis of the Inno-diversification approach is methodically substantiated. The term Inno-diversification has been introduced into scientific circulation, which characterizes the penetration of novelties (innovations) into new areas (diversification), which gives a synergistic effect as a result of their combination. An Inno-diversification approach is proposed as a complex of innovative, diversification and synergetic approaches, the combination of which strengthens their advantages and compensates for their disadvantages. The Inno-diversification approach involves a targeted change in the functioning of an organization as a single management object, a combination of original research methodologies with specific organizational forms of their conduct and a set of principles, the basis of which is the consideration of objects as self-organizing systems. Based on a morphological analysis of various sources of information, a system for the development of organizations of the agro-industrial complex was proposed, which is a closed system consisting of four main elements: causes, aims, functions and principles of state regulation of the agro-industrial complex. The essential structure of the functioning system is a chain, the first link of which is the sphere of agriculture, the second – of industry and the last one – of services. It is proposed to consider the essential model of the digitalization system of state regulation of the dairy industry as a closed system consisting of three elements: state regulation, digitalization and parameters of the industry itself. The novelty of the author's proposals are: inno-diversification approach, the development system of organizations, the essential structure of the functioning system, the essential model of the digitalization system of state regulation of the dairy industry.

Keywords: *Inno-diversification, digitalization, regulation, dairy industry*

I. INTRODUCTION

The agro-industrial complex (AIC) in general and the dairy industry in particular have been and remain important sectors for the Russian economy and make a significant contribution to the country's food security. Currently, the Russian Federation is one of the leading countries in the world for the production and processing of milk, however, the livestock productivity of the dairy herd is more than twice lower than in developed countries.

‘Constraining factors of the dairy industry development include the import into the country of cheaper similar products from Belarus, which is ensured by a high level of state support for producers in importing countries’ [1, p. 10]. Therefore, in order to eliminate the lagging behind of the dairy industry in Russia, it is necessary to increase the volume of state support for this industry [2]. In its turn, in order to determine the necessary level of effectiveness of such support, it is necessary to determine the mechanism of its impact on the main indicators of the dairy industry. It is advisable to present such a mechanism in the form of a digital model.

II. LITERARY REVIEW AND RESEARCH METHODS

A. *Theoretical and methodological foundations for the use of research methods*

The conducted analysis of the dairy industry state in the agro-industrial complex revealed the following trends [2]:

1. State regulation has a direct impact on the state of the dairy industry in the region.

2. Improving the production efficiency in the industry is primarily possible by improving the digitalization system, which can significantly increase the productivity of the dairy herd.

3. Improving the system of digitalization of state regulation poses the challenges of developing information and computer technologies (ICT), allowing to model and predict the effectiveness of regulatory impacts.

4. For the development of ICT, it is necessary to develop various software and, first of all, the main of them all – the mathematical one.

Similar trends are noted by other researchers. In particular, the aim of the study by A.A. Kuzina et alia [3] was to substantiate the concept of the dairy industry development in Russia and to develop forecast scenarios of its functioning based on the implementation of the best digital technologies. They reveal the features of the functioning of the industry and the contradictions caused by them. They concluded that it is possible to effectively develop the industry only with a balanced state policy that considers international experience and the challenges that the industry has to face. Kuzina A.A. et alia offer a conceptual model for the development of the Russian dairy industry based on the best digital technologies. They conclude that the development and implementation of the best digital technologies at dairy enterprises using foreign experience and state regulatory instruments can serve as a response to the system-wide and rapid transformations currently taking place in the industry.

The subject of research by Savchenko A., Salyamon-Mikheeva K. Golinskaya M. [4] was the theoretical and methodological foundations of the use of mathematical modeling methods for analysis and audit of key economic indicators of economic entities on the example of the dairy industry. To achieve this goal, they used a system of general scientific and special methods. The research was conducted using regression analysis, namely ridge regression, which distinguishes the effect of each factor on multicollinearity.

B. Morphological analysis

Morphological analysis was chosen as a preliminary research method, which is an effective methodological approach – a way of seeing and a generalized attitude to reality. Fritz Zwicky [5] proposed to generalize and systematize the concept of morphological research and include in it not only the study of the forms of geometric, geological, biological and generally material structures, but also the study of more abstract structural relationships between phenomena, concepts and ideas, whatever their nature is. Morphological analysis is just an ordered view of things.

Morphological analysis is based on the concept of a universal connection between all objects, events and spheres of reality. ‘...in the final and true image of the world, everything is related to everything, and nothing can be discarded a priori as insignificant’ [5].

According to this approach, creativity is simply a combination of seemingly different things and parameters, as well as a combination of disparate pieces of information from

various areas that are usually not obvious and are not interconnected.

Morphological analysis (MA) [5] or general morphological analysis (GMA) [6] is a method for creatively solving multidimensional, complex problems by systematically structuring them and exploring the space of all possible solutions, as well as an effective tool for developing creative ideas and designing new products, technologies and services.

The method is based on the analysis of attributes and parameters of the system, the generation of alternative options for their presentation, as well as the creation and selection of their new combinations.

Morphological analysis requires the determination of all possible elements on which the solution of the problem may depend, listing the possible values of these elements, and then it is necessary to generate alternative solutions by enumerating all possible combinations of these values.

C. Inno-diversification approach

The term ‘Inno-diversification’ [7] has been used by the scientific community since 2016 and characterizes the penetration of novelties (innovations) into new areas (diversification), which gives a synergistic effect as a result of their combination. Table I summarizes the main advantages and disadvantages of innovation and diversification [8-9].

A comparative analysis of the advantages and disadvantages of innovation and diversification (Table 1) showed that the common advantage of both approaches is the increase in competitiveness, which determines the effectiveness of the enterprise. Since innovation helps to increase the level of professional qualities, this will compensate for the need for highly qualified personnel for diversification. Innovation attracts the flow of investment, which is in dire need of diversification. The development of modern human intelligence in the process of innovation solves the problem of team cooperation, and the improvement of the senior management system solves the problem of decision making. Consequently, innovation can offset four of the six weaknesses of diversification.

TABLE I. COMPARATIVE ANALYSIS OF INNOVATION AND DIVERSIFICATION CHARACTERISTICS (COMPOSED BY AUTHORS)

Advantages <i>Innovation</i>	Disadvantages <i>Diversification</i>
Competitiveness increase.	
Development of professional skills.	Need for highly qualified personnel.
Investment inflow.	Investment need.
Development of modern human intelligence.	Problem of team cooperation.
Senior management system improvement.	Decision making problem.
Automation increase.	
Quality of goods and services improvement.	
Reduction in natural resource consumption.	
Meeting the needs of the population.	
	Time delays until profit.
	Lack of information.
Diversification	Innovation
Competitiveness increase.	
Risk redistribution.	Risks of inflation and unemployment.
Creditworthiness improvement.	High price.
Industry rise.	
Reduction in dependence on a single product or market.	
	Imperfection of training and retraining programs.
	Imperfection of technical and technological base.

In its turn, diversification by redistributing risks can reduce the risks of inflation [10] and unemployment [11] inherent in the innovation process, and increased creditworthiness will smooth out the high cost of innovation. Consequently, diversification can compensate for two of the five disadvantages of innovation. A one and a half times increase in advantages from the integrated use of innovations and diversification (Inno-diversification) and a two and a half times reduction in disadvantages gives a synergistic effect.

A synergistic approach to state regulation and stimulation of investment activity in the region aimed at solving economic problems associated with the dynamic development of the region's economy was investigated by O. Chernyshova in her thesis work [12].

Application in the study of a synergistic approach to state regulation and stimulation of investment activity allowed O. Chernyshova to redistribute investment flows in the economic system of the region; to formulate and form a model for the reaction of regional authorities to external influences, to determine the range of parameters within which the region's economy is stable, a strategy for regulating and stimulating investment activity in the region; to create a common methodology for managing the economic system in which the subjects of the regional economy are connected by investment flows and which allows the formation of institutions that do not lead to an increase in poor-quality manifestations.

Based on the results of previous researchers, further research can be based on the methodology of the Inno-diversification approach, which includes a combination of innovative, diversification and synergetic approaches using methods of economic interpretation of the obtained results, functional, comparative and statistical analyzes.

Advantages and disadvantages of the Inno-diversification process are shown in Table II.

TABLE II. ADVANTAGES AND DISADVANTAGES OF INNO-DIVERSIFICATION PROCESS (COMPOSED BY AUTHORS)

Advantages	Disadvantages
Inno-diversification process of the digital economy, being a symbiosis of innovation and diversification, in related business areas provides financial synergies from the general management.	For the process of Inno-diversification, in whatever area it is implemented, highly qualified personnel in the field of the digital economy will be required, therefore, a team for any area of the digital economy needs to be created from scratch, including senior managers, as the specifics of the areas with which the diversification risk is associated can differ dramatically.
The process of Inno-diversification through expansion is able to neutralize market fluctuations in seasonal business sectors, which include AIC.	It takes time to get financial returns from the process of Inno-diversification.
Successful expansion or merger as a result of Inno-diversification will increase the organization's profit.	Since the diversification risk of the digital economy is associated with the emergence of new industries, the 'transition' of traditional industries, and always a lot of money is needed for this appearance and expansion. And the more the spheres differ, the more funds are required for innovation.
The process of Inno-diversification gives the entrepreneur new points of support. Even if individual business sectors become unprofitable or the market changes to a new product, the diversity of production will not allow the company to go bankrupt.	Certain areas of entrepreneurship in the process of Inno-diversification can be unprofitable up to several years, which greatly increases the burden on the main type of business.
Using the process of Inno-diversification, it is possible to create closed production cycles, which reduces the dependence on related organizations.	

From the proposed terms and definitions follows the formulation of the Inno-diversification approach as a complex of innovative, diversification and synergetic approaches, the combination of which strengthens their advantages and compensates for their disadvantages. The Inno-diversification approach involves a targeted change in the functioning of the organization as a single management object, a combination of original research methodologies with specific organizational forms of their conduct and a set of principles, the basis of which is the consideration of objects as self-organizing systems.

III. RESEARCH RESULTS

With regard to the Inno-diversification approach implemented into the agro-industrial complex, digitalization is considered as innovation, and diversification implies its penetration into all sectors of the AIC, and specifically for the dairy industry, into all its spheres (agricultural, manufacturing

and services). The digitalization process itself should be regulated in the direction necessary for the state

A. The development system of the AIC organizations

Based on various sources of information [2; 13-19], a structure for the development of the AIC organizations was proposed (Fig. 1), which is a closed information system [20], consisting of four main elements: causes, aims, functions and principles of state regulation of the AIC. All of the listed components of the system elements are exemplary, not constant, and changing their components requires adjustment of other elements (one or more). Therefore, the system changes dynamically and the task of regulation is to determine the vector of these changes.

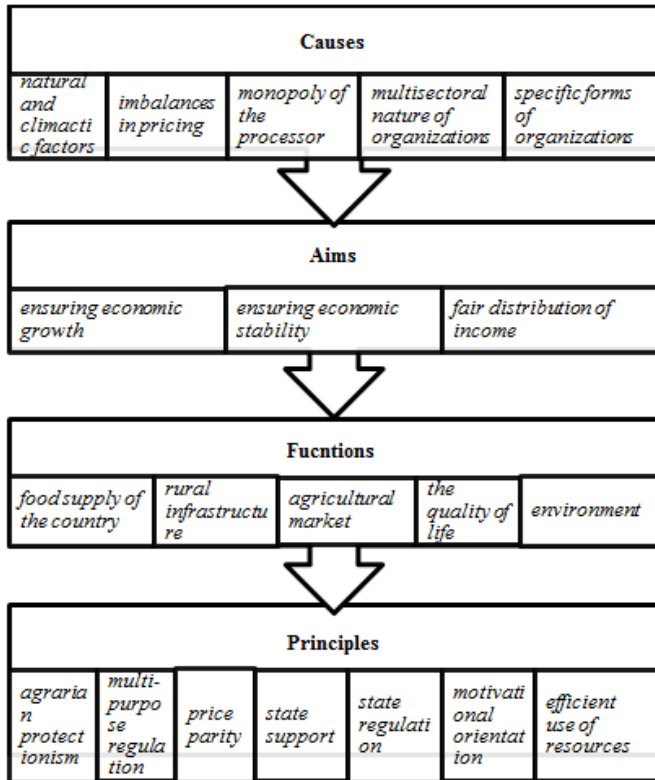


Fig. 1. The system of development of the AIC organizations (composed by authors)

B. The essential structure of the AIC

The agro-industrial complex in the Russian Federation structurally can be represented as a system consisting of three interconnected sub-complexes (Fig. 2), combining three areas of activity: agricultural (crop production, animal husbandry, etc.), industrial (processing of agricultural products) and services (agricultural products and products of its processing sales). The essential structure of the functioning system is a chain, the first link of which is the agricultural sector, the second link is industrial and the closing one – services.

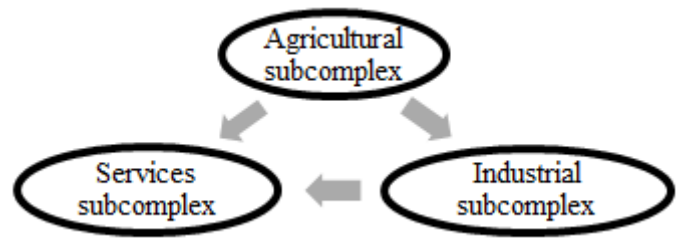


Fig. 2. The essential structure of the AIC (composed by authors)

C. The essential model of the digitalization system of the AIC regulation

It is proposed to consider the essential model of the digitalization system for the AIC regulation as a closed system consisting of three elements: state regulation, digitalization and parameters of industry objects (Fig. 3). The “State regulation” block through regulatory levers exerts disturbing impact on the “Digitalization” block. A reaction to the disturbing impact is the development of information and computer technologies that are transferred for use directly in the organization of the agro-industrial complex. The results of the application of information and computer technologies are analyzed and the effect (positive or negative) in the form of feedback is transmitted to regulatory authorities. The received response is analyzed, the regulatory actions are adjusted, and the system cycle is repeated.

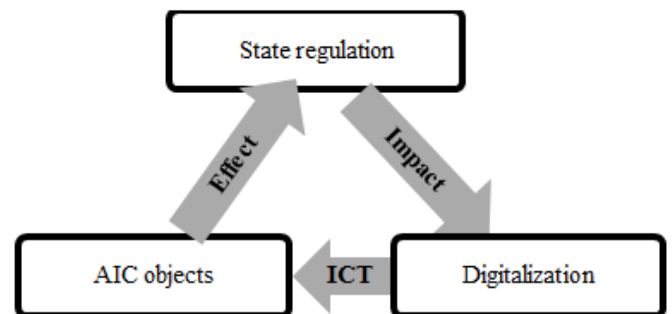


Fig. 3. The essential model of the digitalization system of the AIC regulation (composed by authors)

D. Morphological analysis of essential systems, structures and models

Morphological analysis of the essential model of the digitalization system of state regulation of the agro-industrial complex (Fig. 3) demonstrates that each of its elements can cover all areas of the essential structure of the agro-industrial complex (Fig. 2), creating a decision field (three by three) out of 9 possible combinations. In addition, each of these combinations includes all elements of the agro-industrial complex development system (Fig. 1), creating a volume of 36 possible combinations that can be depicted as a rectangular parallelepiped (Fig. 4).

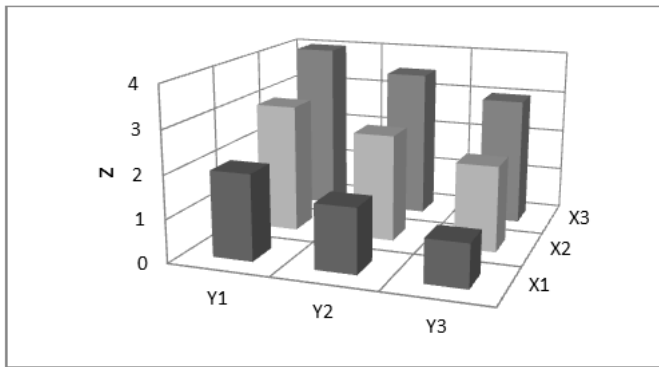


Fig. 4. Morphological rectangular box (composed by authors)

Fig. 4 shows the morphological rectangular box, which makes it possible to single out the most important for the analysis of the digitalization regulation parameter of the agro-industrial complex (Table 1), the variability of which is due to the elements of the essential model of the digitalization system (X), the structure of sub-complexes (Y) and the dynamics of the development of organizations (Z). The structural elements of the morphological box are shown in Table III.

TABLE III. ELEMENTS OF THE MORPHOLOGICAL BOX STRUCTURE (COMPOSED BY AUTHORS)

Digitalization systems	Of subcomplexes	Of organizations' development
X1 – Regulation	Y1 – Agricultural	Z1 – Causes
X2 – Digitalization	Y2 – Industrial	Z2 – Aims
X3 – Objects	Y3 – Services	Z3 – Functions
		Z4 – Principles

IV. DISCUSSION

The morphological box (Fig. 4) is a multidimensional matrix of the space of solutions, each axis of which acts as a subsystem and is associated with other subsystems, in some cases hierarchically (development system of organizations). The matrix allows you to determine possible configurations and limitations of consistency from the causes for the need to regulate the agricultural sector of the AIC (X1-Y1-Z1) to the principles of development of objects in the agricultural service sector (X3-Y3-Z4). This allows you to evaluate and choose the most productive ideas and solutions.

A. Analysis of the morphological model of the process of regulation of the AIC into the digital economy

All possible elements are determined from which the solution to the problems of transforming the AIC into the digital economy can be determined, possible values of the necessary ICT are listed, and then alternative solutions are generated by enumerating all possible scenarios to achieve the target values of the parameters of the AIC due to directed regulatory effects. For clarity, the volumetric matrix of the AIC was transformed into three flats by fields of activity, which are presented in Tables IV – VI.

TABLE IV. REGULATION MATRIX OF THE AIC TRANSFORMATION INTO THE DIGITAL ECONOMY FOR THE AGRICULTURAL SECTOR (COMPOSED BY AUTHORS)

Y1 – Agricultural	X1 – Regulation	X2 – Digitalization	X3 – Object
Z1 – Causes	Significant impact of natural and climatic factors Inadequate funding	Direct regulatory effect on the parameters of the agricultural sector (herd livestock, cow productivity, milk production)	The need to develop agricultural organizations to ensure food security
Z2 – Aims	A fair distribution of income among members of the society, providing equal chances in the market, fair market competition, etc.	Development of information and computer technologies for targeted regulation of the parameters of the agricultural sector	Implementation of information and computer technologies regulating the parameters of agricultural organizations
Z3 – Functions	Balanced economic growth through digital technology stimulation. Orientation of legislation on improving the quality of life of the rural population. Environmental protection and nature management	Analysis of the state of the agricultural sector. Development of software Algorithmization. Programming. Adaptation.	New business processes in agricultural organizations (smart farms, etc.), organizational structures, rules, regulations, new responsibility for data, new role models.
Z4 – Principles	Rational agricultural protectionism. Support, motivational focus, most efficient use of resources.	Changing the form of doing business in rural areas in a digital reality based on data	Transition to the business of agricultural organizations in digital reality based on data

TABLE V. REGULATION MATRIX OF THE AIC TRANSFORMATION INTO THE DIGITAL ECONOMY FOR THE INDUSTRIAL SECTOR (COMPOSED BY AUTHORS)

Y2 – Industrial	X1 – Regulation	X2 – Digitalization	X3 – Object
Z1 – Causes	The dependence of the producer on the local monopoly of the agricultural processor	Indirect regulatory impact on industrial sector parameters (dairy production)	The need to develop the processing enterprises (smart factories, workshops, sites, etc.) in a highly competitive environment
Z2 – Aims	Ensuring economic growth, which involves the economy progress of a state or region, which is expressed in changes in the general situation of the economy	Development of information and computer technologies for targeted regulation of the parameters of the industrial sector	Implementation of information and computer technologies
Z3 – Functions	Creation of a market production infrastructure in rural areas	Analysis of the state of the industrial sector. Development of software. Algorithmization. Programming. Adaptation	New business processes, organizational structures, rules, regulations, new data responsibility, new role models
Z4 – Principles	The combination of economic and social goals. Program-targeted regulation	Changing the form of business in processing enterprises in digital reality based on data	Transition to doing business in processing enterprises in digital reality based on data

TABLE VI. REGULATION MATRIX OF THE AIC TRANSFORMATION INTO THE DIGITAL ECONOMY FOR THE SERVICES SECTOR (COMPOSED BY AUTHORS)

Y3 – Services	X1 – Regulation	X2 – Digitalization	X3 – Object
Z1 – Causes	Imbalances in pricing between agricultural and industrial products. The diversified nature of organizations	Secondary indirect regulatory impact on the parameters of the services sector (consumption of milk and dairy products)	The need to develop trade enterprises (vending machines for food products, etc.) in a competitive environment
Z2 – Aims	Ensuring economic stability, which involves maintaining the stability of commodity prices, preventing and containing hyperinflation, etc.	Development of information and computer technologies for targeted regulation of the parameters of the services sector	Implementation of information and computer technologies regulating the system of trade organizations
Z3 – Functions	Creating a sustainable food supply system of the country. Formation of an efficiently functioning market for agricultural products, raw materials and food.	Analysis of the state of the service sector. Development of software. Algorithmization. Programming. Adaptation.	New business processes, organizational structures, rules, regulations, new responsibility for data, new role models.
Z4 – Principles	Establishment and maintenance of prices and incomes parity in agriculture and other sectors of the economy	Changing the business form of trade organizations in digital reality based on data	Transition to conducting business of trade organizations in digital reality based on data

B. The essential structure of the dairy industry

The morphological model (Fig. 4) developed for the AIC can be extended to its branches, especially to the problematic ones [21]. For example, despite the rather high level of food security achieved in the country, surpassing the targets of the ‘Doctrine of Food Security of in Russia’ [22] in most positions, the dairy industry is an unfortunate exception. The insufficient state support provided to the livestock industries as a raw material basis for domestic food and a slight expansion of the country's export potential characterizes the level of production efficiency and technical equipment of most AIC enterprises as low. To eliminate this problem, urgent measures are needed to strengthen state support measures and stimulate the AIC, primarily due to the effective transformation into the digital economy. To adapt the dairy industry to the morphological model of the AIC, it is enough to make adjustments: replacing the objects of the AIC in the essential model of the digitalization system of state regulation (Fig. 3) with the objects of the dairy industry, focusing on the features of this industry in the development system of

organizations (Fig. 2) and transforming the essential structure to the form shown in Fig. 5.

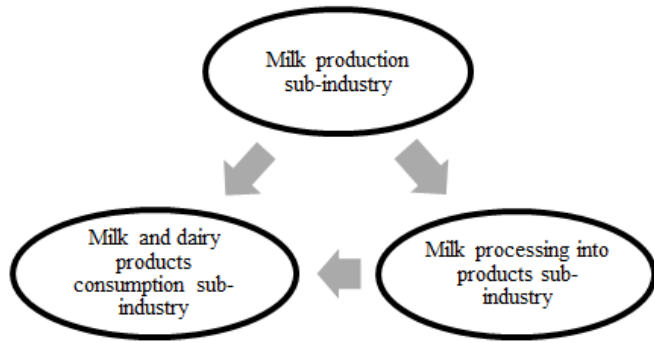


Fig. 5. The essential structure of the dairy industry (composed by authors)

V. CONCLUSION

According to the results of morphological analysis, it is possible to form areas of future research. The aim of further research should be to improve theoretical principles and develop practically important recommendations for predicting the effectiveness of regulation of AIC parameters in the context of transformation into a digital economy. To achieve this aim, the following tasks must be solved:

- clarify the theoretical foundations of improving the efficiency of regulation of the agro-industrial complex parameters in the context of transformation into a digital economy;
- assess the state of the AIC and its subcomplexes and industries;
- develop algorithms of mechanisms for regulating the agro-industrial complex, its subcomplexes and industries;
- propose digital technologies for the implementation of these mechanisms to forecast the results of regulation of the AIC parameters, its subcomplexes and industries;
- create scenarios for forecasting the results of state regulation of the AIC to achieve the set aims.

The novelty of the author's proposals are: inno-diversification approach, the development system of organizations, the essential structure of the functioning system, the essential model of the digitalization system of state regulation of the dairy industry.

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