

Organizational and economic aspects of the implementation of digital technologies in the innovative development of dairy cattle breeding

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Abstract — In article the main possibilities of the innovative development of milk cattle breeding are considered, approaches of use of digital technologies in data management by processes and forming of the organizational and economic mechanism designed to stimulate progress in science and technologies are investigated. The reasons for the slowdown in economic growth in the industry, which led to changes in the mechanism for managing innovative development, are revealed. The purpose of implementation of digital technologies is the acceleration of processes of the innovative development of the industry, increase in overall performance of the agricultural enterprises of milk cattle breeding and level of food supply. A key trend in the development of innovative control mechanism of dairy farming is the digitalization, based on the introduction of through technologies to the manufacturing processes, creation of new business - models of the market interaction between enterprises, using modular applications for a variety of practical problems. Tasks are defined and the structure of the organizational mechanism of management of the innovative development of the industry of milk cattle breeding on the basis of model the digital platform of agrarian and industrial complex as service which includes the Agriculture and Sustainable Development of Rural Territories subplatform, is offered.

Keywords — *dairy cattle breeding, digital technology, management mechanism, innovative development, Big data, state information systems (SIS), SC – analysis.*

I. INTRODUCTION

The situation on the market of products of dairy cattle breeding was a catalyst for reducing the level of development of this industry in RF [1, 2]. For the consumption of milk and dairy products, the values are below the recommended ones by nearly 40% and below the level of 1991 by 29.7%; consumption of meat and meat products has returned to the value as of 1991 due to the consumption of the cheaper poultry meat. For valuable and expensive beef, there was a decrease not only in the consumption structure, but also in production by almost 3 times (from 29.3 kg to 10.9 kg per capita).

The cattle breeding is the backbone industry of AIC, which development allows to use competitive advantages of the

Russian Federation in significant areas of agricultural lands [3, 4]. The current State program for 2013-2020 with subsequent changes in December 2014, made after announced sanctions and in order to ensure food security, was amended by the subprogram "Development of dairy cattle breeding", which makes the further development of the industry a priority of the first level in the field of production. The main objectives of the subprogram "Development of milk cattle breeding" are the accelerated import substitution, increase in efficiency and competitiveness of the industry that has to provide for the growth of specific weight of milk and milk products in the general resources from 76.6% of the actual level to 90.2% in the long term.

II. RESEARCH METHODOLOGY

In this connection, there is an actual task of developing the tools for accelerating the development of innovative dairy cattle, based on the introduction of digital technology, financial, economic and organizational interaction of subjects of innovation activity.

Understanding of the essential foundations of digital technology in the innovative development directs us to more detailed research from positions of positive and normative theories of market economy in relation to regional economy. The methodological basis is the dialectical method of scientific perception. In our opinion, the conceptual aspects in definition of digitalization in the innovative development of milk cattle breeding have to be considered on the basis of system, resource, behavioral and reproduction scientific approaches, which explain the objective patterns and the designing mechanisms of high-quality economic growth and effective development. The methods of analysis and synthesis, comparison and analogy were used in the research. As methodical base of this article, the normative and legal and program documents in the field of digitalization of agriculture and the innovative development of milk cattle breeding of the Russian Federation, including the specific region the Smolensk region were used.

III. RESULTS OF THE RESEARCH

The research showed that the number of cattle in farms of all categories of the Russian Federation during 1991-2017 was reduced by 57.2%, including cows for 49.8% that led to production cutback of milk for 41.3%, beef — by 15 times. It should be noted that there is the positive dynamics of growth in animal productivity. Thus, the average annual milk yield per cow is increased by 2.4 times, the increase in live weight per animal - by 18%. But, unfortunately, these processes are underdeveloped; they do not cover the general needs for these types of products.

The uniqueness of the industry of cattle breeding consists almost in universal placement across the territory of the Russian Federation. Currently, the largest number of cattle is in the Volga (28.33%), Siberian (20.82%) and the Central (14.2%) federal districts. The share of the Smolensk region in the CFD on this indicator has negative dynamics from 1991, there was reduction from 5.9% to 3.4%. The reduction in livestock led to the loss of a significant part of agricultural land and arable land, which are overgrown with shrubs and low forest.

TABLE 1. ANALYSIS OF THE PROFIT COMPOSITION AND DYNAMICS IN THE AGRICULTURAL ORGANIZATIONS OF THE SMOLENSK REGION, MLN RUB

Indicators	Years										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Revenues from the sale of goods, products, works, services	3768	4144	3537	3761	4012	5042	5962	6425	7850	8599	9286
Prime cost of goods, products, works and services sold	3745	4258	3663	4037	4171	5305	6664	5757	6991	7986	8431
Sales profit (loss)	23	-114	-126	-276	-159	-264	-703	668	859	613	855
Balance of other non-operational income and expenses	140	177	270	588	1355	342	213	517	565	542	538
Balanced financial result (profit minus loss)	163	63	144	312	326	78	-490	738	1053	872	695

First of all it belongs to the Non-chernozem zone of the CFD which in the course of the economic development generally specialized in the industrial milk and meat direction of cattle breeding.

The role of the country farms (CF) in development of milk cattle breeding of the Smolensk region is very insignificant. They produce less than 14% of all raw milk in the region. The main production of cattle breeding is concentrated in the agricultural organizations (SHO) where 75.3% of the general number of cattle, including 66.5% of cows contain. In structure of the general production of milk they occupy 58.4% that gives the grounds to assume about smaller productivity, than in the personal subsidiary farms (PSF) where 13.2% of the cattle, including 23.8% of cows are concentrated, their share in gross production of milk makes 28.5%.

The investment activity in milk cattle breeding depends on the level of profitability and provision of not only the self-sufficiency, but also the expanded reproduction [5, 6]. Dynamics of productive indicators of activity of the agricultural organizations of the Smolensk region (table 1) reflects losses from sale of products from 2008 to 2013 inclusive and positive dynamics of profit, since 2014.

Other revenues of the agricultural organizations are represented by the subsidies and grants from the state, their sum covers all expenses, except for 2013. Owing to the governmental support, the agricultural organizations had the undistributed earnings, required to operate in a market economy. The value of this indicator varies significantly over the years, which affects the sustainability of further development. By 2017, the situation has worsened due to the fact that agricultural commodity producers are forced to

annually spend the considerable funds from the profit in order to cover the additional expenses, caused by the inflationary processes. [7]. It is established that the branch profitability indicator should be in the range of 30-35% to ensure the extended reproduction 5-7% per year. Reduced economic efficiency remains one of the main factors of reducing production both in general and in the cattle breeding branch.

Research shows that there is a whole range of problems in the activities of agricultural organizations engaged in dairy cattle breeding: insufficient level of innovation development; low rates of industry modernization, renewal of basic production assets and digital transformation; financial instability, lack of own funds and difficulty in attracting investments; shortage of qualified personnel and others. In the strategy of the innovative development of agrarian and industrial complex and long-term State program until 2020 the importance is given to the forming of the organizational and economic mechanism of management of innovations. Necessary changes in it are connected with implementation of digital technologies. The efficiency of the enterprises of milk cattle breeding will increase due to widespread introduction of new digital and through technologies, the innovation business models of market interaction of participants on the basis of model the platform as service.

Obviously, such a concept provides for the integration of information resources (IR), software (SW) and information systems (IS), since digitalization as the basic elements is represented by continuously transforming integrated product-service systems (PSS). Without it, it is impossible to imagine the innovative development of dairy cattle breeding [8].

The mechanism of management of the innovative development is designed to stimulate progress in science in milk cattle breeding and technicians, to promote implementation of resource-saving technologies. In our opinion, the organizational and economic component of the innovative development of dairy cattle breeding should be a structure of the main information and financial flows in conjunction with the financing structure of the innovation process participants.

Information needs of the sphere of management of the innovative development of milk cattle breeding have to be satisfied on the basis of forming of effective accounting and reporting system, completeness of these operating information systems of the Ministry of Agriculture of the Russian Federation (FGIS) and the region which operators are specialized departments. The Analytical Center of the Ministry of Agriculture of Russia performs the function of data collection and aggregation. According to experts, Federal State Information System capacities are used by only 2-3%, it is necessary to increase the efficiency of their use. Own automated information systems (AIS) are deployed not in all regions yet, herewith, the level of development of regional information systems has essential differences. There are regions - leaders, which have their own automated information systems (AIS) deployed. The leaders constitute less than the half of the required amount, the others either have no own AIS, or they are being developed. Smolensk region is not among the leading regions.

Digitalization of agro-industrial complex provides use at all levels of through technologies effective in the long term,

TABLE 2. ANALYTICAL BLOCKS OF INDICATORS OF INNOVATIVE DEVELOPMENT OF DAIRY CATTLE BREEDING

No.	Name	Data sources
1	Social and economic conditions of activity	Federal State Statistics Service, Central Statistical Database
2	Population size and composition	Federal State Statistics Service
3	Employment and unemployment	Federal State Statistics Service
4	Indicators of living standards of the population	Federal State Statistics Service
5	Agriculture	Federal State Statistics Service
6	Educational potential of the population	Federal State Statistics Service
7	Technical and scientific potential	Data unavailable
8	Innovation activity	Data unavailable

This approach will allow to reveal influence of separate factors on quality of the innovation policy and efficiency of development of milk cattle breeding. Algorithms of calculation of the aggregated indexes which cornerstone comparison of the current indicators of development of the industry with forecast is can act as instruments of monitoring of system. Forecast indicators are given in the long-term national, targeted and regional Development programs. In turn, the quality of the

forecast indicators defining the level of development of milk cattle breeding depends on condition of information base

including Big data (Big data) as specific technology of processing of arrays of information and the Internet of things (IoT) as technologies of communication and information transfer on the Internet between the equipment and devices which will allow to increase visualization, objectivity and reliability of data, necessary for adoption of management decisions.

The existing structure of information flows, including available statistical information, is not compliant with the modern challenges of innovative development of dairy cattle breeding and does not adequately reflect the trends of ongoing changes. We suggest to add the structured system of indicators of the existing statistical reporting new, reflecting conditions and premises of the innovative development of the industry, the level of the state support and quality of scientific and technical potential.

To do this, it is required to use an organization of databases (DB) that allows to logically connect the essence of the phenomenon being studied, optimize the required information flows and speed up the obtaining of the necessary data on dairy cattle breeding. The solution of this task is accompanied by a structured system of indicators that have their specific place, a way of collecting and processing on the basis of clear, prescribed instructions of the Federal State Statistics Service. The analysis and comprehensive assessment of the information field indicators made it possible to determine that the system of indicators of innovative development of dairy cattle breeding should include the following analytical blocks (tab. 2):

which main source are data from departmental sources of statistical information and Russian Federal State Statistics Service.

The organizational mechanism of management of the innovative development of milk cattle breeding of the region on the basis of the digital platform of agrarian and industrial complex presented on figure 1 differs in the differentiated approach to forming of various forms of implementation of the innovation activity at implementation of the innovation projects belonging to the separate classes that allows to coordinate the innovation processes in the specified industry.

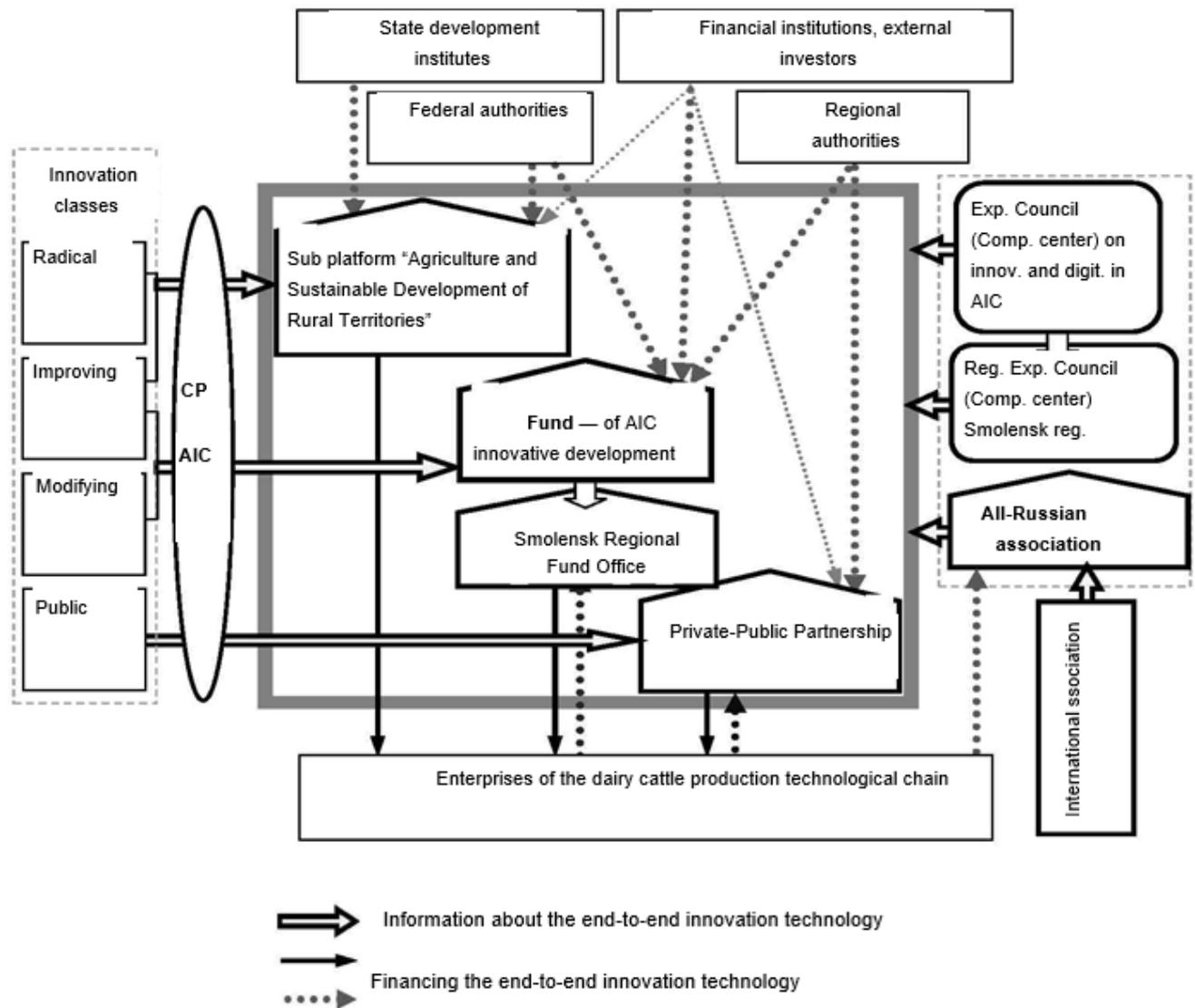


Fig. 1 The organizational mechanism of management of the innovative development of milk cattle breeding of the region on the basis of the digital platform of agrarian and industrial complex

IV. DISCUSSION OF RESULTS

The offered forms of implementation of the innovation activity accumulate financial resources for the purpose of investment into innovations in milk cattle breeding, improve interaction between science and production. The architecture of the digital platform of agrarian and industrial complex (the CPU of agrarian and industrial complex) is provided by the main spheres of agrarian and industrial complex. The Agriculture and Sustainable Development of Rural Territories subplatform contains smaller subplatforms of livestock production, including milk cattle breeding. The modern software in the field of milk cattle breeding has to combine the program modules solving various service problems at production of milk cattle breeding (API application) and the digital platform of forming of market chains of producers and consumers of products. Among large number of the program modules developed by Scientific Research Institute RAS and other organizations which can be included in the digital platform optimization of diets of feeding, planning of structure of herd and others are.

For operation of this mechanism through technologies of the distributed register and Big data are built in the Milk Cattle Breeding subplatform. Artificial intelligence systems and robotics can be used to control and create a “smart herd”. It should be emphasized that the creation of a complete digital platform is a very costly process. But it begins to gain steam not from scratch. And at the first stage the main question is selection of suitable program modules with the subsequent completion and reconstruction taking into account the established purposes and tasks. For these purposes, the mechanism provides for the formation of an expert council or a Competence Center for AIC innovations and digitalization.

It will be reasonable to offer also differentiated approach to forming of various forms of implementation of the innovation activity at implementation of the innovation projects belonging to the separate classes of innovations (radical, improving, modification and public).

Structures which create information flows of innovations and send them to the corresponding links of technology chain of production of milk cattle breeding, the All-Russian Association of producers and also Advisory council (The

center of competences) on innovations and digitalization in agrarian and industrial complex with representations in regions are.

Thus, the organizational mechanism for managing the innovative development of dairy cattle breeding includes the interaction of dairy cattle breeding enterprises through the digital platform of AIC and relevant sub-platforms with the authorities that provide for the reliable information about innovations, provide for the funding and implementation of these projects in this industry branch.

One of the directions of state financial support for the development of innovation and the achievement of financial sustainability of dairy cattle breeding enterprises are the measures to improve the availability of credits, which is ensured by the provision of subsidies for credits and loans. To increase the effectiveness of such a program, the condition of a more rigorous selection of submitted projects is required.

To evaluate and select innovative projects in dairy cattle breeding, it is required to determine: economic efficiency of production, the level of sustainability and competitiveness, the degree of innovation and riskiness. For this purpose we suggest to use in applications of application programs (API) of the subplatform "Agriculture and sustainable development of rural territories" the digital platform of agrarian and industrial complex for the solution of practical tasks technique of the system and cognitive analysis (SK-analysis). The use of SC-analysis involves the development of a stochastic model to study the influence of the main types of factors on the production, economic and financial performance [9, 10]. This method is also applicable when choosing not only the investment projects, but also scenarios of forecast development variants, as well as making management decisions in current activities.

According to the method, it is required to establish the upper and lower values of the factors under consideration (V_{max} and V_{min}), determine the scale factors (P), calculate

the values of the indicators selected for the assessment in relative standard units Y_i . Close attention should be paid to the factors that directly affect the established criteria for the selection of a project or management decision. We take into account that there are factors increasing the efficiency of the project, managerial decisions, and ones reducing it in the aggregate. For simultaneous accounting of influence of multidirectional factors we will use Harrington's function and function with double exponent which has upper and lower approach. As a result, we obtain a function that reflects the level of efficiency, and use it in solving practical problems.

$$Z_n = e^{-e^{P-Y_i}} Z_n = e^{-e^{P-Y_i}} \tag{1}$$

To match the values of the factors Y_i with the scale of the scale it is necessary to determine the appropriate scale factor

$$P = \frac{V_{max}-V_{min}}{Y_{max}-Y_{min}} P = \frac{V_{max}-V_{min}}{Y_{max}-Y_{min}} \tag{2}$$

where

V_{max} and V_{min} - the upper and lower bound of the relevant factor.

To calculate indicators in relative normative units, we use the formula

$$Y = Y_{min(max)} \pm \frac{V_i-V_{min}}{P} Y = Y_{min(max)} \pm \frac{V_i-V_{min}}{P} \tag{3}$$

where

V_i – the actual value of a particular factor.

The total level of economic efficiency is an integrated indicator, and it is calculated using the following geometric average formula

$$Z = \sqrt[n]{nZ_n} Z = \sqrt[n]{nZ_n} \tag{4}$$

where

Z_n – value of performance indicators, selected for evaluation;

n – number of efficiency indicators;

Z – final level of economic efficiency.

TABLE 3. COMPARATIVE CHARACTERISTICS OF THE EFFICIENCY OF PRODUCTION OF DAIRY CATTLE IN VARIOUS INNOVATIVE PROJECTS

Selected efficiency indicators (n)	Value of the indicator in standard units (Y_i)			Efficiency level by separate project indicators (Z_n)		
	Y_{np1}	Y_{np2}	Y_{np3}	Z_{np1}	Z_{np2}	Z_{np3}
Labor costs	3.283	3.681	4.478	0.236	0.382	0.642
Expenditures on fodders	3.471	3.471	4.630	0.305	0.305	0.683
Fixed asset maintenance cost	4.281	4.567	6.228	0.307	0.411	1.01
Direct labor cost	4.689	4.509	4.645	0.460	0.390	0.439
Prime cost	4.306	5.343	6.241	0.316	0.681	0.605
Net income	4.055	4.980	6.045	0.231	0.560	0.865
Internal rate of return of the project	2.814	2.016	2.315	0.143	0.092	0.127
Project payback period	5.143	5.986	5.897	0.260	0.562	0.831
Integrated final efficiency level (Z)	-	-	-	0.314	0.473	0.696

According to the final indicator of the level of economic efficiency, the third variant of the project is the most preferable one. The final selection of an option will be affected not only by the quantitative approach in the assessment, but a qualitative analysis of the associated factors as well. Perhaps, the set of indicators of efficiency for assessment will change at correction of selection criteria which can be directed to technology or social efficiency the importance of the project.

V. CONCLUSION

The innovation processes in the dairy cattle breeding are characterized by the longer period of duration in connection with the considerable duration of reproduction cycle which intertwines with the natural course of bioprocesses (terms of

growing and fattening of animals) and low coefficient of asset turnover. The proposed improvements of the innovation project management organizational mechanism of dairy cattle breeding on the basis of the digital platform of AIC in the

Smolensk region will allow to develop reasonable forecast indicators on management of the innovation activity, to increase the level of the innovation activity and increase the efficiency of the innovation project management. Application of the SK-analysis in applications of application programs (API) of the Agriculture and Sustainable Development of Rural Territories subplatform will allow to consider influence of multidirectional factors on net result and will promote acceptance of the optimal solutions directed to increase in production efficiency.

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