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**THE SYSTEM APPROACH TO THE PLANNING AS THE BASIS
OF FOOD SECURITY**

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Abstract

The article analyzes the current state of dairy cattle breeding in agricultural organizations of Smolensk region. Feasibility of the system modeling and system dynamics methods aimed to coordinate the investment plan with the sectoral anti-crisis program is assessed on the example of two dairy companies located in the Vyazemsky district of Smolensk region. The long-term planning model for the production structure of an agricultural company reflects real business processes, helps to identify the main production parameters, the optimal structure of livestock, optimal feeding rations, to determine measures in order to improve the productivity of dairy farming, profitability, and to reduce the payback period. The optimal production structure ensures the full and rational use of resources to achieve the maximum efficiency; balanced investment decisions can deepen the specialization and improve the productivity of animals. The article substantiates projects aimed at solving the problems of optimization of the production structure: the release of arable land and labor resources in agricultural organizations. To solve the problem of releasing arable land, the mathematical model for growing the most profitable crops based on the funds of the federal program was developed. The solution to the problem of releasing labor resources involves the creation of a farm whose effectiveness is substantiated by the results of the economic and mathematical model. The optimal period for the receipt of budgetary funds required for the implementation of the program measures depends on the model. The scope of application of the method is analyzed.

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Keywords: Dairy farming, government support, investments, simulation, system dynamics, system modeling



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1. Introduction

Food security is the basis for the sustainability of socio-economic processes in the region. The government aims to provide the population with quality products. The key objectives are sustainable development and modernization of agriculture; development of agricultural production; improvement of the efficiency of state support for agricultural producers; development of livestock breeding and feed production (Shagaida & Uzun, 2015). The state should participate not only in the development of scientific and technical policy, but also in its implementation through production and investment activities (Svetlov, 2019).

For the sustainable development of rural areas, increasing employment and living standards in rural areas, as well as increasing the volume of agricultural production and its competitiveness, Smolensk region adopted the program "Development of agriculture and regulation of markets for agricultural products, raw materials and foodstuffs" for 2014-2020. One of the directions is animal husbandry, including dairy farming.

Thanks to the program, agricultural companies were able to re-equip production facilities and improve their financial conditions through the government support. In order for the government support to be effective, an effective mechanism for selecting and justifying the necessary measures is required (Svetlov et al., 2019).

2. Problem Statement

Dairy farming is the most important branch of animal husbandry in Smolensk region. In the structure of agricultural production, the share of these products is 55%. From 2011 to 2019, the number of cows decreased by 38%, and their productivity increased by 16%, which decreases the volume of milk production by 46%. The main reasons for the current state of dairy cattle breeding are the low-productive livestock, unsatisfactory living conditions and irrational use of resources. Which determine the need for the development and implementation of measures for the development of the dairy farming industry.

In order to create conditions for sustainable reproduction, it is necessary to rationally use the available resources, improve the information support for making managerial decisions using the most effective methods (Buzdalov, 2013). This problem can be solved by applying a system of economic and mathematical methods and models aimed at overcoming the crisis in the dairy farming industry. Without mathematical modeling, the measures will not be successful, and the likelihood of managerial errors is high, which is confirmed by the low effectiveness of previous attempts to restore the normal reproductive process in the dairy farming sector (Jones et al., 2017).

3. Research Questions

When analyzing and predicting the development of complex systems consisting of a large number of objects, it becomes necessary to use the system analysis method, which will allow to study the structure of the system, identify bottlenecks in production and improve the management system (Ermolieva et al., 2015). The systems analysis is based on a combination of methods of collective expertise, computer simulation and operations research.

The application of these methods presupposes the development of appropriate mathematical models: measures aimed to overcome the crisis in the dairy cattle breeding sector are developed through the system modeling; the study of ways to increase the volume of production of dairy products is carried out using the system dynamics method.

The proposed system of models makes it possible to avoid managerial errors in the conditions of mutual influence of program activities and to substantiate managerial decisions that increase the economic efficiency of dairy farming.

3.1. System modelling

Anti-crisis measures have been developed using a system of economic and mathematical models, which include

1. The model of long-term planning of the production structure of an agricultural organization, reflecting the investment program for several years. The investment period includes several years, during which anti-crisis measures are implemented, and the effect of achieving goals over the long post-investment period is taken into account and presented as one model block. In the post-investment block, production and sales of products are optimized, taking into account the results of the anti-crisis measures and the investment program. This technique helps to determine the volume of capital investments, the expected profitability from the anti-crisis measures, the payback period and the net present value of projects.

2. The model of long-term planning of the structure of peasant farms. The mathematical model is presented as an integer programming problem, since for a peasant farm the integer number of animals and restrictions on the repayment of loans are essential (Yescombe, 2014).

3. The model of the project designed for the development of agricultural production. The mathematical model makes it possible to develop a program for the cultivation of profitable crops on the released arable land during the investment period, as well as to determine the volume of financing under the state program for specialized equipment.

The models make it possible to design the development of agricultural production, taking into account government support measures, which determine standard strategies and appropriate investment decisions, and solve the problem of cultivated areas reduction and the flow of rural labor resources.

3.2. System dynamics

To study ways to increase the volume of production of dairy products, the system dynamics method is used. It is a type of simulation modeling capable of describing complex processes and systems with a large number of nonlinear relationships (Egorova, 2020). The model contains the following subsystems:

1. "Herd Turnover" reflects the movement of the herd. There are 12 levels: 7 levels reflect the movement of the main dairy herd by sex and age groups and four levels reflect a plan for culling cows, replacement heifers of different ages, which are fattened for two months.

2. "Production and distribution of crop production" reflects the receipt of certain crops and their distribution based on the needs of cattle, and for commercial purposes. The subsystem includes two levels: manufactured products and commercial products.

3. "Labor resources" reflects the consumption of labor resources in accordance with the production program.

4. "Profit" reflects the generation of profit from the sale of products and costs on production, reconstruction, and purchase of livestock and breed bull semen for inseminating the livestock of cows.

The proposed model has been developed for one year with a monthly step and is used for operational planning.

4. Purpose of the Study

The aim of the article is theoretical substantiation, methodological support, development and testing of a set of measures aimed at overcoming crisis phenomena in the dairy farming industry using the method of mathematical modeling as a tool for making informed management decisions.

5. Research Methods

The following general scientific methods were used: the abstract-logical method; the calculation and constructive method; the methods of mathematical modeling and synthesis of systems.

The method of economic and mathematical modeling is used to substantiate measures aimed to overcome the crisis in dairy farming.

The system dynamics method is used to investigate ways to increase the volume of production of dairy products.

6. Findings

The score method has been tested on agricultural companies of the Vyazemsky district of Smolensk region: SEC Nekrasovsky and JSC JV Shuiskoye.

To determine the ways to increase the economic efficiency in dairy farming based on the resources of the federal program, economic and mathematical long-term planning programs were developed. After the implementation of measures of state support and optimization of production and investment activities, the profitability of animal husbandry increased by 29% in SEC Nekrasovsky and by 22% in JSC JV Shuiskoye; economic prerequisites for a sustainable reproduction process have been created. The way out of the crisis situation was found through the full or partial replacement of low-productive livestock with breeding cows, insemination of cows and heifers and reconstruction of livestock buildings for keeping cows.

Due to these measures, the productivity of cows increased by 58% and 17%, respectively. The net present value of the projects was 1.9 million and 320 thousand rubles, respectively, which confirms the feasibility of the investment program.

Measures for the post-crisis development of dairy cattle breeding increase the yield of milk per unit of land area, thereby releasing land areas for the development of other branches of agricultural

production, and contribute to an increase in labor productivity, which can lead to a crisis in the social sphere, namely the outflow of the population from rural areas due to the unemployment. On the released land, more profitable crops (for example, potatoes) can be grown.

The results of the mathematical modelling indicate the feasibility of growing potatoes and the need to purchase equipment for its production. The payback period for this project is 4.5 and three years in the Nekrasovsky SEC and in the Shuiskoye JV JSC, respectively. The outflow of labor resources from rural areas can be terminated through the creation of dairy farming enterprises. The economic and mathematical model was developed to testify to the feasibility of the project.

According to the optimal plan, the farm forms its own fodder from spring grains and grasses, partially sown released land plots by renting them. During the investment period, there is an increase in the volume of production of meat products by 55% and dairy products by 28%, the profitability of production can be 22%. To achieve these indicators, the farm needs to take two loans: short-term (for the purchase of breeding animals) and long-term (for the purchase of equipment) ones, part of the costs are financed through the federal program. On the whole, the net present value of the farm may be 88.5 thousand rubles. Consequently, the creation of such a farm will be beneficial. Since further release of labor from agricultural production is expected in connection with intensification and ongoing automation, such projects for creating peasant farms will be in demand, provided that there are sufficient credit resources for the purchase of equipment and breeding animals. Employment of the population in peasant farms solves such problems as an increase in agricultural production at the regional and state level, the production of environmentally friendly crop and livestock products, the stabilization of the demographic policy of the region, the preservation of rural settlements, the preservation, stabilization and the possibility of development of the agro-industrial complex of the region.

The system dynamics method was used to identify the months when the organizations require the government support. According to the project aimed at the purchase of breeding heifers, it was established that the herd renewal is profitable for the organization only if the support is provided in March. It is also advisable to purchase breeding bull semen in March. Small areas of premises can be reconstructed, and capital construction should be postponed to the next year due to the lack of funds.

7. Conclusion

The developed systematic approach to the agricultural production planning based on the federal program made it possible to determine promising ways to reduce the cost of milk through the complete or partial replacement of low-yielding livestock, reconstruction of livestock buildings and improvement of the quality of offspring. It is necessary to prevent a reduction in arable lands and an outflow of labor from rural areas by deepening the specialization of production and increasing the labor productivity in agricultural organizations. The measures allow agricultural organizations to overcome the crisis and restore a sustainable reproduction process.

This method is applied by agricultural enterprises of the dairy sector in the Vyazemsky district of Smolensk region. The agricultural enterprises developed projects for the reconstruction of cowsheds, and plan to purchase breeding animals and improve the quality of offspring by purchasing semen of breeding bulls.

The developed models can be used at dairy enterprises and by municipal districts when building plans for the development of dairy cattle breeding and developing measures of state regulation of this industry. Scenario calculations based on the models can be performed both for individual farms and for projected integration formations.

Further research involves the introduction of random conditions into the model structure that can affect the outcome of government measures aimed at overcoming crisis phenomena. Analysis of various scenarios will allow to anticipate in advance the indirect effects of the implementation of measures, use political instruments with greater confidence in positive results, as well as minimize production and economic risks (Svetlov, 2019).

The comprehensive methodology can be used in research aimed at identifying prospects for overcoming the crisis in the dairy cattle breeding industry and analyzing measures of state support for the industry.

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