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A Systematic Approach to Improving the Production and Sales Activities of Farms

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Abstract: The article presents a study on the improvement of production and marketing activities in peasant farms specializing in milk production using a systematic approach. The authors formulated the task and developed an economic and mathematical optimization model that takes into account the interaction of various parts of the agro-industrial complex and the structure of agricultural production. The model includes three main blocks: the purchase of feed, the production of dairy products and the sale of finished products, interconnected through transportation costs. The model variables, resource constraints, production, milk distribution, sales, and optimality criteria are described in detail. The proposed methodology was tested using the example of a peasant farm in the Smolensk region. The modelling results made it possible to analyse the production and financial activities of the farm, optimize the structure of forage lands, determine optimal production volumes, identify the most effective channels for the purchase of feed and sale of products, and justify the economic feasibility of farming. In conclusion, the prospects for further research are outlined, including taking into account random factors, adapting the model to farms of other specializations, and applying the methodology in dairy farming organizations.

1 INTRODUCTION

In a market economy, innovation is a critically important factor for sustainable development, especially in such strategically important industries as agriculture (Svetlova, 2020). The production of milk and dairy products in Russia does not have time to meet the growing demand, which creates favourable conditions for the development of peasant farms. Despite the difficulties associated with their small size, farms have significant advantages: minimal administrative costs, flexibility in adapting to market changes, and high productivity. The success of farms in the dairy sector depends on the effective sale of products and the profitable purchase of resources (Babkina, Puchkova, Svetlova, 2024; Staheev, Staheeva, Krokhalev, 2019).

According to the main results of the agricultural micro-census of 2021 of the Federal State Statistics Service for Peasant farms and individual Entrepreneurs, by 2021, there is a decrease in the number of farm facilities compared to previous periods: from 285 thousand in 2006 to 188 thousand in 2021. However, over the same 15 years, the total number of cattle increased 3.1 times (from 980 to 3056 thousand heads), and the number of cattle per farm increased 7.5 times, to 26 heads. This inverse relationship between the number of facilities and the number of cattle is primarily due to an increase in the proportion of peasant farms and individual entrepreneurs engaged in agricultural activities during the reporting period.

Such scientists as R. Adukov, V. Bautin, A. Gataulin, A. Nosov, G. Prokopyev, V. Tikhonov, Z. Ivanov, V. Lazovsky and many others dealt with the problem of improving production and sales activities in agriculture. According to A. Nosov, the efficiency of agricultural producers depends on high-quality government support and fast transportation of manufactured products (Nosov, 2021).

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In order to improve production and sales activities, farms need to:

1. To develop a systematic approach to solving this problem.

2. To establish the logistics of purchasing the necessary feed.

3. Optimize the industrial and industrial structure of the economy.

4. Determine the optimal channels for the sale of finished products.

The purpose of the research is to develop a systematic approach to solving the problem of improving production and sales activities in peasant farms, as well as to build an economic and mathematical model for optimizing production and sales activities in the economy.

To achieve the goal, it is necessary to solve the following tasks:

1. Structure the problem of improving production and sales activities in peasant farms.

2. To design a model for optimizing the production and sales activities of the economy, to consider the main variables and limitations of the model.

3. To test the economic and mathematical model using the example of the I.S.Yakushev farm, located in the Vyazemsky district of the Smolensk region.

2 MATERIALS AND METHODS

The problem of improving production and sales activities in peasant farms can be presented in the form of a spiral hierarchical structure developed by the Corresponding member of the Russian Academy of Sciences, Doctor of Economics A.M. Gataulin (Gataulin, Svetlov, 2005). This structure allows us to identify the core of the problem, the theoretical and methodological, qualitative and analytical, quantitative and analytical and applied aspects of the study.

The core formulates the formulation of the problem of improving production and marketing activities in peasant farms, the history of their formation, as well as the prerequisites for solving this problem with available resources (Osipova, 2021).

In the theoretical and methodological aspect, the categorical apparatus of the problem, the basics of methodology are considered, and the choice of methods of economic and mathematical modelling for optimizing production and sales activities in peasant farms is substantiated.

The qualitative and analytical aspect covers the analysis of production and sales activities in peasant farms and state support measures for farms (Maslova, 2022).

In the quantitative and analytical aspect, the economic efficiency of the state and development trends of peasant farms is substantiated; an economic and mathematical model for optimizing production and sales activities is being developed (Babkina, Puchkova, Svetlov, Afanasyeva, 2018).

The study ends with an applied aspect, which substantiates a long-term plan for the development of peasant farms, as well as provides recommendations for improving production and sales activities and increasing the profitability of production.

The system of modelling methods for optimizing production and sales activities in peasant farms includes: methods of processing and controlling statistical data, methods of economic and mathematical modelling (Svetlov, Svetlova, 2021).

The basis of the economic and mathematical model for optimizing production and sales activities in peasant farms is the model of agricultural production allocation, which has a block structure:

1. The feed procurement unit is presented aggregately and includes all organizations that can supply feed to the farm.

2. The production unit is reflected in the form of an economic and mathematical model for optimizing the production structure of peasant farms.

3. The sales unit consists of channels for the sale of finished products, including contractual obligations.

The blocks are interconnected by transportation costs, which are necessary for the transportation of feed and finished products.

The criterion of optimality is the maximum profit from economic activity peasant farms (Svetlov, 2006).

To solve the mathematical model, it is necessary:

1. Generate the initial data.

2. To form regulatory information on animal husbandry, crop production and production resources, as well as transportation costs (Osipova, 2021).

The main variables of the model are: feed suppliers, land, livestock, feed for each group of animals by feeding period, raw materials for the production of finished products, finished products, population demand for finished products, exports of finished products, transportation costs, production costs of finished products and revenue from sales of finished products.

The limitations that characterize the production and marketing processes in the farm include:

1. Restriction on the purchase of feed, tons.

$$\mathbf{x}_1 \geq \mathbf{x}_4 \quad (1)$$

where $\mathbf{x}_1$ is the vector of feed suppliers, tons;

$\mathbf{x}_4$ is the feed vector for each group by feeding period, tons.

2. Restriction on feed production, tons.

$$\mathbf{x}_4 \leq \mathbf{A}_5\mathbf{x}_2 \quad (2)$$

where $\mathbf{x}_2$ is a vector of land, hectare (integer);

$\mathbf{A}_5$ is the crop yield matrix, tons per hectare.

3. Limitation on the cost of raw materials for the production of finished products, tons.

$$\mathbf{x}_5 \geq \mathbf{A}_8\mathbf{x}_6 \quad (3)$$

where $\mathbf{x}_5$ is the vector of production of raw materials for finished products, tons;

$\mathbf{x}_6$ is vector of finished products, tons;

$\mathbf{A}_8$ is a matrix of raw material costs per unit of processed products, tons per ton.

4. Restriction on the distribution of whole milk, tons.

$$\boldsymbol{b}_1\boldsymbol{x}_3^{(1)} \geq \boldsymbol{x}_4^{(1)} + \boldsymbol{x}_4^{(2)} + \boldsymbol{x}_4^{(3)} + \boldsymbol{x}_4^{(4)} \quad (4)$$

where $\boldsymbol{b}_1$ is the productivity of cows, tons per head;

$\boldsymbol{x}_3^{(1)}$ is the number of cows, head;

$\boldsymbol{x}_4^{(1)}$ is milk for drinking during the stall period, tons;

$\boldsymbol{x}_4^{(2)}$ is milk for drinking during the grazing period, tons;

$\boldsymbol{x}_4^{(3)}$ is milk for own consumption, tons;

$\boldsymbol{x}_4^{(4)}$ is milk for processing, tons.

5. Limitation of the population's demand for finished products, tons.

$$\mathbf{x}_7 \geq \mathbf{b}_4 \quad (5)$$

where $\mathbf{x}_7$ is the vector of the population's demand for finished products, tons;

$\mathbf{b}_4$ is the vector of the minimum demand of the population for finished products, tons.

6. Restriction on the sale of finished products, tons.

$$\mathbf{x}_6 \geq \mathbf{x}_7 + \mathbf{x}_8 \quad (6)$$

where $\mathbf{x}_7$ is the vector of the population's demand for finished products, tons;

$\mathbf{x}_8$ is the vector of exports of finished products, tons.

7. Limitation on transportation costs, thousand roubles.

$$\mathbf{c}_1\mathbf{x}_1 = \boldsymbol{x}_9 \quad (7)$$

where $\boldsymbol{x}_9$ is the transportation cost, thousand roubles;

$\mathbf{c}_1$ is the vector of transportation costs, thousand roubles per ton.

8. Current cost limit, thousand roubles.

$$\mathbf{c}_2\mathbf{x}_1 + \mathbf{c}_3\mathbf{x}_2 + \mathbf{c}_4\mathbf{x}_3 + \mathbf{c}_5\mathbf{x}_6 + \boldsymbol{x}_9 = \boldsymbol{x}_{10} \quad (8)$$

where $\mathbf{x}_3$ is the vector of the number of animals, head (integer);

$\boldsymbol{x}_{10}$ is the total cost of manufacturing finished products, thousand roubles;

$\mathbf{c}_2$ is the cost vector for purchased feed, thousand roubles;

$\mathbf{c}_3$ is the cost vector for land, thousand roubles per hectare;

$\mathbf{c}_4$ is the cost vector for cattle, thousand roubles per head;

$\mathbf{c}_5$ is the cost vector for processing, thousand roubles per ton.

9. Limitation on revenue from the sale of finished products, thousand roubles.

$$\mathbf{p}_1\mathbf{x}_7 + \mathbf{p}_2\mathbf{x}_8 = \boldsymbol{x}_{11} \quad (9)$$

where $\boldsymbol{x}_{11}$ is the revenue from the sale of finished products, thousand roubles;

$\mathbf{p}_1$ is the vector of prices for the sale of finished products to the local population, thousand roubles per ton;

$\mathbf{p}_2$ is the price vector for the sale of finished products to the city, thousand roubles per ton.

The target function is the maximum profit from the sale of finished products, thousand roubles.

$$maxZ = \boldsymbol{x}_{11} - \boldsymbol{x}_{10} \quad (10)$$

The use of the MS Excel Solution Search software, which made it possible to perform a large amount of model calculations in a short time, contributed to obtaining reliable and accurate modelling results.

3 RESULTS AND DISCUSSION

The approbation of the considered methodology was carried out on the I.S.Yakushev farm, located in the Vyazemsky district of the Smolensk region. The farm is engaged in the breeding of dairy cattle and sells whole milk, cottage cheese and sour cream to the local population, and is also fully family-owned, with only one employee involved. The number of cows is 12 heads, heifers – 3 heads, young animals – 10 heads and 1 bull producer. The average annual milk yield is 2.6 tons. The feed of its own production includes hay and green fodder, and the farm buys concentrated feed and whole milk substitute from third-party organizations.

In the Vyazemsky district, as well as the areas closest to it, there are four organizations that can supply concentrated feed: the limited liability company Gorodnyanskoye Joint Venture, the limited liability company Vyazemsky Mill, the limited liability company Usadba Agropark, and the Vlasovo agricultural production cooperative. The purchase of a whole milk substitute is carried out in the Tagris Milk limited liability company.

As a result of solving an economic and mathematical model for optimizing production and sales activities in a peasant farm, the following results were obtained.

The simulation result showed that the optimal number of cattle corresponds to the actual number on the farm. It is profitable for a peasant farm to purchase concentrated feed in the limited liability company Gorodnyanskoe in the amount of 14.14 tons. Also, due to the optimization of economic activity, there is a slight reduction in the area under hayfields (by 2.33%).

Let's compare the planned production and sales volumes of finished products with those currently available on the farm (Table 1).

Table 1: Production and sale of finished products, tons.

Indicators	Milk	Cottage cheese	Sour cream
Production:			
Fact	24.00	0.40	0.35
The optimal plan	24.00	0.44	0.35
The optimal plan as a percentage of the fact	100.00	109.70	100.00
Realization:			
Village	24.00	0.40	0.35
City	0.00	0.04	0.00

According to the optimal plan, it is necessary to increase the sale of cottage cheese by 9.7%, which is planned to be supplied to the urban population in the amount of 40 kg.

Optimal placement of fodder crops makes it possible to produce the required amount of feed in accordance with the needs of animal husbandry, and the purchase of missing feed completely balances the feeding ration.

The number of cattle does not change, which indicates the limited capacity of the farm to maintain livestock, as well as the capabilities of the farmer himself, since the farm is entirely family-owned.

The economic efficiency of the commercial activity of the farm is shown in Figure 1.

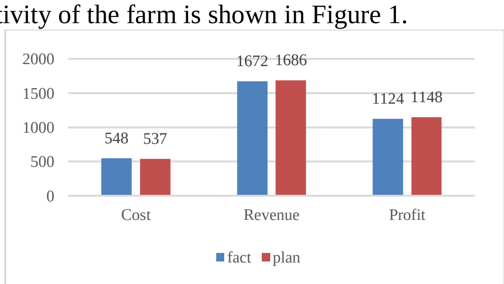

Figure 1: Economic efficiency of commercial activity of the I.S.Yakushev farm, thousand roubles.

Optimization of the production and economic activities of the farm leads to a reduction in costs by 10.87 thousand roubles, an increase in revenue by 13.58 thousand roubles, as a result of which profit increases by 24.45 thousand roubles, and profitability of production by 8.7%. According to the solution of the model, it is beneficial for the farm to purchase a whole milk substitute from the Tagris Milk limited liability company (0.62 tons).

Thus, the study showed that the application of this methodological approach allowed not only to identify optimal channels for the purchase of feed, but also to increase the efficiency of commercial activities of the farm.

4 CONCLUSIONS

Currently, many farmers need to optimize production and sales activities, as well as logistics processes, as they affect the efficiency of the farm. The absence of a universal mechanism will lead to an increase in the cost of production and transportation of products, and, as a result, a decrease in profitability. The presented methodological approach allows not only to identify optimal channels for the purchase of feed and the sale of finished products, but also to optimize the production activities of the farm itself.

The proposed economic and mathematical model for optimizing production and sales activities in peasant farms can be used in the planning of production in dairy organizations of various forms of ownership.

It is planned to deepen the research by introducing various random factors into the model that affect the economic activity of the farm, as well as by developing similar projects for farms of other specializations.

The developed systematic approach to improve production and sales activities in peasant farms allowed us to identify promising ways to reduce production costs, namely, the cost of production; increase production by optimizing cattle feeding rations; identify channels for the purchase of necessary feed, as well as the sale of finished products.

The proposed methodology has found its application in the practice of production and economic activities of the I.S.Yakushev farm. The farm has reviewed its feed suppliers, and an increase in cottage cheese production is also planned.

In the future, the research can be deepened by introducing various random factors into the model design, for example, the impact on economic efficiency of changes in prices for purchased feed; to develop similar projects in relation to peasant farms of other specializations.

The designed economic and mathematical model for optimizing production and sales activities can be used in scientific research, as well as in production planning in dairy agricultural organizations of various forms of ownership.

REFERENCES

Babkina, A., Puchkova, O., Svetlova, G., 2024. Justification of anti-crisis measures in the management of dairy cattle breeding based on mathematical modeling. *Bio web of conferences.* Blagoveschensk, P. 02009

Babkina, A.V., Puchkova, O., Svetlova, G., Afanasyeva, S., 2018. The system approach to the planning as the basis of food security. *European Proceedings of Social and Behavioural Sciences:* Proceedings of the Conference on Land Economy and Rural Studies Essentials, pp. 98-101.

Gataulin, A.M., Svetlov, N.M., 2005. *The book*, Cost, equilibrium and costs in agriculture. Moscow: FGOU VPO RGAU-Moscow Agricultural Academy named after K. A. Timiryazev, 243 p.

Maslova, V.V., Svetlov, N.M., Silaeva, L.P., Avdeev, M.V., 2022. Formation and improvement of state support measures in agriculture in Russia. *Economics, labour, management in agriculture*, No. 12(94). 19-30.

Nosov, A.L., 2021. The role of logistics in the agricultural sectors of the country. *Innovative economic development*, No. 1(61), pp. 92-98.

Osipova, M.B., 2021. System formulation of the problem of modelling logistic processes in peasant farms. *Youth science on current problems and prospects of development of national economy branches:* Collection of articles based on the materials of the All-Russian Scientific and practical Conference of students. Novosibirsk, pp. 240-243.

Staheev, D.E., Staheeva, L.M., Krokhalev, A.A., 2019. Problems of implementation – logistics of transportation in peasant farms. *Youth and science*. Yekaterinburg: Ural State Agrarian University, No. 2, p. 108.

Svetlov, N.M., 2006. *The book*, Album of visual aids for lectures on the course "Modeling of micro- and macroeconomic processes". Moscow: Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, 205 p.

Svetlov, N.M., Svetlova, G.N., 2021. Economic cybernetics – the scientific foundation of digital technologies for regulating agriculture. *National Scientific and practical Conference dedicated to the 85th anniversary of the birth of A.M. Gataulin*: Collection of conference articles. Moscow: Megapolis Limited Liability Company, pp. 10-23.

Svetlova, G.N., 2020. Digital agriculture: concept and reality. *System modelling of socio-economic processes*: proceedings of the 43rd International Scientific School-Seminar. Voronezh: Voronezh State University, pp. 240-243.