

# APPLIED ASPECTS OF ECONOMIC AND MATHEMATICAL MODELING OF PRODUCTION ACTIVITY OF ENTERPRISES OF THE AGRICULTURAL SECTOR

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## ABSTRACT

The urgency of the problem of improving the management of production activities of enterprises in the agricultural sector is substantiated. The importance of using economic and mathematical methods in general and optimization models, in particular, in the process of ensuring the optimal correlation between crop production and animal husbandry in agricultural enterprises, in conditions of limited resources are highlighted. The economic-mathematical model of optimization of structure of production of agricultural production in the specific enterprise of agricultural sector with use of modern information technologies is developed. The purpose of this research is to generalize the theoretical and methodological principles and develop applied recommendations for the use of economic and mathematical methods in the process of modeling the structure of agricultural production in a particular agricultural enterprise. As a result of researches the optimum parameters of realization of production activity of the agrarian enterprise are justified on an example of PF "V.V. Plakushchenko" of Odessa region. The optimal structure of the sown area is found, which allows to provide the highest values of production volumes of the main types of agricultural products, in particular plant growing and animal husbandry. Labor costs and mineral fertilizers for the production of each type of product are calculated. The optimal value of the pig population is calculated and the fodder base for the development of this industry is formed. The main financial indicators of production activity of the enterprise are determined (the value of gross output, production and commercial cost, sales revenue and profit).

**Keywords:** economic-mathematical model, optimization, production structure, agricultural products, agricultural enterprise, agricultural sector

## INTRODUCTION

Agriculture includes two large productions - crop production and animal husbandry, which are interconnected and interdependent, a certain combination of these industries in certain conditions forms the structure of agricultural production. Implementation of production activities by a specific business entity, involves the production of crop and livestock products, in combination or separately, in order to make a profit and efficient use of available resources, as well as to ensure food security, meet consumer needs in crop and livestock products, solutions problems of rural employment.

The relevance of scientific research on the application of economic and mathematical modeling in the activities of modern enterprises of the agricultural sector is due to the fact that the choice of a particular industry or their rational combination, formation of a certain ratio between types of products produced by the enterprise or the structure of agricultural production, ensuring of its optimality, is an important and quite complex task for agricultural enterprises, the solution of which greatly facilitates the use of economic and mathematical methods.

The definition of the essence of the category "structure of production of agricultural commodities" and its role and importance in ensuring the effective functioning of agricultural enterprises, identifying the factors under the influence of which it is formed and developed, attention is paid by such economists as: A. Azizov V. Ambrosov V. Andriychuk, I. Balanyuk, O. Bitte, O. Bogdanovich, R. Zatorsky and B. Brynzey, V. Zinovchuk, O. Dovganyuk, M. Domaskina and K. Yarizhk, M. Bigdan and Yu. Karlyk., P. Kaninsky, V. Kutsenko, M. Lysenko, Y. Lupenko, M. Malik, V. Nelep, P. Sabluk, T. Samilyk, V. Tkachuk, V. Shiyan, D. Shiyan, V. Yurchishin.

The development of theoretical and practical principles of modeling of agricultural production was engaged by such scientists as: M. Braslavets, Y. Brodsky, A. Gataulin, V. Dankevich, J. Danzig, L.

Kantorovich, V. Kardash, R. Kravchenko, E. Krylatykh, A. Kurnosov, S. Minyuk, S. Nakonechny, I. Popov, S. Savina, V. Sukhorukov, M. Tuneev etc.

However, the use of this tool for a particular agricultural producer, requires a separate author's approach, taking into account the maximum number of factors and conditions in which it has to operate, leading to scientific and applied interest in this study.

The object of research is the process of economic and mathematical modeling of the structure of agricultural production in an agricultural enterprise.

The subject of research is theoretical, methodological and applied aspects of the process of economic and mathematical modeling of the structure of agricultural production in PF "V.V. Plakushchenko" of Velykomykhailivskiyi district of Odessa region.

The purpose of the article is to generalize the theoretical and methodological principles and develop applied recommendations for the use of economic and mathematical methods in the process of modeling the structure of agricultural production in a particular agricultural enterprise.

Achieving the goal set in the work requires the solution of the following tasks: to reveal the meaning of the concept of the structure of agricultural production; determine the importance of economic and mathematical models in general and highlight the role of optimization problems in particular, in the planning of agricultural production; to characterize organizational and legal bases and resource maintenance of functioning of the enterprise; analyze the production activities of the enterprise; evaluate the efficiency of production and economic activities of the enterprise; to carry out the economic substantiation of the set task and the criterion of optimality and to develop the structural mathematical model of the problem; to form the initial parameters of the optimization model and to build an extended matrix of the economic-mathematical problem; carry out a comparative economic analysis of the optimal plan.

## RESULTS AND DISCUSSION

Market terms of management set to the leaders of agricultural enterprises the task of independently choosing the direction of their activities, choosing the leading industry - crop or livestock, in order to achieve maximum profits to ensure expanded reproduction and intensify production. It should take into account a wide range of factors regarding the choice of production direction: environmental safety and preservation of soil fertility; availability of production resources; quantity and quality of labor resources; natural and climatic conditions, etc. [1, 2, 3].

Scientists in their research apply with different categories: the production structure of the enterprise, the production and industry structure of the enterprise, the industry structure of production, the structure of production of agricultural commodities in the enterprise. Based on the generalization of scientific approaches, the essence of the concept of "the structure of production of agricultural commodities in the enterprise" is defined as a certain combination or ratio of crop and livestock industries under certain conditions, their share in the total output. The combination of different industries in agricultural production allows to eliminate the seasonality of agricultural production, to make fuller use of machinery and labor resources. However, a large number of industries in one farm is undesirable.

The term "optimal structure of agricultural production" is substantiated, as such that in an agricultural enterprise ensures the fulfillment of contractual obligations for the sale of products, allows the most complete and efficient use of available production resources, and if necessary to attract them, get the highest economic effect and increase the profitability of the enterprise.

It is determined that optimization is understood as a choice from a set of possible options of economic development such that gives the chance to use the available production, financial and other resources most effectively, and the search for the optimal structure of agricultural production is carried out in the conditions of certain requirements for crop rotation and the structure of sown areas, ensuring the rational nutrition of animals with feed and fertilizer application rates per unit of sown area.

The economic-mathematical model is an economic abstraction expressed in formal-mathematical terms, the logical structure of which is determined both by the objective properties of the objects of description and by the subjective target factor of the research for which this description is made. Structurally, each mathematical model is a set of interconnected mathematical dependencies that reflect certain groups of real economic dependencies. The type of mathematical model depends on both the nature of the system and the tasks of the study. In the general case, the mathematical model of the system contains a description of the

set of possible states of the latter and the law of transition from one state to another (the law of functioning) [4].

In-depth research was carried out on the materials of the Peasant Farm "V.V. Plakushchenko", which is registered and located in the Odessa region of Velykomykhailivsky district in the village of Hrebennyky, carries out its activities on the basis of the constituent documents approved by the founders (participants), operates in the form of a farm, guided by the Laws of Ukraine "On Peasant Farming Economy" and "On Farming Economy". The governing body of this legal entity is the head of the farm - Eugene Plakushchenko.

The farm has quite favorable conditions for agricultural production. The climate is moderately continental, arid. The population is enough to provide by employees all production processes in the enterprise, developed social infrastructure, represented by educational institutions, medical, financial and cultural institutions. The developed network of transport connections, which is represented by the railway Odessa - Kiev, as well as the highway E95 M05, that contribute to the competent organization of sales.

In the farm is experiencing a decrease in the level of provision of production resources, which is confirmed by a decrease in land area, a reduction in the number of employees and a decrease in the value of fixed assets. Due to the fact that after the end of the lease agreement, the owners of land shares refused to continue cooperation with the farm, also the reduction of the number of employees by 3 people, due to the instability of the economic situation of the farm in the agri-food market and dissatisfaction of these people with working conditions. It should be noted that 11 people are involved in crop production, and 4 people are involved in animal husbandry.

The decrease in the value of fixed assets by 4.2% in 2020, compared to 2018, is due to the aging of fixed assets and the write-off of their depreciation. New equipment was not purchased during this period, as unfavorable weather conditions in 2019 and 2020 led to a deterioration in the financial condition of the enterprise. The growth of indicator of capital security and capital-labor ratio is explained by the fact that the rate of reduction of the number of employees is ahead of the rate of reduction of land area and the value of fixed assets. The livestock industry has developed steadily, as evidenced by the increase in livestock of pigs by 3.6% in 2020 compared to 2018.

During 2018-2020, the entire land area that the farm had was cultivated. In PF "V.V. Plakushchenko" grew cereals and legumes (winter wheat, winter barley, corn, oats, millet, peas), the share of which in the structure of crops was 58.4% in 2018 and increased to 64% in 2020. The share of industrial crops decreased from 41.6% in 2018 to 36% in 2020. This was due to the expansion of the product range of cereals and the introduction of oats, millet and peas.

The production direction of the farm can be described as technical-grain. The reduction in the size of the enterprise and adverse weather conditions during 2019 and 2020 (no precipitation and severe drought, two years in a row, caused significant damage to crops) led to a significant decrease in yield. As a result, the decline in production of all types of products, which had a negative impact on sales. A decrease in market prices while increasing the cost of production, led to a decrease in its profitability.

The decrease in productivity of pigs is a consequence of unbalanced feeding, because with the reduction of the harvest of cereals, it was not possible to use the required amount of grain and legumes for feed purposes.

The level of efficiency of economic activity of the studied enterprise decreased, which is confirmed by a decrease in yields of all crops and animal productivity, increasing production costs and reducing its profitability, deteriorating financial results and reducing indicators that characterize the amount of financial result per unit of resource expended. a significant reduction in profitability.

The management of PF "VV Plakushchenko" focuses on the demands of the world market and grows the most popular crops, namely groups of grain and industrial crops. Ukraine is one of the world's largest producers of oilseeds. The results of cultivation and organization of sales of which affect the efficiency of the enterprise as a whole.

Thus, the analysis of production and sales activities of PF "V.V. Plakushchenko" confirms the need to optimize its production structure in order to achieve the maximum level of financial results under the available production resources and management conditions.

Carrying out economic activity in market conditions forces the heads of domestic agricultural enterprises to constantly work to ensure a high level of competitiveness in a particular market of agricultural products. Among the main measures that contribute to this is the optimization of the structure of production in the farm. This will rationally distribute the resources available to it between the main industries: crop

production and animal husbandry and ensure their best ratio, get the maximum result from economic activity and meet the existing demand for products produced in PF "V.V. Plakushchenko". To this end, we have developed and solved an economic-mathematical model, which obtained the optimal structure of agricultural production in PF "V.V. Plakushchenko" and the optimal areas of crops and livestock were determined.

This economic and mathematical model reflects a large number of conditions, the relationship between resource costs and production results, balanced production and use of resources in such a way as to ensure the rational use of available production resources.

Carrying out the economic substantiation of the set task, its following formulation is given: to define such combination of volumes of manufacture of crop production and animal husbandry production in the investigated enterprise, at optimum use of resources available at economy at which the receipt of the maximum gross profit is provided.

The criterion of optimality is chosen gross profit. When developing this model of optimization of the structure of agricultural production in the studied enterprise, the task of linear programming was used. The structural mathematical model is represented by a set of mathematical expressions, dependencies (equations and inequalities), which reflect the resources available in the farm and management conditions.

The product range in the farm for the future is represented by such types of products as: winter wheat for marketable grain and winter barley for marketable and feed grain; corn for commercial and fodder grain; oats for commercial and fodder grain; millet for marketable grain, peas for commodity and feed purposes; sunflower seeds; winter rape seeds. The farm plans to continue to develop pig farming, which involves determining the level of productivity of pigs, the need for feed, their nutritional value and fodder value.

The extended matrix of the economic-mathematical problem includes 35 variables of unknown values, of which 9 are the required values of sown areas of crops and crop rotations, livestock, which are subject to 52 restrictions. The problem is solved with the help of Microsoft Excel - "Solution Search" function.

As a result of solving the economic-mathematical problem, the optimal values of the structure of sown areas are obtained, which allow to ensure the optimal ratio between the production of crop and livestock products and contribute to increasing the profitability of management. The optimized structure of sown areas envisages an increase in the share of grain crops by 10.48 percentage points, and a decrease in the share of industrial crops by the same amount. Volumes of fodder production, which amount to 5389.50 centner of fodder units, allow to keep 357 heads of pigs and to provide production of 500 centner of increase in live weight of pigs. Among grain crops are expected to increase the production of winter wheat, winter barley, corn, oats, millet and peas. Production volumes of industrial crops will decrease by 22.28%.

According to the optimization calculations, the production direction of PF "V.V. Plakushchenko" will change from technical-grain to grain-technical with developed pig breeding. The above changes will positively affect the final results of economic activity of the farm. Thus, it is planned to increase sales revenue by 1.9 times. This will be possible through the use of effective sales channels, increase sales prices and increase sales of manufactured products. Gross profit will increase 5 times. The level of profitability of economic activity will reach 71.08%.

Thus, the proposed measures to optimize the structure of agricultural production in the studied enterprise will increase the efficiency of its economic activity.

## CONCLUSION

As a result of researches the optimum parameters of realization of production activity of the agrarian enterprise are substantiated on an example of PF "V.V. Plakushchenko" of Velykomykhailivskyi district of Odesa region, namely: the optimal structure of sown areas was found, which allows to provide the highest values of production volumes of the main types of agricultural products, in particular plant growing and animal husbandry; labor costs and mineral fertilizers for the production of each type of product are calculated; the optimal value of the pig population is calculated and the fodder base for the development of this industry is formed; the main financial indicators of production activity of the enterprise are determined (the value of gross output, production and commercial cost, sales revenue and profit).

Further research on the application of economic and mathematical modeling in the management of enterprises in the agricultural sector should focus on solving software problems of management staff, study of new software products and information technology by them.

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