

# Parameter Optimization of Effective Development of Egg Producing Poultry Farm

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**Abstract** — Nowadays, the strategic task for poultry farming in Russia is the expanded reproduction and intensive development of the industry based on its import substitution. A significant role in increasing production volumes of poultry products belongs to specialized poultry enterprises, taking into account the intensification of their innovation and investment activities. The analysis of development of specialized egg producing poultry farms in the Voronezh region was made. The dynamics and development trends of egg production are revealed. The optimal parameters of the strategic development scenario of the poultry farm under study with the criteria for maximizing profit are substantiated by economic and mathematical modeling. The economic efficiency of the developed business project for processing eggs into dry egg powder is proved. The financial results of the strategic development scenarios of the enterprise under study were assessed using the CVP analysis method. Organizational and economic measures to achieve the strategically high parameters of economic efficiency of poultry farms development are proposed.

**Keywords** — *poultry enterprise; development scenario; economic and mathematical model; egg processing; efficiency; organizational and economic activities.*

## I. INTRODUCTION

Poultry farming is a dynamically developing agricultural sector, characterized by the ability to double production volumes in the shortest time with the least labor and money costs. Poultry farming plays an important role in providing the population with high-quality dietary foods, which have a high content of animal protein – eggs and poultry. The constantly growing demand for eggs and poultry meat is explained by both their consumer properties and the significantly low level of consumer prices in comparison with other types of meat products. Especially the demand for eggs and poultry meat increased during the COVID-19 pandemic, the global financial

crisis and the long-term self-isolation of the world's population, due to the need to consume low cost high-grade foods rich in animal protein and, at the same time.

The strategic task for poultry farming in Russia at the present stage is the expanded reproduction and intensive development of the industry based on its import substitution. A significant role in increasing production volumes of poultry products belongs to specialized poultry enterprises, taking into account the intensification of their innovation and investment activities [8].

The formation of sustainable development of poultry enterprises is possible on the basis of strategic planning, which, unlike other forms of foresight, assumes a crisis-free, stable operation of the enterprise, regardless of various kinds of impacts on industrial poultry farming. In these circumstances, the issue of developing a strategy for the egg producing poultry farm and calculating its economic efficiency becomes relevant [13].

## II. RESEARCH METHODOLOGY

The works of foreign and Russia's scientists and economists such as I. Ansoff [2], O.S. Vikhansky, N.Ö. Doğan [2], A.J. Strickland, A.A. Thompson, R.A. Fathutdinova, A.P. Kurnosova, K.S. Ternovykh [12] and other are devoted to the theoretical and methodological aspects of strategic planning at enterprises. The theory, methodology and development of measures to increase the economic efficiency of poultry industry production are considered in the works of G.A. Bobyleva, A.A. Gaidaenko, L.L. Gorshkova, V.V. Regusha L.M. Reuter, P.M. Taranov [12], V.I. Fisinin and others. The periodical press widely covers the experience of some poultry farms that managed to increase the efficiency of poultry production under market conditions.

However, the issues of strategic planning in the agrarian sector remain studied insufficiently; the features of the economic strategy for the development of poultry enterprises in the regions of Russia are not cleared up. All the above determined the purpose and objectives of scientific research.

The purpose of this study is to develop methodological and practical recommendations for substantiating the development strategy of poultry enterprises in the region.

The implementation of this research goal is driven by the need to formulate and solve a set of interrelated tasks:

- to study the dynamics of the development of specialized egg producing poultry enterprises of the Voronezh region and identify their functioning problems;
- to develop scenario approaches to the substantiation of strategic parameters for the development of a poultry farm and to justify the economic efficiency of a development strategy for an eggplant of the Voronezh region.

The subject of the study is a combination of methodological and methodological aspects of the development strategy of poultry enterprises of the Voronezh region.

As an object of study, the authors chose a specialized egg producing poultry enterprise LLC Ryaba situated in Khokholsky district of the Voronezh region.

In the course of scientific research, the authors used the methods of economic analysis, such as systemic, abstract-logical, monographic, and statistical-economic, program-target and economic-mathematical methods of research.

The information base of the study was the Federal State Statistics Service, the Territorial State Statistics Service of the Voronezh Region, regional targeted development programs for the agro-industrial complex of the Voronezh Region, electronic network resources and annual reports of poultry enterprises of the Voronezh Region.

### III. SCIENTIFIC RESULTS AND DISCUSSION

World statistics in recent years show that the leading countries for the production of poultry products are China, the USA, Japan, Brazil and India. In the overall ranking of commodity egg production in the world, Russia ranks 6th and produced 44.9 billion eggs in 2018, losing to China, the USA and India.

At the present stage of development, Russian egg poultry, as well as poultry farming in the Voronezh region, are at a growth stage, both in terms of production and economic [17].

By the end of 2019, egg poultry farming in the Voronezh region was represented by three specialized egg producing poultry enterprises: The Tretyakovsky Poultry Farm (SPK Shiryayeva) of the Borisoglebsky District, LLC Ryaba of the Khokholsky District and LLC Farm Zabrodenskoye of the Kalacheevsky District (Table 1).

TABLE I. THE MAIN DEVELOPMENT INDICATORS OF THE SPECIALIZED EGG PRODUCING POULTRY FARMS OF THE VORONEZH REGION

Indicators	(Tretyakovskaya Poultry Farm)	OOO Ryaba	Farm Zabrodenskoye
<b>2017</b>			
The average annual stock, thousand heads	72	655	261
Egg production, million units	1.5	119.7	53.0
Egg production capacity, pcs.	219	289	260
The cost of units sold eggs, rubles / pc	2.6	3.0	3.5
Sale price of sold eggs units, rubles / pc.	3.9	4.1	3.9
Profit for the whole enterprise, million rubles	176.1	16.2	20.8
Profitability level,%	48.6	3.8	13.1
<b>2018</b>			
The average annual stock, thousand heads	809	661	223
Egg production, million units	129.4	123.8	49.8
Egg production capacity, pcs.	338	303	268
The cost of units sold eggs, rubles / pc	3.0	2.7	3.0
Sale price of sold eggs units, rubles / pc.	4.7	3.8	3.7
Profit for the whole enterprise, million rubles	420.3	78.2	6.6
Profitability level,%	72.3	17.8	3.8
<b>2019</b>			
The average annual stock, thousand heads	760	610	219
Egg production, million units	147.7	135.1	47.4
Egg production capacity, pcs.	287	294	282
The cost of units sold eggs, rubles / pc	3.6	3.0	2.6
Sale price of sold eggs units, rubles / pc.	4.1	4.1	3.6
Profit for the whole enterprise, million rubles	283.6	136.2	39.6
Profitability level,%	36.5	29.6	29.9

The analysis of the main indicators of the poultry enterprises development in table 1 showed a positive dynamic in the development, characterized by an increase in the production of marketable eggs and an increase in profit and profitability in general for enterprises. The conducted studies allowed identifying trends in the development of eggplants of the Voronezh region, the main of which are following: concentration of production in the poultry farming, deepening the specialization of poultry enterprises and increasing production volumes.

The researchers showed that the most stable and efficiently developing egg producing poultry enterprise in the Voronezh region is LLC Ryaba of the Khokholsky District [16], which has been operating in the Voronezh Region market since 2006, with an annual egg production of 135.1 million pieces per year and with stable average production growth of 7 % annually [4].

However, there are certain problems in the development of the poultry industry in the Voronezh region, which include:

- disparity in the prices of poultry products production, expressed in a high level of prices for energy resources, for compound feeds and costly acquisition of equipment and breeding stock for production;
- depreciation of fixed assets at poultry farms of the region;
- low level of marketing services for the s poultry products sale.

The researchers discovered that the main tool for solving the effective sustainable development of poultry industry in the Voronezh region and Russia as a whole is to develop a development strategy for poultry enterprises on a long-term basis, taking into account their trends, characteristics and dynamics in the economic environment.

When developing a strategy for the poultry enterprises growth, the application of economic and mathematical methods has a number of significant advantages over other methods. Firstly, the principle of a systematic approach is fully implemented; secondly, the speed and quality of plans development increases; thirdly, the implementation conditions for a multivariate statement of the problem appear; fourthly, there is the possibility of operational adjustment in accordance with changes in the internal and external conditions of production.

The need to use economic and mathematical methods in planning the strategic development of poultry enterprises in the egg sector is also dictated by some factors: specific features of the poultry industry, the process of complicating economic ties, the need to expand production and processing of poultry products, as well as increasing competitiveness in the regional market [7].

Considering the question of the optimality criterion, it should be noted that the optimization of economic decisions is achieved not only by substantiating the optimality criterion, but also by choosing the best option for it. Approaching the optimum is ensured by the correct definition of the whole set of basic conditions of the real economic process, which are expressed in various components of the economic and mathematical model in the restrictions on products and resources, in production methods that characterize the options for using resources from the point of view of cost and efficiency.

As a criterion of optimality in the economic and mathematical models developed by the authors, such indicator as the maximum profit was adopted to measure the economic efficiency of a poultry enterprise development.

To solve economic and mathematical models on LLC Ryaba, the authors developed three possible alternative scenario approaches of strategic development for the optimal solution: pessimistic, traditional and optimistic. The influence of external and internal factors on their development at the present stage was taken into the consideration.

A pessimistic scenario for the development of an enterprise implies the development of an enterprise under the negative influence of internal and external factors on the production of poultry products. They include the global financial crisis, the saturation of the domestic food market with foreign products, rising prices for fixed and current assets, low consumer ability of the population, lack of proper support from the state as well as adverse climatic conditions of management, which affects the availability and price in most cases of purchased feed.

In this regard, the pessimistic type of LLC Ryaba strategic development provides for a 2-fold increase in the prices of concentrated feed by the example of the dry year of 2010. The optimality criterion in this embodiment for the economic-mathematical model was breakeven production, i.e. profit equal to zero.

In the traditional scenario of developing a poultry enterprise, a model is compiled and solved according to actual prevailing production data. It should be noted that LLC Ryaba has not yet fully utilized its production capacities (a workshop for laying hens and a workshop for replacement chickens are being reconstructed), therefore, a livestock of 80% of the possible is provided.

The results of solving the problem make it possible to assess the actual development in view of the best use of the existing economic and organizational conditions to ensure the highest possible level of production. Analyzing the results of solving this problem, we can reveal the shortcomings of the poultry enterprise strategic development and their causes, production reserves and specific directions for improving the production process at the enterprise.

The third development scenario that can be characterized as optimistic, involves solving the economic and mathematical model of strategic development of LLC Ryaba based on favorable outside and inside factors affecting the production of egg and meat poultry products and the use of all potential capacities of the enterprise under study. The favorable outside factors include the following factors: development of a poultry enterprise, because of western sanctions against the Russian Federation, under the condition of import substitution, additional state subsidization of poultry farming, protectionism policy in the market of eggs and poultry meat, the absence of abnormal fluctuations in climatic conditions and others. The inside factors include the full development of production capacities, and compliance with veterinary requirements for the organization of production, keeping, feeding, drinking, manure cleaning at poultry enterprises are important too [3].

The analysis of the optimal options in table 2 showed that with an optimistic development option, LLC Ryaba has the potential to increase the production of eggs (the main product) by 75% from the level of 2019 to 237 million pcs. per year and poultry meat (by-product) by 15 % to 527 tons. At the same time, the egg production of laying hens will increase by 326 psc. There will be a growth in an annual number of all age – sex groups by almost 35 percentage points and the amount will be 826 thousand heads.

**TABLE II. PRODUCTION PERFORMANCE OF LLC RYABA FOR THE OPTIMAL SOLUTION**

Indicators	Years			Project Options		
	2010	2015	2019	Pessi- mistic	Tradi- tional	Opti- mistic
<b>Average stock, thousands heads</b>						
The average annual stock	386	534	610	416	686	826
incl.total number of laying hens	216	332	459	366	633	754
replacement chickens	170	202	151	50	87	103
<b>Production</b>						
Eggs, million pcs.	51	102	135	101	183	237
Poultry meat in slaughter weight, tons	432	549	453	256	422	527
<b>Laying hens production</b>						
Egg production, pcs.	236	307	294	276	304	326

In Russia, many poultry enterprises specialize in the production of marketable food eggs obtaining good results. They sell almost all products in the shell, only 10–11 % of their products goes to industrial processing.

Recently, the general trend in developed countries is the active replacement of habitual eggs in the shell with processed egg products. This trend is confirmed by many sources. For example, in the EU 28 % of eggs were processed in 2015, in 2018 this figure rose to 30 %. According to forecasts, over the next 10 years it will reach 35 %, in the United States already process about 35 % of eggs produced, and in Japan more than 40 % [12].

Guided by the fact that chicken egg products are in great demand, more competitive in the market, and the demand for whole eggs is seasonal, since in the summer poultry farms are forced to lower prices for their products, a business project for processing eggs at the Ryaba poultry farm for a period of 5 years was developed.

Egg products can simplify and decrease the cost of the process, reduce energy and labor costs, the amount of waste, the production time of the final product and logistics costs, as well as provide high safety and nutritional value.

Modern equipment and flexible technological processes allow dividing the egg into protein and yolk and produce egg products in dry, liquid, chilled and frozen forms. Liquid products are filtered, pasteurized and packaged in aseptic packaging.

The advantages of chicken egg products are the safety of all the nutritional properties of fresh eggs; significant cost reduction of the egg. The duration of storage of dry processed products increases by 6 times and neither generate waste no take up much space in the warehouse [1].

According to the calculations in the business project for egg processing at LLC Ryaba, the egg volume for processing, taking into account the egg breakage, non-high-quality commercial eggs, will be about 20 % of the produced egg volume, which is about 370,000 pcs. eggs per year. Thus 74,000 eggs per day can be sent for processing (Table 3).

Judging by the number of eggs being processed, and dividing them into three types of final products, we selected

the most suitable set of equipment with a capacity of 240 kg of dry egg products per day in all respects (productivity, size, cost). The shell, when processing eggs, will go to feed the birds as a valuable additive to feed with calcium content.

The important advantage of egg dry products produced by LLC Ryaba is its low cost for the enterprise and low prices for consumers of these products. In order to ensure the competitiveness of the products sold and the high demand for them, we planned the sale prices of products below average.

**TABLE III. EFFICIENCY OF THE PROJECT FOR THE PROCESSING OF EGGS INTO EGG POWDER AT LLC RYABA**

Indicators	2021				2023	2025
	Product types			Total		
	Egg powder	Protein	Yolk			
1. The volume of products sold, kg	61600	36400	92400			
2. Costs of production, million rubles	3.5	8.3	5.3	17.0	20.2	24.0
3. Costs of sales, million rubles	0.2	0.4	0.3	0.9	1.0	1.2
4. The total cost of units products, rub/kg	0.1	0.2	0.1			
5. Sale price, rub/kg	80	350	130			
6. Revenues from sales, million rubles	4.9	12.7	12.0	29.7	35.9	43.5
7 Balance sheet profit, million rubles	1.2	4.1	6.5	11.8	14.6	18.2
8. The single agricultural tax, million rubles	0.1	0.2	0.4	0.7	0.9	1.1
9. Net profit, million rubles	1.2	3.8	6.1	11.1	13.8	17.1
10. Profitability level, %	31.6	44.2	110.1	62.0	64.7	67.5

Because of the calculations, the efficiency of the business project for the introduction of equipment and a chicken egg-processing workshop at LLC Ryaba poultry farm was revealed. Since the profitability index from the sale of processed products is 34.4, which is much more than 1, and the internal rate of return is 79.5 %. The payback period of the project, taking into account discounting, will be 6.5 months; the net present value of the project is 192.8 million rubles.

Dry egg products of LLC Ryaba will have a high price-quality ratio in comparison with other poultry enterprises in the Voronezh region. They will contain high preservation of all the nutritional properties of fresh eggs. They are good raw materials for the production of flour and confectionery products, as well as for the production of sauces and mayonnaise. All these goods will be sold at the confectionery factories of the Voronezh region and the Central Black Earth region, oil and fat plants and bakeries.

Consider the economic effect under various options for the strategic development of the egg plant LLC Ryaba, according to the data of the economic and mathematical model in a multivariate implementation (table 4).

The results analysis of solving the economic and mathematical model allows concluding that with the

traditional way of enterprise development, it is possible to achieve a profitability level of production and sales of products of 17 %, which is 1 % higher than the actual level of 2019.

TABLE IV. EVALUATION OF THE FINANCIAL RESULTS OF POULTRY PRODUCTS AT "RYABA" ACCORDING TO THE CVP-ANALYSIS METHOD FOR OPTIMAL SOLUTION

Indicators	2019	Options Project		
		Pessi- mistic	Tradi- tional	Opti- mistic
Number of products sold (eggs), million pcs	134.9	101.3	175.3	208.5
Selling price, rubles / pcs.	4.1	4.5	4.1	4.5
The number of processed eggs, tons	-	-	-	285.6
Selling price on average, thousand rubles / to	-	-	-	190.0
The number of products sold (poultry in processed form), tons	132	145	245	356
Selling price, thousand rubles / ton	25.5	27.8	25.5	28.0
Revenue from sales of products total, million rubles	596.8	445.8	763.9	1132.1
Variable costs, million rubles	442.9	398.5	563.0	735.3
Gross margin, million rubles	153.9	47.3	200.9	396.8
Fixed costs, million rubles	17.7	47.3	22.5	29.0
Total cost, million rubles	460.6	445.8	585.5	764.3
Profit, million rubles	136.2	0	178.4	367.8
The level of profitability (payback),%	29.6	(100)	30.5	48.1
Gross margin ratio	0.2579	0.1061	0.2629	0.3505
Profitability threshold, million rubl	68.6	145.4	85.6	82.8
Leverage Effect	1.13	-	1.13	1.08
Stock of financial strength, million rubles	528.2	-	678.3	1049.3
Margin of financial strength, %	88.5	-	88.8	92.7

With an increase in production and the egg-processing introduction at LLC Ryaba, the level of profitability may increase to 48.1 % against 367.8 million rubles of total profit. The profitability margin will be 82.8 million rubles, and the margin of financial strength – 10493 million rubles. or 92.7 %.

In order to achieve the traditional option in substantiating the development strategy of the poultry enterprise, in our opinion, it is advisable to form stocks of concentrated feed.

Our economic calculations in a business project and economic and mathematical modeling showed the profitability of commissioning an egg processing workshop at the LLC Ryaba poultry farm, which, ultimately, will provide high economic results, increase competitiveness in the market and bring the poultry farm to a large scale chicken egg production and processing.

Thus, the assessment of the financial results of the development strategies for the egg producing poultry enterprise LLC Ryaba according to the CVP analysis method in table 3 indicates the presence of reserves for the growth of production at the enterprise.

As follows from the analysis of our studies, we proposed organizational and economic measures to achieve the optimistic scenario of the strategic development of poultry enterprises on optimal parameters, which include:

1. Conducting economic activities of enterprises based on investment and innovation renewal;
2. Use of highly productive bird crosses;
3. Feeding poultry with complete feed;
4. The use of effective veterinary and preventive measures ensuring high safety of the bird;
5. The use of energy and resource saving technologies;
6. Expanding the range and improving the quality of products using resource-saving technologies;
7. Implementation of the scientific organization of labor;
8. Deepening product processing;
9. Rational management of natural resources and waste management;
10. The development of modern methods of marketing, sales and advertising;
11. Improving the social conditions of workers in poultry enterprises;
12. State financial and credit support for the poultry industry, development of a system for increasing the interest of producers;
13. Scientific support and research support, as well as promising developments in the field of studying the properties and finding new possibilities for using chicken eggs in the regional, state and world markets.

#### IV. CONCLUSIONS

Conducted scientific research allows drawing the following conclusions.

1. The analysis of the main quantitative and qualitative indicators of egg producing poultry enterprises of the Voronezh region showed a positive dynamic in the development of enterprises, characterized by an increase in the production of marketable eggs, an increase in profit from sales of products and the level of profitability in general for enterprises. The studies conducted allowed identifying trends in the development of poultry enterprises, the main of which are: concentration of production in the poultry farming, deepening the specialization of poultry enterprises and increasing production volumes.

2. The developed scenarios of the development strategy proved the enterprise's potential for expanded reproduction and its economic efficiency. Therefore, with an optimistic type of the enterprise development under study, based on the favorable effects of economic factors on the enterprise, using all potential opportunities and processing non-sorted eggs into egg powder, the maximum profit at the enterprise can be reached up to 367.8 million rubles per year. It is almost 3 times higher than the actual level of 2019. There will be an increase in the poultry stock of all ages by 37 percentage points to 826 million heads, an increase in the production of eggs (the main product) by 15 percentage points to 237 million pieces and poultry meat (by-product) by 15 % to

527 tons. A profitability level of production and sales of products will achieve the level of 48.1 %, a profitability threshold – 82.8 million rubles, and a financial safety margin – 10493 million rubles or 92.7 %.

3. In the result of the studies, organizational and economic measures were proposed to achieve the economic efficiency of the strategic development of poultry enterprises. They include investment and innovation renewal of enterprises, the use of highly productive bird crosses, feeding poultry with complete feed; the use of effective veterinary preventive measures; application of energy and resource saving technologies; expanding the range and improving product quality; the introduction of the scientific organization of labor; deepening product processing, etc.

Thus, the developed optimal parameters for the strategic development of poultry enterprises, as well as the proposed organizational and economic measures to achieve them, will ensure, if implemented, a significant increase in the economic efficiency of poultry enterprises.

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