

Scenario approach for substantiating the mid-term development of the region

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Abstract — The article presents methodology of scenario anticipation of perspective development of the region tested on the data of dairy cattle in Ryazan oblast.

Keywords — region, anticipation, scenario approach, milk

I. INTRODUCTION

Anticipating agricultural development on the basis of the scenario approach is often used in operations. Choosing the optimal direction of the branch development, considering factors of external and internal realities and developing the mechanism of achieving the aim are basic elements of the method.

Determining indicators of the regional development is based on a combination of factors, principles, mechanisms and instruments of some branch efficient development. Herewith, every economic subject must function. The state must provide the rational system of taxpayer support for manufacturers oriented on production, import limits, regulation of price proportions, etc. [1]

II. MATERIALS AND METHODS (MODEL)

Choosing anticipation instruments is a difficult task and depends on specific peculiarities of the subject area and the object of study. Herewith, all structural, dynamic and probabilistic characteristics must be taken into account.

Nowadays a person taking a decision (PTD) can use more than 150 methods of anticipation making possible to provide

the grounded and true judgment about future state and development of the object on the basis of last data and factors of external and internal realities.

In our opinion, ARIMA models should be used to anticipate changes of agricultural processes and phenomena. The reasons for that are as follows:

- the main parameters characterizing the efficiency of the development of agricultural production (gross output, gross milk yield, profit) are stochastic. As a result, such time series are, as a rule, nonstationary, since characteristics of the random values of the series can vary at different time periods. ARIMA modeling involves procedures for bringing such time series to a stationary form, for example, using the difference method [3];

- the ARIMA methodology itself corresponds satisfactorily the nature of time series of agricultural production, since the autoregressive component allows modeling the influence of already achieved values of development parameters for the future taking into account the chosen depth of the lag. Therefore, when anticipating the "fresh" values of the time series are most valuable, and the initial parameters are taken into account with a lower share;

- autoregressive models allow mitigating sharp fluctuations in the time series that perturb anticipation (for example, the effects of drought or flooding);

- the autocorrelation component of ARIMA allows to take into account the impact of fluctuations in the values of the

time series on its dynamics, which may affect the management decision taken;

- the autocorrelation model with a long time series allows to take into account production cycles.

The obvious advantages of the ARIMA methodology also include the possibility of taking into account exogenous (external factors). As a result, the time series becomes multidimensional, and the anticipation model acquires the features of factorial regression.

Thus, all of the above allows us to conclude that when anticipating the development of dairy cattle industry in Ryazan oblast, one should choose an integrated model of auto regression and moving average (ARIMA, the Box-Jenkins model). The ARIMA model (p, d, q) used for the non-stationary time series Y_t (milk yield for time t), taking into account the influence of a series of exogenous factors x_{kt} , is as follows: [4]

$$\Delta^d Y_t = c + \sum_{i=1}^p a_i \Delta^d Y_{t-1} + \sum_{j=1}^q b_j \varepsilon_{t-j} + \varepsilon_t + \sum_{k=1}^r g_k x_{kt}$$

where ε_t – stationary time series (auto covariance process);

c, a_i , b_j , g_k – parameters of the model;

Δ^d – time difference operator d.

Testing the scenario approach was done on the example of the dairy cattle industry in Ryazan oblast.

The goals and tasks facing the livestock sector of Ryazan oblast are formulated in the State Program "Development of Agriculture and Regulation of Agricultural Products, Raw Materials and Foodstuffs for 2013-2020". This program provides for a significant increase in the scale of production of livestock products and improving its quality. So, it is planned to increase the production of milk and meat of cattle, increase the number of cows, and stimulate breeding work aimed at improving the breeding and productive qualities of farm animals. Achieving these goals should be carried out at the lowest cost, which requires optimizing the elements of the resource potential of the industry and increasing the efficiency of its use.

Determining the basic indicators of the dairy cattle industry development in Ryazan oblast is done with the help of planning and anticipating. At the same time, a wide toolkit of cognition of socio-economic processes and phenomena is used, as well as a set of modern methods and means of economic anticipation. [2]

To anticipate milk production in Ryazan oblast for 2025 we use data for the period from 2000 to 2016 (Table 1) (Y_t).

The time series under investigation has a distinct trend: the average values of milk production volumes are gradually increasing. A preliminary analysis of time series showed that most of them are nonstationary and are close to random walk processes with time-varying dispersion. [5]

Table 1 – Milk production in Ryazan oblast

Year	Milk, thousand tons
2000	462
2008	382.6
2009	375.2
2010	369.9
2011	370.6
2012	364.4
2013	366.2
2014	370.5
2015	354.9
2016	364.4

The constructed periodogram of the time series revealed a pronounced peak, which indicates the existence of a stable production cycle. To reduce the variance of the analyzed series, a logarithmic transformation was applied. This operation revealed the presence of a monotonically increasing trend, which can be removed due to the difference operator of the first order. As a result of a series of optimization experiments and a visual analysis of actual and predictive data, autoregression (p) and autocorrelation (q) lags equal to 1 are recognized as most suitable for the ARIMA models used. Realization of these actions allows bringing the analyzed time series to stationary form and using for anticipation. [6]

To take into account the influence of the main factors of agricultural production on the gross production of milk, we use the autoregressive and autocorrelation component. As exogenous variables of the model, we distinguish: [7]

- the state of the material and technical base of production;
- the state of the production infrastructure;
- the financial status of agricultural organizations in Ryazan oblast;
- возможность повышения уровня интенсификации производства;
- the use of progressive breeds of farm animals;
- the use of advanced milk production technologies;
- participation in federal and regional government support programs for agricultural producers.

However, assessing the state of the above factors throughout the analyzed period is a difficult task. This is due to the following reasons: [8]

- factors are analyzed using quantitative characteristics, which reduces the possibility of comparability of indicators;
- values of some statistical indicators, especially value indicators, over the long time period become incommensurable;

- values of some statistical indicators are difficult to quantify.

To assess the exogenous factors affecting the scale of the dairy cattle industry, empirical research methods were used. Within the framework of the study, the status of the selected factors was evaluated on a 10-point scale as a result of a questionnaire for a group of experts. [9]

Further, according to the actual data obtained as a result of questioning the heads of agricultural organizations in Ryazan oblast, their rationing was carried out.

By means of averaging standardization to the level of the initial value of the time series, and also the convolution of expert estimates of n factors, time series of exogenous variables were formed (X_{kt}). [10]

$$X_{kt} = \sqrt[n]{\prod_{h=1}^n X_{hkt}} = 0,739$$

where X_{hkt} – a standardized estimate of factor h at time t .

III. RESULTS AND DISCUSSION

Convolution, carried out according to the algorithm of standardized estimates with the subsequent extraction of a root of degree equal to half of the number of factors, allows, in our opinion, to take into account the integral and mutually limiting effects of combining qualitative exogenous factors of different nature. The obtained results allow giving an integral assessment of the factors affecting the development of the dairy cattle industry in Ryazan oblast. The presented data allow drawing a conclusion that the process of improving the state of dairy cattle has been outlined, due to the growth of the investment attractiveness of the industry, and then the adoption and implementation of state programs for the development of the agricultural sector. However, despite the positive trends, the integral indicator of the group of qualitative factors for agricultural enterprises in Ryazan oblast still remains rather low (0.739), which is caused by the stagnation of the industry.

Besides, some structural changes occur in the breed composition of the cattle in Ryazan oblast, resulting in changes of requirements for cattle feeding and management, implying an increase in the share of modern technologies, which should be taken into account when developing anticipation scenarios for the development of the industry.

The existing conditions and the achieved level of development of the agro-industrial complex of Ryazan oblast suggest the following scenarios for the development of animal husbandry.

The first scenario, which we developed, can be classified as extensive. This is due to the fact that we suppose to maintain the existing trends in the development of the livestock sector. Naturally, this scenario should not be understood literally. The development of the livestock sector according to the extensive scenario does not imply only an increase of resources in the industry, but also the availability of an innovative component, the share of which corresponds to

the actual pace of the innovation activity development, taking into account the further implementation of the targets for the priority national project "Development of the Agroindustrial Complex" and the State Program "Development of Agriculture and Regulation of Markets for Agricultural Products, Raw Materials and Food for 2013-2020". In this scenario, the gross production of the main livestock products in Ryazan oblast will increase due to higher productivity of the livestock and improvement of the breed composition of animals. The livestock productivity is calculated on the basis of the existing trends and rates of its growth, taking into account the normative level of provision with fodders satisfying the requirements for basic nutrients.

The second scenario, which we developed, can be classified as intensive. It assumes qualitative economic growth and characterizes the accelerated variant of the development of the livestock sector. The intensive scenario will be based on active state support, implementation of major investment projects, and attraction of domestic and foreign investors. The improvement of the quality of human capital and the use of high-tech industries on this basis are fundamentally important.

The calculations carried out made it possible to anticipate milk production in Ryazan oblast for 2025 according to each of the forecasts. To anticipate according to the extensive scenario, constant values of exogenous predictors achieved by 2014 were used.

IV. CONCLUSION

An intensive scenario involves a gradual increase in the level of using competitive advantages at a level estimated by experts. The extensive anticipation is based on the premise of maintaining the current level of development of the dairy industry throughout the horizon of anticipation.

The next stage in the formation of scenarios for the development of the livestock sector is the calculation of the main technical and economic parameters for each scenario (Table 2).

Table 2 – Conditions of developed scenarios of dairy cattle development

Parameters	Scenario of development	
	extensive	intensive
Milk production, thousand tons	633.8	895.4
Cows, thousand heads	8661	8661
Annual average milk yield per 1 cow, dt	73.18	103.38
Expenses for 1 cow, rubles	75334.49	75334.49
Prime cost of 1 dt of milk, rubles	1029.44	728.71

When calculating efficiency parameters, actual indicators for cows' population were taken. Costs per 1 cow were discounted based on the planned level of inflation. Growth in the scale of milk production will lead to positive results - the cost of 1 dt of milk will be low, and this will let domestic agricultural producers remain competitive and oust foreign producers.

Thus, the use of the scenario approach is an effective tool for identifying perspective directions for the development of the region, since not only an important property of the developed anticipation methodology is its universality. The main results of the investigation, in spite of the pronounced sector focus of its application due to the systemic nature of objects and system tools, can be used in other subject areas.

Acknowledgment

The work is done with the support of the grant of Russian fund of fundamental studies "Modeling processes of imports phase-out at food market when reduced consumption", No. AAAA-A18-118012090007-3

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