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METHODOLOGY OF PRODUCTION PLANNING OF AGRICULTURAL PRODUCTS IN THE CONTEXT OF FOOD SUPPLY OF THE REGION

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Abstract:

Current conditions and problems of foreign policy determine the problem of food provision for the population as the most important. This problem is of paramount strategic importance for the country, since food security is one of the main indicators of the quality of life. Agriculture is faced with the task of determining the volume of production, taking into account the level of monetary incomes, purchasing power, effective demand for agricultural products, raw materials and food, the production potential of agriculture and manufacturing in the region, the dynamics of the price of agricultural products and the availability of spare products.

As a tool for agricultural production planning, it is proposed to use a one-dimensional time series model and construct an additive time series model. As a result, the authors calculated three variants of the forecast of consumption of the main types of food products, which take into account: scientifically based nutrition norms; methodological recommendations for calculating the subsistence level in the regions of the Russian Federation; actual level of consumption. The calculations showed a high degree of reliability of the planned indicators and the availability of an acceptable level of income. The proposed methods allow planning the production, import and consumption of some types of agricultural products.

Keywords: planning, agricultural products, food, time series model, additive model, consumption of agricultural products.

I. INTRODUCTION

Modern conditions of socio-political and economic instability in the regions of the world, the introduction of international sanctions against Russia, from the standpoint of national security, food security for the population as a country in general, and regions acquires special significance. The solution of this task lies with the producers of agricultural products and rural areas. In accordance with the Constitution of the Russian Federation: "A person, his rights and freedoms are the highest value, and the Russian Federation is a social state whose policy is aimed at creating conditions that ensure a decent life and free development of a person". Proceeding from this, the satisfaction of the diverse human needs, the main of which is the satisfaction of the needs for food, is the paramount task of a democratic society. All transformations in society, including politics, economics, culture and the social sphere, are carried out for the sake of man. In this context, the importance of the development of food security both of the country as a whole and of its individual regions is a defining element of the domestic policy of the state.

An important aspect in solving the problem of food provision for the population of the region is the planning of interaction between such processes as production and consumption. The essence of planning the production of agricultural products is to determine the amount of food required for consumers on the basis of scientifically-based norms of consumption. Analysis of the structure of average per capita consumption and its dynamics are the basis for planned calculated indicators in different perspectives. In this regard, there is a need to develop a methodology for planning agricultural production and food consumption, which would allow to accurately identify the emerging patterns and make forecasts of various socio-economic indicators, as well as assess the likelihood of their achievement.

The presented method of planning the production of agricultural products in the context of food provision for the population of the region is the need to present in the foreseeable future the state of food provision for the population, which affects the efficiency of the functioning of the agro-industrial complex and agricultural production as an integral part of it. The difference between the presented methodology is that it uses a complex approach that takes into account the multiplicity of factors. For example, in the partial equilibrium model of supply and demand for a particular type of product, only the reaction of agricultural producers to price changes is taken into account. The calculation is based on the demand of the population of the Kemerovo region for food on the basis of scientifically grounded norms of consumption and can be used in forecasting the management of the socio-economic development of the region.

The main factors affecting the level of food consumption in the region can be summarized as follows: population size, sex and age structure, ratio of urban and rural population.

II. METHODOLOGY

As the object of research in this work is the agriculture of the region. The subject of the study is the planning of production of agricultural products in the context of food provision for the population of the region using models of one-dimensional time series and constructing an additive time series model.

The aim of the study is to model the development of agriculture in the context of food provision for the population of the region.

As methods of research in the work used:

methods of statistical forecasting;

economic and mathematical modeling of development;
methods of the probable state of the object;
methods of regressive and comparative analysis.

To solve the problem of agricultural development in the context of food provision for the population of the region, we apply the method of mathematical modeling.

The agriculture of the region is an example of a large socio-economic system, therefore, when planning production of agricultural products and food provision of the population of the region, there are problems of mutual coordination of interacting in the system participants in this process: producers - processors - food market - consumers. The description of processes in complex systems requires the use of a large amount of data, which necessitates their automated processing. In turn, the effectiveness of the application of automated analysis tools is determined by the balance of mathematical models describing the content processes in a complex system.

When considering the structure of personal consumption of food products among sex and age groups of the population, it is necessary to be guided by the federal legislation of the Russian Federation, in particular Law No. 227-FZ "On the consumer basket in the Russian Federation" of December 3, 2012.

The minimum food basket is differentiated by the main socio-demographic groups of the population: the able-bodied, pensioners, children.

The minimum food basket for calculating the subsistence minimum is developed by the Institute of Nutrition of the Academy of Medical Sciences of Russia. In accordance with their recommendations, the daily energy value of food products should be for: men of working age - not less than 2710.4 kcal; women of working age - 2138.4 kcal; pensioners - 1976.7 kcal; children under 6 years old - 1581.6 kcal; teenagers from 7 -15 years old - 2236.7 kcal.

The final stage of the reproduction process is consumption, which is reduced to the satisfaction of deterministic needs, therefore, there is a close interaction of such concepts as production and consumption, whereas the essence of production is to satisfy consumption needs. The quality of life depends on the level of consumption, its dynamics and composition. A careful assessment of the dynamics and structure of per capita consumption is the basis for forecasting and determining forecast indicators in the operational, short, medium and long term.

In the changed uncertain economic conditions in order to ensure the sustainable functioning of the structures of agricultural production, it is necessary to understand and use the basic principles of strategic management, the implementation of which is impossible in isolation from making effective management decisions. Management decisions should be based on a systems approach, the analysis of those external and internal factors that directly or indirectly affect the activities of the enterprise. With this approach, conceptual and practical significance developments on the problems of making managerial decisions in market conditions will increase dramatically.

In a changing environment, risk and uncertainty, widely used extrapolation methods based on the use of retrospective trends are suitable only for stable economic conditions or within relevant boundaries. There is a need for a strategic approach, the essential basis of which is the definition of the object's mission and goals, the solution of strategic tasks, which products (and above all new ones) to produce, which markets to enter, which business to develop (start, continue, stop).

Modern methods of statistical forecasting allow predicting and revealing the regularities of various indicators, including socio-economic ones, with a sufficiently high accuracy, to carry out reliable forecasts and an assessment of their performance in the long-term period. The forecast provides a scientifically grounded argument for the probable state of an object in the future, possible options for ways and time, when it reaches such a position.

III. RESULTS

To determine the population's need for basic foodstuffs, it is first of all necessary to forecast the population of the Kemerovo region until 2025, and it should be noted that this indicator has been constantly decreasing over the past 14 years. With the help of the mathematical apparatus on the use of the power trend model, the population forecast is calculated.

The tightness of the connection, determined with the aid of the correlation and determination indices, indicates an inverse very strong dependence between the parameters studied (the value of the correlation coefficient "-0.99", that is, the coupling strength, is characterized by the Cheddock scale as very high. The determination coefficient was 98% and the closer the coefficient of determination to unity, the more confident it can be to say that the factor value has a significant effect on the resultant result. That is, the regression equation shows that up to For other factors, it takes 2% of its variance (residual variance [8]) and the regression equation is statistically significant.

The dispersion analysis showed the statistical reliability of the regression equation on the basis of Fisher's F-criterion and the significance of linear correlation coefficients according to Student's t-criterion.

Thus, taking into account the correction of the population forecast, through the use of the power trend model, it is determined that the number of residents of Kuzbass by 2025 will be 2517.4 thousand people, as a result, the population decline to the data of 2017 will be - 9.3%, respectively.

Based on the obtained model data on the population of the region, it is possible to obtain a forecast of average per capita consumption, taking into account the actual level of consumption of foodstuffs and the level of the population's solvency (savings and current incomes).

As initial data for the construction of the forecast, data from the reporting forms of the Department of Agriculture and Processing Industry were used, official statistical data of the federal, regional level.

The most important factors influencing the population's consumption of food products, which are the basis of the forecasting process, are: the level of monetary incomes, the purchasing power of per capita monetary income of the population, effective demand for agricultural products, raw materials and food; production potential of the region's agriculture and processing industry; the dynamics of prices for agricultural products, the availability of substitute products on the market, assortment.

Applying the "Methodological recommendations for providing food to the population of large cities", the following options for forecasting are proposed: the first - taking into account scientifically-based norms of nutrition; the second - methodical recommendations for calculating the subsistence minimum in the subjects of the Russian Federation; the third - is based on taking into account the prevailing level of consumption and the forecast of solvent demand of different population groups.

The authors propose an algorithm for calculating the long-term forecast of food consumption, including: constructing a time series of per capita consumption of each individual food product; the definition of an analytic function that will allow us to describe the dynamics of changes in the time series with the most accurate.

In our opinion, it is with the help of time series that it is possible to describe statistically the development of socio-economic processes taking place in time. The sequence of values of the indicator (feature), arranged in order of increasing time series (chronological order), is called: a time series; dynamic series; a number of speakers. The time indicator, in this study selected individual periods - years.

As the object of forecasting are the processes, phenomena and events, to which the activity of the forecasting subject is directed - the consumption of food products. The subject of forecasting are agricultural and other commodity producers of the main types of food products.

At the initial stage of forecasting, a database of retrospective information was created that contains data on average per capita consumption for each food product of the main type of food - meat, bread and bakery products, milk and dairy products, vegetables and melons, eggs and potatoes.

Analysis of trend series for the period from 2000 to 2015. showed that in the calculation period there was no significant spread of the forecast indicators, the variance did not fluctuate significantly, the unstable

economic situation in 2008 and the consequences of the crisis did not significantly affect the actual indicators. The forecast of average per capita consumption of basic food products until 2025 is proposed to be implemented in accordance with the above algorithm, and using the Microsoft Office Excel 2010 software.

In order to form a more accurate forecast of consumption of staple foods, a regression analysis was performed to assess the extent of the relationship between the variables, based on historical data that is beyond the actual values until 2025.

Using the models of one-dimensional time series and constructing an additive model of a time series, the planned volume of consumption of food products by the population of the region is calculated. In general, the additive model is as follows: $Y = T + S + E$

According to the model, each level of the time series can be represented by the sum of trend (T), seasonal (S), and random component.

The construction of the additive model reduces to calculating the values of T, S, and E for each level of the series.

In constructing the forecast of consumption of the main types of food, the following types of trend lines or regressions were used in the diagrams: linear, logarithmic and polynomial trend lines that are selected based on the form of the dependence of the data on the actual level of consumption of basic food products on the time factor, seasonal and random components.

For reliability of the forecast of different types of trend lines, it is necessary to determine the value of the average approximation error - A, that is, the value reflecting the proximity of the values of the trend line to the actual data. This value can take up to 100%. The value of the average approximation error in the range up to 13% indicates that the average deviation of the calculated data from the actual deviation is not significant.

In the additive model, the seasonal impacts over the period are intertwined, that is, the sum of the values of the difference between the actual levels of the series and between the centralized moving averages and the actual levels of the series.

As a result of constructing an additive model of the time series for meat and meat products, the average error of approximation is in the range from 6.9 to 11.6% and indicates that the average deviation of the calculated data from the actual ones is not significant. As an example, based on the resulting totals, we plot the forecast of the level of consumption of meat and meat products. A similar calculation of the alignment of the input data by the moving average method, the estimation of the additive model of the aligned values of T and the error E in the additive model and on their basis the forecast of consumption for the remaining types of food products by the population of the Kemerovo Region until 2025.

A similar calculation of the leveling of the initial levels by the moving average method, the estimation of the seasonal component in the additive model, the aligned values of T and the error E in the additive model and on their basis the forecast of consumption for the remaining types of food products by the population of the Kemerovo region until 2020.

Analytical alignment for: bread and bakery products is carried out using a fourth-degree polynomial trend; potato - a polynomial trend of the third degree; milk, vegetables and meat - the logarithmic type of the trend line; egg - a linear trend.

When determining the trend component, the following results were obtained:

1) when forecasting the consumption of meat and meat products, the logarithmic equation of the trend is used: $y = 11,297 \ln(x) + 33,389$, the level of consumption by 2020 will be 67.23 kg / year, and by 2025 - 69.75 kg / year;

2) for bakery and pasta - a fourth-order polynomial trend: $y = 0,0125x^4 - 0,3067x^3 + 2,2043x^2 - 4,5977x + 140,21$, as a result, by 2020 the level of average per capita consumption will reach 141,8, and to 2025 - 132.96 kg / year;

3) potato consumption is also described by a polynomial trend, but only of the third order - " $y = -0.05556x^3 + 1.521x^2 - 10.445x + 137.48$ ". It is forecasted to reduce consumption of this type of food: by 2020 to 116.29 kg / year, and by 2025 - 129.44 kg / year / person;

4) Consumption of vegetables and milk by the population of the region is described by logarithmic trend equations: " $y = 11.43 \ln(x) + 46.722$ " and " $y = 8.8032 \ln(x) + 200.81$ ", as a result, actual consumption by

2020 will be 80, 96 kg / year and 227.18 kg / year, respectively, by 2025 - 83.51 kg / year and 229.15 kg / year, respectively;

5) when predicting the consumption of eggs, a linear trend equation was used: $y = 3.2545x + 215.02$, from which the level of consumption by 2020 will be 280.11 kg / year, and by 2025 - 296.38 kg / year.

The reliability criterion of the additive model is the average error of approximation (A), for each type of food product it varies from 0.4% for bakery and pasta products, to 6.3% for meat and meat products, which indicates that the average deviation of the calculated data from the actual is not significant.

The calculated data will be plotted on the graph of the forecast values of consumption of types of products according to the actual level of supply of purchasing power in the additive model for the period up to 2020.

The next step is the application of the mathematical model developed by the authors of the process of changing the per capita consumption of basic food products in time.

This method of least squares, consisting in minimizing the squares of deviations of the theoretical levels of the time series from the actual ones, is used to calculate the parameters of the trend equation.

Proceeding from the chosen forecasting models, three variants of the forecast of consumption of the main types of food products by the population of the region are given, taking into account: scientifically grounded norms of nutrition; methodical recommendations for calculating the subsistence minimum in the regions of the Russian Federation; the current actual level of consumption and the forecast of the effective demand level of different population groups, with the simultaneous calculation of linear and nonlinear trend lines (the selection of the most reliable results by the average error of approximation (A.) The year 2015 is taken for the reference settlement period with which the forecast indicators are compared.

The population forecast and the norms fixed in the minimum set of the consumer basket are taken into account in the calculations of the first variant.

The calculations of the second variant of forecasting the level of food consumption are based on actual consumption and the forecast of the purchasing power of the population, which made it possible to determine the requirements of total volumes in terms of the main types of food. By 2025, to satisfy the population of the region, it is necessary to produce 260 thousand bread and bread products, 601 thousand tons of milk and dairy products (less by 43% to scientifically grounded consumption norms). Consumption of eggs and vegetables and melons in 2025 will exceed the actual level of 2015 by 11 million pieces and 26 thousand tons respectively.

The third variant of forecasting the level of consumption takes into account: scientifically-based norms of consumption, taking into account differentiation of the population by age groups; population of the region. The forecast was carried out taking into account the average actual per capita consumption of food products and its change over a certain period of time.

IV. CONCLUSION

The conducted calculations showed that in order to provide the population with food products in accordance with the recommended standards, it is necessary to achieve by 2025 the volume of production of agricultural products, thousands of tons: bread and bread products - 277; meat and meat products - 198; milk and milk products - 898; potatoes - 264; vegetables - 370; eggs - 687 million pieces.

According to the data of the calculation of the forecast of the demand for basic foodstuffs for the period up to 2025, taking into account the indicators of the average actual per capita consumption of food products, there is a significant convergence of the results of forecasting by different models, which allows us to reasonably judge the plausibility of the forecasts and their permissible errors as of the year 2025.

At the same time, it should be noted that the predicted values reflect only the general trend of variations in the level of consumption for the future and may differ from its actual values. Note that fluctuations in consumption values will be more pronounced, which is associated with the use of exponential smoothing.

Using the proposed methodology, it is possible to forecast the production, import and consumption of certain types of agricultural products. For carrying out forecast calculations it is enough to have data for one year, average annual rates of population change, income of the population, food prices. In addition, the obtained forecast data can be used when adjusting the program of strategic social and economic development of the Kemerovo region for the period until 2025.

In modern conditions for agricultural enterprises (associations), it is important to improve the systems of prospective and current planning - the formation of indicative plans, annual business plans, operational plans of on-farm production units. In the system of long-term planning, it is necessary to intensify the work of commodity producers in developing organizational and economic plans covering all the main issues of rational construction of enterprises (associations), taking into account the impact of internal and external factors, the main of which include: supply and demand for products; territory organization; specialization, concentration and combination of industries; cooperation and integration; mechanization and automation of production; investments; systems of conducting branches of plant growing and cattle breeding. The development of organizational plan is, in essence, the basis for the development of the achievements of scientific and technological progress.

Studies have shown that among the main factors for the sustainable development of the agrarian sector of the economy the most important is the modernization of its material and technical base associated with the development of new efficient technologies in production. The use of statistical modeling methods based on a software package in forecasting allowed the author to develop proposals for optimizing the technical equipment of production.

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