EFFECTIVE APPLICATION OF ECONOMETRIC MODELING METHODS IN THE DEVELOPMENT OF EXPORTS OF FRUITS AND VEGETABLES

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ЭФФЕКТИВНОЕ ПРИМЕНЕНИЕ МЕТОДОВ ЭКОНОМЕТРИЧЕСКОГО МОДЕЛИРОВАНИЯ В РАЗВИТИИ ЭКСПОРТА ПЛОДООВОЩНОЙ ПРОДУКЦИИ

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Abstract
In this article, the state of fruit and vegetable exports in our country was studied, and the data obtained on factors affecting the export of fruit and vegetable products were analyzed using mathematical and statistical methods. The quality of the forecast of the obtained model was assessed and conclusions were drawn on the further development of this area based on the results of the analysis.

Keywords: agricultural products, fruit and vegetable products exposition, result factor, factors affecting, correlation coefficient, regression equation parameters, multicollenarity, econometric model, model evaluation.

Аннотация

В данной статье изучено состояние экспорта плодоовощной продукции в нашей стране, получены аналитические данные о факторах, влияющих на экспорт плодоовощной продукции с использованием математических и статистических методов. По результатам анализа было оценено качество прогноза полученной модели и сделаны выводы о дальнейшем развитии этой сферы.

Ключевые слова: сельскохозяйственная продукция, экспозиция плодоовощной продукции, фактор результата, влияющие факторы, коэффициент корреляции, параметры уравнения регрессии, мультиколленарность, эконометрическая модель, оценка модели.

Annotasiya

Ushbu maqolada mamlakatimizda meva-sabzavot yeksportining holati oʻrganiladi, matematik va statistik usullardan foydalangan holda meva-sabzavot mahsulotlarini yeksport qilishga ta'sir qiluvchi omillar toʻgʻrisida tahliliy ma'lumotlar olinadi. Tahlil natijalariga koʻra, olingan model prognozining sifati baholandi va ushbu sohani yanada rivojlantirish toʻgʻrisida xulosalar chiqarildi.

Kalit soʻzlar: qishloq xoʻjaligi mahsulotlari, meva-sabzavot mahsulotlarining ta'siri, natija omili, ta'sir yetuvchi omillar, korrelyasiya koeffisienti, regressiya tenglamasi parametrlari, multikollenarlik, yekonometrik model, modelni baholash.Introduction

Introduction

The horticulture occupies a special place in ensuring the welfare of the population and the food security of the country. The existing conditions for the development of the industry in Uzbekistan make it possible to produce products of the industry in much larger quantities than what will be sufficient to meet the country's domestic needs. High competitiveness of export-oriented products can also be achieved. Because the natural and climatic conditions of our country, the labour potential of the industry, and the economic and organizational conditions that contribute to the development of the industry are sufficient.

In recent years, Uzbekistan has made significant progress in the production of fruit and vegetable products. One of the main reasons for this is a significant increase in productivity and production of agricultural products. Improvements were made possible thanks to reforms in the agricultural sector, which shifted the focus from cotton monoculture to more diversified production and improvement of rural

infrastructure. In agriculture, the acreage has been significantly expanded in this direction and the necessary measures have been taken to provide the domestic market with high-quality fruit and vegetable products and to increase the export potential of the country by increasing the production of fruit and vegetable products. Practical measures were also taken to specialize the districts in fruit and vegetable growing, to unite producers of products into fruit and vegetable clusters and cooperatives.

Agriculture is one of the main sectors of the economy and requires increased attention due to the fact that most of the population in rural areas is employed in this area, and that, as a result of agricultural exports, a healthy balance of trade and foreign exchange reserves can be maintained. After all, international trade not only leads to increased productivity but also increases the level of employment in countries, thus making it possible to participate in the global economy. This leads to the stimulation of economic growth.

President Sh.M. Mirziyoyev, in his "Message to the Oliy Majlis" dated December 29, 2020, also noted that "the fight against poverty will be the main economic issue of 2021. The most rapidly developing factor in reducing poverty and increasing the incomes of the rural population is a sharp increase in productivity and efficiency in agriculture ... "[1]

Therefore, a variety of measures are planned to grow this industry and boost exports, and entrepreneurs are given advantages and financial support. The government of our nation has implemented reforms in this area with the goal of raising the productivity of a significant sector of the economy—agriculture—by introducing new technologies, conserving resources, accelerating the process of further processing, and boosting the price of export-oriented goods.

Research Methodology
Science In the past ten years, econometrics has made significant scientific progress, and the range of research and scientific work that employs econometric and economic-mathematical approaches is continuously expanding. The fact that numerous economists, including R. Fridzh and J. Tinberg (1969), L. Klein (1980), T. Haavelmo (1989), J. Heckman and D. McFadden (2000), J. Engrist and G. Imbens (2021), have received the prestigious Nobel Prize in their field of study is proof that econometrics is recognised and studied by scientists all over the world.

According to the definitions of illustrious scientists provided in the book "Econometrics" by N.Sh. Kremer and B.A.Putko, we gain an understanding of the numerous interpretations of econometrics. According to definitions, one of the fields of economics devoted to the creation and use of statistical techniques for determining

the relationship between economic variables is econometrics (S. Fischer and others). The primary goal of econometrics is to add empirical support to economic reasoning (L. Klein). The aim of econometrics is to derive economic laws empirically (E. Malenvo). When studying the economic environment in which we live, econometrics serves as both a telescope and a microscope (C. Griliches). According to S.A. Ayvazyan, econometrics integrates a number of techniques and models that allow qualitative relationships based on economic theory, economic statistics, and mathematical statistics to have quantitative representations. [2]

In his textbook "Econometrics," V.P. Nosko states: "Econometrics is a set of procedures for analysing the correlations between various economic indicators (factors) based on real statistical data." This methodology uses mathematical statistics and probability theory as its tools. These techniques can be used to detect new, previously undiscovered correlations between economic indicators, disprove various assumptions concerning the presence of certain relationships between economic indicators put forth by economic theory, and forecast future values of economic indicators. One of the main areas of study in contemporary economics, along with microeconomics and macroeconomics, is econometrics. To analyse statistical data, econometrics use mathematical statistics and probability theory techniques. But although some models and techniques are more frequently employed in macro-level research, others are more frequently used in micro-level study. [3]

The textbook "Econometrics" by I.I. Eliseeva et al. gives a brief historical overview of the origins and progress of econometrics, discusses coupled regression from the perspective of econometric analysis, i.e., the particulars of the regression equation and its correspondence to the original data, discusses the properties of residuals, and illustrates the potential using straightforward econometric tests. The situation of using spatial data and all the issues that arise in this case are also taken into consideration in the presentation of econometric modelling, which corresponds to the nature of economic processes and phenomena, first and foremost: non-linearity of efficiency, multicollinearity of variables, and heteroscedasticity of random residuals. [4]

When we look at studies from other countries, we also notice that the demand for fruits and vegetables is rising significantly on a global scale. Because of the rise in the import of fruits like grapes, melons, citrus fruits, apples, and others in developed countries, we are now seeing a thorough investigation of this issue. [6] The extension of developing nations' exports into rich nations' markets will boost both the number of their more developed trading partners and global economic expansion. Research is being conducted on a large group of professionals in the food industry in both

developed and developing countries. This research is being done for many people in the fields of agriculture, export, and trade, as well as to further enrich the diets of developed countries, ensure diversity and security in the world food supply, and achieve a sustainable level of diversification of trade in fruits and vegetables from developing countries to developed countries.

The Results of Research

To study various economic phenomena and processes, specialists use their simplified formal descriptions, called economic models. Examples of economic models are consumer demand models, firm models, economic growth models, equilibrium models in commodity, factor and financial markets, and many others. By constructing models, theoretical economists identify the essential factors that determine the phenomenon under study and discard details that are not essential for solving the problem. The formalization achieved at the same time of the main features of the functioning of economic objects makes it possible to assess the possible consequences of the impact on them and use such assessments in management and decision-making.

Economic models make it possible to identify the features of the functioning of an economic object and, based on this, predict the future behavior of the object when any parameters change. Predicting future changes, for example, an increase in the exchange rate, a deterioration in economic conditions, a drop in profits can only be based on intuition. However, important interrelations of economic indicators may be overlooked, incorrectly defined or incorrectly evaluated. In addition, they can manifest themselves in this situation in a completely different way. Usually, the choice of a model is based on the basic provisions of economic theory, knowledge about the general nature of the studied dependencies at previous stages of research, some subjective assumptions (theoretical hypotheses). Therefore, from all possible formulations of the model, the one that best corresponds to real statistical data, as well as the essence of the ongoing economic processes is selected.

In the model, all relationships of variables are formulated explicitly and can be quantified, which makes it possible to obtain a better and more reliable forecast. For any economic entity, the ability to analyze and predict changes in the current situation means, first of all, obtaining better results or avoiding losses, both at the level of firms and in public policy.

By definition, any economic model is abstract and, therefore, incomplete. Highlighting the most significant factors that determine the theoretical regularities of the functioning of the economic object under consideration, she abstracts from a

number of other, less well-known factors. However, despite their relatively rarer applicability, they are real in some specific cases and together can determine not only deviations in the behavior of an object, but also its behavior itself.

Preference should be given to those models that undergo diagnostic tests, although they may have a low coefficient of determination, over those models that have a high coefficient of determination, however, diagnostic criteria indicate a violation of the fundamental hypotheses necessary to justify the assessment methods used. An important rule of modern econometric modeling is a comprehensive check of the evaluated model for violations of certain assumptions or assumptions. Let's list the main criteria that are currently being applied in order to check whether the regression model is correctly specified before evaluating its parameters based on real statistical data of the corresponding economic object or phenomenon. Criterion of missing variables. This criterion is the criterion for adding the variable that is suspected to have been missed. Many other diagnostic criteria also use criteria for adding variables. Criteria of functional form. The Ramsey criterion RESET (Regression specification error test).

Structural change criteria (Chow criterion, CUSUM and CUSUMSQ) and emission criteria. Residual autocorrelation criteria (Darbin-Watson criterion, Breushi-Godfrey criterion (alternative Darbin criterion), point-optimal King criteria), Cochran-Orcutt, Hildreth-Lu. Criteria for the exogeneity of regressors (Darbin-Wu-Hausman criterion). The criterion of the first differences and other criteria for data transformation. Non-applied criteria (nonnested tests). Criteria for stationarity of variables (Dickey-Fuller – ADF test). Criteria for error heteroscedasticity (Spearman rank correlation test, Park, Glazer, Goldfeld-Quandt test). Criteria of normality. This also includes indicators that are not related to the verification of statistical hypotheses and do not reveal the inaccuracy of the model specification, but indicate the unreliability of estimates and their potentially poor robustness: Indicators of the influence of observations (DFFITS, DFBETAS). Indicators of multicollinearity (the number of conditionality, etc.).

The general procedure for using diagnostic criteria procedures is as follows. Each of the criteria corresponds to statistics, which is a function of data. Assuming that the probabilistic model used is correct, it is possible to theoretically deduce the distribution of this statistic (often the distribution is derived from the asymptotic theory and is known only approximately).

The procedure for checking the model is that if the statistics obtained on the basis of the available data set goes beyond a certain confidence interval set in advance, then the null hypothesis is rejected. In case of rejection of the null hypothesis, it is

concluded that the assumptions made are incorrect, i.e. the model is specified incorrectly.

The confidence interval is usually set by specifying the critical boundary. The probability that the statistics will go beyond the confidence interval set by this critical boundary, and thus the correct null hypothesis will be rejected, is called the significance level. It is clear that the statistics obtained on the basis of the available data set correspond to a certain level of significance. This level of significance in itself can be considered as statistics and used to test the null hypothesis. Most often, in practice, the 5% border is used. If the significance level is less than 5%, then the null hypothesis is rejected and it is concluded that the model is specified incorrectly.

The study of real phenomena and processes in the economy is a study (verification, justification, evaluation) of quantitative model patterns and qualitative statements (hypotheses) based on the analysis of statistical data characterizing them, the methods used in this case are an integral part of econometrics, a science that studies economic phenomena from a quantitative point of view. Econometrics establishes and investigates quantitative patterns in socio-economic phenomena and processes by formalized methods of probability theory and mathematical statistics. Therefore, depending on the nature of the subject area, they need to be adapted to the processing of economic data that reflect their informal, subject content.

Patterns in the economy are expressed in the form of connections and dependencies of economic indicators, which cannot fully reflect the mathematical models of their behavior. Such dependencies and models should be verified using real statistical data, taking into account real internal communication mechanisms and random factors. A model that has been obtained and tested based on the analysis of statistical data may not correspond to the concepts of economic theory. This behavior of the model indicates the need for its refinement and development.

Econometric analysis is especially important in macro and microeconomics, where the interrelationships of quantities are often not obvious and changeable. Often there is a situation when the model stops "working" due to the appearance or activation of some factor, and this contributes to the development of macroeconomic theory. Therefore, the proposed material is "tied" to macroeconomic problems and models.

Econometric analysis makes it possible to substantiate and clarify the form of dependencies in the considered macroeconomic models, to better understand the mechanisms of interrelation of macroeconomic indicators.

The main task of economic research is the analysis and structure of the interrelationships of economic variables. The study of such relationships is complicated by the fact that they are not strict, functional dependencies.

Firstly, it is always very difficult to identify all the main factors affecting a given variable.

Secondly, many such impacts are random, that is, they contain a random component. Thirdly, economists, as a rule, have a limited set of statistical observations, which also contain various kinds of errors.

Effective application of econometric modeling methods in the development of fruit and vegetable exports. Economic analysis and forecasting, creating an opportunity for making informed economic decisions. Any economic research always involves combining formal theory (economic model) and real practice (statistical data). Theoretical models are used to describe and explain the observed socio-economic phenomena and processes. Statistical data are collected both to substantiate and refine existing models, and to empirically construct new models that expand and deepen economic theory.

It is usually assumed that all factors not explicitly taken into account in the economic model have some resultant effect on the object, the magnitude of which is unknown in advance and can be described as a random function. To describe it, a random variable is added to the model (usually in an additive way). As an example, consider the demand model $q = f(p,I) + \varepsilon$ where q is the quantity of goods, p is the price, I is the consumer's income. The variable takes into account not only the influence of all other factors (prices for other goods, changes in the market, weather, etc.) that affect consumption, but are not explicitly taken into account in the demand function. There are a number of other reasons, in particular, the wrong choice of the mathematical function $f(p,I)$, the inclusion of not all significant factors in this case.

Since it is necessary to deal with sample data when establishing such relationships, it is necessary to take into account sampling errors related to the nature of the collected data and a number of difficulties in measuring micro- and macroeconomic indicators. Therefore, in economics, not functional, but statistical dependencies are considered. The finding, evaluation and analysis of such dependencies, the representation of model expressions and the evaluation of their parameters are the subject of econometric research.

The introduction of a random component into an economic model leads to the fact that the relationship of its other variables ceases to be strictly deterministic and becomes stochastic, which is observed in real reality. This partly makes the model available for empirical verification based on statistical data about a specific economic

object. If the test has shown the adequacy of the model, then sometimes it is possible to assess the parameters of the functioning of a particular economic object and formulate recommendations for practical decisions.

Working with econometric models requires the use of assessment tools and statistical verification of the model ("science" of modeling-research institute), as well as solving the problems of choosing the type of model, a set of explanatory variables and the type of relationships between them (the "art" of modeling). Economic data: cross-section data and time series (time series). Statistical data in econometrics are the basis for identifying and substantiating empirical patterns. Without specific quantitative data characterizing the actual functioning of the studied economic object, it is impossible to determine the practical significance of the applied economic model. This is true even when the goal is to identify mainly only qualitative patterns.

Data from the State Statistics Committee and experimental estimates of transport costs based on the findings of an expert survey were used to explore the effects of fruit and vegetable production volumes and transport costs on the volume of fruit and vegetable exports. [5] For the relationship between the volume of fruit and vegetable output in the republic and transport expenses, an econometric model has been created. The parameters of the linear regression equation were established using the least squares approach, and a correlation analysis was completed between the model's contributing elements. The econometric analysis of the republic's exports of fruit and vegetable products utilises statistical data from 2011 through 2020.

Despite the fact that the share of agriculture in the total volume of gross domestic product tends to decrease, there are high growth rates of agricultural products. In particular, in 2021, the volume of agricultural production increased 1.4 times compared to 2019, amounting to 317781.6 billion. soums, including crop production, reached 151083.4 trillion. sum, livestock products – 151441.5 trillion. sum . In the structure of GDP, the share of agriculture, forestry and fisheries in 2021 amounted to 26.9%. This year, the growth rate of products (services) of agriculture, forestry and fisheries, compared with the corresponding period in 2020, amounted to 104.0%, including in crop production – 103.4% and animal husbandry – 102.1%.

Analysis.

The majority of the focus on this subject in our nation is producing outcomes. Despite the pandemic's detrimental effects, exports of fruits and vegetables reached USD $1 billion in 2020. (Figure 1). The State Statistics Committee states that even if exports of fruits and vegetables slightly decline in 2020 as a result of the epidemic, overall exports have increased in recent years. The sector, however, is concentrating on

supply chains, infrastructure, market penetration into Europe, and production that is export-oriented.
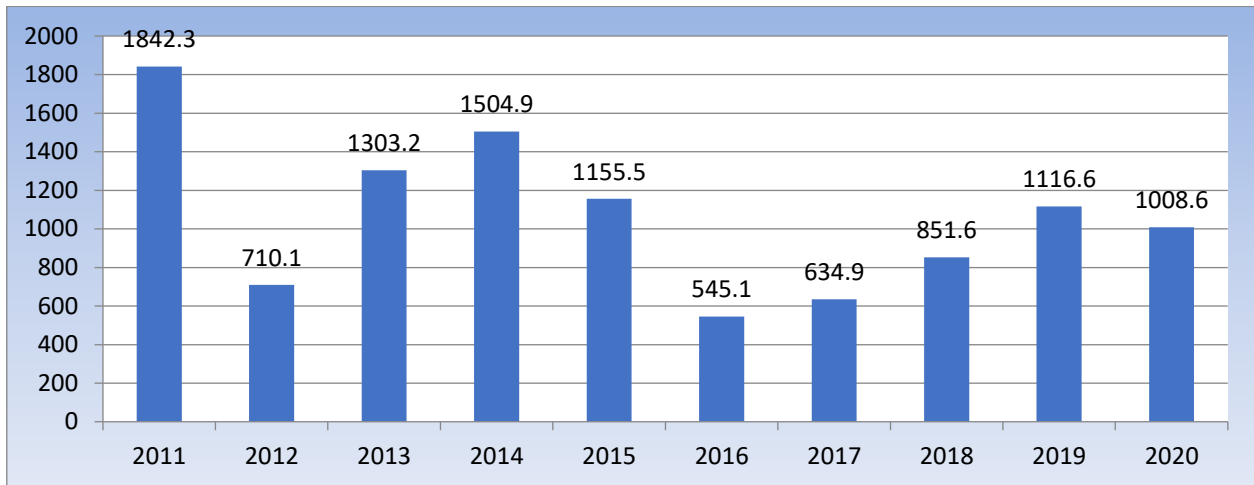

Figure 1. The volume of exports of fruits and vegetables (million US dollars)*

*State Statistics Committee   www.stat.uz

An examination of agricultural indicators for the production of fruits and vegetables reveals that the sector had significant increase beginning in 2016. (Fig. 2). Naturally, this is promising because it means that there will be an abundance of food on the home market, more people will be working in agriculture, and so on. Studying how this issue affects the rise in exports of fruits and vegetables is also crucial.
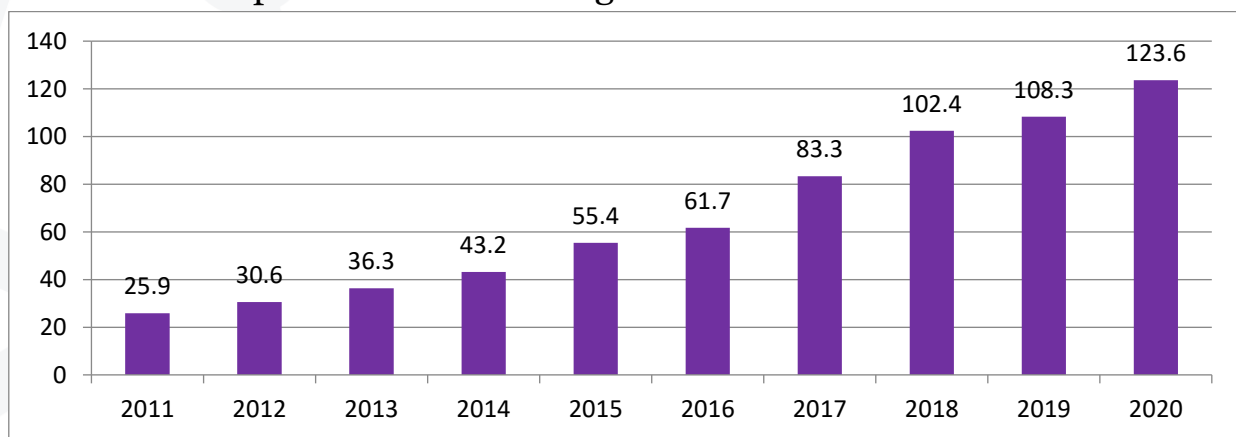

Figure 2. Volume of fruit and vegetable production (billion sum)*

*State Statistics Committee   www.stat.uz

It makes use of statistical data that affects the amount of fruit and vegetable product production (X1) (SSCom data), transport costs (X2) (experimental direct transport costs based on the findings of an expert poll), and the amount of fruit and vegetable product export (Y).

It is feasible to create plans and recommendations for the further development of the sector after determining the impact of these aspects. First, in order to determine the

relationship between the resulting component and the influencing factors, the correlation coefficient is examined (Table 1).

Table 1 Correlation coefficient between factors[4]

	y	$x1$	$x2$
y	1		
x_1	-0,3813	1	
x_2	0,966446	-0,40263	1

The table reveals a very tight connection between the second influencing factor and the resultant factor, which is below the inverse average for the first influencing component. Given that there is no multicollinearity among the contributing elements, it is clear from the statistical data analysis that the cost of transportation directly affects the export of fruits and vegetables.

It is necessary to create a linear regression equation in the plural of the following form in order to explore the relationships between the components that have been analyzed:

$$y = a_0 + a_1 * x_1 + a_2 * x_2 + \ldots + a_n x_n \tag{1}$$

Where y is the resulting factor, $x_1, x_2, \ldots, x_n$ - influencing factors and $a_0, a_1, a_2, \ldots, a_n$ - regression equation parameters. Using the least squares method, it will be possible to determine the parameters of the regression equation using the following system of normal equations:

$$\begin{cases} n * a_0 + a_1 \sum x_1 + a_2 \sum x_2 + \ldots + a_n \sum x_n = \sum y \\ a_0 \sum x_1 + a_1 \sum x_1^2 + a_2 \sum x_1 * x_2 + \ldots + a_n \sum x_1 * x_n = \sum y * x_1 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ a_0 \sum x_n + a_1 \sum x_n * x_1 + a_2 \sum x_n * x_2 + \ldots + a_n \sum x_n^2 = \sum y * x_n \end{cases} \tag{2}$$

Conclusion and Suggestions

According to the study's findings, there are other issues in the supply chain rather than an increase in product cultivation that are responsible for the rise in fruit and vegetable exports.

This specifically relates to researching the needs of the importing nations, prioritizing the size of the sector in terms of packaging design and researching the needs of the importing nations in this regard, as well as maintaining supply chain continuity. Simultaneously, in order to advance agriculture, it is required to raise the level of the sector's material and technical assistance, address issues with the sector's financial support, offer financial incentives to large producers to promote the sector's growth, and expand its export potential. The issue of exports of the items in this sector being as liberalized as possible must be taken into account.

Fruit and vegetable exports are a significant and expanding area of international trade. Based on this, methodological analysis of several important decisions is of utmost relevance for entrepreneurs involved in this economic activity. This will undoubtedly result in challenges that need to be solved, some of which are related to the complexity of the process, the dearth of many agents, options, information, and modelling tools. Additionally, we believe it's critical to give digital agriculture additional attention, to move the Smart Agriculture program's work along, and to make it easier for business owners in the sector to document their exports. In conclusion, it should be noted that new equipment and technologies must be added to the infrastructure supporting agriculture in order to develop the sector in our nation, increase exports of the industry's goods, and secure its place and position in future global markets. Additionally, service activities must be further enhanced, and new innovations must be introduced.

In our opinion, it is necessary to develop and effectively implement a state policy aimed at using the opportunities of agriculture in order to manage risks:

- effective use of opportunities with a clear plan for implementing agricultural policy measures in line with climate change, developing the capacity of key agricultural institutions and making the necessary investments in infrastructure, support services and modernization of farms;

- implementation of a system for assessing the state of agriculture and the implementation of continuous monitoring based on internationally recognized methodologies and best practices;

- conducting research aimed at increasing the fertility of crop production and the productivity of animal husbandry,

- development of industry programs to intensify the production of socially significant types of products;

-introduction of a system of interventional procurement in the domestic market of fruit and vegetable products.

Large agricultural organizations use different strategies for their business units. For some, the growth strategy will be decisive, for others, the reduction. Simultaneous application of both approaches in the development of a single organization has received the definition of a combination strategy. In general, the agromarketing strategy is a section of the general agromarketing plan, a large-scale action program aimed at achieving the main marketing goals.

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