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METHODOLOGY OF EMPIRICAL ANALYSIS OF THE DEVELOPMENT OF AGRICULTURAL PRODUCTION

Berdiyev Abdumalik Hakimovich[1], Mukhitdinov Khudayar Suyunovich[2], Jumayeva Gulrukh Jurakulovna[3], Sultanov Dilshod Normamatovich[4]

Axmatov Abutolibxon Ochilxon o'g'li[5]

[1]Karshi engineering economics institute, Dean of the Faculty of Economics

[2]Professor of the Karshi engineering economics institute. xsmukhitdinov@gmail.com

[3] Karshi engineering economics institute "Department of Accounting and Auditing" candidate of economic sciences, Associate Professor

[4] Karshi engineering economics institute independent researcher

[5] "TIIAME" NATIONAL RESEARCH UNIVERSITY Karshi institute of irrigation and agrotechnologies Assistant of the "Geodesy and Geoinformatics" department

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Abstract: A methodology for empirical analysis of the development of agricultural production has been developed. Development of production of agricultural products in the region theoretical foundations of empirical model building and forecasting mechanisms using digital technologies have been improved. A mathematical apparatus for creating a complex numerical econometric model of the regional economic system has been developed. Kashkadarya region production of agricultural products economic analysis based on empirical models.

Keywords: Digital technology, empirical model, econometric model, forecast results, information system, endogenous variables, exogenous variables.

1. INTRODUCTION

Developing the production of agricultural products, obtaining optimal solutions using the methodology of empirical analysis in determining the optimal ratios of efficient use of resources, ensuring the food security of the population based on the development of future forecast indicators of agricultural production is currently an urgent issue.

As a result of the scientific analysis of agriculture in a number of studies, the main factors were systematized and grouped. The main focus is on the importance of factors in ensuring the development of the sector.

The importance of such a systematic approach in the development of agriculture is that in the case of a systematic analysis of existing problems and their causes, it is not enough to observe a certain economic process in the network to make a final decision.

For example, the production function is used in the studies of the agricultural sector at the national level. In this case, they limit themselves to obtaining primary conclusions based on the model built on labor resources and capital expenditure from the production function in the form of Cobb-Douglas [3].

To analyze the production of agricultural products, we select the variables of the kinetic

production function.

$$Y_k = A_k \cdot e^{a_j x_j} \cdot \prod_{j=1}^{4} x_j^{\alpha_j} \quad (1)$$

Here x1 – agricultural land area (thousand ha); x2 – average number of workers; x3 – annual average value of the main production funds; x4 – amount of working capital (billion soums); We use the following equation to linearly express Y - agricultural gross regional product volume (billion soums) (1).

$$\ln(Y) = \ln(a_0) + \sum_{j=1}^{4} a_j x_j + \sum_{j=1}^{4} \alpha_j \ln(x_j) \quad (2)$$

(2) according to international experts[4], the model is very flexible and satisfactorily describes the basic production and technological interdependence of agricultural production. We have also seen that the most commonly used Cobb-Douglas production function is a special case of (2).

For the constructed production function, it is important to check the relationship between the actual and theoretical levels of the effective indicator. In this theoretical (), actual ($Y'Y_i$), and the average of gross production values during the analysis period ($\overline{Y}$) has the following relation.

$$Y_i - \bar{Y} = (Y_i' - \bar{Y}) + (Y_i - Y_i')$$

Here, the satisfaction of the criterion requirement of the difference means that the productive cluster has used the available i-resource more efficiently than the average. It is also possible to estimate the value of the efficiency coefficient for the i-resource, that is, the relationship is reasonable.$Y_i - Y_i'\alpha = Y_i/Y_i'$

The essence of determining the production potential is that it provides an opportunity to determine which resources are in short supply in the region, to analyze them and to develop options for optimally compensating for the cost of scarce resources and increasing the efficiency of resource use.

For example, logically, the volume of working capital directed to the production of agricultural products has a great impact on the volume of the gross agricultural product. It is possible to have processed information to obtain optimal options for covering the shortage of working capital spent on agricultural production in the region. In the presence of an increase in the costs of a certain resource, the possibilities of increasing the level of efficiency by achieving the optimal indicators of the use of these resources are calculated [5].

Relying on foreign experience is one of the main sources for evaluating modern production parameters. When it comes to the use of digital technologies in the economic sectors of developed countries, its efficiency indicators can be taken as information not only in agriculture, but also in various sectors of the economy. Because digital technologies simultaneously serve for the comprehensive development of all economic sectors and determine the state of general development. In this sense, when connecting the level of economic growth with digital technologies, in the research work of many leading scientific research centers and research institutes, a certain sector of the economy was not limited to the analysis of the results related to this sector [6].

Also, issues of sustainability and multifactor econometric modeling are explored using specific methods. Here we can present the methods of harmonic and spectral analysis, regression

and correlation analysis [7].

Optimization issue organization of production in agriculture begins with planning. The planning stage represents the introduction of production activities and is of great importance in increasing production efficiency. Requirements are set in planning. The basic potential of the manufacturer is analyzed. Planning should be carried out on the basis of a number of scenarios and the most optimal one should be determined among them. This process is related to the concept of optimization. Akhil Varma, researchers at the University of Cambridge; Ajith S. Nath; V Regikumar [8] investigated the evaluation of agricultural production optimization models using a large number of simulations.

In the studies of these scientists, the gradual development of property reforms in the agricultural system has been extensively econometrically and statistically analyzed, and scientific approaches have been justified [9].

- Analytical study of foreign experiences of production and management of agricultural products and determination of opportunities to adapt them to Uzbekistan;

- To carry out a statistical analysis of the development trends of the production of agricultural products in Kashkadarya region, as well as to evaluate the development of the production process based on trend models;

- econometric modeling of the development and management of agricultural production in the region using the cluster analysis method;

- based on the potential of agricultural production resources in the region, the method of calculating the production potential of the region using cluster analysis has been improved in practice.

In the "Strategy of Actions on five priority areas of development of the Republic of Uzbekistan in 2017-2021" [1], approved by the decree of the President of the Republic of Uzbekistan No. PF-4947 dated February 7, 2017, tasks aimed at solving a number of problems of modernization and rapid development of agriculture are defined. The main source of the implementation of these tasks is the research of the priorities of the rapid development of agriculture through deep structural changes and modernization, which is approaching the result view today. In particular, analytical studies are being carried out on the state of ensuring the performance of tasks.

Table 1

The main aspects of the empirical analysis of the production process of agricultural products

Unique features	Organizers	Necessity of econometric modeling
Sufficient complexity of agriculture as a systematic process	Technical-technological, socio-economic and political process	Simplification and research of a complex system as a model
Scale of consumption of agricultural products (food and non-food)	Structurally safe production of the product Satisfy the need	Determination of stability conditions based on demand and supply models, forecasting of reserve need indicators
The number of influencing factors and their different nature	Internal and external factors under the control of the system administrator	Determining the degree of interdependence of factors

Different production methods and their participation in one process	Extensive and intensive	Determining the effectiveness of any method in production according to quantitative changes in economic indicators
Organic and inorganic characteristics of products	Storage of food and other products	Expression of economic laws of security conditions
Scarcity of production resources	Natural, economic and other resources	Optimization of resource allocation, assessment of efficiency of use
Classification of production entities	Farming, farming and agricultural organizations	Assessment of the economic activity of all categories of producers
Organization of product production	Technical, technological, economic, etc	Optimal planning Reliable forecasting Ensuring the right decision
Individual problems of the sector in the context of digitalization of the economy	ICT literacy of manufacturers, sources of reimbursement for new technologies, etc	Development of efficiency criteria of application and use, assessment of factors of minimization of supply costs, etc

In the course of the research, the need for econometric modeling of the production process of agricultural products was scientifically and analytically studied, and based on the specific characteristics of agriculture, we distinguished certain issues as the main aspects of the need (see Table 1).

The growth rate of production occurs through factors affecting the process. Determining the priorities of production development and management[2] necessarily requires knowing the degree and direction of the influence of these factors. This is done on the basis of deep econometric analysis. Econometric analyzes are carried out using special analysis methods (correlation, harmonic, spectral, cluster, etc.).

It is possible to estimate the efficiency indicators of the category of manufacturing entities using the statistical data of production for a certain period according to the classification of manufacturing entities. Also, which category has a decisive role in the development flow in the future, based on the quantitative expressions of the economic indicators of the categories, it is determined by econometric analysis, establishing functional and correlation relations for certain indicators, and forecast values for the main indicators of the categories in the future.

In our opinion, in the econometric modeling of the development and management of agricultural production, it is necessary to distinguish the main issues of the process based on a systematic approach and generalize the resulting components. At the same time, we combine the challenges posed to the modeling domain into four main objectives. We distinguish between the goals of assessing the stability of production economic growth and multifactor econometric modeling (see Table 2).

Table 2.

Empirical modeling strategy of agricultural production development

STEP-BY-STEP TASKS OF MODELING			
Establishing normative requirements for the consumption of production resources, analyzing performance indicators	**Conducting a cluster analysis on production potential and dividing the territory into clusters**	**Econometric analysis of cyclical laws in the production process**	**Conducting an econometric analysis of factors affecting the production process**
Development of governing and governed criteria	**Construction of kinetic production function for clusters**	**Development of dynamic econometric models**	**Development of multifactor econometric models**
Optimal production planning	**Evaluation of the effectiveness of the use of production potential**	**Calculation of forecast indicators of the main indicators of production**	
EXPECTED MODELING RESULTS			
Development of recommendations for increasing production efficiency in agriculture		**Production in agricultureto determine the laws that ensure economic growth, to offer reliable forecasts**	

The purpose of empirical modeling revealing the laws of agricultural development, management should be aimed at ensuring the reliability and efficiency of the results achieved on the basis of correct decision-making in the system [11]. For this purpose, objects representing the main problems of production, aimed at solving them, should be provided. Econometric modeling of agricultural development and management in our scope will be appropriate based on the four objects mentioned above.

The fact that the factor affecting the output factor in the agricultural sector has a low or high value in a certain period creates fluctuations in the continuous process. It is always reasonable to hypothesize that fluctuations of the resultant factor exist as a reaction to fluctuations of the base. Only the degree of reaction may be different. If we look at it in examples, the reaction to the volume of grain cultivation in the region, in terms of the effect of its yield, may be high, and the effect of the number of productive farm categories may be low. Because the reduction of production facilities does not cause the reduction of land resources. Accordingly, having a large amplitude oscillation of the base may not represent a high response of the system.

The most common harmonic analysis and less commonly used spectral analysis methods can be used to conclude the sustainable development of agriculture based on a certain periodical repetition of the reality occurring in the field [12]. Harmonic and spectral analysis is one of the methods of researching technological processes, and it is used to determine the quality of the system pulse signal, and to determine the periodic or non-periodic signals of the complex dynamic system. The signals we receive are time-separated statistics that form a time series.

Harmonic analysis means spreading the resulting factor values into a Fourier series for

further analysis. In this case, the time series composed of periodic fluctuations and a random component, maintaining the trend formed under the influence factors, is as follows.

$$Y = (y_0, ..., y_t, ..., y_n)$$

Here yt is the level of the series ($0 \le t \le n$). Then we can write the arbitrary economic time series as follows:

$$Y' = Y^{tr} + \sum_{k=1}^{K} Y_k^{garm} + \varepsilon (4)$$

Here Y^{tr} - trend, Y_k^{garm} - part of the general trend (harmonics), ε - a random variable. If the average of the change value of the resulting factor for a long-term period $\overline{Y}$ assuming that formula (4) is expressed in the following form.

$$Y' = \bar{Y} + \sum_{i=1}^{K} a_k cos \frac{2\pi kt}{n} + \sum_{i=1}^{K} b_k sin \frac{2\pi kt}{n} (5)$$

Here, ak and bk are quantities representing the presence of annual recurring fluctuations and are defined as follows:

$a_k = \frac{2}{n} \sum_{i=1}^{K} Y' cos \frac{2\pi kt}{n}$, . Ferret coefficients are determined by the formula (6). In order to exclude insignificant coefficients from the model, they are checked by Student's test. $b_k = \frac{2}{n} \sum_{i=1}^{K} Y' sin \frac{2\pi kt}{n}$

To apply spectral analysis, we determine the trend in the formula (1.2.5) in a linear structure. Also here we get the following representation of the harmonic represented by the cosine.

$$Y_k^{garm} = A_k cos\left(\frac{2\pi kt}{n} - \varphi_{0t}\right).$$

Here A_k - vibration amplitude: $A_k = \sqrt{a_k^2 + b_k^2}$, φ_{0t} - is the initial phase of oscillations and is defined as the Fourier coefficients in the formula (1.2.6). As a result, formula (1.2.5) can be written as follows.

$$Y' = a + bt + \sum_{k=1}^{K} cos\left(\frac{2\pi kt}{n} - \varphi_{0t}\right) + \varepsilon (7)$$

The presence of a trend in a time series can be checked using the series criteria, and the presence of a monotonic trend can be checked using the inversion criterion.

In the conditions of new Uzbekistan, the agricultural service system will be closely connected with such important areas as irrigation, land reclamation, breeding. After all, it is impossible to imagine Uzbekistan's agriculture without high-level development of these sectors. In particular, the SWOT analysis of the agricultural development of Kashkadarya region is presented (see Table3).

Table 3

SWOT analysis of agricultural development of Kashkadarya region

STRENGTHS	WEAKNESSES
✓ the implementation of special agricultural reforms for the development of agriculture and the creation of legal bases; ✓ the adoption of a separate Law "On Agriculture" for the development of agriculture;	✓ lack of development of necessary economic mechanisms for agricultural development; ✓ that today there is no well-regulated, convenient supply system for agriculture; ✓ the provision of necessary resources to agriculture is mainly carried out by private

✓ On the basis of the law, he was formed as the owner of land and property; ✓ the introduction of agriculture into the form of entrepreneurship and the satisfaction of the public interest of the main link of the society; ✓ that peasants and farmers have fully developed the skills of working with the land; ✓ quick flexibility as a small commodity producer, not prone to bankruptcy; ✓ that the activity is aimed at earning income.	individuals; ✓ limited access to quality resources for agriculture; ✓ lack of interest in increasing the economic literacy of the villages, they consider it sufficient if they know how to work with the land, and as a result: ✓ the number of farms with legal status is decreasing day by day. ✓ lack of necessary technical means, violation of mutual cooperation relations with other economic entities, lack of a system of purchase of cultivated products.
OPPORTUNITIES	**THREATS**
✓ the increasing interest of the rural population as a result of the increase in agricultural economic efficiency indicators; ✓ that the number of people employed in the village is increasing at the expense of agriculture; ✓ increasing opportunities to attract local investments; ✓ constant high quality index of agricultural farms specializing in animal husbandry; ✓ that the state continuously adopts measures and programs supporting agriculture.	✓ the growing number of people engaged in business in the field of agriculture; ✓ the fact that agricultural holdings are always pronounced side by side with private estates and household holdings, which leads to the conclusion that all three holdings can be combined into one; ✓ the fact that the interests of the village are negatively and partially satisfied at the expense of "speculators"; ✓ the sharp decline in the number of farms in desert zones.

Through the SWOT analysis, it helps to understand the importance of the sector in satisfying the interests of households, society and the state, which should be paid attention to in the organization of regional agriculture.

The results of the SWOT analysis provide information about the current situation to the entities operating in the region, as the analysis lists the strengths and weaknesses, opportunities and threats of agriculture.

Studying agricultural production and management as an object of research, we were convinced that its development is related to the elimination of the following problems.

- existence of land irrigation imbalances;
- lack of practical and theoretical experiences for the proper use of land;
- low purchase prices of some products;
- the leading position of monopoly enterprises processing agricultural products is still preserved;
- the insufficient formation of the market for services to agricultural workers;
- lack of full financing of agricultural production;
- the existence of some old-fashioned approaches to the conclusion of a contract;
- shortage of fuel and lubricants in the performance of technical services;
- lack of demand or high costs of service in alternative car tractor fleets.

We believe that the following solutions are available to overcome the problems mentioned:

- ✓ organization of information advisory groups to help agricultural workers in their work;
- ✓ increasing online responsibility for all types of contracts;
- ✓ contract reviews, monitoring production with accuracy of plan execution;
- ✓ to achieve free use of funds by farms;
- ✓ to improve the service of alternative water supply associations in the use of water resources and to establish efficient use of water resources through smart meters;
- ✓ improvement of lending mechanisms for land improvement;
- ✓ improving the provision of services to farms and improving contracts with service enterprises.

The following tasks of reforms in the agrarian sector will be solved through digitization of agriculture:

- private ownership and a stratum of owners will be formed in the village and digital agribusiness will develop;
- economic relations in the agricultural sector are carried out in accordance with the methods and mechanisms of the digital economy;
- agricultural entrepreneurs will have material interest as a result of direct production, and effective use of this orca property will be achieved;
- real competition arises, as a result of which the interest and desire to improve production efficiency, product quality and the final economic and financial indicators of the farm increases;
- activities are carried out on the basis of contracts concluded directly with other economic entities due to the expansion of economic activity, distribution of income and freedom of entrepreneurship, as well as expanding production in order to further increase income, that is, not only the cultivation of agricultural products, but also their processing and production of ready-made products there is an interest in setting up.

To analyze the changes of the components involved in the economic process in a certain period of time, explanatory indicators and methods are used. In this case, the concept of time series is often used in practice. In different sources, the concept of time series is given basically the same short definitions. In the works of econometrician B.B. Berkinov, this concept is expressed as follows: "A time series is a series of numerical indicators located in sequence over time, which describe the state and degree of change of an event or process" [13].

Time series consists of components, the main component of which is the trend. The concept of a trend is a continuous trend in a time series without usually hidden fluctuations, and in the interpretation of the Russian economist and econometrician I.I. Eliseevoy, it is a stable trend to a certain extent freed from random deviations in the time series[14]. There are specific indicators in the agricultural economy, which are the main means of analyzing the patterns of agricultural development of the region. The development prospects of the network can be assessed by the curve of stable trends of these indicators. In other words, the laws underlying the agricultural development of the region are evaluated using the trend models of the main indicators.

Analyzing the volume of production of agricultural products, it is necessary to pay special attention not only to its increase, but also to intensive and extensive growth. In today's increasingly scarce resources, ensuring intensive growth in agriculture, which is strongly

dependent on natural resources, remains one of the most important issues.

For this reason, we will look at the level of use of production factors of agricultural products in the region based on quality indicators. For this, we want to pay attention to the dynamics of the volume of production per hectare. For this analysis, the data of the next period were obtained, because the years 2010-2022 were selected, taking into account that the years 2000-2010 saw sharp changes in the share of product manufacturers as a result of many structural and privatization of Mobay. Also, the data were transferred to real values, taking 2010 as a base. According to the results, the real value of the amount of products per hectare of land in Kashkardarya region has a growing trend and has the following appearance (Fig. 1).

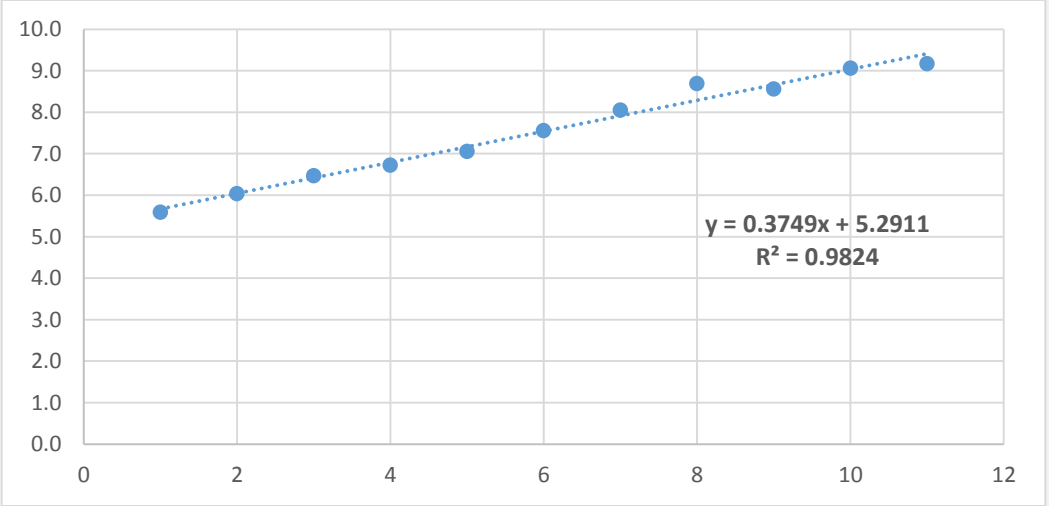

Figure 1. Real value of agricultural products produced per hectare in the region (in millions of soums)

According to the results of the regression analysis, all the coefficients are adequate according to the Student and Fisher criteria, and the coefficient of determination has a high value (Appendix 6). According to the data, in 2010, the real value of the product per hectare was 5.6 million soums, and by 2020, this figure was equal to 9.2 million soums and increased by 1.64 times. It can be seen that the main part of the increase in agricultural production is due to intensive growth. The trend model obtained as a result of modeling this process shows that in the next period, the real value of the product per hectare is increasing by 0.37 million soums on average. In general, it is observed that the rate of growth in relative indicators has decreased due to the effect of scale.

Based on the level of development of agricultural products, there is a large share of commonality in all research works. These are natural factors, state incentives, scientific and technical processes, competitiveness and price factors as primary factors [15]. There is no clear limit to the number of factors affecting the production process of agricultural products. The fact that the influence of some factors is insignificant or that there is no basis for determining the level of influence reduces the possibility of covering all factors for the development of the field. However, failure to examine the factors in detail can actually cause a factor with a high level of influence to fall into the range of insignificant or unsubstantiated factors.

We conditionally divide the group of factors affecting the production process of agricultural products into 8 parts (Fig. 1):

- Group 1. Natural factors
- Group 2. Contributing factors
- Group 3. Science and innovation factors

- Group 4. Social factors
- Group 5. Supply factors
- Group 6. Service Factors
- Group 7. Legal and regulatory factors
- Group 8. Random factors

Natural factors include changes in land area, land reclamation, geographical location, weather, farm specialization, location of farm land in relation to the settlement, product productivity, environmental pollution. However, today, econometric analysis based on statistical information on these factors has not been conducted sufficiently. Cropland and pasture land area, salinity level of the land used for the production of agricultural products, climate change, product yield, statistical sources of pollutants released into the atmosphere feel the need for internal grouping when creating an econometric model. Because one of the main requirements in building a multifactor econometric model is that there should not be a strong correlation between the selected independent factors.

Natural factors - depending on the natural location and specific features of the field:

-land area changes; -reclamation condition of land;-geographical location; obi air climate change; proximity of agricultural lands to settlements; product yield; environmental pollution;

Contributing factors - depending on the development of economic sectors: - industry development; service development; development of forestry and fisheries in the area; development of beekeeping and cocooning in the area; development of construction works in the area; development of transport and communication services.

Factors of supply-depending on the main resources of production:

-capital supply; technical support; energy supply; labor supply; water supply; fuel supply; Fertilizer and seed supply; drug supply.

Random factors –depending on possible events and emergency situations: -pandemic; epidemic; - natural disasters; sanctions; - political conflicts; - military operations; various discoveries and inventions; -unexpected socio-economic events.

Table 4

Statistical indicators of influence factors obtained by group of natural factors[1]

Years	*X1*- total cultivated area in the region (thousand ha.)	X2- the total area of pasture land in the region (per thousand)	X3- the average value of productivity of products (ts/ha);	X4- the share of saline land area in the region (%);	X5- climate change (0S);	X6- pollutants released into the atmosphere (thousand tons)
2001	442,203	1487.6	66.91	48.5	1.0575	112.8
2002	440,909	1487.8	73.51	48.3	1.0775	124.3
2003	448,105	1345.9	76.8	48.1	1.06	131.5
2004	450,544	1326.9	79.24	47.7	1.0125	130.8
2005	441,901	1323.3	81.71	47.4	1.0325	141.7

[1]It was compiled by the author based on the data of the Kashkadarya Regional Statistics Department and the Regional Agricultural Department

2006	454,817	1315.7	80.12	47.6	1,085	158.7
2007	458,013	1315.2	88.45	47.3	1.12	150.7
2008	466,704	1315.2	94.76	48.6	1.1325	147.7
2009	472,811	1457.2	93.72	49.2	1,105	143.4
2010	493,003	1455.8	103.17	49.9	1.0925	144.8
2011	478,976	1455.8	101.54	51.8	1.1575	142.5
2012	478,467	1455.6	117.93	51.9	1.13	163
2013	494,327	1415.4	118.62	52.3	1,105	167
2014	499,097	1415.3	127.4	52.9	1,095	171.8
2015	493,918	1408.4	129.84	53.3	1.14	176.3
2016	493,895	1408.4	124.6	55.7	1,105	167.9
2017	472,831	1384.7	128.31	58.2	1.0575	165.7
2018	463,115	1392.4	122.33	59.5	1.0375	152.2
2019	443,428	1401.5	129.57	61.4	1.0975	140.4
2020	455,808	1387.6	136.04	60.4	1.1175	128.1

We introduce designations for the factors of group 1: X1 - total cultivated area in the region (thousand ha.); X2 - total pasture land area in the region (thousand ha.); X3- the average value of productivity of products (ts/ha); X4- percentage of saline land area in the region (%); X5- climate change (0S). Correlation analysis was performed based on statistical data on selected factors of group 1 factors (Table 4).

According to the results of the correlation analysis, except for the high correlation between x1 and x4, their relationship with the x5 factor is not strong, and the x13 and x14 factors are strongly related with the resulting factor. Therefore, they can be included in the multifactorial empirical model. Land is the main resource in agriculture, however, large differences in the area of cropland and pasture land over the years are not noticeable. This, of course, does not have a significant impact on the production volume. Therefore, the results of the correlation analysis presented above also corroborate this. However, logically, land as the main resource, its quality and efficiency indicators of its use are of great importance.

Table 5

Correlation analysis results

	X11	***X12***	***X13***	***X14***	***X15***	***Y1***	***Y2***	***Y12***
X11	1.00							
X12	0.27	1.00						
X13	0.60	0.13	1.00					
X14	0.16	0.15	0.85	1.00				
X15	0.51	0.25	0.38	0.12	1.00			
Y1	0.17	0.07	0.86	0.99	0.12	1.00		
Y2	0.10	0.06	0.83	0.99	0.10	0.99	1.00	
Y12	0.13	0.07	0.84	0.99	0.11	1.00	1.00	1.00

The main parameters representing land reclamation are soil type and composition, salinity level. However, the correlation between the volume of production of agricultural products and the level of salinity of the land is gaining a positive value. In addition, the level of

dependence is extremely high. According to the results of the study of the main reasons for this, despite the fact that the salinity level of the land has a tendency to increase, the volume of product production has also increased. As a result, the effect of the change in the salinity level of the land on the volume of product production has become insignificant. This reason proves once again that other factors have a significant influence on the process.

Conclusion

In conclusion, it can be said that the change in the production and management of agricultural productsEconometric modeling in the study of theoretical and practical aspects of a number of issues such as forecasting with the use of econometric methods and models in the development of medical environment and market conditions, in-depth analysis of their essence and laws, choosing an alternative solution from multiple options, making optimal management decisions in conditions of risk and uncertainty is important.

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