Improving the country's food security in the conditions of developing a circular economy

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Abstract. This article discusses the analysis and trends of the country's food security. Even at the current stage of agriculture occupies an important place at the economic and social level. Increasing the production and export potential of agriculture greatly contributes to improving the well-being of the rural population, economic growth, and maintaining the balance of the consumer market. In an econometric model was proposed and forecasts were developed. Expected indicators for 2022-2027 are determined based on the number of food products per capita. Uzbekistan plans to increase the composition and production volume of industrial consumer products for 2021-2030, and this strategy is currently working rapidly. The goal of this strategy is to develop mechanisms that increase food safety, enrich the food segment of the markets in the region, provide the population with cheap food products, and improve a healthy competitive environment along with opening a wider path to foreign trade.

1 Introduction

At the current stage of development, Uzbekistan continues to carry out economic and social reforms in the agricultural sector. Issues such as increasing the volume of exports of agricultural products in foreign trade, providing the rural population with the necessary knowledge and skills in the production of agricultural products and improving their well-being, economic and social development, and at the same time maintaining the balance in the consumer market is receiving serious attention. In 2010-2018, the gross domestic product of Uzbekistan grew by 8% anually and reached 50.5 billion US dollars. During the same period, the annual growth of the agricultural GDP was slightly lower and amounted to 7.3%. Research and analysis of the problem of food security is one of the most popular areas of modern economics in Uzbekistan. Such great interest in this problem is related to a number of circumstances: 1) Rapid population growth - Uzbekistan is the most populous republic in Central Asia. As of April 1, 2021, the number of permanent residents of Uzbekistan was 34.7 million [1]. The problem is to meet the rapidly growing food needs of the population of the

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republic. 2) decrease in the size of land areas considered fertile - despite the fact that in 2015 the total area planted with agricultural products was 3694.2 thousand hectares, in 2018 this indicator decreased to 3396.0 thousand hectares. The reduction of arable land leads to the reduction of agricultural products. 3) Climate change and lack of irrigation water to meet agricultural needs. Climate change is causing desertification of agricultural land. The lack of irrigation water leads to a decrease in the productivity of agricultural crops, which in turn requires large areas for crop cultivation, which is no longer feasible due to high costs [2].

The practical significance of the research is that in the conditions of modern development, many countries are studying ways to continuously. Food security is a key component of any country's economic security. It is necessary to develop agriculture and the processing industry of agricultural raw materials. New investments and technologies in agriculture make it possible to get more crops. Prevention of defects and losses of agricultural products also increases the efficiency of agricultural production and food safety. At the current stage of the development of daily life of the society, one of the main directions is to improve the efficiency of production of new innovative projects that ensure food safety in Uzbekistan and to improve the comprehensive characteristics of the state policy, which serves to increase the economic activity of the participants of the population. [3].

The main rules of the Republic of Uzbekistan aimed at preventing food safety problems and shortcomings at the state level are defined in the "Agricultural Development Strategy of the Republic of Uzbekistan established in 2020-2030" and include the main directions aimed at solving the problems of ensuring food safety and independence (independence). Sufficiency is the to safe food products in the amount corresponding to the established rational consumption standards [4].

In recent years, diversification of production in Uzbekistan, improvement of land-water relations, creation of favorable conditions for agribusiness and production chains with high added value, support for the development of cooperation, wide Agricultural reforms aimed at the introduction of market mechanisms, provision of information and informatization are being actively implemented. Effective use of communication technologies, as well as scientific achievements, and increase the potential of personnel.

2 Literature review

Such an understanding of the food security situation P.V. conforms to the definitions proposed by . Leshilovsky, E.N. Krilatyx, as well as V.S. Balabanov and E.N. Borisenko. P.V. As Leshilovsky, A. M. Galiakhmetova proposes to divide into two groups: indicators of food sufficiency and indicators of food accessibility.

According to the economist M. Tracy food security is an argument in favor of measures aimed at protecting domestic food production.In the case of classifying the historical experiences domestic food security makes the economic security of other sectors in the country equal to zero[5].

It also means getting rid of excessive dependence on food imports. It should also be noted that food security is not only a high level of food supply. The role of food products imported from foreign countries is incomparable in this regard. The state's food security policy mainly focuses on the development of its own agricultural production and domestic sales markets, and partly on the basis of food imports from abroad to satisfy the population's need for food at an acceptable level. is intended.

3 Data and methodology

Research methodology and as well as their own methods of graphical representation of data in the form of diagrams, graphs, figures and tables [6].

The practical significance of the study is justified by the fact that in modern development, many countries are exploring ways to ensure uninterrupted provision of food products to the population. One of the main elements of the country's economic security is food security. In order to provide the population with food products without interruption, it is necessary to develop agriculture and the processing industry of agricultural raw materials. Investments and new technologies in agriculture allow you to get more crops. The prevention of defects and losses of agricultural products also makes it possible to increase the efficiency of agricultural production and food security.

Among the econometric tools for the study of reproductive processes in agriculture, production functions play an important role.

Main functions related to the production process and the total volume of economic products achieved as a result of their support.

The alternative production function can be expressed as follows:

$$y = y(K, L); y'_x > 0; y''_{xx} < 0 \tag{1}$$

According to the conditional importance of production-related factors, we can draw the following two conclusions about the functional relationship between these factors:

Distances from the points on the graph of the indices of production indicators to the points on the graphs of labor expenditure are found in the capital ratio. . He then turned to Charles Cope with a request to determine the relationship between this property and the mathematical relation, and Cope recommended the substitution function given below [7]:

$$y = AK^{\alpha}L^{\beta} \tag{2}$$

Although the above function was proposed by Philip Wickstead 30 years ago, they were the first to respect to labor and capital is equal to α and β, since:

$$\frac{\partial y / \partial K}{y / K} = \frac{A\left(\alpha\left[K^{\alpha-1}\right]\right)L^{\beta}}{AK^{\alpha-1}L^{\beta}} = \alpha \tag{3}$$

and similarly, it is easy to show that (dy/dL)/(y/L) is equal to β.

Considering factor markets as competitive, they are expected shares of labor income and capital, respectively. If the labor market is highly competitive, the wage rate (w) will be equal to the marginal product of labor.(dy/dL):

$$w = \frac{\partial y}{\partial L} = AK^{\alpha}\beta L^{\beta-1} = \frac{\beta y}{L} \tag{4}$$

Therefore, the total amount of wages (wL) is equal to β y, and the share of labor in total output (wL/Y) is a constant value β . Similarly, the profit margin is expressed as dy/dK:

$$\rho = \frac{\partial y}{\partial K} = A\alpha K^{\alpha-1} L^{\beta} = \frac{\alpha y}{K} \tag{5}$$

and, consequently, the total profit (ρK) will be equal to αy y, and the share of profit will be a constant value α.

$$\ln(y) = \ln(A) + \alpha \ln(K) + \beta \ln(L) \tag{6}$$

1) When using OLS, the goal is to minimize the sum of quadratic deviations (SSD) between the observed values ln(yi), (i=1...N; N is the number of observations) and the corresponding estimates.

$$SSD = \sum_{i=1}^{N} \left(\ln(y_1) - \ln(\hat{y}_i)\right)^2 = \sum_{i=1}^{N} \left(\ln(y_i) - \ln(\hat{A}) - \hat{\alpha} \ln(K_i) - \hat{\beta} \ln(L_i)\right)^2 \tag{7}$$

2) We introduce vectors

$$Z_{(N\times 1)} = \begin{pmatrix} \ln(y_1) \\ \ln(y_2) \\ \vdots \\ \ln(y_N) \end{pmatrix} W_{(N\times 1)} = \begin{pmatrix} \ln(K_1) \\ \ln(K_2) \\ \vdots \\ \ln(K_N) \end{pmatrix} = \begin{pmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{pmatrix} U_{(N\times 1)} = \begin{pmatrix} \ln(L_1) \\ \ln(L_2) \\ \vdots \\ \ln(L_N) \end{pmatrix} = \begin{pmatrix} U_1 \\ U_2 \\ \vdots \\ U_N \end{pmatrix} \tag{8}$$

$$\hat{X}_{(3\times 1)} = \begin{pmatrix} \hat{X}_1 \\ \hat{X}_2 \\ \hat{X}_3 \end{pmatrix} = \begin{pmatrix} \ln(\hat{A}) \\ \hat{\alpha} \\ \hat{\beta} \end{pmatrix} \text{ and the matrix } H_{(3\times N)} = \begin{Vmatrix} 1 & W_1 & U_1 \\ 1 & W_2 & U_2 \\ \vdots & \vdots & \vdots \\ 1 & W_N & U_N \end{Vmatrix} \tag{9}$$

Then the criterion can be written as

$$SSD = (Z - HX)^T (Z - HX). \tag{10}$$

$$H^T H\hat{X} = H^T Z \quad \text{or} \quad \hat{X} = \left(H^T H\right)^{-1} H^T Z \tag{11}$$

$$\sigma^2_{\hat{X}_i} = c_{ii}\sigma^2 \tag{12}$$

where cii are the elements of the main diagonal of the matrix $\left(H^T H\right)^{-1}, i = 1,2,3.$

σ^2 – the variance of the measurement error.

The score σ^2 is determined by the formula

$$\widehat{\sigma}^2 = \frac{\sum_{i=1}^{N}\left(\ln(y_i) - \ln(\widehat{y}_i)\right)^2}{N-P} \tag{13}$$

The value of the t – parameter is calculated

$$t = \frac{\widehat{X}_i}{\sigma_{\widehat{X}_i}} \cdot$$

If the resulting value t is greater than the tabular t_α at (N-3-1) degrees of freedom, then Xi is significantly different from zero at the level α.

The confidence limits for are determined by the formula

$$T = X_i \pm t\alpha\sigma_{\widehat{X}_i}\sqrt{c_{ii}} \tag{14}$$

Then the probability that the value of Xi is really within these limits will be $1-\alpha$.

1) To assess the adequacy of the regression model to the observed values of output volume y, the multiple determination coefficient is calculated:

$$R^2 = \frac{\sum_{i=1}^{N}\left(\ln(\widehat{y}_i) - \overline{\ln(y_i)}\right)}{\sum_{i=1}^{N}\left(\ln(\widehat{y}_i) - \overline{\ln(y_i)}\right)^2} \quad \text{if} \quad \overline{\ln(y_i)} = \frac{1}{N}\sum_{i=1}^{N}\ln(y_i) \tag{15}$$

For a small sample size, an adjusted multiple determination coefficient is used

$$\widetilde{R}^2 = 1 - (1-R^2)\frac{N-1}{N-3} \tag{16}$$

Thus, the economic characteristics of the econometric model are as follows:

$$y = AK^{\alpha}L^{\beta} \tag{17}$$

where K is the number of production capital

L is the number of production hours or, in other words, the number of production units of humane capital

Or in linear form[8]:

$$\ln(y) = \ln(A) + \alpha\ln(K) + \beta\ln(L) \tag{18}$$

4 Result

Among the econometric tools for studying reproduction processes in agriculture, production functions play an important role. As mentioned above, the production function reflects the

functional relationship between the efficiently used production factors (labor and real estate) which are usually located in the first and last rows of the sample.

To construct the production function of Cobb-Douglas, we present the initial data in logarithms (Table 1). First, let's do some descriptive statistics to test the mean, mode, median, and other estimated factors of the factors in the multivariate regression model. Let's check the factors for normality. To do this, we use the Eviews 9 program.

Table 1. Initial data for constructing the Cobb-Douglas production function. Data of the State Statistics Committee of the Republic of Uzbekistan.

Years	Gross agricultural output. billion soums, Y	The cost of fixed assets of agriculture. billion soums, K	The number of people employed in agriculture. thousand people, L	Area of agricultural crops. thousand hectares, N
2000	17779.7	447.4	3085.7	4016.2
2001	18526.5	1332.1	3054	3687.1
2002	19638.1	1478.1	3038.3	3788
2003	21071.7	2059.9	3055	4033.6
2004	22947	2363.8	3039.2	3938.7
2005	24186.2	3401.7	2967.4	3899.1
2006	25806.7	3358	2928.8	3898.8
2007	27380.9	5304.7	2990.9	3829.4
2008	28613	5934.2	3029.7	3882.2
2009	30272.6	7139.4	2891.8	3891.1
2010	32361.4	8256.3	3120.9	4001.9
2011	34497.2	10313.7	3232.5	3906.2
2012	36981	11252.3	3054.2	3864.2
2013	39532.7	13205.3	3392.3	3973.7
2014	42300	16203.9	3524.9	4012.2
2015	45176.4	18590.7	3604.5	4027.2
2016	44297.3	16529	3208.7	3993.3
2017	46074.4	17660	3440.6	3824.3
2018	47851.5	18791.1	3472.4	4010.6
2019	50531.2	20106.8	3588.1	4014.6
2020	52299.8	20327.3	3549.2	4034.6

The results of descriptive statistics of factors are shown in Table 2.

Table 2. Results of descriptive statistics of factors.

	lnY	**lnK**	**lnL**	**lnN**
Mean	10.36946	8.768856	8.069275	8.276075
Median	10.38472	9.018732	8.034534	8.278606
Maximum	10.86475	9.919750	8.189938	8.302662
Minimum	9.785813	6.103453	7.969634	8.212596
Std. Dev.	0.210040	1.088749	0.073495	0.024469
Skewness	-0.124142	-0.804657	0.460411	-0.859439
Kurtosis	1.726594	1.750104	1.642374	2.144813
Jarque-Bera	1.354650	1.345257	1.208075	1.603122
Probability	0.210554	0.312663	0.316524	0.840080
Sum	217.7587	184.1460	169.4548	173.7976
SumSq. Dev.	2.450559	23.70750	0.108030	0.011975

An analysis of the results of descriptive statistics shows that the standard deviations (Std. Dev.) of all factors took on rather small values, respectively, their errors also took on small values. Skewness coefficients for three factors are negative, only the value of the factor employed in agriculture (lnL) is positive. This shows that the left "tails" of 3 factors are longer than the right "tails" of these factors. The coefficients of kurtosis (Kurtosis) for three factors (lnY, lnK, lnL) are less than 3, i.e. they are gentle, only the factor (lnN) has a kurtosis coefficient greater than 3 and it has a sharp peak (Figure 1).

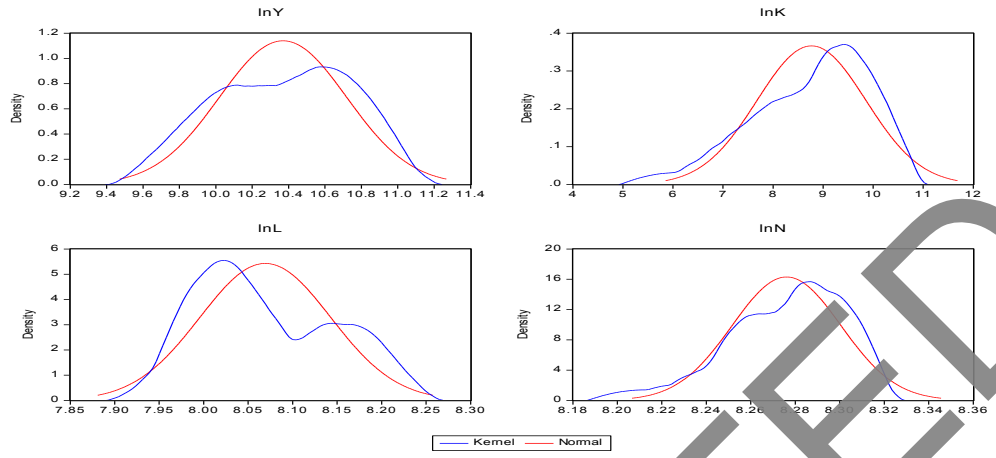

Fig. 1. Checking factors for normal distribution.

All factors included in the multivariate model follow a normal distribution, and this gives us the opportunity to test these factors for a strong relationship between the dependent variable (lnY). These connections are shown in Figure 2.

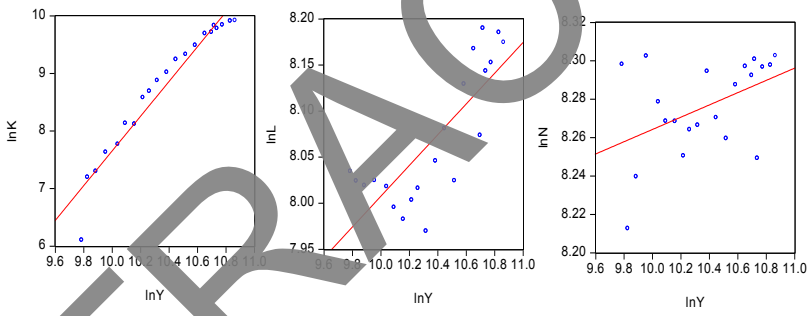

Fig. 2. Graph of the relationship of independent factors with the resulting factor.

Only the factor (lnK) and the resulting factor (lnY) have a strong relationship. The remaining two factors (lnL) and (lnN) have an average and low relationship with the resulting factor (lnY).

To build a multifactorial model of agricultural production in the Republic of Uzbekistan, we will build a factorial model. Calculations in the Eviews 9 program are shown in Table 3.

Table 3. Results of multivariate regression analysis.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
lnK	0.318937	0.017643	14.67623	0.0000
lnL	0.981514	0.283335	3.404149	0.0044
lnN	0.981013	0.326768	2.996046	0.0054
C	-2.186433	5.113613	-1.565549	0.1359
R-squared	0.984350	Meandependentvar		10.36946
Adjusted R-squared	0.987647	S.D. dependentvar		0.350040
S.E. ofregression	0.061981	Akaikeinfocriterion		-2.554326
Sumsquaredresid	0.065309	Schwarzcriterion		-2.355369
Loglikelihood	30.82042	Hannan-Quinncriter.		-2.511147
F-statistic	206.9626	Durbin-Watsonstat		1.492110
Prob(F-statistic)	0.000000			

Using the calculated parameters of Table 3, we construct an additive Cobb-Douglas production function:

$$\ln \hat{Y} = \underset{(5.1136)}{\ln(-2.1864)} + \underset{(0.0176)}{0.3189 \ln K} + \underset{(0.2833)}{0.9815 \ln L} + \underset{(0.3268)}{0.9810 \ln N} \tag{19}$$

$$F_{\text{calcul.}} = 206.9626\,,\ R^2 = 0.9733\,,\ DW = 1.4921 \tag{20}$$

Let us reduce the calculation model to a power model. To do this, we potentiate the left and right parts of the model. As a result, we obtain the Cobb-Douglas power-law production function:

$$\hat{Y} = 0.000415 \cdot K^{0.2589} \cdot L^{0.9645} \cdot N^{0.9790}$$

$$F_{\text{calcul.}} = 206.9626\,,\ R^2 = 0.9843\,,\ DW = 1.4921 \tag{21}$$

Cobb-Douglas production function analysis shows that a 1% increase in the cost of basic agricultural products leads to an average increase of 0.2589% in total agricultural output. Increasing the agricultural labor force in the Republic of Uzbekistan by 1% increases the total agricultural output by 0.9645%. An increase in cultivated area by 1% leads to an increase in the total agricultural output by 0.9790%.

Let's check the obtained Cobb-Douglas production function, which reflects the state of agriculture in the Republic of Uzbekistan, for adequacy. To do this, we use Fisher's F-test. If the calculated value of the F-criterion is greater than the tabular value, then the resulting model is adequate.

$$F_{\text{calcul.}} = 206{,}963 > F_{\text{tabl.}} = 3{,}20 \tag{22}$$

In our example, the resulting model really reflects the processes taking place in agriculture in the Republic of Uzbekistan, and it is adequate to the process under study. To check the reliability of the coefficients of model (2.4), we use Student's t-test. If , then the coefficients are considered reliable.

$$\begin{aligned} t_{\ln K} &= 14{,}6762 \quad \text{prob} = 0{,}0000\,; \\ t_{\ln L} &= 3{,}4041 \quad \text{prob} = 0{,}0034\,; \\ t_{\ln N} &= 2{,}9960 \quad \text{prob} = 0{,}0044 \end{aligned} \tag{23}$$

With an accuracy of 95 percent, the tabular value of Student's t-test is $t_{\text{tabl.}} = 2{,}086$.

This shows that all factors included in the model are reliable. The model can predict all factors for the future. A study of the current state and changes in agriculture in Uzbekistan over a 20-year period (2000-2020) showed that domestic crop and livestock farming are inefficient and not competitive enough. Internal factors include resources used in crop production. External factors at the national level are the operating conditions of any branch of the national economy: natural, political, economic, social, demographic and technological resources; At the global level, it is the level of development, conditions and characteristics of agriculture in the countries of the world community that have the greatest impact on the world economy.

Conclusion

Based on the analysis of the dynamics of cultivated land, it was found that land resources in agriculture are used inefficiently. There is a large-scale reduction in sown areas under industrial crops. The problem of land use efficiency, first of all, needs to be solved in farms, since they are the main and promising agricultural producers.

It is necessary to stimulate innovations in agriculture, which ensure the food security of the republic. For example: on the economical use of water resources, on the creation of a new type of greenhouses, etc.

To prevent threats to food security in Uzbekistan, it is necessary:

✓increase in the physical volume of agricultural products;

✓introduction into agricultural circulation of previously unused and newly developed agricultural lands;

✓introduction of international experience in efficient farming;

✓state subsidies for the development of agriculture;

✓it is necessary to protect water intake facilities (reservoir) and establish quarterly monitoring of the state of these facilities.

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