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MODELING FOOD SECURITY IN THE REGION

Abstract: *The article builds economic-mathematical models reflecting the influence of various factors on food security in the Surkhandarya region. They also provide scientifically based and practical recommendations for improving the food security of the region.*

Key words: *food security, economic-mathematical model, agricultural products.*

Language: *English*

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Introduction

The issues of identifying and eliminating threats to economic security remain relevant in increasing the openness of the Uzbek economy. The food security aspect is of particular importance. First of all, food consumption of the population is a vital necessity, because the creation of conditions for its quality and affordable prices is one of the priorities of the authorities at all levels.

Analysis of Subject Matters

The concept of food security and scientific-practical issues of its provision are widely studied by scientists in the field of economics.

Yu.S.Xromov in his opinion, food security means the state of the economy guaranteed to ensure that all population's access to food at any time requires an active, healthy lifestyle [1].

P.V.Leshchylovsky, V.T.Konkovic, and A.V.Mozols in their researches "food security is guaranteed by the amount of food guaranteed by the population, regardless of the situation on the world market, and to ensure that they are kept at the level of medical standards (requirements) [2].

Research Methodology

The main purpose of the research is to develop scientifically-practical proposals and recommendations to satisfy the population of the Republic of Uzbekistan with high quality food. Economic-statistical methods were widely used in the research. As a result of the research, economic and mathematical models of the Republic of Surkhandarya were reflected in the influence of various factors on food security and developed scientific and practical recommendations on further improvement.

Analysis and results

Our analysis allows us to state that the tools that are currently used in government and municipal governance will not provide a satisfactory level of food security to Surkhandarya region.

At the same time, there is another urgent problem of regional food safety management - the absence of a mathematical model of estimation and forecasting, which allows to take into consideration the supply and demand factors in the regional food market. This article is devoted to solving this problem.

Based on our research, it will be possible to identify a set of conditions for providing food security at the regional level in Surkhandarya region.

The analysis shows that the main food security requirement in the region is the main food security requirement. In our opinion, this level is achieved by cultivating the major agricultural products in the region in line with rational standards.

The calculations show that in 2017, the amount of food produced in Surkhandarya region in line with rational norms increased by 170.9%, potatoes -

447.3%, melons - 54.0%, grapes - 38.7%, wines - 188.5 % indicating their population [3].

Thus, using the values of the aforementioned indicators, it is possible to forecast the level of food security of the region and to identify reserves to increase it.

In the correlation-regression analysis of the official statistical reports for Surkhandarya region in 2009-2017, the influence of various factors on the dynamics of food production was determined.

Table 1. Dynamics of agricultural production and main indicators of agricultural activity for 2009-2017 in Surkhandarya region.

Years	*Potatoes (tons)*	*Vegetables (tons)*	*Vegetable crops*	*Fruits (tons)*	*Grapes (tons)*	*Number of farms (pcs)*	*Number of used machinery in product development (pcs)*	*Planting area size (hectares)*	*Number of workers attracted to agriculture (person)*
2009	116509	429567	102872	84123	67471	4652	9194	771022,694	140301
2010	127550	486419	113947	92292	77051	4850	9194	771022,694	135500
2011	145100	540157	123562	101542	95141	5028	9194	771022,694	145669
2012	159042	632884	137346	108763	103196	5140	9413	774999,496	111791
2013	174879	689835	150042	119085	113029	5155	9413	774999,496	149944
2014	193997	807007	169934	124806	115695	5323	9413	774999,496	140444
2015	217802	869498	197397	137782	118801	6003	9413	774999,496	129863
2016	244826	966804	207923	154457	135518	8833	9413	780999,496	131380
2017	279743	983953	231774	154951	135890	10302	9413	794999,496	130300

Source: Regional Statistical Office data.

According to the table, the dynamics of the main indicators of agricultural production in the region - potato production (Y_1), vegetable production (Y_2), melon cultivation (Y_3), grape production (Y_4), wet fodder production (Y_5) (X_1), number of farms (X_2), size of cultivated area (X_3), number of workers (X_4), as a factor affecting these indicators.

Here, we will consider the measurement of the relationship between factors, the causes of factors dependence, the regression model, and the evaluation of the parameters. We use double regression to investigate relationships with multiple factor regression methods.

$$y = f(x_1, x_2, x_3, x_4)$$

Using data from the Surkhandarya Region Statistical Division for 2009-2017, we will look at the matrix of correlation coefficients between the major types of agricul- tural production and the main indicators of agricultural activity in the region.

Table 2. Matrix of double correlation coefficients between potato crop production and main indicators of agricultural activity in Surkhandarya region.

	Y_1	X_1	X_2	X_3	X_4
Y_1	1	0,906	0,747	0,876	-0,234
X_1	0,906	1	0,484	0,939	-0,250
X_2	0,747	0,484	1	0,547	-0,367
X_3	0,876	0,939	0,547	1	-0,267
X_4	-0,234	-0,250	-0,367	-0,267	1

Source: Developed by the author on the basis of the provincial statistics office.

Table 3. The matrix of the correlation coefficients between vegetable production and the main indicators of agricultural activity in Surkhandarya region.

	Y_2	X_1	X_2	X_3	X_4
Y_2	1	0,821	0,824	0,772	-0,240
X_1	0,821	1	0,484	0,939	-0,250
X_2	0,824	0,484	1	0,547	-0,367
X_3	0,772	0,939	0,547	1	-0,267
X_4	-0,240	-0,250	-0,367	-0,267	1

Source: Developed by the author on the basis of the provincial statistics office.

Table 4. Matrix of double correlation coefficients between the basic indicators of the cultivation of melons and the basic agricultural activities in Surkhandarya region.

	Y_3	X_1	X_2	X_3	X_4
Y_3	1	0,871	0,764	0,834	-0,245
X_1	0,871	1	0,939	0,939	-0,250
X_2	0,764	0,484	1	0,547	-0,367
X_3	0,834	0,939	0,547	1	-0,267
X_4	-0,245	-0,250	-0,367	-0,267	1

Source: Developed by the author on the basis of the provincial statistics office.

Table 5. Matrix of double correlation coefficients between grape cultivation and basic agricultural performance indicators in Surkhandarya region.

	Y_4	X_1	X_2	X_3	X_4
Y_4	1	0,776	0,851	0,744	-0,200
X_1	0,776	1	0,484	0,939	-0,250
X_2	0,851	0,484	1	0,547	-0,367
X_3	0,744	0,939	0,547	1	-0,267
X_4	-0,200	-0,250	-0,367	-0,267	1

Source: Developed by the author on the basis of the provincial statistics office.

Table 6. Matrix of correlation coefficients between the main indicators of fertilization and agriculture in Surkhandarya region.

	Y_5	X_1	X_2	X_3	X_4
Y_5	1	0,856	0,791	0,792	-0,221
X_1	0,856	1	0,484	0,939	-0,250
X_2	0,791	0,484	1	0,547	-0,367
X_3	0,792	0,939	0,547	1	-0,267
X_4	-0,221	-0,250	-0,367	-0,267	1

Source: Developed by the author on the basis of the provincial statistics office.

By analyzing the obtained matrix, it is possible to conclude that with the factor Y_1, Y_2, Y_3, Y_4, Y_5, Factor and X_1, X_2, X_3 factors (correspondent correlation coefficients, 0,906 for potatoes, 0,747, 0,876, 0,821 for vegetable, 0,824, 0,772 , 0,791, 0,764, 0,834 for grapes, 0,796 for 0,851, 0,744 for grapes, 0,856 for 0,791, 0,792 for fruits, but the value of the double correlation coefficient with factor X4 was very low (correlation coefficients, potatoes - 0,234 , for vegetables – 0,24, for melons – 0,245, for grapes – 0,2, for Fruits – 0,221). Therefore it is not advisable to put this factor into equation. Between the X_1 and X_3 factors, the pair correlation coefficient is high (correspondent correlation coefficients

0,939), which indicates the presence of multicollinearity among them. Therefore, only one of the factors X_1 and X_3 is given in the equation.

As a software tool to analyze the data, we use Regression in the "Data Excel Analysis" program. The results are shown in Table 7.

Table 7. Regression analysis of EXCEL for agricultural products grown in Surkhandarya region.

Indicator	Potato	Vegetable	Vegetable crops	Grape	Fruits
Plural R	*0,9725*	*0,9548*	*0,9550*	*0,9480*	*0,9588*
R-square	*0,9459*	*0,9117*	*0,9120*	*0,8987*	*0,9193*
Normalized R-squared	*0,9278*	*0,8823*	*0,8827*	*0,8650*	*0,8924*
Standard error	*14729,8*	*70688,87*	*15443,34*	*8726,56*	*8416,03*
F	*52,4661*	*30,986*	*31,103*	*26,634*	*34,2041*
Coefficients (Y_1)	*-818346,6*	*-9422268,8*	*-1650913,6*	*-1186329,8*	*-1006798,5*
Coefficients (X_1)	*19,4073*	*56,4987*	*14,6759*	*5,6195*	*7,8879*
Coefficients (X_2)	*201,660*	*1047,85*	*184,173*	*134,76*	*115,42*
Standard error (Y_1)	*499317,95*	*2396244,6*	*523505,6*	*295817,27*	*285290,71*
Standard error (X_1)	*2,9610*	*14,2101*	*3,1044*	*1,7542*	*1,6918*
Standard error (X_2)	*54,3744*	*260,944*	*57,008*	*32,2137*	*31,0674*
t-statistics (Y_1)	*-3,6416*	*-3,9320*	*-3,15357*	*-4,0103*	*-3,5290*
t-statistics (X_1)	*6,5542*	*3,9759*	*4,72732*	*3,2033*	*4,6623*
t-statistics (X_2)	*3,7087*	*4,01563*	*3,23064*	*4,1833*	*3,7154*
Observations	*9*	*9*	*9*	*9*	*9*

According to the data in Table 6, the correlation coefficient of coefficient indicates a correlation between 0,97 for potato crop production, 0,94 for grape product, and 0,95 for vegetables, melons and gourmet products.

R2 determining plume coefficient is conditioned by the influence of factors such as potato crop production by 94 percent, grape harvesting by 0,89 percent, vegetables, melons and gourds by 91 percent.

We continue our analysis by examining the significance of regression on the basis of Fisher's F-criterion. The value of the F-table is 5,41, with a probability of 0.95 reliability [4]. This can be attributed to the fact that regression equation can be justified because of the inequality in Table 7 for the Potatoes, Vegetables, Melons, Grapes and Grapes. Hence, according to Fisher's F-criterion.

The results of the evaluation of the significance of regression coefficients by Stuudent's criterion indicate that all coefficients are important.

The results of the calculations allow to confirm that the greatest impact for achieving the optimal level of this coefficient depends on the factors such as the area of crops, the number of farms, and the availability of equipment.

Based on the results above, models for the factors of agricultural production in Surkhandarya region are presented in Table 8.

Table 8. The results of modeling of dynamics of development of agricultural products in Surkhandarya region.

Product name	*Conditional characters*	*Equation in the Model*
Potatoe	*$K_{potatoe}$ - Product production coefficient* *X_1 - Number of farms.* *X_2 - Number of techniques.*	*$K_{potatoe} = -1818346,6 + 19,4\ X_1 + 201,7\ X_2$*
Vegetable	*$S_{vegetable}$ - Product production coefficient* *X_1 - Number of farms.* *X_2 - Number of techniques.*	*$S_{vegetable} = -9422268,8 + 56,5\ X_1 + 1047,9\ X_2$*
Vegetable crops	*$P_{vegetable}$ - Product production coefficient* *X_1 - Number of farms.*	*$P_{vegetable\ crops} = -1650913,6 + 14,7\ X_1 + 184,2\ X_2$*

	X_2 - Number of techniques.	
Grape	*U_{grape} - Product production coefficient* *X_1 - Number of farms.* *X_2 - Number of techniques.*	*$U_{grape} = -1186329,9 + 5,6\ X_1 + 134,8\ X_2$*
Fruits	*H_{Fruits} - Product production coefficient* *X_1 - Number of farms.* *X_2 - Number of techniques.*	*$H_{Fruits} = -1006798,6 + 7,89\ X_1 + 115,4\ X_2$*

Analysis of the obtained equation shows that the factor X_2 (the number of techniques) has the greatest influence on the volume of production of absolute growth: the increase in the number of techniques by 1%, potatoes, melons and gourds, by 10%, vegetable production by 13% grape products - by 11%. Increase in the number of farms by 1% leads to the increase of potato production by 0,6%, grape products - by 0,3%, fruits - by 0,2%, vegetables and melons - by 0,5%.

On the basis of acceptable economic and mathematical models, the regional food production rate can be forecasted. To do this, we select the most appropriate option using the linear, parabolic and exponential features of the trend equations. The results are shown in Table 9.

Table 9. Prognostic values obtained by extrapolation of major types of agricultural products in Surkhandarya region (tons).

Indicator (factor variable)	*Trend equation*	*True*	*Prognosis*			*2017 ў. 2020 ў, %*
		2017ў.	*2018ў.*	*2019ў.*	*2020ў.*	
Potatoe	*$\overline{Y_t} = 1406,1\ t^2 + 5691,1\ t + 111401$*	*279743*	*308922*	*344141*	*382172*	*137*
Vegetable	*$\overline{Y_t} = 215,4\ t^2 + 72704\ t + 341449$*	*983953*	*1090029*	*1167256*	*1244915*	*126*
Vegetable crops	*$\overline{Y_t} = 899,25\ t^2 + 7304,1\ t + 94425$*	*231774*	*257391*	*283597*	*311566*	*134*
Grape	*$\overline{Y_t} = -553,22\ t^2 + 14014\ t + 54315$*	*135890*	*139133*	*141529*	*142819*	*105*
Fruits	*$\overline{Y_t} = 167,05\ t^2 + 7635\ t + 76291$*	*154951*	*169346*	*180489*	*191966*	*123*

Source: Developed by the author on the basis of the provincial statistics office.

Forecast estimates show that according to past retrospective trends, average production of potatoes in Surkhandarya region by 2020 will increase by 37% compared to 2017, vegetables by 26%, melons by 34%, grapes by 5%, and fruits by 23% possible.

The calculations are based on the physiological principle that potatoes can be grown by 55%, vegetables by 100%, melons by 300%, grapes by 230% and wet products by 23%. In the future, the economic benefits of food will increase, as the incomes of the population will significantly increase the subsistence level.

It is possible to conclude that in order to ensure food security in Surkhandarya region, state and municipal authorities should prioritize the economic potential of food products. This can be achieved by bringing up modern agricultural techniques, based on the revenues that are supported by the high growth rate of exports of agricultural products to the physiological norm.

Conclusions and Suggestions

According to the above information, Surkhandarya region needs to work in several directions to improve food security. Including:

- ✓ improving the legal framework for regional food security;
- ✓ establishment of regional norms of per capita food consumption per capita;
- ✓ increasing the production of basic foodstuffs for the population of the region in accordance with recommended consumption standards;
- ✓ supporting import substitution, including measures to reduce the dependence on the domestic food market on the basis of increased competitiveness of domestic commodities.

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