Econometric Analysis of the Efficiency of Production of Horticultural Products

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ABSTRACT

The article reveals the main production factors that affect the increase in the production of horticultural products. In the dissertation work, using a logarithmic-linear model based on the Cobb-Douglas production function, within the framework of the goals and objectives set for the study, as well as their scientific and methodological solutions are substantiated. A forecast was developed for the gross agricultural product of the Tashkent region and innovations introduced into agriculture for 2022-2027.

Keywords: Agriculture, gross product, horticulture, innovation technologies, econometric model, Cobb-Douglas production function, discoveries and inventions, patents, productivity, main tool, labour resources, capital, correlation, regression, efficiency, forecast.

Introduction

A number of reforms are being carried out in our country regarding the development of agriculture, in particular, horticulture, fruit and vegetable and viticulture industries in accordance with international standards and the wide involvement of new innovations in the field. “The consistent development of production by deepening structural transformations in agriculture, production in the agricultural sector of the economy, the effective use of innovative technologies in solving economic and social problems are of the most important tasks” [16].

The convenience of the natural and climatic conditions of the regions, the technological possibilities for the development of intensive horticulture, the amount of precipitation and groundwater in mountainous and foothill areas are sufficient for intensive horticulture, and the experience and culture of agriculture are further expanding opportunities in this regard. At the same time, as the president of our republic noted, "... today only 5 percent of fruits and vegetables grown in our country are processed and 8 percent are not exported" [17]. This means that the infrastructure and related services associated with the delivery of freshly cut or processed fruit to the final consumer are underdeveloped.

Research methodology Agriculture is one of the main industries in our country and each of the processes carried out has a certain characteristics. Therefore, econometric analysis is convenient to use in the analysis of production processes and the efficient use of resources in agricultural industries. One of the main tools of econometric analysis is the production function (PF), which is widely used in the economic literature.

In scientific studies conducted by many economists, land resources, labor resources, capital, fertilizers were studied as the main indicators of production efficiency in agriculture [6]. In particular, in a study conducted on the example of the country of Pakistan, the impact of the amount of fertilizer applied per hectare, the use of machinery per hectare, the use of labor resources per hectare, on the value of gross agricultural output was studied. [9]. Also, to estimate the value of the gross domestic product, in the study conducted by Gong on the example of the Chinese state, he used indicators such as the cost of labor, the cost of land, fertilizers and equipment [3]. In the studies of local economist I. B. Rustamova, such variables as the value of the gross product (billion soums), the value of fixed assets (billion soums), the number of agricultural jobs (persons) and sown areas were used as the main agricultural indicators feature has been installed and researched[15].

Based on the research work of the above economists, in our scientific work, in our scientific work, such indicators as the sown area of fruits and vegetables in the

Tashkent region, the amount of water used in irrigation, the number of jobs in horticulture, the number of agricultural machinery used and the number of innovative (new) technologies involved in the network are used in the cost of production of horticultural products Let's take look at the effect.

As a result of our literature research, we can conclude that these variables are expected to have a positive impact on the cost of horticultural products. The reason is that these indicators are the main production factors affecting the increase in the production of fruits and vegetables in agriculture. In addition to these derived factors, we also evaluate the impact of the number of innovative (new) technologies involved in the network.

These highlighted indicators (factors) are the main factors affecting the production of common farms, especially in horticulture, and the influence of these indicators has been studied in many studies. It is known that the cultivation of fruit and vegetable products by different large and small farms manifests itself relatively differently when assessing their effectiveness. For example, in small horticultural farms, they can get a high yield by using the land in a certain intensive way [7].

The larger farms will also be able to spend more and have higher gross output [8]. They also note in their scientific research that large farms are more efficient than small farms [18]. Thus, it has been observed that farms with a larger area of land have a positive effect on the cost of agricultural production.

Results

Horticultural farms located in the Tashkent region were included in the data analysis. The following map shows a map of the Tashkent region in sections of districts

(Figure 1).

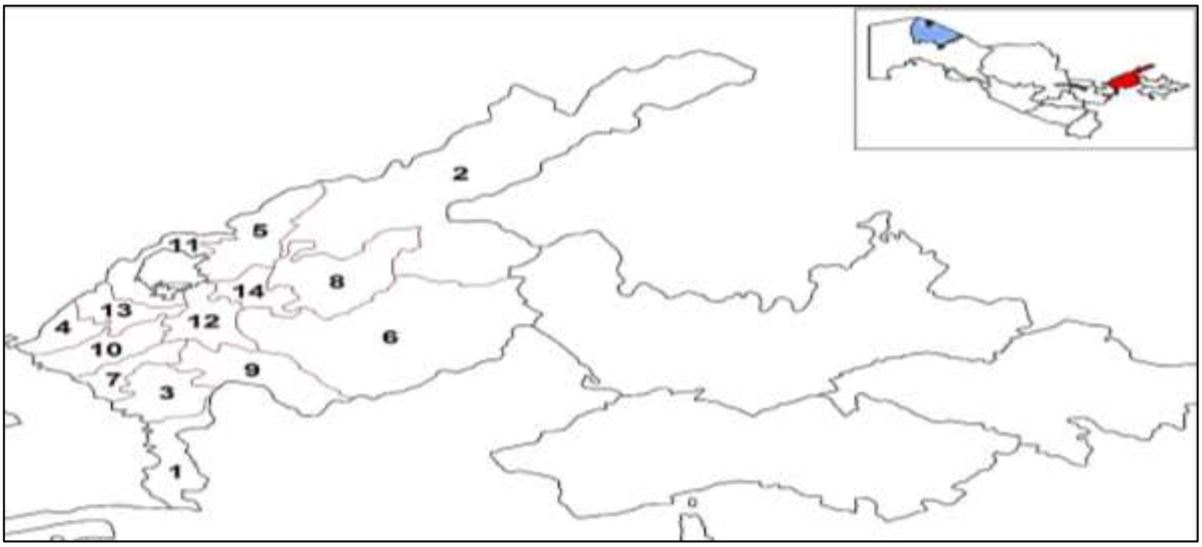


Figure 1. The map of Tashkent region divided into districts [4]

The expected impact of the above factors on the value of the gross output of horticultural products is presented in Table 1 below.

Table 1

Expected influence of factors on the gross value of horticultural products [10]

№	Factors	Explanation
1.	Cultivated area	+
2.	Amount of water used	+
3.	Number of jobs in horticulture	+
4.	Number of agricultural machinery	+
5.	Number of innovative (new) technologies	+
6.	Volume of innovations develop in-house	+

In the dissertation work, using a logarithmic-linear model based on the Cobb-Douglas production function, within the framework of the goals and objectives set for the study, as well as their scientific and methodological solutions are substantiated. Due to the large value of arbitrary variables and some arbitrary variables in the model, in order to quantify them, logarithmic and other arbitrary variables were used linearly, and the following model was created

$$lnY_i = \alpha_i + \beta_1 lnx_i + \cdots + \beta_6 x_i + u_i \quad (1)$$

Here ,

LnY – *arbitrary variable, the value of the gross product received in the horticulture network in the model(million soums);*

LnX_1 – *independent variable, total land area (ha);*

LnX_2 – *independent variable, the total amount of water used (m^3);*

LnX_3 – *independent variable, number of jobs in horticulture, person;*

LnX_4 – *independent variable, number of agricultural machinery, pcs;*

LnX_5 – *independent variable, number of innovative (new) technologies, pcs;*

LnX_6 – *independent variable, volume of innovations developed by own efforts, million soums;*

$\beta_1 ... \beta_n$ – *the coefficient of each variable, that is, the coefficients of the independent variables obtained from the regression results ;*

α_1 – *fixed unobserved factors;*

u_i – *standard errors.*

We have tried to create a database to highlight the research work. In this case, the selected factors were chosen as follows:

(1) the volume of production of fruits and vegetables in horticultural farms;

(2) the total area, the amount of water used, the number of objects, the number of receptions, and the number and volume of innovative technologies in horticulture.

The data was collected through the Tashkent region department and department of agriculture in the region. The data obtained included the period from 2015 to 2021 by region. The gross value of horticultural output, used as a dummy variable in the analysis, was calculated by multiplying the quantity of horticultural output produced by its price in the given years. Based on the collected available data, we developed the following criteria for estimating the gross value of horticultural products and presented their descriptive statistics in Table 2.

Table 2

Statistical analysis of variables used in the analysis [11]

Indicators	Average cost	Standard deviation	Minimum value	Maximum value
Gross value of products obtained in the fruit and vegetable industry (million soums)	6227,7	2301,8	401,3	53542
Total land area (thousand ha)	18,0	12,5	5,9	63,8

Total water consumption (thousand m3)	2738,2	580,9	960	3440
Number of jobs in horticulture, thousand people	25,4	8,7	11,8	56,6
Number of agricultural machinery, pcs	200,4	104,1	58	297
Number of innovative (new) technologies, pcs	7,3	3,8	0	12,6
The volume of innovations developed in-house,(million soums)	241,7	198,1	98,4	564,8

Table 2 shows the results of the model, and the calculated R-square is 0.9814, which means that the model chosen for analysis is appropriate for the dataset. R-squared is a statistical measure that represents the proportion of the variance of an independent variable that is represented by the dependent variable or variables in a regression model.

While correlation represents the strength or weakness of the association between independent and independent variables, R-square indicates how much the variance of one variable represents the variance of another variable. If the calculated R-squared value is greater than 0.50, this means that almost half of the analyzed variations can be expressed in the model based on the selected factors

Table 3

Estimated parameters of the economical model [1]

Variables	Coefficient	Standard error	*t*-statistics	*p*-value
Ln_ Total land area (thousand ha)	0.5681	0.125	2.531	0.026
Ln_ Total water consumption (thousand m3)	0.4032	0.4856	0.4818	0.000
Ln_ Total water consumption (thousand m3)	0.5460	16.1012	0.4011	0.004
Ln_ Number of agricultural machinery, pcs	-0.2614	3.1491	-0.7851	0.091
Number of innovative (new) technologies, pcs	0.6498	9.9502	3.2116	0.000
Ln_ The volume of innovations developed in-house (million soums)	0.8954	31.069	1.2085	0.000
R- square	0.9814	*Mean value of the dependent variable*		242.30
regression standard error	365.9567	*Probability (F-statistic)*		0.000
Sum of squared residuals	342.389	*F-statistic*		341.8862

Received in the form * p<0.1, ** p<0.05, *** p<0.01.

In Table 3, we can see that the model results and the model results show that the amount of water used and the total cultivated area have a positive effect on the value of the gross horticultural product and are statistically significant. For example, according to the results of the model, an increase in the sown area by 1% led to an increase in the cost of the region's gross horticulture output by 0.6%, i.e. by 16696 thousand. This result is also consistent with our research hypothesis that the water content and the size of the cultivated area have a positive effect on the value of gross horticultural production.

But we see that the number of methods has a negative effect on the value of gardening in the model. The negative relationship between the number of machines and the cost of the gross product can be explained by the fact that most of the agricultural machines are physically and morally obsolete tractors and machines. In particular, in agrarian reforms, special attention should be paid to public investment and the modernization of agricultural machinery.

Also, the results of the regression showed that the two variables chosen to represent the main indicators of our research work, i.e. "*number of innovative (new) technologies*" and "*number of self-developed innovations*" also have a positive impact on the value of the gross product, and the coefficients are statistically significant. In particular, it has been scientifically proven that a 1% increase in the number of innovative technologies and the volume of self-developed innovations can increase the value of the gross horticultural product by 6.5% and 9%, respectively.

So, the studies and analysis (1) of the parameters of the Cobb-Douglas production function in terms of the gross product show that it will be necessary to develop the agricultural sector of our republic through innovative technologies and determine the directions for the effective use of investments invested in it. After all, it is difficult to achieve high productivity without the development of modern agriculture.

As part of large-scale digitalization programs carried out in recent years, a number of practical works have been carried out in the agro-industrial complex of our republic. In particular, the number of various large and small innovative developments introduced into the agriculture of the Tashkent region in 2014 amounted to 221, and by 2021 we see an increase in this figure by 3.02 times. Using these indicators, we calculated the predictive parameters of innovative developments that can be increased in the network for the next five years.

To develop predictive parameters, we used a multifactorial econometric model of innovation processes in agriculture [5].

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n + u_i \quad (2)$$

Here ,

y_i- output factor (gross agricultural product);

$x_1 \dots x_n$ - influencing factors;

$\beta_1 \dots \beta_n$ - model parameters;

u_i – Standard error.

In order to analyze innovative processes in agriculture in the Tashkent region, the following factors were taken as parameters of the above model:

As a result factor-gross agricultural product, bln.soum (Y);

As influencing factors- the cost of fixed agricultural assets, billion soums (X_1), the number of introduced innovations (X_2), the number of agricultural research(X_3), the number of patents for discoveries and inventions in agriculture (X_4).

The law of normal distribution of factors used in the multifactorial econometric model was also tested. In the model, the normal distribution function was calculated using the following formula:

$$f(x|\mu,\sigma) = \frac{1}{\sqrt{2\pi}\sigma} e^{\left(-\frac{1}{2\sigma^2}(x-\mu)^2\right)} \quad (3)$$

From the results obtained from the normal distribution function, we found out that all factors obey the normal distribution law. This allows you to explore relationships between factors.

For this, if we consider the use of all factors accepted in the model, it is proved that an increase in all factors leads to an increase in the gross agricultural product (Table 4).

As can be seen from Table 4, we see that all factors (variables) used in the model are statistically significant and have a positive effect, that is, if the tabular value of the Fisher criterion is *F=441,21* then we can say that the model is statistically significant.

Table 4
Estimated parameters of the multifactor econometric model [2]

Variables	Coefficient	Standard error	*t*-statistics	*p*-value
X_1	0.2561	0.61520	1.51400	0.0002
X_2	0.0542	0.08486	0.01460	0.0024
X_3	0.0714	0.12058	0.52034	0.0001
X_4	0.0521	0.04502	0.02716	0.0092
R- square	0.9149	*Mean value of the dependent variable*		264.03
The value of the similarity function	*145.214*	*Probability (F-statistic)*		0.0000
Regression standard error	365.9567	*F-statistic*		441.21
Sum of squared residuals	271.084	*Durbin-Watson statistics*		*3.8365*

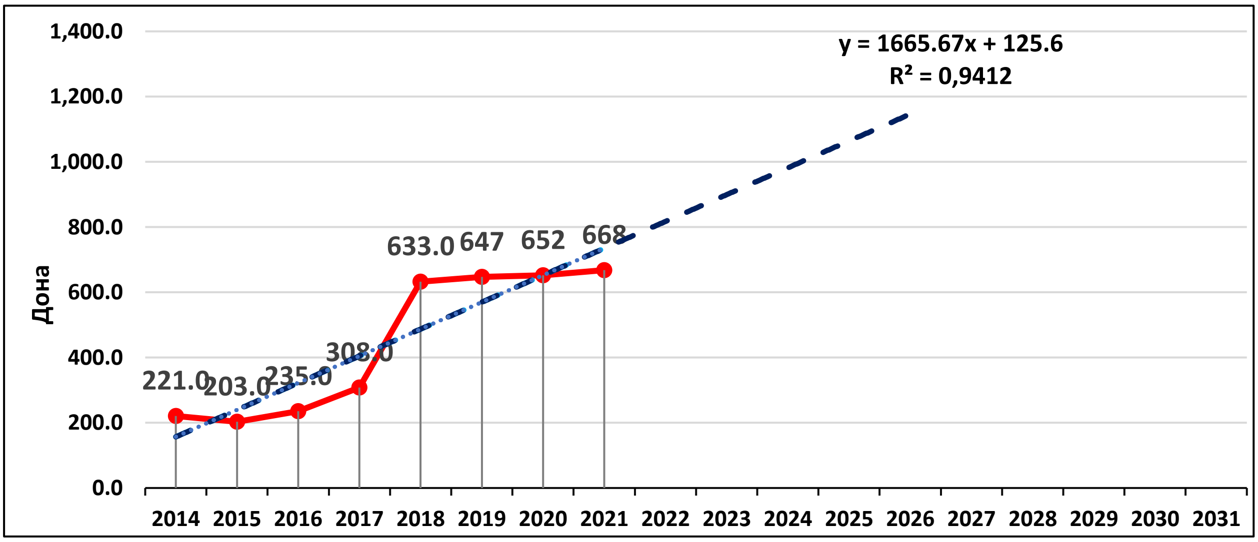
Received in the form * p<0.1, ** p<0.05, *** p<0.01.

The economic essence of the parameters of the multifactorial econometric model lies in the fact that with the value of the fixed assets of agriculture (X_1) 1 billion soums increases, gross agricultural output (Y) averages 0,256 billion soums. the increase to soums was scientifically substantiated. It has also been scientifically proven that an increase in the number of agricultural innovations (X_2), agricultural research (X_3), the number of patents for agricultural discoveries and inventions (X_4) by one unit can positively increase the gross agricultural output of the region.

In this case, the reason for the lower model coefficient in the interaction between the above three variables *(X2, X3 and X4)* and the agricultural gross product (Y) is that research and patents included in the network are not always successful. , because any innovation is reflected in the network, it takes some time to find it, and only then it will be reflected in the gross agricultural product.

Innovations used in agriculture of the Republic of Uzbekistan are increasing year by year. Therefore, it is necessary to develop a forecast of innovations introduced into the agriculture of the region. After all, by introducing innovations into the network, you can slightly increase the volume of the gross product and prevent excessive spending (Fig. 2).

Figure 2. The function of forecasting innovations introduced into agriculture in the Tashkent region for 2022-2027 [12]



In Figure 2, we have developed forecast indicators for 2022-2027 using the data on trends of innovations introduced to agriculture in the region in 2014-2021. Fig .2

In 2014, the number of innovations involved in the network was only 221, in this indicator, growth trends can be seen for the coming years, that is, in 2021 it will be 3 times more than in 2014, and by 2027 there will be 716 innovations introduced, i.e.3.23 times more (Fig.3)

Table 3 Forecast for the introduction of innovations in agriculture in the Tashkent region for 2022-2027 [13]

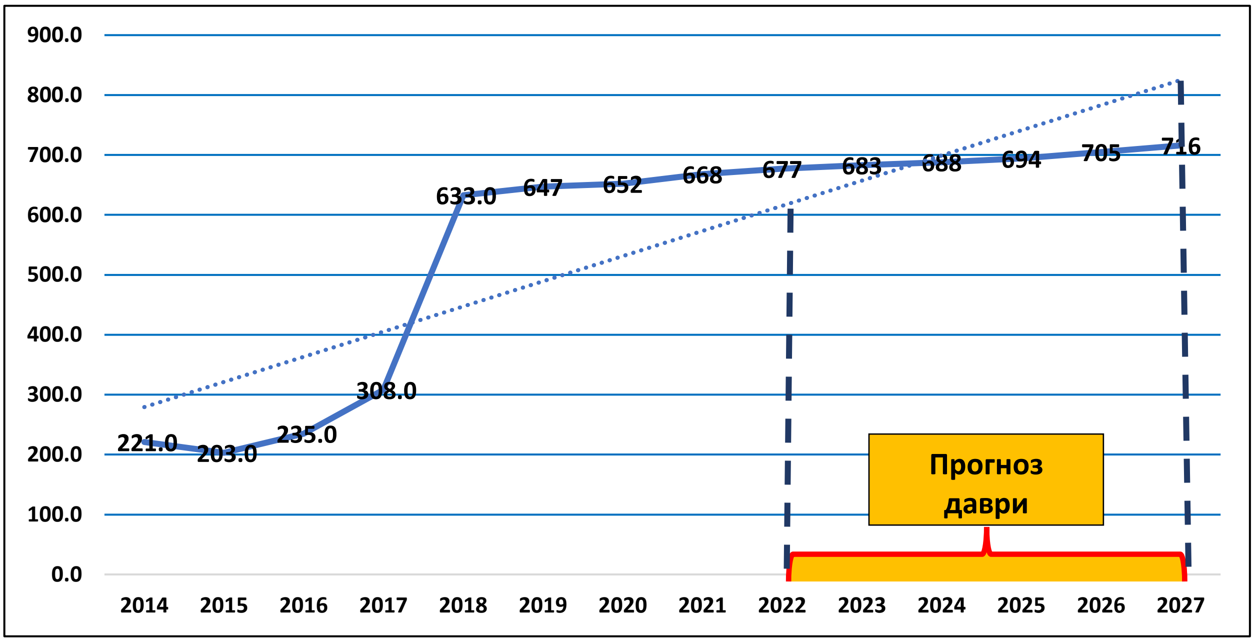


Figure 3. Forecast for the introduction of innovations in agriculture in the Tashkent region for 2022-2027[13]

At the same time, the gross agricultural output of the Tashkent region tends to increase in the forecast period. The average annual growth of the gross product in the region is 1.7 trillion. for the amount of soum. This increase is 3.1 times compared to 2010 and 1.75 times compared to 2015. In 2010, the gross output of the region in agriculture amounted to 2.237 billion tenge. if it was soums, then by 2027 they will amount to 25.886 billion soums. sum. 11.6 times magnification

One of the main reasons for this is the widespread introduction of innovative technologies in the agro-industrial complex of the region, the use of new methods of organizing production, and a number of other factors (Fig. 4).

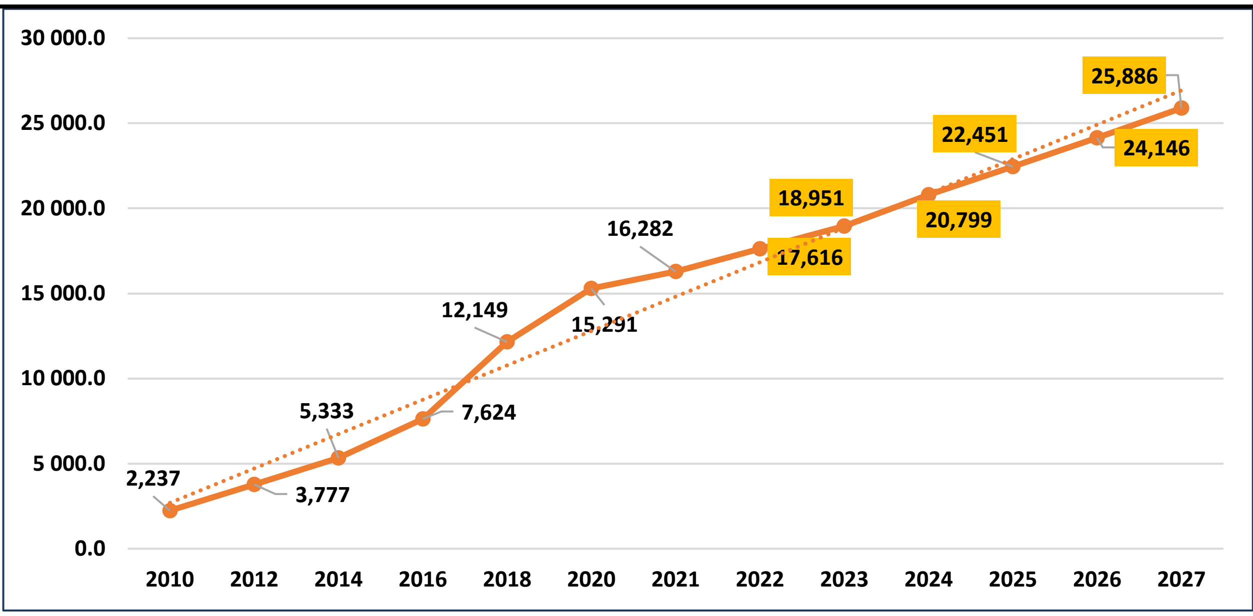


Table 4 Forecast of gross agricultural output of Tashkent region for 2022-2027 [14]

In conclusion, the innovative development of agriculture in our republic requires research activities mainly in those areas where science is in great demand in agriculture. Also, the result of this, in turn, contributes to an increase in the gross agricultural product and an increase in the welfare of the rural population.

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