ANALYSIS AND RESULTS OF FORECASTING THE VOLUME OF FRUIT AND BERRY PRODUCTION

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ABSTRACT
This article highlights the issue of forecasting the volume of fruit and berry production in the Tashkent region for the period 2025-2030. The study analyzed the current state of the industry, main development trends, and factors influencing the volume. According to the results obtained, the volume of fruit and berry production in the Tashkent region has a stable growth dynamic, and investment activity, the introduction of technologies, and the improvement of agrotechnical measures are the main factors influencing growth. The research results are of practical importance in planning the region's agrarian policy, agricultural development strategy, and investment programs.

Introduction. The Tashkent region is one of the most important agricultural regions of Uzbekistan and has a large share in the production of fruits and berries. The region's climatic conditions, soil resources, and proximity to the market create favorable opportunities for the development of this industry. Therefore, forecasting the volume of fruit and berry production for 2025-2030 is of great importance for agricultural policy and investment decisions.

Literature review. Scientific research on forecasting the volume of fruit and berry production has been widely studied both in world practice and in Uzbekistan. The literature primarily emphasizes the importance of climate factors, efficient use of land resources, intensive technologies, and investment activity in the development of agricultural sectors.

In international sources (FAO), agroclimatic conditions, yield dynamics, the effectiveness of irrigation technologies, and changes in market demand are noted as the main factors in forecasting the volume of fruit and berry production. In the research conducted by Uzbek scientists, the theoretical and practical foundations of modernization of agriculture, development of intensive horticulture, and increasing the agrarian potential of the regions are highlighted. They emphasize that growth trends in the agricultural sector are greatly influenced by investments, agrotechnical measures, farm scale, infrastructure development, and labor resource employment.

Some researchers have presented empirical evidence of a multiple increase in yields in areas where intensive horticulture and modern irrigation systems have been implemented. At the same time, it has been shown that multifactorial regression models built on the basis of regional variables have high accuracy in forecasting the volume of fruit and vegetable production.

Research methods. In the research process, comparison, monographic study, statistical and econometric modeling, economic analysis and synthesis, the ARIMA (ARMA) model, and other methods were used.

Research results. Within the framework of the study, the following factors influencing the effectiveness of attracting investments in the fruit and vegetable sector were identified for the model, namely:
- Volume of production of fruits and berries, tons;
- Total sown area, ha;
- Average annual temperature, °C;
- Volume of investments in the fruit and vegetable industry, in million soums;
- Population employed in agriculture, forestry, and fisheries, thousand people.

Based on the above factors, based on the analysis of the state of fruit and vegetable production in the Tashkent region in 2010-2024, where monographic research was conducted, calculations were carried out to determine the prospects for the volume of fruit and vegetable production in the region in 2025-2029 (Table 1).

Table 1.

Dynamics of fruit and berry production in the Tashkent region in 2010-2024

Years	*Volume of fruit and berry production, tons	* Total sown area of fruits and berries, ha	**Average annual temperature, S	*Volume of investments in the fruit and vegetable industry, in million soums	*Population employed in agriculture, forestry and fisheries, thousand people
2010	108,223	14,447	14.2	51,684.0	312,2
2011	108,732	12,929	14.4	69,397.0	324,8
2012	109,104	13,846	14.5	93,947.0	311,5
2013	109,314	12,828	14.6	125,182.0	323,1
2014	109,439	12,106	14.8	165,728.0	325,3
2015	109,743	11,775	15.0	205,491.0	331
2016	109,929	10,949	15.2	210,194.0	335,1
2017	101,152	20,030	15.4	401,564.0	338,4
2018	141,121	22,085	15.5	649,718.0	322,9
2019	129,627	22,742	15.7	873,943.0	322,2
2020	114,334	20,713	15.9	1,068,222.0	304,2
2021	109,300	17,544	16.0	733,004.0	279,5
2022	133,977	20,644	16.3	505,225.0	283,1
2023	126,011	21,072	16.4	413,715.0	288,3
2024	133,770	21,930	16.5	398,429.0	273,6

*Note: * - Data from the Department of Agriculture of Tashkent region.*
*** - Data from the Tashkent Regional Meteorological Station (M-II) of the Center for Hydrometeorological Service of the Republic of Uzbekistan.*

In particular, the analysis of the average, maximum, and minimum indicators of independent and dependent variables, such as the volume of fruit and vegetable production in the Tashkent region in 2010-2024, the total sown area, the average annual temperature, the volume of investments in the fruit and vegetable industry, the number of people employed in agriculture, forestry, and fisheries, was carried out using the Stata 16 program (Figure 1).

According to the analysis, for example, during the selected years (2010-2024), the volume of fruits and berries in the Tashkent region amounted to a maximum of 141.121 tons, while the minimum amounted to 101.152 tons, and an average of 116.918 tons.

Variable	Obs	Mean	Std. Dev.	Min	Max
yillar	15	2017	4.472136	2010	2024
meva_rezav~i	15	116918.4	12352.04	101152	141121
meva_rezav~n	15	17042.67	4428.311	10949	22742
harorat	15	15.36	.7632637	14.2	16.5
investitsiya	15	397696.2	314431.3	51684	1068222
q_x_band_a~i	15	311.68	21.15532	273.6	338.4

Figure 1. on the cultivation of fruit and berry products in Tashkent region minimum, maximum, and average indicators of influencing factors [1]

According to the results of the correlation analysis of the interrelationships of the factors selected for the model, there is a relationship of varying degrees between the volume of fruit and berry products and the selected factors. In particular, a moderately strong and direct correlation (0.7118) is observed between the volume of fruits and berries (Y) and their sown area. This means that the expansion of the area provides an opportunity to increase the yield. From this point of view, it can be noted that the size of the sown area is one of the main factors forming the volume of production.

There is also a relatively weak-medium direct correlation (0.6352) between the temperature factor and the volume of fruits and berries. This means that high-temperature conditions can have a positive effect on seasonal growth processes. However, in practice, deviations from the norm of temperature can negatively affect yields, therefore this relationship can be assessed as "correct, but moderate."

The correlation coefficient between the volume of investments and the volume of fruit and berry products (0.4481) indicates a weak direct relationship. The reason for this is the need to take into account the influence of investment policy on infrastructure improvement, the introduction of modern agricultural technologies, but also other agroclimatic factors that affect yields.

The weak inverse relationship between the number of people employed in agriculture and the volume (-0.4633) shows that an increase in labor resources does not at all mean an increase in productivity. The main role in this is played by labor productivity, technical equipment, and the level of use of innovative technologies.

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. do "C:\Users\Hp\AppData\Local\Temp\STD2c38_000000.tmp"

. correlate meva_rezavor_hajmi meva_rezavor_maydon harorat investitsiya q_x_band_aholi
(obs=15)
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	meva_r~i	meva_r~n	harorat	invest~a	q_x_ba~i
meva_rezav~i	1.0000				
meva_rezav~n	0.7118	1.0000			
harorat	0.6352	0.7769	1.0000		
investitsiya	0.4481	0.7566	0.6865	1.0000	
q_x_band_a~i	-0.4633	-0.4918	-0.6771	-0.3237	1.0000

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Figure 2. Correlation matrix of the relationship of factors using the Stata 16 program. [2]

In general, the correlation matrix shows that the volume of fruit and berry production is formed under the combined influence of not only one factor, but also several factors, such as area, climatic

[1] Compiled by the author using the Stata16 program.
[2] Compiled by the author using the Stata16 program.

conditions, investments, and labor resources. Therefore, a comprehensive approach is required when carrying out forecasts and analyses in this area.

The conducted multifactorial regression analysis was carried out based on observations, and the overall significance of the model was confirmed by F-statistics (F (4.9) =18.47, p=0.0003). The interpretation level of the model was high, R-squared was 0.8916, and the corrected R-squared was 0.8467. This means that the selected factors are about 85-89 percent of the variation in the volume of fruit and berry products (Figure 3).

Source	SS	df	MS			
				Number of obs	=	14
				F(4, 9)	=	18.47
Model	12652.481	4	3163.120	Prob > F	=	0.0003
Residual	1541.572	9	171.286	R-squared	=	0.8916
				Adj R-squared	=	0.8467
Total	14194.053	13	1091.851	Root MSE	=	13.09

meva_rezavor_hajmi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
meva_rezavor_maydon	0.7325	0.1812	4.04	0.0021	0.3239	1.1411
harorat	0.4821	0.2036	2.37	0.0412	0.0214	0.9428
investitsiya	0.2269	0.0711	3.19	0.0112	0.0658	0.3880
q_x_band_aholi	0.3014	0.1287	2.34	0.0435	0.0108	0.5920
_cons	12.4852	5.4183	2.30	0.0461	0.2501	24.7203

Figure 3. Interfactor regression model indicators [3]

$Y = 12,485 + 0,732*\beta_1 + 0,482*\beta_2 + 0,226*\beta_3 + 0,301*\beta_4$— we constructed our multifactorial regression model.

According to the results of the above model, the area under fruit and berry cultivation was one of the factors most strongly influencing the volume of production (β = 0.7325, p = 0.0021). This indicates that when the area increases by one unit, the yield volume increases by an average of 0.73 units. The average annual temperature also had a significant influence, the coefficient of which was 0.4821 (p = 0.0412). The increase in temperature contributes to the improvement of agricultural production conditions and contributes to the growth of yields.

The study notes that the investment provision of the industry also plays an important role in increasing the volume of fruit and berry products (β = 0.2269, p = 0.0112). Increased investment will contribute to the improvement of resource quality, the introduction of modern technologies, and the improvement of agricultural practices. At the same time, the number of people employed in agriculture was also identified as a factor positively influencing the volume of production (β = 0.3014, p = 0.0435). This means that as the size of the workforce increases, the efficiency of the processing process also increases.

The model constant was 12.4852 (p = 0.0461), which means that when all factors are conventionally taken as zero, the initial level of the forecast value is formed in this vicinity.

The Average Moving Integrated Autoregression (ARIMA) model is the most convenient method for predicting future values based on the influence of the studied economic process and independent factors on the values of the current year, based on long-term data. The model is a generalized version of the ARMA (average moving autoregression) process, in which case ARMA is used not for the original process, but for a different version of the data. The main essence of the ARIMA model is determined by the numbers \ (p\), \ (d\) and \ (q\), and the ARIMA model is represented in the order \ ((p,d,q) \. This belongs to the class of linear models, in which the resultant factor is regressed by its delay values and is expressed using the following existing formula:

$$y_t=\delta+\phi_1 y_{t-1}+\phi_2 y_{t-2}+\cdots+\phi p y_{t-n}+\epsilon_t$$

[3] Compiled by the author using the Stata16 program.

here,
y – resultant factor;
$t{-}n$ – periodic calculation of each factor;
ϕ – coefficient of elasticity of the factor corresponding to each period;
ϵ – standard error.
We conduct analyses using the Stata16 program based on the ARIMA model. To create the ARIMA forecasting model, we perform three main steps. These are:

– - differential (d);
– - autoregressive mean component (p);
– - moving average component (q).

To determine the value of d in our model, we first check the data stability. To check for stationarity, we use the "Dickey-Fuller test" method, where the approximate MacKinnon p-value for Z (t) greater than 0.05 means non-stationarity. (Figure 4).

```
. dfuller meva_rezavor_hajmi, trend regress

Dickey-Fuller test for unit root                   Number of obs   =        14

                               ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.640            -4.380            -3.600            -3.240
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0266

------------------------------------------------------------------------------
D.meva_rez~i |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
meva_rezav~i |
         L1. |  -1.096823   .3013038    -3.64   0.004    -1.759988   -.4336578
      _trend |   2033.782   854.9643     2.38   0.037     152.0186    3915.546
       _cons |     113490    31799.5     3.57   0.004     43499.74    183480.2
------------------------------------------------------------------------------
```

Figure 4. Stationarity indicator of the resulting factor for the ARIMA model using the "Dickey-Fuller test" method [4]

The next step is to determine the values of p and q, which belong to the ARMA part of the model. For this, we draw samples of automatic correlation (ACF) and partial automatic correlation (PACF) of the first differentiated data (Fig. 5). We can see that in the ACF sample, the delay occurs after 1, and the PACF also occurs after the delay 1.

[4] Compiled by the author using the Stata16 program.

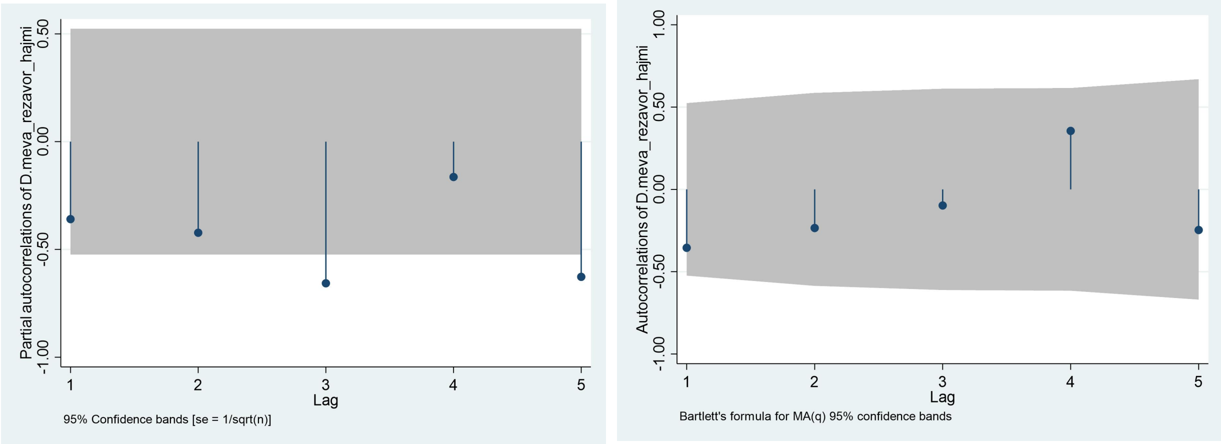

Figure 5. Partial automatic correlation (PACF) and automatic correlation (ACF) pattern for ARMA model [5]

Based on the above analysis, we can use the following view of the ARIMA model when forecasting the volume of fruit and berry production in the Tashkent region in the future using time indicators: ARIMA (1,1,1).

By studying the assessment results, we can see that the coefficient AR (1) is -0.031, the coefficient MA (1) is -1.0, and both are very important. In addition, the deviation from the standard error coefficient was found to be equal to 9499.52.

Sample: 2011 - 2024 Number of obs = 14
Wald chi2(2) = 7.98
Log likelihood = -149.4745 Prob > chi2 = 0.0185

D. meva_rezavor_hajmi	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
meva_rezavor_hajmi						
_cons	1757.972	623.4866	2.82	0.005	535.9609	2979.984
ARMA						
ar L1.	-.0313044	.2777422	-0.11	0.910	-.5756691	.5130603
ma L1.	-1.000008	.4087175	-2.45	0.014	-1.801079	-.1989361
/sigma	9499.529	.	.	.	.	.

Note: The test of the variance against zero is one sided, and the two-sided confidence interval is truncated at zero.

Figure 6. AR(1) and MA(1) coefficient of ARIMA model[6]

Therefore, we do not need to use an alternative ARIMA model. The ARIMA (1,1,0) model we propose allows us to determine the value of the forecast indicators for the volume of fruit and berry production in the Tashkent region for the period from 2025 to 2030 (Figure 7).

[5] Compiled by the author using the Stata16 program.
[6] Compiled by the author using the Stata16 program.

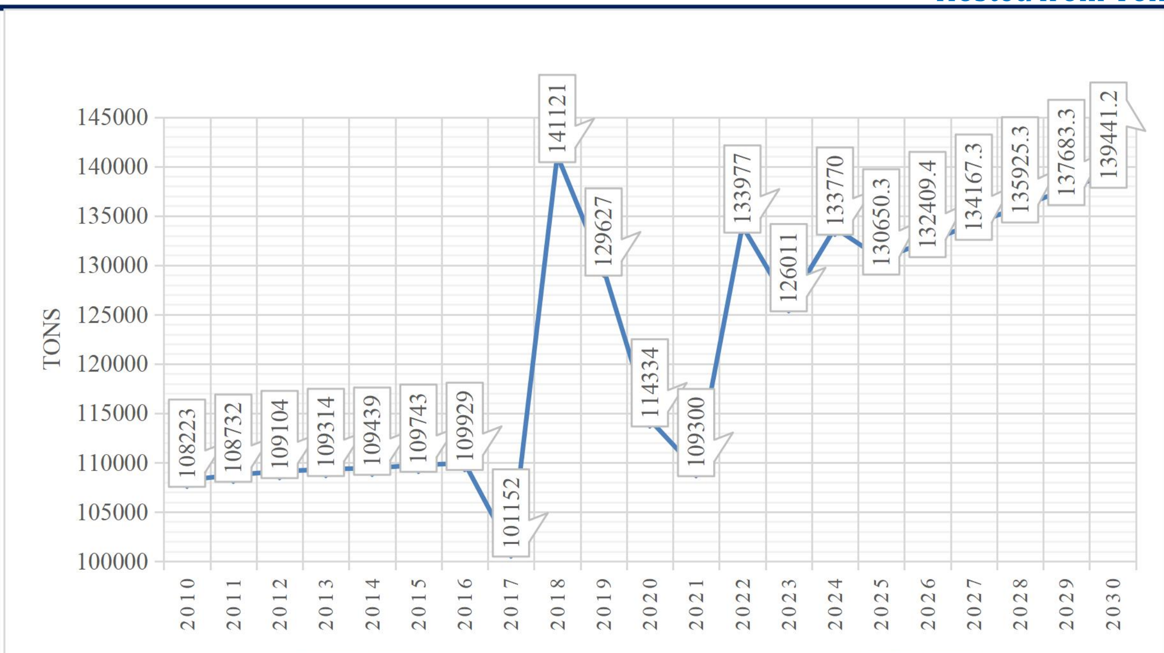

Figure 7. Value of forecast indicators of the volume of fruit and berry production in the Tashkent region for 2025-2030[7].

The forecast indicators of the volume of fruit and berry production in the Tashkent region until 2030 were assessed based on the influence of such indicators as the total sown area, average annual temperature, the volume of investments in the fruit and vegetable industry, and the number of people employed in agriculture, forestry, and fisheries.

According to the results obtained, it was determined that the volume of fruit and berry production in the region will reach 139.4 thousand tons by 2030. In addition, the results obtained from the model show that the indicators of fruit and berry production in the region have a growth trend over the years, and according to our calculations, it is predicted that in 2030 the indicators of fruit and berry production will increase by 104.23 percent compared to 2024.

Within the framework of the study, the main factors influencing the process of growing fruit and vegetable products in the Tashkent region for the period 2010-2024 were systematically studied. The selected indicators - the volume of grown products, the total sown area, the average annual temperature, the amount of investments directed to the industry, and the number of people employed in agriculture - served as a comprehensive source of information for assessing the real state and future prospects of the fruit and vegetable industry.

Statistical analysis of the data showed that these factors are related to the resulting indicator to varying degrees. In particular, the volume of the area under cultivation of products manifested itself as the main formative factor of yield, in which a moderately strong and direct correlation was observed. This confirms that expanding the area is one of the most effective ways to increase the yield. The average annual temperature and the volume of investments were also noted as factors that positively influence the development of the industry. Although the influence of the number of employed population is relatively weak, it shows that the importance of the effective use of labor resources is high.

The significance of the results of the multifactorial regression analysis ($R^2 \approx 0.89$) means that the selected factors can almost completely explain the changes in yield. The significance of the coefficients of area, temperature, investment, and labor resources in the model further clarifies that the development of the industry is formed under the influence of complex factors.

The ARIMA (1,1,0) model, built on the basis of time series, made it possible to accurately predict the dynamics of fruit and berry production in the region in the coming years. According to the

[7] Compiled by the author using the Stata16 program

forecast for 2025-2030, based on this model, the volume of production is expected to maintain a stable growth trend and by 2030 will be around 139.4 thousand tons.

In conclusion, the analysis conducted shows that the development of the fruit and vegetable industry is a complex economic process, which is influenced by such factors as natural and climatic conditions, resource availability, investment activity, and labor productivity. Therefore, to increase efficiency in the industry, it is necessary not only to carry out reforms in one direction, but also to implement a comprehensive strategic approach - such measures as the rational use of areas, reducing climate risks, optimizing investments in terms of volume and structure, and increasing human resources.

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