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MULTIFACTOR ECONOMETRIC MODELING AND FORECASTING OF COTTON FIBER PRODUCTION IN UZBEKISTAN

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Abstract: Cotton is considered as the most common natural fiber. The life of more than 200 million people from more than 70 countries of the world is associated with the collection of cotton; another 60 million people are employed in various enterprises processing the cotton fabric, as well as by-products (seed oil or protein used in the production of animal nutrition). Cotton is the most grown non-food crop - more than 20 million tons of annual cotton fiber production is obtained from plants occupying 30 million hectares of crops. This study deeply examines the most influential factors affecting cotton fiber production from the perspective of the agricultural sector. A multifactor economic model has been created using the data on cotton fiber production for 2007-2019. As the factors affecting the volume of cotton fiber production (Y) were selected in this research: the volume of raw cotton grown in the country(X_1), the area in which cotton is cultivated (X_2), and productivity of yield (X_3).

Keywords: cotton fiber, raw cotton, processing, econometric modeling, prediction, multiple regression, prognosis

1. Introduction

Cotton fiber is the most important strategic commodity in world trade. According to the International Cotton Advisory Committee (ICAC) World production volumes in the 2018/19 season almost reached pre-crisis levels - 26.2 million tons. The Republic of Uzbekistan today is the 6th largest producer of fiber with a production volume of about 1 million tons (Fig.1).

It should be noted that the leading position of China (1952 kg / ha), Brazil (1498 kg / ha) and Australia (2107 kg / ha) are based on high cotton yields, which are more than two to three times higher than the Republic of Uzbekistan (754 kg / ha) and the USA (897 kg / ha). Large reserves are hidden in increasing cotton productivity to increase cotton production in the republic (Azhimetova 2011).

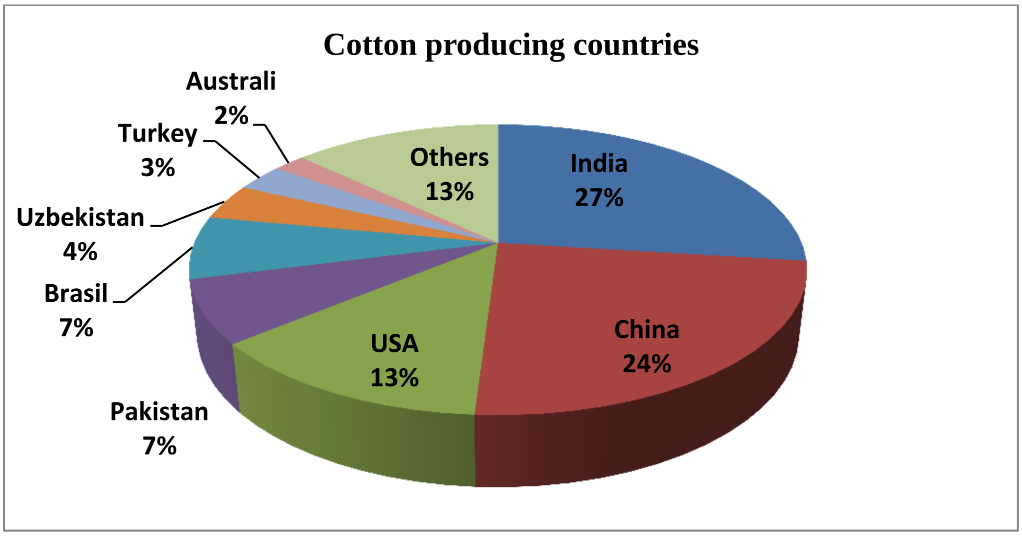

Fig. 1. Share of cotton producing countries

At the same time, a fundamentally important aspect of the development of the cotton complex in Uzbekistan is the increase in domestic consumption of produced fiber. Consistently increasing volumes of deep processing of cotton fiber directly at domestic enterprises due to the development of their own textile production. Uzbekistan has enormous potential for the development of the textile and clothing industry due to the availability of its own raw material base.

Since the 40s of the 20th century, world cotton consumption has been steadily increasing by 2% per year (Fig 2). Developing countries make the main contribution to this increase in demand for cotton, consuming a significant portion of world cotton stocks. Characteristically, between 1981 and 1998, developing countries accounted for 77% of world cotton consumption, and since 1999 their consumption has exceeded 80% (Azhimetova 2011). A significant proportion of the cotton produced is consumed by the economies of producer countries. China, the United States, India and Pakistan account for approximately 56% of global consumption. Continued growth in cotton consumption is projected at 2% per year (data from ICAC) (Fig.2).

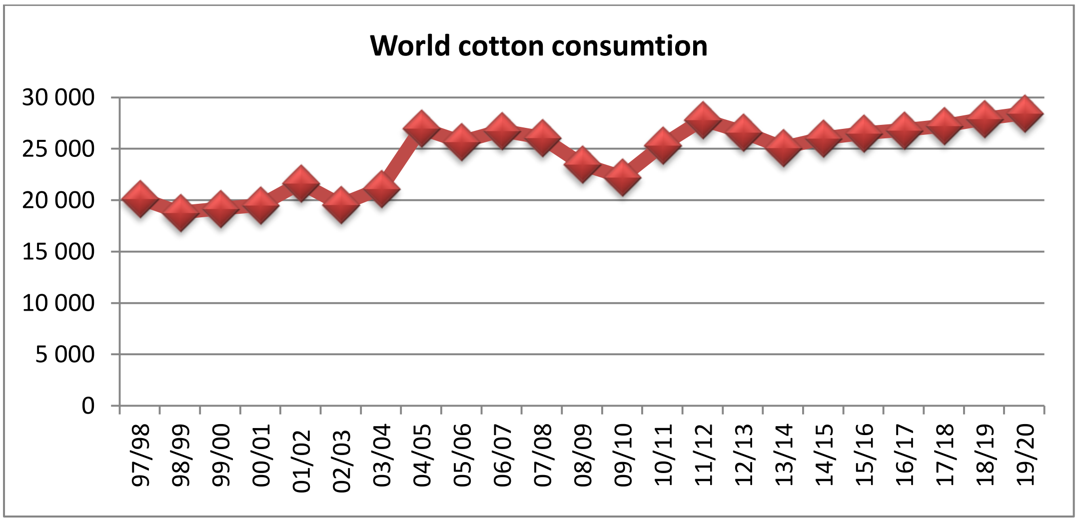

Fig. 2. Dynamics of world cotton consumption

Source: data from ICAC

2. Analysis and results

Cotton fiber production in Uzbekistan

One of the priorities of the policy of Uzbekistan, one of the world's largest producers of cotton, is the further innovative development of its textile industry. In world experience, the textile industry is considered one of the important components of the country's GDP. According to static data, today the share of the textile industry in GDP in Uzbekistan is 5.2%. While in developed countries, this figure is 10-21%.

The main concern in the Uzbekistan economy is cotton growing and the processing industry associated with it. Reforms in the cotton industry over the years of independence have become one of the most important elements of the country's development and transition to a market economy. The most important and relevant issue is the effective use of innovative methods of organizing production to increase the productivity of the cotton industry and ensure its competitiveness. A historically formed Uzbek school with many years of experience in growing the most stable and productive varieties of cotton is developing and improving day by day. Annually about 3.5 million tons of raw cotton is grown in the country, 1.1 million tons of cotton fiber are produced (Conception 2016). Uzbekistan is considered as the sixth largest producer of cotton in the world among 70 cotton growing countries (ICAC).

Every year in the country there is a decrease in the area and volume of cotton growing. This is due to the fact that in the future all the cotton produced in the republic is completely processed and finished textile products are now the leaders in the export structure.

Creating an appropriate econometric model and empirical analysis

As it is considered, in a market economy, forecasting is a key factor in the successful development of an enterprise and industry. Making an effective strategic decision requires a prediction of the development of the economic situation.

For this, we turn to static forecasting methods using time series, taking into account the past and the inherent patterns of development of the industry.

As we know, a time series is a set of variables tied to consecutive, usually equally spaced, instants of time. Time series are data on the release or consumption of various goods over a given time period.

The time series included information on the features and patterns of the forecasting process, and statistical analysis was used to assess the characteristics of the process in the future. The forecasting problem is reduced to obtaining estimates of the value of the series for a certain period of the future, that is, to obtaining the values of Y (t), t = N + 1, N + 2, ... using extrapolation methods, we proceeded from the assumption that the laws of past development on forecasting period (Carter R.Hill et.al, 2011).

The forecast is designed in two stages. At the first - formal - using statistical methods revealed the pattern of past development, extrapolated to a certain period of the future.

On the second, the forecast obtained is adjusted, taking into account the results of a meaningful analysis of the current state.

In order to modeling and predicting the process of producing cotton fiber from raw cotton, the modern econometric tool - STATA was used (Lee C. Adkins et.al, 2011).

The data on cotton fiber production for 2007-2019 are given (table 1). The factors affecting the volume of cotton fiber production (Y) are: The volume of raw cotton grown (X_1), the area in which cotton is cultivated (X_2), and yield productivity(X_3).

Table 1.

Fundamental data for model

Year	Cotton fiber, t	Cotton crop, t	Area	Productivity (centner/ha)
2007	1164509,5	3650500	1543944	23,64399227
2008	1152144	3600450	1507444	23,88446934
2009	1138599	3450300	1470944	23,45636544
2010	1130564,6	3500200	1434444	24,40109199
2011	1189250	3550000	1369500	25,9218693
2012	1169000	3500000	1339000	26,13890963
2013	1176400	3460000	1311000	26,39206712
2014	1156000	3400000	1300000	26,15384615
2015	1139000	3350000	1298000	25,80893683
2016	1020000	3000000	1267500	23,66863905
2017	1081200	3180000	1235000	25,74898785
2018	1037400	2963400	1100500	26,92776011
2019	1003000	2950000	1047000	28,17574021

Now we need to find the objective function in the form of the equation:

$$Y = f(X1, X2, X3 ....)$$

To build a multi-factor econometric model, also for the accuracy of the results we need to logarithm the data (table 2) :

Table 2.

Logarithmic Data for model

#	logY	logX1	logX2	logX3
1	13.96781	15.11037	14.24985	3.163109
2	13.95714	15.09657	14.22593	3.173229
3	13.94531	15.05397	14.20142	3.155142
4	13.93823	15.06833	14.17629	3.194628
5	13.98883	15.08246	14.12996	3.255087
6	13.97166	15.06827	14.10743	3.263425
7	13.97797	15.05678	14.0863	3.273063
8	13.96048	15.03929	14.07788	3.263996
9	13.94566	15.02447	14.07633	3.250721
10	13.83531	14.91412	14.05256	3.164151
11	13.89358	14.97239	14.02658	3.248395
12	13.85223	14.90185	13.91127	3.293158

13	13.81851	14.89732	13.86144	3.338461

The next step is to determine and analyze the regression coefficients. To do this, we execute the appropriate command in the STATA program:

Table 3.

Regression analysis results

```
. reg logY logX1 logX2 logX3
note: logX3 omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =        13
-------------+----------------------------------   F(  2,     10)  =     69.37
       Model |  .037128281         2  .018564141   Prob > F        =    0.0000
    Residual |  .002676002        10    .0002676   R-squared       =    0.9328
-------------+----------------------------------   Adj R-squared   =    0.9193
       Total |  .039804283        12  .003317024   Root MSE        =    .01636

------------------------------------------------------------------------------
        logY |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       logX1 |   1.015493   .1393497     7.29   0.000     .7050024    1.325983
       logX2 |  -.2152021   .0920361    -2.34   0.041    -.4202713   -.0101329
       logX3 |          0  (omitted)
       _cons |     1.7048   1.102831     1.55   0.153    -.7524601     4.16206
------------------------------------------------------------------------------
```

But since the value of ***t-student*** is negative here, this model turns out to be unreliable in this case.

We will try to find out what went wrong in our model. To check the relationship between the variables, the coefficients of partial and pair correlation is calculated (table 4):

Table 4.

Correlation analysis results

```
. pwcorr logY logX1 logX2 logX3

             |     logY    logX1    logX2    logX3
-------------+------------------------------------
        logY |   1.0000
       logX1 |   0.9466   1.0000
       logX2 |   0.7588   0.8928   1.0000
       logX3 |  -0.2636  -0.4585  -0.8096   1.0000
```

As can be seen between the variables *X2 and X1*, there is a strong autocorrelation: *k = 0.8928*. This may affect the regression analysis. The remaining variables are weakly interconnected. Therefore, we skip the variable *X1* in our model.

Table 5.

Regression analysis results #2

```
. reg logY logX2 logX3

      Source |       SS           df       MS      Number of obs   =        13
-------------+----------------------------------   F(  2,     10)  =     69.37
       Model |  .037128279         2  .01856414    Prob > F        =    0.0000
    Residual |  .002676004        10   .0002676    R-squared       =    0.9328
-------------+----------------------------------   Adj R-squared   =    0.9193
       Total |  .039804283        12 .003317024    Root MSE        =    .01636

------------------------------------------------------------------------------
        logY |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       logX2 |   .8002911   .0706234    11.33   0.000     .6429323    .9576499
       logX3 |   1.015496   .1393501     7.29   0.000     .7050042    1.325987
       _cons |  -.6334732   1.385455    -0.46   0.657    -3.720459    2.453512
------------------------------------------------------------------------------
```

After obtaining the results from regression analysis, we will try to build a multifactor econometric model having the following form

$$Y = 0.8X_2 + 1.016X_3 - 0.64$$

Analysis of the obtained multivariate model showed that:
- an increase in the area of cotton sowing per 1 ha will lead to an increase in the production of cotton fiber by an average of 0.8 tons;
- an increase in cotton productivity by 1 ton will lead to an increase in cotton fiber production by 1.016 tons.

The statistical significance of the obtained multivariate model was verified using the coefficient of determination.

The calculated value of the determination coefficient R. This shows that the volume of cotton fiber production by 93.28% depends on factors:
- on the area of sowing cotton;
- on the volume of raw cotton.

The rest is influenced by unaccounted factors.

To check the adequacy of the obtained model, the value F is used - *Fisher statistics. If* $F_{count} > F_{table}$, then the resulting model is adequate to the process under study. Since $F_{count} = 69.37$, *and* $F_{table} = 3.16$, we can say that our model is adequate.

Checking the reliability of the coefficients of the multifactor model showed that the use of t is Student's statistics. If $t_{count} > t_{table}$, then the obtained coefficients of the multifactor model are reliable. Since $t_{x2} = 11.33$, $t_{x3} = 7.29$, and $t_{table} = 2.43$, we can say with confidence that the factors are reliable.

3. Predicting the prognosis values based on econometric model

Based on the obtained multifactor model, was made forecasting the volume of cotton fiber production in Uzbekistan (table 6).

Table 6.

Forecasted values of the volume of cotton fiber production in Uzbekistan

Year	Volume of cotton fiber, t	Volume of cotton crop, t	Area of cultivation	Productivity
2007	1164509,5	3650500	1543944	23,64399227
2008	1152144	3600450	1507444	23,88446934
2009	1138599	3450300	1470944	23,45636544
2010	1130564,6	3500200	1434444	24,40109199
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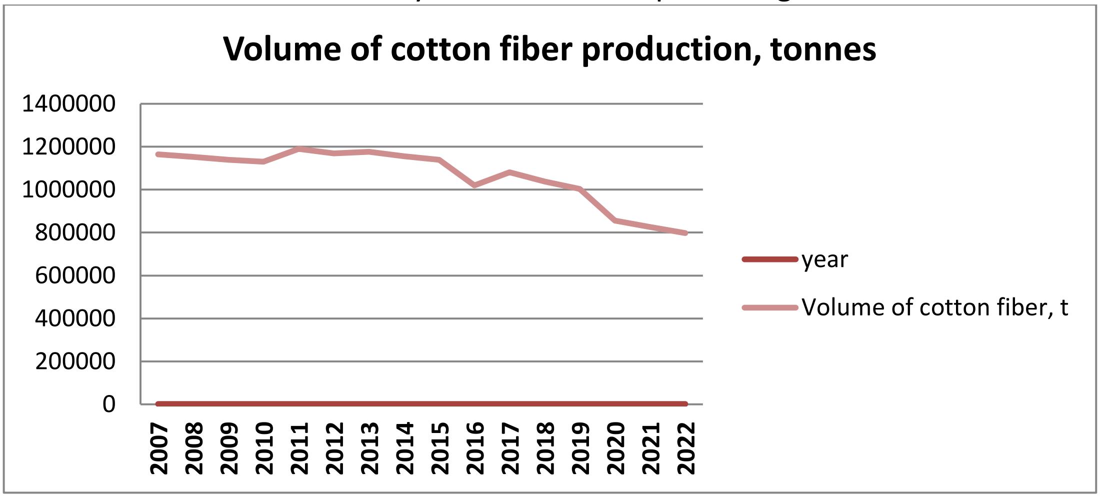
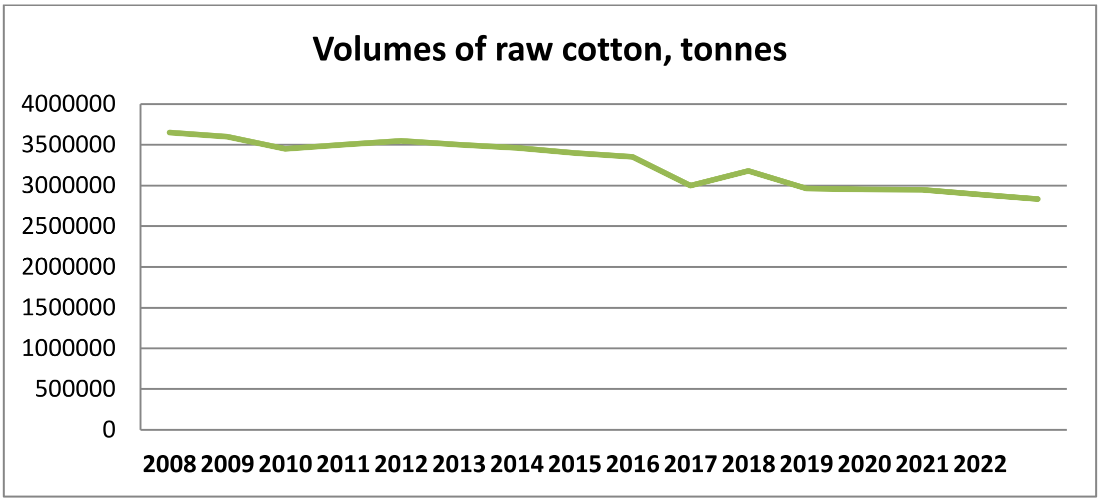
2017	1081200	3180000	1235000	25,74898785
2018	1037400	2963400	1100500	26,92776011
2019	1003000	2950000	1047000	28,17574021
2020*	**855582,715**	**2947679**	**1069445**	**27,29775612**
2021*	**826383,022**	**2890152**	**1032945**	**27,56596871**
2022*	**797183,328**	**2832624**	**996444,6**	**27,83679825**

As can be seen from prognosis in the given model, fiber production volume will be decreased considerably in next three years. Based on prediction from the table, in order to explain the results better it is worthy to create descriptive diagram.





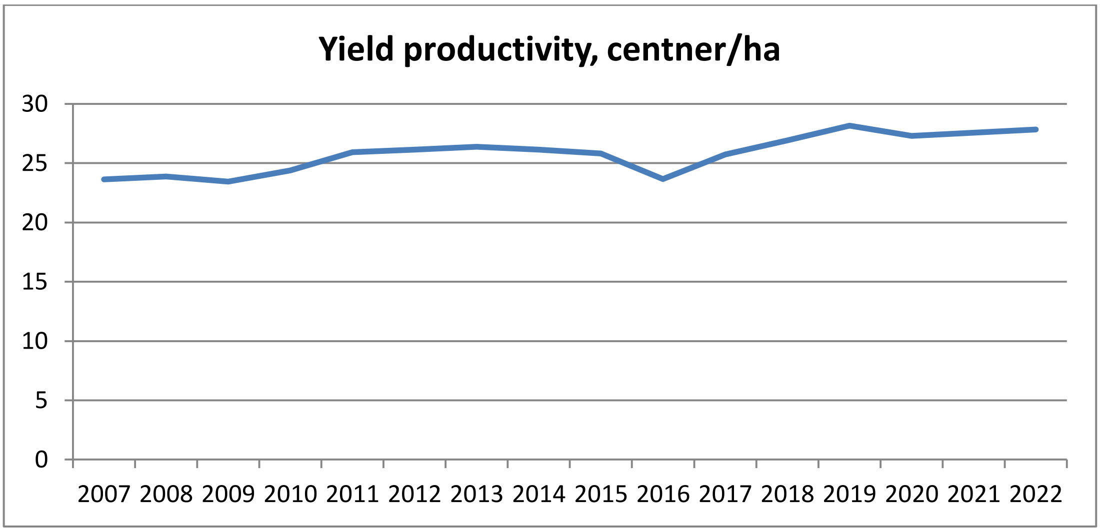


Fig 3. Prognosis values of cotton fiber production in Uzbekistan

As the data from the graphs show, the volume of cotton grown in the country will decrease significantly in near future, which in turn ultimately will lead to a decrease in cotton fiber production. As for cotton productivity, there is a growth trend on it. Over the next 3 years, cotton productivity continues to grow steadily. This is due to the improvement of soil composition, climatic conditions, improvement of agricultural activities, etc.

4. Conclusion

According to experts, in the near future in Uzbekistan an increase in the consumption of cotton fiber in the amount of more than 600-800 thousand tons is expected. To date, the country has developed a program for the development of textile and light industry of Uzbekistan for the period until 2024. The program provides for the implementation of dozens of investment projects. Data implementation projects will bring the level of processing of cotton fiber to 100% of total production and increase export potential of Uzbekistan's industry more than three times. Such a systematic reorientation of domestic exports from raw materials for finished products with high added value, is economic policy of the republic, aimed at the future.

According to forecasts by the International Cotton Advisory Council (ICAC), cotton production in 2025 will face problems related to climate change, high production costs, production technology and policy issues. The two main climate changes that will affect cotton production are rising temperatures and high levels of carbon dioxide. Rising temperatures will promote early sowing, growth insect and pest populations, insects will spread to new territories, the activity of microorganisms will increase, which will lead to an increase in the number of diseases and poor box ovary. Stress due to drought will increase. The concentration of salt in the soil will increase, and because of this, the absorption of micronutrients will deteriorate and the need for basic nutrients will increase. The increase in production costs will require large financial resources, turning cotton production into a more risky enterprise for farmers. By 2025, the requirements for agricultural technology of cotton will greatly change (Gulyayev, 2017).

Environmental standards under pressure from the political sector, civil society and consumers will become stricter. Cotton farmers will be faced with the need to make critical strategic decisions. Farmers will need to ensure rational, competitive approaches to balance between productivity and fiber quality.

Cotton production in 2025 will have to adapt and coexist in various forms of production systems, such as organic cotton, biotech cotton and fair trade in cotton in addition to traditional cotton. Breeding new varieties could provide a solution to many problems, including high costs. But breeders today must plan to meet the needs of spinners in 2025. The current direction in the development of new technologies requires the interconnectedness of various disciplines. Public sector institutions must adapt to a changing atmosphere and review their priorities and incentives.

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