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ECONOMETRIC MODELING OF SUBSIDIARY FARMING ACTIVITIES IN UZBEKISTAN

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Abstract: *This study presents an econometric analysis of subsidiary farming activities with a focus on forecasting agricultural production using trend models. Based on data from the Kashkadarya region for the years 2011–2024, the paper explores the dynamics of early, mid-season, and late crops, including vegetables, melons, onions, and garlic. Trend models were constructed using least squares estimation, while correlation and regression analyses were conducted to assess statistical significance. Findings show significant growth in production volumes and strong model adequacy, particularly for early vegetables and off-season crops. The study underscores the relevance of statistical forecasting tools in improving agricultural planning, resource utilization, and food security.*

Keywords: *subsidiary farm, econometric modeling, trend analysis, agricultural statistics, regression, correlation, forecasting*

INTRODUCTION

In the context of growing global concern over food security and sustainable agricultural development, the challenge of meeting rising demand for agricultural products with finite natural and economic resources has become a priority on national and international policy agendas. The need to increase productivity without compromising resource sustainability necessitates a shift toward data-driven planning, innovation-led intensification, and scientifically grounded forecasting tools.

In Uzbekistan, subsidiary farms characterized by small-scale, household-based agricultural activities constitute a critical pillar of the rural economy. These units not only supplement family income but also serve as a strategic component in ensuring national food security, employment, and the rational use of marginal and household land resources. With more than 4.9 million such household plots operating across the country, their cumulative contribution to vegetable, melon, and off-season crop production is substantial.

Despite this importance, the scientific modeling of production trends within these subsidiary farms remains underdeveloped. Traditional approaches often lack precision, particularly in capturing seasonal shifts, resource constraints, and long-term demand projections. Therefore, there is an urgent need to construct econometric models based on time series data that reflect both the historical dynamics and potential future trajectories of agricultural production within this sector.

METHOD

This study is grounded in empirical data on crop production gathered from household subsidiary farms operating within the Kashkadarya region of Uzbekistan over the period from 2011 to 2024. The analysis covers a range of cultivation types, including early and mid-season vegetables and melons, as well as off-season (late-harvest) crops such as onions and garlic. These crops were selected based on their economic relevance, caloric value, and consistent presence in household-level agricultural activity.

To analyze production dynamics and forecast future outputs, trend models were constructed utilizing the least squares estimation method. This statistical technique was employed to identify and quantify linear, polynomial and exponential relationships between time (as the independent variable) and production volume (as the dependent variable). The models were developed separately for each crop type to ensure specificity and precision in forecasting.

The validity and robustness of the regression models were rigorously assessed through a series of established econometric tests. In particular, the Student's t-test was applied to evaluate the statistical significance of individual regression coefficients, while the Fisher's F-test was used to examine the overall explanatory power of the model. The Durbin–Watson statistic was employed to detect potential autocorrelation in the residuals, ensuring model reliability. Additionally, the coefficient of determination (R^2) served as a key indicator of model fit, quantifying the proportion of variance in production volume explained by time-based trends.

Initial calculations and data organization were performed using Microsoft Excel, while time series modeling techniques were applied to extrapolate trends and produce forecasts extending through the year 2029. These forecasts were designed to support evidence-based planning and to anticipate shifts in agricultural output under current development trajectories.

RESULTS AND DISCUSSION

Ensuring sufficient and high-quality agricultural production to meet growing demand, while maximizing output across various product categories through the efficient use of limited resources, represents one of the most critical challenges of today. Assessing the development of key factors such as the expansion of agricultural production and service volumes through trend models allows for the comparison of interrelationships among multiple dataset elements. This includes constructing time series-based trend models, identifying quantitative relationships between economic phenomena and processes using correlation coefficients, developing bivariate regression models for economic growth, and evaluating as well as forecasting agricultural products cultivated by subsidiary farms through the application of trend modeling techniques.

In this study, we considered it appropriate to examine the dynamics of key factors such as the production volumes of early and mid-season crops (including vegetables and melons), as well as off-season crops (such as onions and garlic), cultivated by subsidiary farms in rural areas. The number of active household farms engaged in agricultural production was also analyzed. These variables were studied using time series data to construct trend models and to generate forecasts based on the identified patterns.

Therefore, in our research, we aimed to analyze the dynamics of agricultural production over time and, based on the increasing demand from the population, to forecast each type of agricultural product individually through the use of extrapolation techniques and trend modeling. To achieve this, the following steps were implemented:

- in the first stage, the variables included in the model were selected. For this purpose, paired and partial correlation coefficients were calculated using Microsoft Excel;
- in the second stage, the parameters of the regression equations were determined;
- in the third stage, the statistical significance of the econometric model was tested. The reliability of the model was evaluated using several criteria:

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a) The regression coefficients were assessed using Student's t-test;

b) The overall significance of the econometric model was tested using Fisher's F-test;

c) The presence of autocorrelation was evaluated using the Durbin–Watson statistic;

d) The overall explanatory power of the model was measured using the coefficient of determination (R^2).

- in the fourth stage, forecasts were generated based on the most optimal trend model identified.

The constructed econometric model can be regarded as the most appropriate model corresponding to the studied process, and it may subsequently be used as a basis for forecasting the key performance indicators of subsidiary farming activities for the coming years.

Table 1.

The volume of agricultural products cultivated by subsidiary farms in the Kashkadarya region by type of product during the period from 2011 to 2024.

Year	Early crops		Mid-season crops		Late (off-season) crops	
	Total vegetables (tons)	Total melons (tons)	Total vegetables (tons)	Total melons (tons)	Onions (tons)	Garlic (tons)
2011	173595	87117	86797	147587	112856	1706
2012	195909	90547	97955	166231	135162	2097
2013	214902	92783	107451	133457	146943	2898
2014	234361	99452	117181	115787	123401	4258
2015	249990	124789	124995	99457	130955	8693
2016	265179	136994	132589	82478	114339	5817
2017	281020	178871	140510	90459	121056	8658
2018	283551	202335	141775	100456	110875	8629
2019	267792	221456	133896	121547	120292	12391
2020	284797	235220	116358	126253	129719	14269
2021	299787	247600	122482	132898	136546	15020
2022	352690	291295	144096	156351	160642	17670
2023	371253	306626	151680	164580	169097	18600
2024	360718	233409	188929	106635	216359,26	26823

We developed trend models in both n-degree polynomial and exponential forms to analyze the changing patterns in the production volumes of agricultural products cultivated through early, mid-season, and off-season methods. The models were constructed using the least squares method to ensure statistical accuracy in representing the underlying processes.

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$$Y_x = a_0 + a_1 x + a_2 x^2 + \cdots + a_k x^k \quad \textbf{(1)}$$

The following steps must be taken to construct the trend model:

$$F = \sum (Y - Y_x)^2 \rightarrow min \text{ ёки } F = \sum \left(Y - a_0 - a_1 x - a_2 x^2 - \cdots - a_k x^k\right)^2 \rightarrow min$$

by taking the partial derivatives, we obtain the following system of equations:

$$\begin{cases} \sum Y = a_0 n + a_1 \sum x + a_2 \sum x^2 + \cdots + a_k \sum x^k \\ \sum Yx = a_0 \sum x + a_1 \sum x^2 + a_2 \sum x^3 + \cdots + a_k \sum x^{k+1} \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ \sum Yx^k = a_0 \sum x^k + a_1 \sum x^{k+1} + a_2 \sum x^{k+2} + \cdots + a_k \sum x^{2k} \end{cases} \quad (2)$$

$Y_x = a_0 + a_1 x$ to construct the trend model, the following steps must be carried out: For this purpose, the least squares method is also applied.

$$Y_x = a_0 + a_1 x \quad (3)$$

$F = \sum (Y - Y_x)^2 \rightarrow min$ or $F = \sum (Y - a_0 - a_1 x)^2 \rightarrow min$ by taking the partial derivatives, the following system of equations is obtained:

$$\begin{cases} \sum (Y) = n\, a_0 + a_1 \sum x \\ \sum (xY) = (a_0) \sum x + a_1 \sum x^2 \end{cases} \quad (4)$$

The obtained results are evaluated using the following assessment criteria:

To assess the significance of the regression equation, Fisher's F-test is applied. The value of Fisher's F-statistic is related to the coefficient of determination (R^2) as follows:

$$F_{real} = \frac{r_{xy}^2}{1 - r_{xy}^2} \cdot (n-2), \quad n \geq 3. \quad (5)$$

If the significance level is set at 5% and the degrees of freedom are $k_1 = 1$ and $k_2 = n - 2$, then the critical value of Fisher's F-distribution is determined from standard statistical tables. If the inequality $F_{\text{calculated}} > F_{critical}$ holds, the regression equation is considered statistically significant.

Errors in the regression equation, as well as the random errors affecting the estimation of parameters "a", "b" and the correlation coefficient r_{xy} must also be taken into account. Therefore, the standard errors m_a, m_b associated with the estimation of the parameters "a" and "b" are calculated.

The standard error of the regression coefficient is determined using the following formula:

$$m_b = \sqrt{\frac{\sum (y - y_x)^2 / (n-2)}{\sum (x - \bar{x})^2}}. \quad (6)$$

The standard error of the parameter in the regression equation is calculated using the following formula:

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$$m_a = \sqrt{\frac{\sum (y - y_x)^2}{n-2} \cdot \frac{\sum x^2}{n \cdot \sum (x - \bar{x})^2}}. \qquad (7)$$

The standard error of the linear correlation coefficient is calculated using the following formula:

$$m_r = \sqrt{\frac{1 - r^2}{n-2}} \qquad (8)$$

The statistical significance of the regression equation parameters can also be evaluated using the Student's *t*-test. When the degrees of freedom are $n-2$ and $\alpha = 0{,}05$ the critical value of the *t*-statistic is determined from the Student's *t*-distribution table. In this case, the following values are calculated:

$$t_a = \frac{a}{m_a}, \quad t_b = \frac{b}{m_b}, \quad t_r = \frac{r_{xy}}{m_r}. \qquad (9)$$

If the calculated values of the *m*-statistic exceed the corresponding critical values from the *t*-distribution table (i.e., яъни $t_a > t_{critical}$, $t_b > t_{critical}$, $t_{rxy} > t_{critical}$), then the parameters "a" and "b" are considered statistically significant.

Based on the data from Table 1, trend models were constructed, analyzed, and their corresponding graphical representations were illustrated as follows:

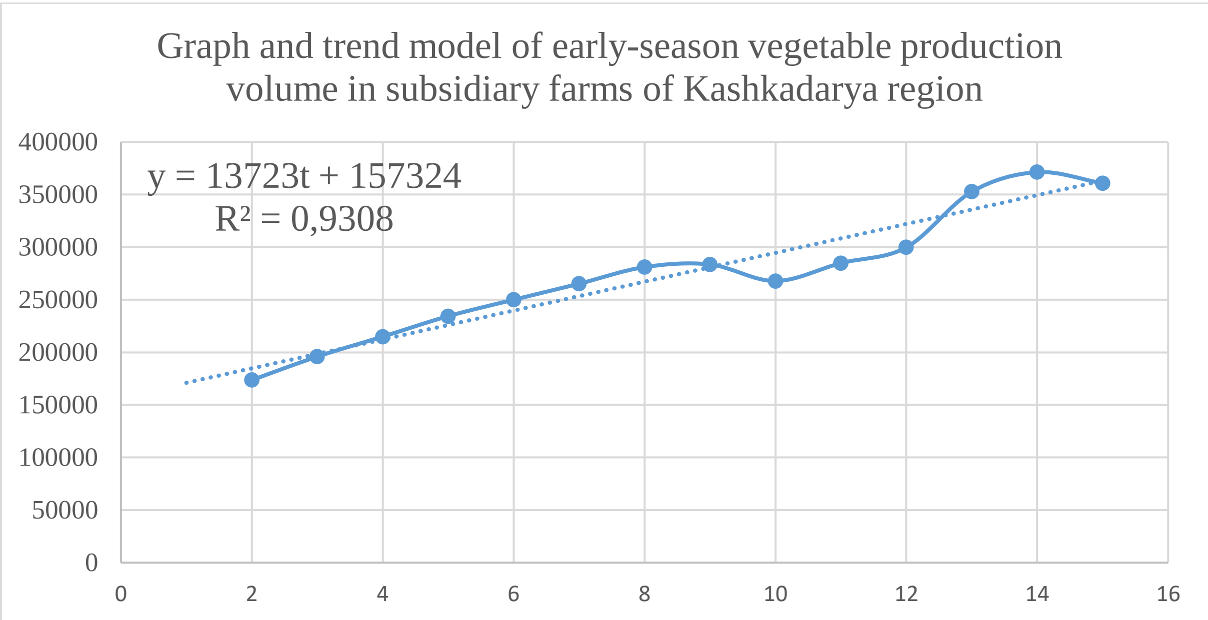

Figure 1. Graph and trend model of early-season vegetable production volume in subsidiary farms of Kashkadarya region (in tons)

In recent years, agricultural production in Uzbekistan has expanded steadily through the use of intensive methods and modern technologies. Among the most essential food products in the country, vegetables hold a prominent position. To analyze changes in their production volume over the years, a correlation–regression analysis was conducted, and several trend models were developed. These models

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were evaluated based on established assessment criteria to identify the most optimal trend model for forecasting future dynamics. This process is illustrated in figure 1.

As observed, the results of the constructed trend model analysis indicate that the coefficient of determination is $R^2 = 0.9308$, the calculated $F_{statistic}$=26,13 and the $T_{statistic}$=682,59. Given the critical values $T_{critical} = 2.1314$ and $F_{critical} = 2.2034$, the linear regression equation $y = 13723t + 157324$ was selected as the best fit. Although other trend models also produced statistically adequate regression equations, the linear regression model was considered the most optimal variant among them.

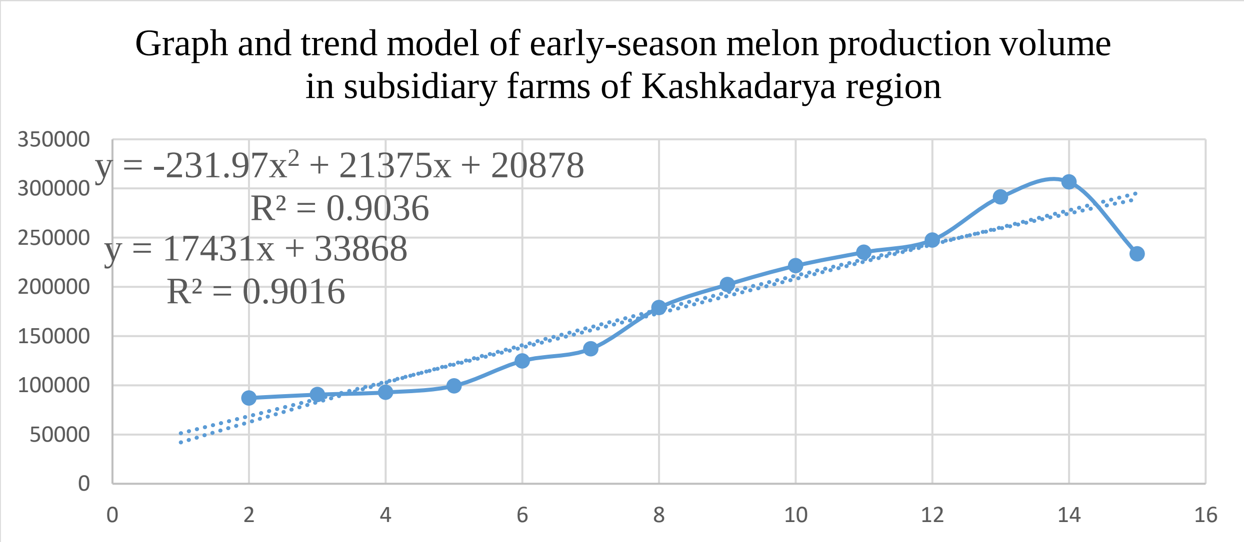

Figure 2. Graph and trend model of early-season melon production volume in subsidiary farms of Kashkadarya region (in tons)

At present, the demand for melon crops is steadily increasing in Uzbekistan. These crops, rich in calories, serve as the raw material for a wide range of consumer products, including dried melon slices that generate high commercial profits. In the Kashkadarya region, the volume of melon production has shown a consistent upward trend from 2011 to 2024. To forecast future production dynamics, we conducted a correlation–regression analysis and developed a trend model, as shown in Figure 2.

The analysis of the constructed trend model reveals the following statistical parameters: coefficient of determination $R^2 = 0.9036$, calculated $F_{statistic}$= 7.53 and calculated $T_{statistic}$= 56.68. Given the critical values $T_{critical} = 2.1314$ and $F_{critical} = 2.2034$, the selected regression equation is: $y = –231.97x^2 + 21375x + 20878$. Several trend models were developed and evaluated based on statistical criteria, and among them, this second-degree polynomial regression equation was identified as the most optimal and statistically adequate model for forecasting purposes.

If we analyze the forecasts obtained based on the trend models constructed for each type of agricultural product, these results can be observed in Table 2.

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Table 2

Forecasting based on trend models constructed using the dynamics of agricultural production volumes under early-season, mid-season, and off-season cultivation methods in subsidiary farms of the Kashkadarya region

Year	Early crops		Mid-season crops		Late (off-season) crops	
	Total vegetables (tons)	Total melons (tons)	Total vegetables (tons)		Total vegetables (tons)	Total melons (tons)
2025	363169	295333	180680	154018	214982,25	28571
2026	376892	312764	212120	169664	261861,52	34795
2027	390615	330195	253592	187533	321066,31	42376
2028	404338	347626	306428	207626	393927,84	51608
2029	418061	365057	371960	229943	481777,33	62852

According to Table 2, taking into account the increasing consumer demand for each agricultural product cultivated by subsidiary farms in Kashkadarya region, the presence of specialized agricultural production zones within the country, and the growing volume of exports to other countries, separate trend models were developed for each product type to forecast future production volumes.

The results of the forecast analysis show that the volume of early-season vegetable production is expected to increase by a factor of 1.006 in 2025 compared to 2024, and by 1.159 by 2029. Similarly, early-season melon production is projected to rise by a factor of 1.564 by 2029. In contrast, mid-season vegetable production is expected to decline slightly to 0.956 in 2025 compared to 2024, but then increase significantly to a factor of 1.968 by 2029.

CONCLUSION

The findings of this study reaffirm that enhancing the performance and efficiency of subsidiary farming is not merely a sectoral objective, but a national priority in ensuring rural sustainability and food security in Uzbekistan. As the agricultural sector grapples with climate variability, land fragmentation, and resource constraints, household-based agricultural production systems emerge as flexible yet underutilized platforms for strategic intensification and diversification.

Year-on-year difficulties in crop planning, yield predictability, and input availability continue to challenge the reliability of household farming. Nevertheless, the study reveals a notable upward trajectory in off-season agricultural activity, particularly in high-demand, nutrient-dense crops such as onions and garlic. Forecast estimates suggest that off-season onion production will increase by 0.993 times in 2025 compared to 2024 and by 2.226 times by 2029. Similarly, garlic output is expected to grow by 1.065 times in 2025 and more than double, reaching a 2.343-fold increase by 2029. These projections underscore not only the growing resilience of off-season cultivation practices but also the latent potential of household farms to meet both domestic and export-oriented demand.

From an academic and policy standpoint, this underscores the need to institutionalize the use of econometric forecasting tools in agricultural planning at the micro and meso levels. Forecasting models must be integrated into the operational mechanisms of district and regional agricultural departments, allowing for anticipatory responses to shifting demand patterns, seasonal disruptions, and market volatility.

Furthermore, subsidiary farms must be provided with improved access to agronomic training, certified seed varieties suitable for late planting cycles, and extension services tailored to micro-scale production realities. The alignment of policy incentives, digital record-keeping, and spatially disaggregated statistics will enhance the granularity and relevance of future forecasting models, contributing to a more informed and adaptive agricultural planning system.

References:

[1] Compiled by the author based on data from the Statistics Agency under the President of the Republic of Uzbekistan – www.stat.uz.

[2] Эконометрика: Учебник./Под ред. И.И.Елисеевой. –М.: Финансы и статистика, 2003- с. 344.

[3] Boychuk N.I., & Komeyeva, E. S. (2017). Economic modeling of small-scale agriculture. “Journal of rural economics”, 12(3), 45–56.

[4] Guseva O.V. (2020). “Statistical methods in agricultural management”. Moscow: Statistics press.

[5] Hasanov Sh.T., & Muratov Sh.A. (2021). Income analysis in household farming. “Uzbek journal of agrarian studies”, 7(2), 77–85.

[6] Warren S.W. (2018). Forecasting in rural development. “Journal of agricultural economics”, 64(4), 489–502.

[7] Mamatqulov B.X., & Utanov B.Q. (2019). Statistical reforms in agricultural productivity. “Central Asian statistics review”, 5(1), 15–29.

[8] Murodov Ch., Hasanov Sh., Murodova M. Agrocluster: theoretical foundations of organization// Economics and Finance, 2014. No. 2. P.19-25.

[9] Xurramov, A., Xushmuradov, O., Turobov, S., Faxriddinov, B., & Namozov, B. (2023). Issues of improving cotton reform. In E3S Web of Conferences (Vol. 452, p. 01041). EDP Sciences.

[10] Хушмурадов, О. (2023). TIJORAT BANKLARI MOLIYAVIY BARQARORLIGINI TA’MINLASH ISTIQBOLLARI. Ижтимоий-гуманитар фанларнинг долзарб муаммолари/Актуальные проблемы социально-гуманитарных наук/Actual Problems of Humanities and Social Sciences., 3(10).

[11] Хушмурадов, О. (2023). ҒАЛЛАЧИЛИКДА БОЗОР МЕХАНИЗМЛАРИНИ ЖОРИЙ ҚИЛИШ ЭРКИН РАҚОБАТ ГАРОВИ. Gospodarka i Innowacje., 411-419.

[12] Хуррамов, А. Ф. Туробов Шерзод Алишерович, & Мингбоев Шухрат Мингбой Ўғли (2018). Уй хўжалигида инновацион фаолиятни ривожлантиришнинг иқтисодий механизми. Экономика и финансы (Узбекистан),(8), 16-20.

[13] Хуррамов, А. Ф., Маматов, А. А., Мингбоев, Ш. М. Ў., & Туробов, Ш. А. (2018). Иқтисодий ресурсларнинг доиравий айланиш моделида уй хўжалигининг тутган ўрни. Экономика и финансы (Узбекистан), (9), 2-6.

[14] Хушмурадов, О. (2023). TIJORAT BANKLARI MOLIYAVIY BARQARORLIGINI TA’MINLASH ISTIQBOLLARI. Ижтимоий-гуманитар фанларнинг долзарб

муаммолари/Актуальные проблемы социально-гуманитарных наук/Actual Problems of Humanities and Social Sciences., 3(10).

[15] Хужакулов, Х. Д., & Хушмурадов, О. Н. (2023). ЎЗБЕКИСТОНДА ДЕМОГРАФИК ЖАРАЁНЛАРНИНГ ЎЗИГА ХОС ХУСУСИЯТЛАРИНИНГ СТАТИСТИК ТАҲЛИЛИ. Gospodarka i Innowacje., 9-18.

[16] Хушмурадов, О. (2023). ҒАЛЛАЧИЛИКДА БОЗОР МЕХАНИЗМЛАРИНИ ЖОРИЙ ҚИЛИШ ЭРКИН РАҚОБАТ ГАРОВИ. Gospodarka i Innowacje., 411-419.

[17] Alisherovich, T. S., & Ugli, N. B. B. (2023). Internal Control in Banks. EUROPEAN JOURNAL OF BUSINESS STARTUPS AND OPEN SOCIETY, 3(3), 34-39.

[18] Alisherovich, T. S. (2023). IMPROVING ACCOUNTING AND ITS MAINTENANCE IN BANKS. Gospodarka i Innowacje., 31, 15-20.

[19] Oman, X., & Alisherovich, T. S. (2022). THE ROLE AND IMPORTANCE OF CLUSTERS IN THE AGRICULTURAL SECTOR. Gospodarka i Innowacje., 29, 202-206.

[20] Туробов, Ш. А. (2022). АЁЛЛАР МЕҲНАТИДАН САМАРАЛИ ФОЙДАЛАНИШ ИСТИҚБОЛЛАРИ. IJTIMOIY FANLARDA INNOVASIYA ONLAYN ILMIY JURNALI, 127-134.

[21] Alisherovich, T. S. (2022). ECONOMIC CONTENT OF HOUSEHOLDS. Gospodarka i Innowacje., 150-155.

[22] Alisherovich, T. S., & Isoqovna, A. G. (2022). Organizing Fundamentals of Digital Audit in the International Practice. Miasto Przyszłości, 24, 424-426.

[23] Туробов, Ш. А. (2021). ҚИШЛОҚ УЙ ХЎЖАЛИКЛАРИДА АЁЛЛАР МЕҲНАТИДАН ФОЙДАЛАНИШ ИСТИҚБОЛЛАРИ. Журнал Инновации в Экономике, 4(5).

[24] Turobov, S. A., & Faxriddinov, B. F. (2021). DEVELOPMENT OF HOME-ENTREPRENEURSHIP-GUARANTEE OF AGRICULTURE STRATEGY. International journal of trends in marketing management, 9(1).

[25] Туробов, Ш. А., & Фахриддинов, Б. Ф. Ў. (2021). УЙ ХЎЖАЛИКЛАРИ ТАДБИРКОРЛИГИНИ РИВОЖЛАНТИРИШ–ҚИШЛОҚ ХЎЖАЛИГИ ТАРАҚҚИЁТИ ГАРОВИ СИФАТИДА. Экономика и финансы (Узбекистан), (4 (140)), 15-20.

[26] Turobov, S. A., & Azamatova, G. I. (2020). REGIONAL CHARACTERISTICS OF HOUSEHOLD ENTREPRENEURSHIP ACTIVITIES IN KASHKADARYA REGION. Economics and Finance (Uzbekistan),(2 (134)).

[27] Turobov, S., & Azamatova, G. (2020). The Role Of Households In The Development Of The Digital Economy. International Finance and Accounting, 2020(3), 35.

[28] Alisherovich, T. S., & Ibodullayevich, I. Z. (2024). THEORETICAL FOUNDATIONS OF REGULATION OF COMMERCIAL BANKS. Gospodarka i Innowacje., 46, 344-349.

[29] Alisherovich, T. S. (2023). Prospects for Increasing the Export Potential of Households..