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ARIMA-BASED ANALYSIS OF SMALL BUSINESS ACTIVITY IN THE AGRICULTURAL SECTOR OF SURKHANDARYA REGION

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Abstract: Small business entities play an important role in ensuring sustainable agricultural development and increasing regional economic activity in Uzbekistan. In recent years, particular attention has been paid to supporting entrepreneurship in the agricultural sector, improving employment opportunities, and enhancing food security. This study aims to analyze and forecast the role of small business activity in the agricultural sector of Surkhandarya region using ARIMA time series models.

The research is based on regional statistical data covering the period from 2010 to 2024. The study applies econometric and time series analysis methods, including stationarity testing and ARIMA forecasting techniques, to evaluate the dynamics of small business activity in agriculture. The findings indicate that small business entities have become one of the key drivers of agricultural production and regional economic growth in Surkhandarya region. The forecasting results also demonstrate a stable upward trend in the contribution of small businesses to agricultural development in the coming years. The practical significance of the study lies in providing analytical recommendations for improving regional agricultural policy, supporting entrepreneurship, and strengthening the role of small businesses in ensuring sustainable economic development.

Key words: small business; Agriculture; Regional economy; ARIMA model; Time series analysis; Forecasting; Entrepreneurship; Surkhandarya region; Agricultural development; Uzbekistan.

Аннотация: Субъекты малого бизнеса играют важную роль в обеспечении устойчивого развития сельского хозяйства и повышении региональной экономической активности в Узбекистане. В последние годы особое внимание уделяется поддержке предпринимательства в аграрном секторе, улучшению возможностей занятости и укреплению продовольственной безопасности. Цель данного исследования заключается в анализе и прогнозировании роли деятельности малого бизнеса в сельскохозяйственном секторе Сурхандарьинской области с использованием моделей временных рядов ARIMA.

Исследование основано на региональных статистических данных за период 2010–2024 годов. В работе применяются эконометрические методы и методы анализа временных рядов, включая тестирование стационарности и методы прогнозирования ARIMA, для оценки динамики деятельности малого бизнеса в сельском хозяйстве. Полученные результаты показывают, что субъекты малого бизнеса стали одним из ключевых факторов сельскохозяйственного производства и регионального экономического роста в Сурхандарьинской области. Результаты прогнозирования также демонстрируют устойчивую тенденцию роста вклада малого бизнеса в развитие сельского хозяйства в ближайшие годы. Практическая значимость исследования заключается в разработке аналитических рекомендаций по совершенствованию региональной аграрной политики, поддержке предпринимательства и усилению роли малого бизнеса в обеспечении устойчивого экономического развития.

Ключевые слова: малый бизнес; сельское хозяйство; региональная экономика; модель ARIMA; анализ временных рядов; прогнозирование; предпринимательство; Сурхандарьинская область; развитие сельского хозяйства; Узбекистан.

INTRODUCTION

Agriculture remains one of the strategically important sectors of the economy of Uzbekistan, particularly in regions with high agricultural potential such as Surkhandarya region. In recent years, comprehensive reforms aimed at supporting small business entities and private entrepreneurship have significantly increased the role of small businesses in agricultural production, employment generation, and regional economic development.

Small business entities operating in agriculture contribute not only to increasing agricultural output but also to improving food security, creating new jobs, and enhancing the socio-economic stability of rural areas. In this regard, the statistical and econometric analysis of small business activity in the agricultural sector has become one of the important directions of modern economic research.

At the same time, the effective forecasting of small business development trends is essential for improving regional economic policy and ensuring sustainable agricultural growth. Time series forecasting models, particularly the AutoRegressive Integrated Moving Average (ARIMA) model, are widely used in economic research to analyze dynamic processes and predict future development tendencies.

This study focuses on analyzing the role of small business activity in the agricultural sector of Surkhandarya region and forecasting its future development using ARIMA models. The research evaluates the dynamics of small business indicators in agriculture and identifies their contribution to regional economic development. The results of the study may serve as an analytical basis for improving state support mechanisms and enhancing entrepreneurial activity in the agricultural sector.

REVIEW OF LITERATURE ON THE SUBJECT

Theoretical and methodological aspects of small business development and its role in regional economic growth have been widely studied by foreign and domestic researchers. In particular, the contribution of entrepreneurship to economic development, employment growth, and agricultural modernization has attracted increasing academic attention in recent years.

Joseph Schumpeter [1] emphasized the important role of entrepreneurship as a driving force of innovation and economic growth. According to his theory, entrepreneurial activity stimulates economic transformation and increases production efficiency.

Peter Drucker [2] highlighted that small business and entrepreneurship play a key role in economic sustainability and competitiveness, especially in developing economies.

Research conducted by Michael Todaro and Stephen Smith [3] examined the importance of small business activity in reducing unemployment and improving rural livelihoods in developing countries.

In the field of agricultural economics, David Colman and Trevor Young [4] analyzed the economic significance of agricultural entrepreneurship and emphasized the importance of supporting small business entities in rural areas.

Econometric forecasting methods based on time series analysis have also been widely discussed in the scientific literature. George Box and Gwilym Jenkins [5] developed the ARIMA modeling methodology, which has become one of the most widely used approaches for economic forecasting and trend analysis.

Among Uzbek researchers, issues related to small business development, regional economy, and entrepreneurship support mechanisms have been studied by economists such as Zainalov[6] , Rasulov [7], and Aliyeva [8]. Their studies mainly focus on improving the efficiency of entrepreneurship activity, strengthening institutional support mechanisms, and increasing the contribution of small business entities to regional economic development.

RESEARCH METHODOLOGY

This study applies statistical and econometric methods to evaluate the impact of small business development on regional economic growth in the case of Surkhandarya region. Descriptive statistics, correlation, and regression analysis were used to assess the relationship between small business activity and regional economic indicators. In addition, factor analysis was employed to construct an integrated index of small business impact, while ARIMA models were applied for time series forecasting.

Analysis and Results

The dataset used in this study is organized as an annual time series covering the period from 2010 to 2024, with a time interval of one year between observations (Delta = 1 unit). This structure allows for the analysis of long-term trends and dynamic changes in small business activity within the agricultural sector of Surkhandarya region. The annual frequency of the data provides a suitable basis for applying ARIMA time series models to evaluate historical developments and generate reliable forecasts for future periods (Table 1).

Table 1. Descriptive Statistics of Agricultural Production Indicators (2010–2024)[1]

Time variable: year, 2010 to 2024

Delta: 1 unit

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
year	15	2017	4.472	2010	2024
Agriculture	15	14684.76	10371.572	2319.9	34533.6

The descriptive statistics indicate that the dataset consists of 15 annual observations covering the period from 2010 to 2024. The mean value of the time variable is 2017, with a standard deviation of 4.472, reflecting a balanced distribution of observations across the analyzed period.

The average value of the agricultural indicator amounted to 14,684.76, while the standard deviation reached 10,371.572, indicating a relatively high level of variability in agricultural activity during the study period. The minimum value was recorded at 2,319.9, whereas the maximum value reached 34,533.6. Such significant differences between the minimum and maximum values demonstrate that the agricultural sector experienced substantial growth and dynamic structural changes over time.

Overall, the descriptive statistics suggest that agricultural activity in Surkhandarya region has shown an upward trend during the analyzed years, creating a sufficient statistical basis for conducting time series forecasting using the ARIMA model (Figure 1).

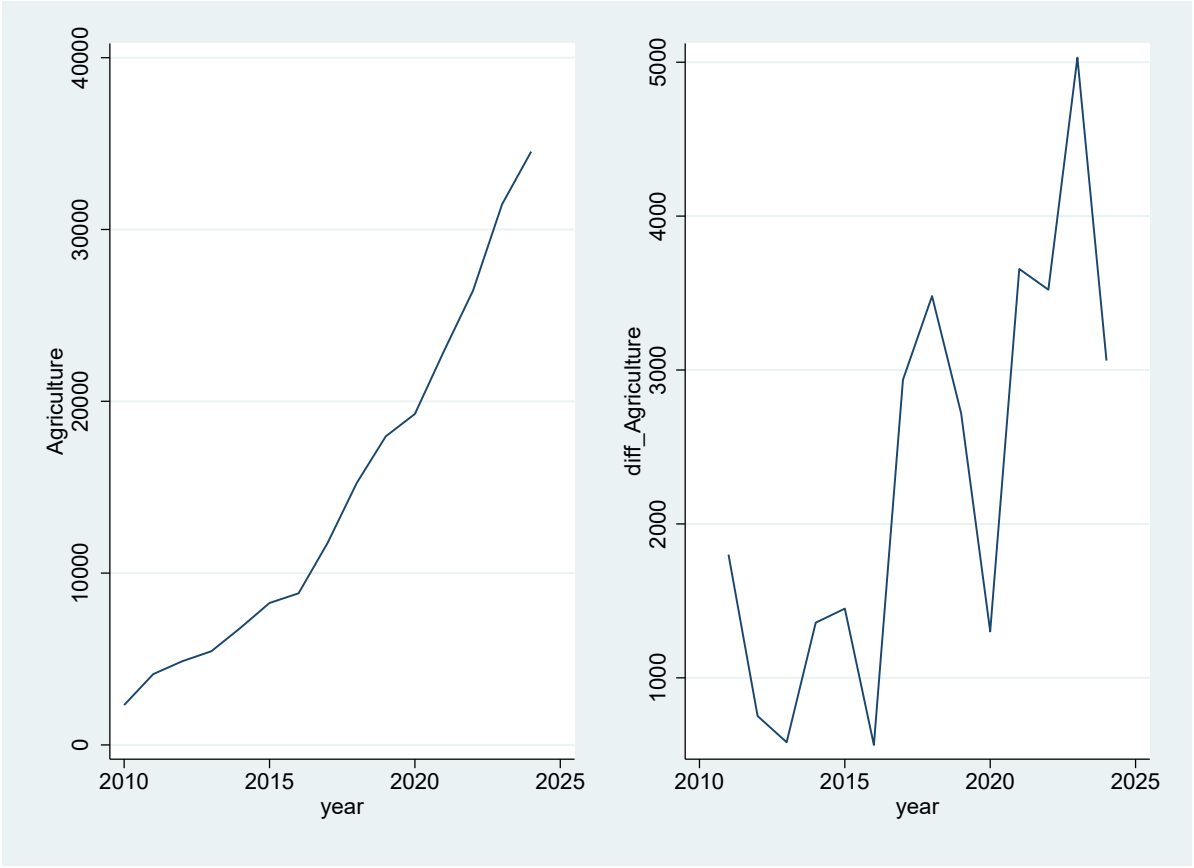

Figure 1. Dynamics of Agricultural Production and First Difference Series in 2010-2024[2]

The left-side graph illustrates a continuous upward trend in agricultural activity in Surkhandarya region during 2010–2024, indicating stable growth in the sector over time. Agricultural production increased significantly, especially after 2017, and reached its highest level by 2024.

1 Source: Author's calculations based on the research data.
2 Source: Author's calculations based on the research data.

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The right-side graph presents the first differenced series of the agricultural indicator. Compared to the original series, the differenced data fluctuate around a more stable level, suggesting that the non-stationary trend component has been reduced. This indicates that the differenced series is more suitable for ARIMA time series modeling and forecasting analysis (Table 2).

Table 2. Dickey–Fuller (ADF) Unit Root Test Results for the Agriculture Variable[3]

Variables	Obs	Lags	Test Statistic Z(t)	1% Critical Value	5% Critical Value	10% Critical Value	p-value	Conclusion
Agriculture	14	0	3.557	-3.750	-3.000	-2.630	1.0000	Non-stationary

According to the Dickey–Fuller unit root test results, the test statistic value for the agricultural indicator is 3.557, which is higher than all critical values at the 1%, 5%, and 10% significance levels. In addition, the probability value (p-value = 1.0000) is greater than 0.05. Therefore, the null hypothesis of a unit root cannot be rejected, indicating that the original agricultural time series is non-stationary. This result suggests the need to difference the series before applying the ARIMA forecasting model (Table 3).

Table 3. Augmented Dickey–Fuller (ADF) Test Results for the First Difference of the Agriculture Variable[4]

Augmented Dickey–Fuller test for unit root	Number of obs= 13			
Variable: Agriculture	Number of lags =1			
H0: Random walk without drift, d=0				
	Test statistic	1%	5%	10%
Z(t)	2.442	-3.750	-3.000	-2.630

According to the Augmented Dickey-Fuller (ADF) unit root test results, the test statistic for the Agriculture variable is 2.442, which is higher than the critical values at the 1%, 5%, and 10% significance levels. Therefore, the null hypothesis of the presence of a unit root cannot be rejected. This indicates that the agricultural time series is non-stationary at its level form. Consequently, differencing is required to achieve stationarity before applying the ARIMA model for forecasting analysis (Table 4).

Table 4. Phillips–Perron (PP) Unit Root Test Results for the Agriculture Variable[5]

Variables	Obs	Newey–West Lags	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	p-value	Conclusion
Agriculture Z(rho)	14	2	1.539	-17.200	-12.500	-10.200	—	Non-stationary
Agriculture Z(t)	14	2	4.614	-3.750	-3.000	-2.630	1.0000	Non-stationary

According to the Phillips-Perron unit root test results, the calculated test statistics are higher than the critical values at the 1%, 5%, and 10% significance levels. In addition, the MacKinnon approximate p-value for Z(t) equals 1.0000, which is greater than the 0.05 significance level. Therefore, the null hypothesis of a unit root cannot be rejected, indicating that the agricultural time series is non-stationary in its level form. This suggests that differencing is necessary before applying the ARIMA forecasting model (Figure 2).

3 Source: Author's calculations based on the research data.
4 Source: Author's calculations based on the research data.
5 Source: Author's calculations based on the research data.

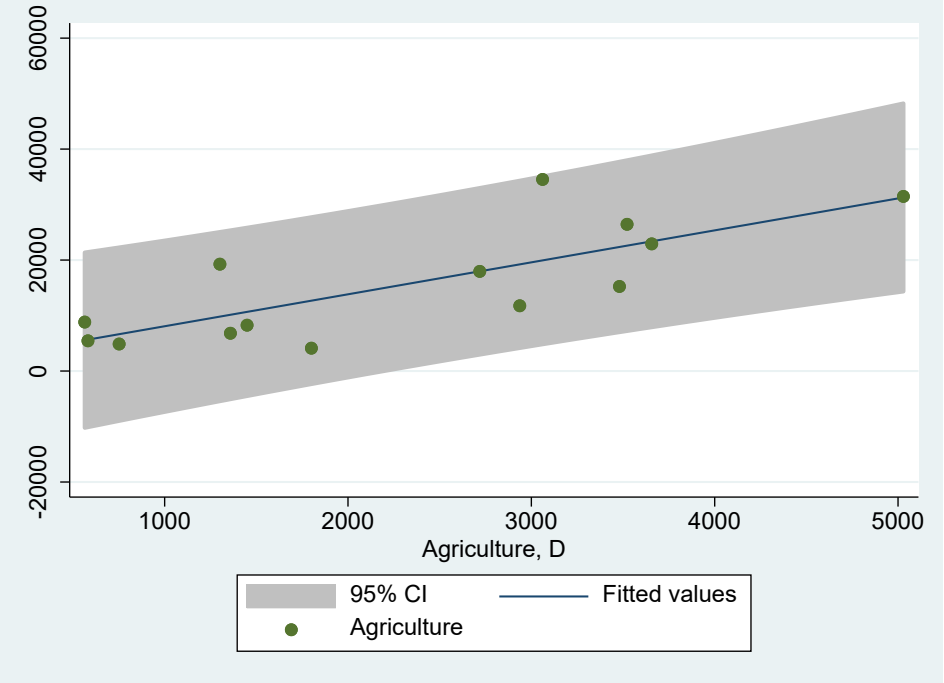

Figure 2. Linear Relationship Between Agricultural Indicators and Fitted Regression Values[6]

The figure demonstrates a positive relationship between the agricultural indicators and their differenced values over the analyzed period. The fitted regression line shows an upward trend, indicating that increases in agricultural activity are associated with growth in the observed series.

At the same time, the shaded 95% confidence interval suggests that the estimated relationship remains statistically reliable despite some fluctuations in the data. Overall, the graph confirms the presence of a positive growth tendency in the agricultural sector of Surkhandarya region (Table 5).

Table 5. Comparative Results of ARIMA Models for the Agriculture Variable[7]

Variable	ARIMA100	ARIMA001	ARIMA101	ARIMA010	ARIMA011	ARIMA110
Agriculture						
_cons	18584.522	14789.485***	17426.15	2300.9786***	2291.9096***	2317.3662***
ARMA						
ar						
L1.	.98471387***	.99999985***	.97971652***			
ma						
L1.			.64408382		.39383714	.50239034*
sigma						
_cons	2654.2966***	-5511.7227	1886.9822***	1324.3884***	1172.9129***	1124.9344***
Statistics						
aic	288.54001	307.7797	281.60431	245.01405	243.78177	242.73367
bic	290.66416	309.1958	284.43651	246.29216	245.69894	244.65084
N	15	15	15	14	14	14

Legend: * p<.1; ** p<.05; *** p<.01

6 Source: Author's calculations based on the research data.
7 Source: Author's calculations based on the research data.

The comparative analysis of the estimated ARIMA models indicates that the ARIMA(1,1,0) model was selected as the most appropriate forecasting model for the agricultural indicator in Surkhandarya region. This model demonstrates relatively lower AIC (242.73367) and BIC (244.65084) values compared to most alternative specifications, indicating a better balance between model fit and parsimony.

In addition, the autoregressive parameter AR(1) is statistically significant at the 10% level, confirming the presence of autoregressive dependence in the agricultural time series. The sigma value of the model is also relatively low, suggesting improved forecasting accuracy after first differencing the series.

Overall, the ARIMA(1,1,0) model adequately captures the dynamic structure of the agricultural indicator and can be considered suitable for forecasting future trends in the agricultural sector of Surkhandarya region (Figure 3).

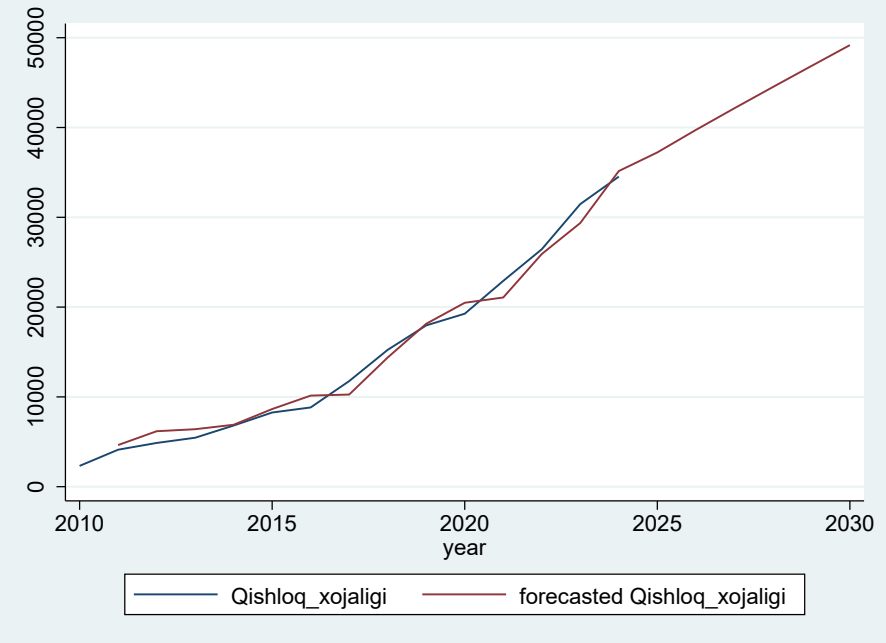

Figure 3. Actual and Forecasted Values of Agricultural Production Based on the ARIMA Model[8]

The forecast results based on the ARIMA(1,1,0) model indicate a continued upward trend in agricultural activity in Surkhandarya region for the forecast period. The predicted values closely follow the historical dynamics of the series, demonstrating the model's ability to capture the general development tendency of the agricultural sector.

According to the forecast, agricultural indicators are expected to increase steadily in the coming years and may reach their highest levels by 2030. This suggests that small business activity will continue to play an important role in supporting agricultural production and regional economic growth in Surkhandarya region.

CONCLUSIONS AND SUGGESTIONS

The results of the study demonstrate that small business activity plays an important role in the development of the agricultural sector in Surkhandarya region. The analysis of time series data for 2010–2024 revealed a stable upward trend in agricultural indicators, reflecting the increasing contribution of small business entities to regional agricultural production and economic growth.

The stationarity tests showed that the original agricultural series was non-stationary, making differencing necessary before applying the ARIMA model. Based on the comparative analysis of alternative specifications, the ARIMA(1,1,0) model was selected as the most appropriate forecasting model for the agricultural indicator. The forecasting results indicate that agricultural activity in the region is expected to continue growing steadily in the coming years.

Overall, the findings confirm that the agricultural sector of Surkhandarya region has strong development potential and that small business entities remain one of the key drivers of sustainable regional economic growth. The results of the study may serve as an analytical basis for improving regional agricultural policy, supporting entrepreneurship, and increasing the efficiency of agricultural production in Uzbekistan.

8 Source: Author's calculations based on the research data.

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