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Original Research Article

The Macroeconomic Variables and their Influence on Iraqi Agriculture for the Period 2000-2023

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Abstract: The research aims to study the impact of economic variables on agricultural product in Iraq by identifying the key factors that contribute to enhancing agricultural growth and the obstacles that hinder its achievement. Using an autoregressive model to explain the relationship between macroeconomic variables and agricultural output, the model demonstrated an explanatory power of 91%, with significant effects from interest rates, inflation rates, and government subsidies. The researchers concluded that agricultural loans have the most significant short-term impact, followed by inflation rates, while interest rates show a statistically significant effect. The findings indicate that a 1% increase in the inflation rate leads to a reduction in agricultural output by $43.88 million, while a $1 million increase in the fiscal deficit results in a decline in output by $0.59 million. The study emphasizes the necessity of enhancing government support for agricultural outputs, adopting effective strategies to mitigate inflation and its adverse effects on agriculture, increasing investment allocations for the agricultural sector. Furthermore, it recommends improving loan programs, facilitating farmers' access to credit, and establishing a system to monitor agricultural performance and periodically evaluate economic policies.

Keywords: Inflation and Agricultural Price, Trade Balance, Economic Factors, ARDL, Agricultural Product.

INTRODUCTION

The agricultural sector in Iraq has experienced a continuous decline in productivity and its contribution to GDP, despite its strategic importance in ensuring food security and providing job opportunities. This decline is attributed to a set of factors, including inflation, government agricultural support, interest rates, investment allocations, trade balance, and agricultural loans, and their effects on Iraq's agricultural product between 2000 and 2023.

This research aims to analyze the impact of macroeconomic variables on Iraq's agricultural output and explore the causal relationship between these variables and agricultural performance in both the short and long term. The study hypothesizes a negative relationship between rising inflation rates and agricultural product growth, as inflation adversely affects agricultural sector investments and depletes farmers' resources. Additionally, the research assumes a strong correlation between macroeconomic variables and agricultural product, as these factors significantly influence the scale and efficiency of agricultural product.

To conduct a robust econometric analysis over a relatively short time series of 24 years, the data converted into semi-annual figures using the Eviews-12 program, resulting in 48 observations. This approach is widely adopted in econometric studies [10, 37].

The inflation increases production costs and reduces agricultural productivity, leading to fluctuations in agricultural product [15,46].

The factors influencing agricultural product growth, the study found a positive relationship between overall economic growth and agricultural product. The researchers recommended enhancing agricultural investment, improving agricultural credit, controlling inflation, and reducing external debt to stimulate agricultural growth [24, 35].

For examined the relationship between exchange rates, money supply, and their impact on agricultural products, showed an inverse relationship between the real exchange rate and agricultural products, and a direct relationship between money supply and

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agricultural products. The researchers recommended the necessity of exchange rate stability and an increase in the money supply to support the agricultural sector [45, 27].

The effect of money supply and public spending on agricultural output in Egypt, using the VAR model, showed that public spending has a positive effect on agricultural output in the long term, while the effect of money supply was weak. The researchers recommended increasing public spending to support agriculture and maintain price stability [38, 43].

The research focused on the impact of macroeconomic variables (such as inflation, government support, interest rates, agricultural loans, and investment allocations) on agricultural product in Iraq.

Although the focus was on money supply and exchange rates, the use of the ARDL model and the analysis of the relationship between macroeconomic variables and agricultural product makes this study closer in methodology and topic. However, the research covers a wider range of economic variables (such as government support and agricultural loans), while the study by Al-Atabi and Al-Wasiti focuses on specific financial and monetary variables [6, 8].

MATERIALS AND METHODS

Economic growth increases GDP, leading to higher demand for agricultural products, which stimulates investment in the agricultural sector, improves production methods, and reduces costs. Economic growth also opens new markets and promotes agricultural innovation [18, 12, 21].

Price theory examines how prices determined by the interaction of supply and demand. When demand for a product increases, prices rise; when supply increases, prices fall. Price equilibrium achieved when supply equals demand [7, 25].

Monetary and fiscal policies influence agricultural production by affecting interest rates and borrowing costs for farmers. Lower interest rates facilitate agricultural investment, while expansionary fiscal policies, such as government investments in infrastructure and research, enhance productivity. Price stability enables better investment decisions, and monetary policies help control inflation, improve purchasing power, and affect currency exchange rates, affecting the competitiveness of agricultural products [44, 15, 36].

Technological advancements improve agricultural efficiency and reduce costs through innovations such as smart irrigation and precision fertilization. These developments enhance competitiveness, enable adaptation to climate change, and support sustainable development goals [9, 41, 11].

International trade theory supports agricultural production by opening new markets, increasing exports, and encouraging farmers to improve quality and efficiency. It enables the effective allocation of resources, boosts profitability, and enhances food security by reducing reliance on domestic production [31, 22].

Between 2000 and 2023, the Iraqi economy faced significant challenges and fluctuating growth due to political instability, security issues, and changes in oil prices. Macroeconomic variables, including economic growth, inflation, and monetary policies, had a noticeable impact on agricultural product [23, 48]. To ensure a sustainable future for agriculture, Iraq's agricultural sector requires new strategies to increase productivity, improve technology, develop infrastructure, and enhance political stability.

This study examines several key variables influencing agricultural product:

Inflation: Inflation affects agricultural production costs, including the prices of fertilizers, seeds, and fuel, as well as wages. Significant inflation may prevent farmers from covering rising costs, leading to reduce production [19, 26].

Interest Rates: Unstable monetary policies during the study period led to higher interest rates, which negatively affected agricultural investments.

Investment Allocations: Investment allocations refer to the funds designated for the agricultural sector, including infrastructure, irrigation systems, and rural roads. While these investments can enhance productivity, insufficient funding for modern agricultural technology has negatively affected output.

Trade Balance: The trade balance influences the prices of agricultural products. A surplus in agricultural exports can lead to higher local prices, encouraging domestic production [1, 5].

Government Subsidies: Government support, such as crop price guarantees, subsidized loans, and discounted agricultural inputs, enhances farmers' competitiveness and increases production.

Agricultural Loans: Access to agricultural loans enables farmers to secure funding for inputs and operational expansion, contributing to higher output.

Climate Change: Climate changes, including droughts and floods, have a direct impact on agricultural production.

Pests and Diseases: Agricultural pests and diseases can lead to significant crop losses.

Agricultural Policies: Government policies play a vital role in shaping the investment environment and determining the overall direction of the agricultural sector.

These variables affect agricultural production both directly and indirectly. Direct effects include changes in production costs, input and output prices, and farmers' ability to invest. Indirect effects influence

investment decisions, marketing opportunities, and the adoption of modern farming technologies [29, 3, 14].

Understanding the Dynamic Relationship

The relationship between macroeconomic variables and agricultural output is dynamic, varying over time and across regions. Understanding these complex interactions is essential for designing effective agricultural policies. For instance, while rising interest rates may reduce production in certain contexts, they could also stimulate production in others by promoting more efficient resource utilization.

This nuanced understanding highlights the need for tailored strategies that consider both the direct and indirect effects of macroeconomic variables on agricultural product.

RESULTS AND DISCUSSION

This research analyses data covering the period from 2000 to 2023. Although this represents a relatively short timeframe for robust statistical analysis, the researcher addressed this limitation by converting the data into semi-annual intervals, extending the observations from 24 years to 48 observations. This approach, implemented using EViews-12, is a widely accepted practice in econometric studies to enhance data availability and improve the reliability of analysis of variables in table (1).

Table 1: Abbreviations and units of research variables

Variable symbol	Variable type	Variable name	Unit of measure
AGP	dependent	Agricultural product	million dollars
INF	independent	Inflation rate	%
GOS	independent	Government support	million dollars
INR	independent	interest rate	%
TRB	independent	Trade balance	million dollars
INA	independent	Investment allocations	million dollars
AGL	independent	Agricultural loans	million dollars

Source: Table prepared by the researcher

Analysis of Agricultural Sector Trends in Iraq (2000–2023)

Based on the research variables, the Autoregressive Distributed Lag (ARDL) model for agricultural product (AGP) in terms of macroeconomic variables will be of the form, $\mathrm{RDL}(p, q_1, q_2, q_3, q_4, q_5, q_6)$ Where:

$$\Delta AGP_t = \alpha + \left\{ \sum_{i=1}^{p} \theta_i \Delta AGP_{t-i} + \sum_{i=0}^{q_1} \beta_{1,i} \Delta INF_{t-i} + \sum_{i=0}^{q_2} \beta_{2,i} \Delta GOS_{t-i} + \sum_{i=0}^{q_3} \beta_{3,i} \Delta INR_{t-i} + \sum_{i=0}^{q_4} \beta_{4,i} \Delta TRB_{t-i} + \sum_{i=0}^{q_5} \beta_{5,i} \Delta INA_{t-i} + \sum_{i=0}^{q_6} \beta_{6,i} \Delta AGL_{t-i} \right\} + \{\gamma AGP_{t-1} + \lambda_1 INF_{t-1} + \lambda_2 GOS_{t-1} + \lambda_3 INR_{t-1} + \lambda_4 TRB_{t-1} + \lambda_5 INA_{t-1} + \lambda_6 AGL_{t-1}\} + \varepsilon_t \ldots (5)$$

It is evident from the final equation that both the short-run and long run coefficients and can be estimated using the ordinary least squares method.$(\beta_1, \beta_2, \ldots \beta_6)(\lambda_1, \lambda_2, \ldots \lambda_6)$

This analysis explores the interplay of key economic factors influencing Iraq's agricultural product during the period 2000–2023. Agricultural product experienced significant growth until 2014, reaching a peak of $11.26 billion. However, a sharp decline followed, stabilizing around $6.27 billion. This trend effectively captured by a polynomial equation with an R-squared value of 92%, indicating a complex, non-linear relationship between contributing factors.

Government support for agriculture remained generally low throughout this period, with the exception of a notable surge in 2015. Despite the limited support, it consistently demonstrated a positive impact on agricultural output. Interest rates fluctuated around an average of 4% and exhibited a moderate influence on agricultural product.

In conclusion, this analysis reveals a complex interplay of government support, interest rates, trade balance, investment allocations, and agricultural loans, all significantly impacting Iraq's agricultural product. The substantial fluctuations in these economic variables highlight the challenges faced by the agricultural sector in achieving sustained growth.

Testing the Stability of Research Variables

Table (2) presents the results of the Augmented Dickey-Fuller (ADF) test conducted to assess the stationarity of research variables during the period 2000–2023. Unit Root Tests and ARDL Model Applicability. The unit root tests indicated that several key variables, including agricultural output (AGP), inflation rate (INF), government support (GOS), trade balance (TRB), investment allocations (INA), and agricultural loans (AGL), were non-stationary at their levels, suggesting the presence of unit roots. However, stationarity achieved after first differencing these variables, classifying them as integrated of order one I (1). In contrast, the interest rate (INR) found to be stationary at its level, signifying it as integrated of order zero (I(0). This mixed order of integration, where variables are either I(0) or I(1), satisfies a key condition for the estimation of an Autoregressive Distributed Lag (ARDL) model. The ARDL methodology is well suited for models with variables of varying integration orders, making it an appropriate tool for analyzing the relationships among these variables in the context of Iraq's agricultural sector.

Table 2: Test results of (ADF) unit root test for study variables during the period (2000-2023)

Variables	Level		First Difference		Integration Degree
	Intercept	Trend &Intercept	Intercept	Trend &Intercept	
AGP	-2.7137*	-2.4167ns	-4.5760***	-5.0590***	I(1)
	(0.082)	(0.365)	(0.001)	(0.001)	
INF	-2.4422ns	-2.4517ns	-4.9780***	-4.9315***	I(1)
	(0.137)	(0.349)	(0.000)	(0.001)	
GOS	-2.0336ns	-3.5784*	-4.8384***	-4.7835***	I(1)
	(0.272)	(0.045)	(0.000)	(0.002)	
INR	-5.0698***	-4.9257***			I(0)
	(0.000)	(0.001)			
TRB	-0.6262ns	-3.5570**	-4.0293***	-4.0357**	I(1)
	(0.853)	(0.047)	(0.003)	(0.015)	
INA	-1.4949ns	-2.2920ns	-4.7082***	-3.5335**	I(1)
	(0.526)	(0.428)	(0.000)	(0.049)	
AGL	-2.3464ns	-1.8257ns	-5.5081***	-4.3853***	I(1)
	(0.164)	(0.670)	(0.000)	(0.006)	
***** significant at 1% level** **** significant at 5% level** *** significant at 10% level** **ns not significant**	The values in parentheses represent the probability value. **P-value**				

Source: Prepared by the researcher based on the results of the statistical program Eviews-12

Table (3) presents the evaluation of information criteria used to determine the optimal lag length for the agricultural product model. The results indicate that all the information criteria (LR, FPE, AIC, SC, HQ) suggest that the optimal lag length for the agricultural output model is 4, based on Vector Autoregressive (VAR) analysis.

Accordingly, the optimal lag length for the dependent variable, independent variables, or both, for estimating the model using the Autoregressive Distributed Lag (ARDL) approach, is four. This corresponds to the joint integration process among the model variables at time (t-4).

Table 3: Determining the optimal lag for the agricultural product model for Iraq during the period 2000-2023 according to the (VAR) analysis

VAR Lag Order Selection Criteria
Endogenous variables:AGP INF GOS INR TRB INA AGL
Exogenous variables: C
Sample: 2000S1 2021S2
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1627.767	NA	7.43e+26	81.73834	82.03389	81.84520
1	-1379.834	396.6922	3.70e+22	71.79171	74.15614	72.64661
2	-1303.493	95.42614	1.19e+22	70.42466	74.85797	72.02761
3	-1178.331	112.6458	5.24e+20	66.61656	73.11875	68.96755
4	-895.1027	155.7757*	2.46e+16*	54.90513*	63.47620*	58.00416*

* denotes the optimal Lag length of the variable
LR: sequential modified LR test statistic

FPE: Final prediction error
AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Source: Prepared by the researcher based on the results of E-views-12

To confirm the suitability of the second lag gap for the model variables, the inverse roots of the autoregressive polynomial function found. And its number (14) Root as in the table (5). It is clear from the table that the absolute values of all roots are(Modulus)It is less than one, meaning that it will be located within a circle with a correct radius of one, and this result confirms the lack of correlation between the residuals or errors of the model, the stability of the variance of the residuals, as well as the stability of the model structure and the validity and quality of all the results that will be obtained by adopting the fourth optimal slowing gap (42). As shown in table (4).

Table 4: Inverse roots of the fourth-order autoregressive polynomial characteristic function for the agricultural product model

Roots of Characteristic Polynomial Endogenous variables:AGP INF GOS INR TRB INA AGL Exogenous variables: C Lag specification: 1 2	
Root	**Modulus**
0.965263	0.965263
0.681471 - 0.665884i	0.952788
0.681471 + 0.665884i	0.952788
0.805537 - 0.208215i	0.832012
0.805537 + 0.208215i	0.832012
0.729235 - 0.397923i	0.830739
0.729235 + 0.397923i	0.830739
0.366304 - 0.690410i	0.781565
0.366304 + 0.690410i	0.781565
0.448679 - 0.637011i	0.779164
0.448679 + 0.637011i	0.779164
0.104278 - 0.502652i	0.513354
0.104278 + 0.502652i	0.513354
0.381473	0.381473
No root lies outside the unit circle. VAR satisfies the stability condition.	

Source: Prepared by the researcher based on the results of Eviews-12

Cointegration Test

To test the co-integration relationship between the variables of the agricultural output model, the Bounds Testing methodology applied. The results presented in table (5).

Table 5: Co-integration test results between agricultural product model variables using bounds testing

Null Hypothesis: No relationship levels				
Test Statistic	**Value**	**Sig.**	**I(0)**	**I(1)**
F-statistic	9.1488**	10%	1.75	2.87
K	6	5%	2.04	3.24
		2.5%	2.32	3.59
		1%	2.66	4.05
t-statistic	-9.1244**	10%	-1.62	-3.70
		5%	-1.95	-4.04
		2.5%	-2.24	-4.34
		1%	-2.58	-4.67
** significant at 1% level				

Source: Dependence on results of the program Eviews-12

The results in the previous table show that the value of (F), amounting to 9.1488, is greater than the upper bound values I (1) at all significance levels. Likewise, it noted that the value of t, amounting to -

9.1244, is greater (in absolute terms) than the absolute values of the upper bound I (1) at all significance levels. Therefore, the null hypothesis, which states that the coefficients of all variables in the agricultural product model in the long-term relationship are equal to zero, rejected, and the alternative hypothesis is accepted. This indicates the existence of a long-term co-integration at the (1%) significance level between the agricultural product variable and the other model variables (inflation rate, government support, interest rate, trade balance, investment allocations, and government loans).

Model Estimation (ARDL)

Following the confirmation of a long-run co-integration relationship among the research variables, an Autoregressive Distributed Lag (ARDL) model estimated to analyze both long-term and short-term dynamics. All variables in the model found to be stationary, either at their levels or after first differencing. To determine the optimal lag order for the ARDL model, an extensive search conducted across 62,500 model samples. The Akaike Information Criterion (AIC) used to select the lag order that minimized information loss. This process identified the following optimal lag order: four lags for agricultural output, inflation rate, government support, investment allocations, and agricultural loans, and three lags for the interest rate and trade balance. Based on these findings, the final ARDL model was specified as ARDL (4, 4, 4, 3, 4, 4, 3), incorporating the optimal lag order for each variable.

Long-term relationship assessment and analysis Deadline

The table (6) displays the long-run relationship estimation results for the ARDL (4, 4, 4, 3, 4, 4, 3) model, which demonstrates the impact of certain macroeconomic variables on Iraqi agricultural output in the long term. Based on the probability values of the t-tests for the macroeconomic variables, all of which were below the 1% significance level, the results indicate a significant impact of these variables on agricultural output in the long runs follows:

- **Inflation rate INF_t :** The analysis reveals a significant negative long-term relationship between inflation and agricultural product. A 1% increase in the inflation rate is associated with a $43.87853 million decrease in agricultural product. This finding aligns with economic theory, as rising inflation leads to increased production costs, making domestic agricultural goods less competitive compared to imports. The reduced competitiveness negatively affects external demand for domestic agricultural products, ultimately contributing to a decline in agricultural product. Among the macroeconomic variables considered, inflation found to have the second most significant impact on agricultural product.

Table 6: Results of estimating the long-run relationship of the ARDL model (4, 4, 4, 3, 4, 4, 3) macroeconomic variables and agricultural product of Iraq during the period (2000-2023)

ARDL Long Run Form **Dependent Variable:ΔAGP_t** **Selected Model: ARDL (4,4,4,3,4,4,3)** **Case 1: No Constant and No Trend** **Sample: 2000S1 2021S2** **Included observations: 39**				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
ΔINF_t	-43.87853	1.961328	-22.37184**	0.000
ΔGOS_t	14.88159	1.028190	14.47359**	0.000
INR_t	-1134.691	228.3758	-4.968526**	0.002
ΔTRB_t	-0.585241	0.156494	-3.739696**	0.007
ΔINA_t	0.001617	0.000145	11.16117**	0.000
ΔAGL_t	8.358817	1.060390	7.882773**	0.000
R-squared	0.91312		F-Stat.	9.95031**
Adjusted R-squared	0.83494		Sig. (F-Stat)	0.000
**** significant at 1% level**				

Source: Dependence on results of the program Eviews-12

- **Government support GOS_t:** The analysis found a positive long-term effect of government support on agricultural product. When government support increases by 1%, agricultural product rises by 14.88159 million dollars in the long run. This variable ranked third in terms of its impact on agricultural output compared to the other macroeconomic variables.
- **Interest Rate INR_t :** The analysis revealed a significant negative long-term relationship between interest rates and agricultural product. A 1% increase in interest rates results in a substantial decrease in agricultural product by 1,134.691 million dollars. This finding is consistent with economic theory, as higher interest rates increase borrowing costs for farmers, making it more difficult for them to invest in essential resources like

modern machinery, quality seeds, and improved livestock. This reduces their access to optimal resource combinations, increases production costs, and ultimately leads to a decline in agricultural output and exports. Among the macroeconomic variables considered, interest rates had the most significant negative impact on agricultural product. It is the most affecting of independent variables.

- **Trade Balance TRB_t :** The study revealed a persistent negative trade balance over the period, which negatively affected agricultural product. A 1 % increase in the trade deficit was associated with a 0.58 million-dollar decline in long-term agricultural output. Among the variables examined, the trade deficit had the fifth weakest impact on agricultural product.
- **Investment Allocations INA_t :** Investment allocations had a relatively weak effect on agricultural product. A 1 million dollar increase in investment allocations resulted in an increase of 0.001617 million dollars (1,617 dollars) in agricultural product in the long run. This variable ranked sixth in terms of its impact on agricultural product compared to other macroeconomic variables.
- **Agricultural Loans AGL_t :** Agricultural loans played a significant role in influencing agricultural output in the long term. A 1 million dollar increase in agricultural loans led to a 8.358817 million dollar increase in agricultural product in the long run. This variable ranked fourth in terms of its impact on agricultural product compared to the other macroeconomic variables.
- **Significance of the model:** The probability value of the F-test for the long-term relationship was 0.000, which is below the 1% significance level. This indicates that the long-term relationship between agricultural output and macroeconomic variables is statistically significant. Moreover, the relationship has high explanatory power, with 91% of the changes in agricultural product attributed to macroeconomic variables.

Error correction factor:

Table (7) presents the estimation results for the error correction factor of the long-term relationship between agricultural product and macroeconomic variables in Iraq during the period 2000-2023.

Table 7: Error correction model factor (ECM) the long-term relationship between agricultural product and macroeconomic variables in Iraq during the period (2000-2023)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT_{t-1}	-1.734056	0.196584	-8.820958**	0.000
** significant at 1% level				

Source: Dependence on results of the program Eviews-12.

The results of the table(8) confirm there is a long-term co-integration relationship between the model variables, i.e. there is a long-term equilibrium relationship between agricultural product and macroeconomic variables, as the co-integration coefficient appeared with a negative and significant value at the level of (1%). Its value estimated at (-1.734056). It indicates that the speed of the return of agricultural product to its equilibrium value in the long run after deviations that occur in macroeconomic variables is relatively high and amounts to (173%) in other words, the co-integration coefficient represents the amount of change in agricultural product as a result of the deviation of each of the macroeconomic variables in the short run from their equilibrium values in the long run by one unit for each of them, meaning that agricultural product will take 14 months to return to its equilibrium value in the long run after the effects of shocks in macroeconomic variables because. $\frac{1}{1.734056} * 2 = 1.15 \text{ year} \cong 14 \text{ months}$.

Estimation and analysis of the short-term relationship:

Table (8) presents the results of estimating the short-term relationship for the ARDL (4, 4, 4, 3, 4, 4, 3) model, which shows the impact of macroeconomic variables on agricultural product in the short run. The results are as follows:

- Inflation Rate: There is a significant negative impact of the inflation rate on agricultural product, and this variable ranked second in terms of its impact on agricultural product compared to other macroeconomic variables.
- Government Support: There is a positive significant impact of government support on agricultural output, with this variable ranking third in its impact on agricultural product.
- Interest Rate: There is no significant effect of the interest rate on agricultural product.
- Trade Balance: There is a significant negative effect of the trade balance on agricultural product, with this variable ranking fourth in its impact on agricultural product.
- Investment Allocations: There is a positive significant impact of investment allocations on agricultural product, with this variable ranking fifth in its impact on agricultural product.
- Agricultural Loans: There is a positive significant impact of agricultural loans on agricultural product, with this variable ranking first in terms of its impact on agricultural product.

- The short-run relationship is statistically significant, indicating that all macroeconomic variables have a significant effect on agricultural output in the short term. Additionally, this relationship has high explanatory power, with 90% of the changes in agricultural product attributed to macroeconomic variables.

Table 8: Results of estimating the short-run relationship of the ARDL model

ARDL Short Run Form Dependent Variable:ΔAGP_t Selected Model: ARDL(4,4,4,3,4,4,3) Case 1: No Constant and No Trend Sample: 2000S1 2021S				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
ΔAGP_{t-1}	0.761891	0.130064	5.857832**	0.0006
ΔAGP_{t-2}	2.141783	0.290604	7.370097**	0.0002
ΔAGP_{t-3}	2.104311	0.300814	6.995396**	0.0002
ΔINF_t	-8.879815	2.949306	-3.010815*	0.0196
ΔINF_{t-1}	60.44964	7.394002	8.175497**	0.0001
ΔINF_{t-2}	53.33528	9.116265	5.850562**	0.0006
ΔINF_{t-3}	42.67574	6.230013	6.850024**	0.0002
ΔGOS_t	6.036218	1.414133	4.268494**	0.0037
ΔGOS_{t-1}	-20.79881	2.535672	-8.202482**	0.0001
ΔGOS_{t-2}	-6.255239	1.070064	-5.845669**	0.000
ΔGOS_{t-3}	-6.207855	0.900075	-6.897044**	0.000
ΔINR_t	8956.387	5834.964	1.534952ns	0.168
ΔINR_{t-1}	-6112.887	7130.153	-0.857329ns	0.419
ΔINR_{t-2}	40901.22	6206.233	6.590345**	0.000
ΔTRB_t	-1.555334	0.229421	-6.779381**	0.000
ΔTRB_{t-1}	-0.526176	0.273604	-1.923127ns	0.095
ΔTRB_{t-2}	-0.546085	0.245442	-2.224907ns	0.061
ΔTRB_{t-3}	-0.506428	0.225093	-2.249859ns	0.059
ΔINA_t	0.001767	0.000236	7.495653**	0.000
ΔINA_{t-1}	-0.000658	0.000279	-2.356137ns	0.050
ΔINA_{t-2}	-0.001318	0.000339	-3.891433**	0.006
ΔINA_{t-3}	-0.000917	0.000203	-4.527119**	0.002
ΔAGL_t	30.79545	3.628338	8.487481**	0.000
ΔAGL_{t-1}	12.31971	2.577052	4.780543**	0.002
ΔAGL_{t-2}	4.967807	2.355421	2.109095ns	0.072
R-squared	0.90915		F-Stat.	19.2645**
Adjusted R-squared	0.86722		Sig. (F-Stat)	0.000
** significant at 1% level * significant at 5% level ns not significant				

Source: Dependence on results of the program Eviews-12

Diagnostic tests for the model

➢ **Normal Distribution of Model Errors:**

One of the tests used to assess the normal distribution of model errors is the Jarque-Bera test (33, 34), which is based on examining the histogram of the model's residuals. The probability value of the Jarque-Bera test was 0.547, which is greater than the 5% significance level. This means that the test is not statistically significant, and the null hypothesis is accepted. Therefore, it can confirmed that the residuals (errors) generated from the estimated ARDL (4, 4, 4, 3, 4, 4, 3) model follow a normal distribution with a mean of -2.9591 and a standard deviation of 171.049.

➢ **Homogeneity of Variance of Model Errors:**

To test the homogeneity of the variance of errors from the estimated agricultural output model ARDL(4,4,4,3,4,4,3), the Autoregressive Conditional Heteroskedasticity (ARCH) test was used (13, 36). This test includes two statistics: the F-statistic and the Chi-Square statistic. The results are as follows:

F-statistic = 0.142342 Prob. = 0.7082
Chi-Square = 0.149659 Prob. = 0.6989

Because the probability values for both statistics are greater than the 5% significance level, the test is not significant, and the null hypothesis of homogeneity of variance in the errors of the estimated model is accepted.

- **The model is free from the problem of autocorrelation:**

To test the absence of autocorrelation in the errors of the estimated agricultural output model ARDL(4,4,4,3,4,4,3), the Q test was used. This test is based on the null hypothesis stating that there is no autocorrelation among the model errors. The test relies on calculating the values of the autocorrelation function (AC) and the partial autocorrelation function (PAC). The results of this test are presented in the table (9).

Table 9: Results of the test of independence of errors of the agricultural output model ARDL (4, 4, 4, 3, 4, 4, 3) for a period (2000-2023)

Sample: 2000S1 2021S2
Included observations: 39

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.061	-0.061	0.1584	0.691
		2	-0.059	-0.063	0.3104	0.856
		3	0.056	0.049	0.4499	0.930
		4	-0.054	-0.052	0.5851	0.965
		5	-0.028	-0.029	0.6224	0.987
		6	0.188	0.178	2.3402	0.886
		7	0.111	0.141	2.9586	0.889
		8	0.045	0.088	3.0651	0.930
		9	-0.102	-0.104	3.6182	0.935
		10	-0.178	-0.198	5.3626	0.866
		11	0.083	0.059	5.7586	0.889
		12	0.132	0.136	6.7957	0.871
		13	-0.075	-0.085	7.1455	0.894
		14	0.022	-0.067	7.1762	0.928
		15	0.076	0.082	7.5575	0.940
		16	-0.108	0.035	8.3721	0.937

Source: Dependence on results of the program Eviews-12

It noted from the results in the table above that all values of the autocorrelation and partial autocorrelation functions lie within the confidence limits, and all probability values of the Q-statistic were above the 5% significance level. This indicates the acceptance of the null hypothesis, confirming that the agricultural product model is free from the problem of autocorrelation.

- **The Model is Free from the Problem of Multicollinearity:**

To detect the problem of multicollinearity among the independent variables of the model, the Klein test (Klein) used. The null hypothesis of this test states that there is no problem of multicollinearity among the independent variables of the model, while the alternative hypothesis suggests otherwise. This test based on comparing the coefficient of determination of the estimated model with each Pearson correlation coefficient between every two independent variables (39).

Table (10) illustrates the matrix of simple linear correlation coefficients (Pearson) among the macroeconomic variables (inflation rate, government support, interest rate, trade balance, investment allocations, and agricultural loans).

Table 10: Simple correlation matrix between macroeconomic variables of Iraq (2000-2023)

	ΔINF_t	ΔGOS_t	INR_t	ΔTRB_t	ΔINA_t	ΔAGL_t
ΔINF_t	1.00000	0.33066	-0.04228	0.21412	0.04616	-0.21037
ΔGOS_t		1.00000	0.15009	-0.03418	-0.17671	-0.28299
INR_t			1.00000	0.18342	-0.03787	0.02673
ΔTRB_t				1.00000	-0.11250	-0.09648
ΔINA_t					1.00000	0.20969
ΔAGL_t						1.00000

Source: Dependence on results of the program e-views 12

The suitability of the Autoregressive Distributed Lag (ARDL) model to represent the relationship between agricultural product as the dependent variable and macroeconomic variables

(inflation rate, government support, interest rate, trade balance, investment allocations, and agricultural loans) as independent variables is evident, as the estimated model showed high significance and great explanatory power exceeding 83%. Furthermore, the model is free from econometric problems, which makes it suitable for predicting future agricultural product (2, 32, 29).

Macroeconomic variables have a significant impact on Iraq's agricultural output during the period (2000-2023). The research findings revealed the presence of a long-term equilibrium relationship between agricultural product and macroeconomic variables. The interest rate found to be the most influential economic variable affecting agricultural output in the long term, followed by the inflation rate as the second most important factor. Government support ranked third in importance, followed by agricultural loans in fourth place, trade balance in fifth place, and finally, investment allocations in sixth place.

A short-term equilibrium relationship also exists between agricultural product and macroeconomic variables. Agricultural loans identified as the most influential economic variable affecting agricultural output in the short term, followed by the inflation rate in second place. Government support came third, followed by the trade balance in fourth place, and investment allocations in fifth place. However, the interest rate did not show a significant impact on agricultural output in the short term.

The inflation rate has a significant negative impact on agricultural product in the long term. An increase in the inflation rate by (1%) leads to a decline in agricultural output by (43.87853) million dollars in the long term. This attributed to the rising costs of agricultural inputs and the decline in the purchasing power of the local currency, leading to economic instability and disruptions in agricultural supply chains. This result aligns with findings in mechanisms and tools of monetary policy and inflation targeting (40, 30, 42).

Government support has a significant positive impact on agricultural product in the long term. An increase in government support by one million dollars leads to an increase in agricultural product by (14.88159) million dollars in the long term. This highlights the encouragement of farmers to invest in supported agricultural projects and adopt new technologies, thereby improving production efficiency in the long term (17, 43).

The interest rate has a significant negative impact on agricultural product in the long term. An increase in the interest rate by (1%) results in a decline in agricultural product by (1134.691) million dollars in the long term. Since most farmers rely on agricultural loans to finance their farms, high interest rates reduce their ability to invest in the sector and hinder their capacity to secure capital for purchasing inputs. Increased loan costs lead to higher production costs (16) (5).

The trade balance negatively affects agricultural product in the long term. An increase in the trade balance (deficit) by one million dollars leads to a decrease in agricultural product by (0.585241) million dollars in the long term. Persistent trade deficits place pressure on foreign currency reserves, reducing the financial capacity of the sector. This negatively affects agricultural investments, and trade deficits may lead to economic dependency, hindering the development of the agricultural sector (28), (14).

Investment allocations play a weak role in enhancing agricultural product. An increase in investment allocations by one million dollars results in an increase in agricultural product by only (0.001617) million dollars in the long term. This is due to the heavy reliance on importing cheaper agricultural goods rather than encouraging domestic production, which diminishes the importance of investment in this vital sector. This finding aligns with the study Saleh, M. M. Q. (43).

Agricultural loans play a significant role in influencing agricultural product in the long term. An increase in agricultural loans by one million dollars leads to an increase in agricultural product by (8.358817) million dollars in the long term.

This is due to the ability to finance the purchase of modern equipment, technology, and agricultural diversification. Loans enhance farmers' competitiveness against imported products and improve their market position locally and globally (20, 47, 18).

There is a long-term cointegration relationship between macroeconomic variables and agricultural product. When macroeconomic variables deviate in the short term from their equilibrium values in the long term by one unit each, approximately (173%) of this deviation corrected within a year. This implies that agricultural product will take about one year and two months to return to its equilibrium value (13, 49, 14).

The most important conclusions are: The results indicate that macroeconomic variables, such as the interest rate, inflation rate, government support, agricultural loans, trade balance, and investment allocations, have significant impacts on Iraq's agricultural product. Therefore, these variables should take into account when formulating agricultural and economic policies. Variation in the impact of variables between the long and short term: Certain variables, such as agricultural loans and inflation rate, have significant short-term effects, while others, like the interest rate and government support, exhibit stronger long-term impacts. This highlights the necessity of integrating short-term

and long-term policies to ensure sustainability in the agricultural sector. The negative impact of inflation rate and interest rate: Inflation rate and interest rate negatively affect agricultural product in the long term, emphasizing the importance of stable monetary and fiscal policies in promoting agricultural growth. The role of agricultural loans and government support in improving agricultural product: Agricultural loans and government support show positive impacts on agricultural product in the long term, underscoring the importance of providing accessible financing and sustained government support to enhance the productivity of the agricultural sector, and focusing on investment allocations: Despite their weak impact, investment allocations still play a role in increasing agricultural product. This calls for allocating more resources to develop agricultural infrastructure and support agricultural projects. The study recommend some recommendations. Such as the necessity of implementing monetary and fiscal policies aimed at reducing inflation rates and stabilizing interest rates, which contribute to enhancing the stability of the agricultural sector and promoting sustainable growth. Given the significant positive impact of agricultural loans on agricultural output, it is essential to expand and facilitate access to affordable loans for farmers, in addition to improving agricultural financing mechanisms to ensure financial support reaches the targeted groups. Increasing government investments in the agricultural sector is crucial, whether through supporting the prices of agricultural inputs or improving rural infrastructure. Achieving trade balance: Considering the negative impact of the trade balance on agricultural product, the government must work to reduce the trade deficit by improving local production and expanding agricultural exports, which would help enhance the overall economic conditions, and strengthening investment allocations in the agricultural sector: Although the impact of investment allocations has been weak, they remain a fundamental component in supporting agricultural growth. Financial allocations for agricultural infrastructure projects and the development of modern farming techniques should increase.

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