The Role of Some Monetary Policy Tools in Supporting Agricultural GDP Growth in Iraq (2003–2023)

Abdul Malik A. Omar[1] and Najlaa S. Madlul[2]
[1,2]Department of Economics and Agricultural Extension, College of Agriculture, Tikrit University, Tikrit, Iraq.
*Corresponding author's email: ao230052pag@st.tu.edu.iq
Email addresses of coauthors: najlaasalah88@tu.edu.iq

Abstract:

This study examines the impact of selected monetary policy instruments—namely, money supply, exchange rate, and agricultural loan interest rates—on the growth rate of agricultural output in Iraq from 2003 to 2023. Through quantitative analysis using time series data and econometric modeling (VECM), the study aims to uncover the nature, direction, and magnitude of these relationships. It also seeks to address the following central research question: To what extent do selected monetary policy variables (money supply, exchange rate, and agricultural loan interest rates) impact the pace of increase in Iraq's agricultural production from 2003 to 2023? The findings demonstrated a positive and statistically significant relationship between Iraq's money supply and the agricultural GDP rate. The results further showed that the agriculture sector was severely impacted by the exchange rate GDP rate in Iraq. The variable of interest rate imposed on agricultural loans had a negative and significant impact on the agricultural GDP growth rate in Iraq. This indicates that the high interest rate imposed on agricultural loans leads to a higher cost of obtaining financing for farmers, and thus a decrease in investment in agriculture, which leads to weak agricultural production, which negatively affects the agricultural production growth rate. It is recommended that monetary policy be directed towards encouraging investment in the agricultural sector by achieving a balanced interest rate regime, high enough to stimulate savings and investment, without negatively impacting the ability of farmers and agricultural companies to obtain the financing needed to develop agricultural production. Low-cost financing should also be provided for agricultural projects through subsidized loans or special programs to aid agricultural businesses of all sizes.

Keywords : Monetary policy, exchange rate, agricultural loan interest rates, AGDP, VECM

1. Introduction:

The agricultural sector is considered a vital economic sector that plays a strategic role in supporting the national economy, especially in developing countries seeking to diversify their sources of income and reduce their dependence on rentier sectors **[8]**. In Iraq, this sector is of particular importance due to its role in achieving food security, providing job opportunities, and developing rural areas, in addition to its contribution to the gross domestic product **[10]**. However, this sector has witnessed a significant decline in growth rates and productivity in recent decades, due to several internal and external factors, most notably security challenges, climate change, insufficient government support, and limited access to financing.

The indirect tools of monetary policy are one of the main factors of economic growth through their impact on economic activities, which is reflected in economic growth. Therefore, the effectiveness of monetary policy, using its tools to achieve the goal of economic growth, is an indicator of the

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efficiency of the monetary authority. Therefore, the importance of studying the relationship between monetary policy tools and economic growth, represented by the gross domestic product (GDP), has emerged. The term "monetary policy" refers to a framework of established policies that regulate the monetary economy's supply, demand, and cost in order to achieve predetermined outcomes. Stable prices, more employment, higher gross domestic product, a healthy balance of payments, and long-term economic growth are the goals of monetary policy in the majority of economies. In order to achieve these goals, other objectives are always pursued indirectly. For example, economic growth cannot be achieved without price stability **[6]**, financial market specialisation must be efficient, Additionally, it is crucial to keep the money supply at a level that aligns with the objective of increasing real income while simultaneously avoiding inflationary expansion. As a rule of thumb, inflation is a product of monetary policy; changes in supply have an effect on inflation, and the central bank influences economic growth via aggregate expenditure. The decision to invest or not invest is influenced by interest rates and monetary policy. Consequently, shifts in monetary policy tools cause shifts in aggregate demand **[9].** The monetary authority relies on the relationship between the monetary and real sectors of the economy to influence GDP through its tools. The transmission of the effects of monetary policy tools to the economy entails two stages: The first is implementing a policy of expansionary monetary expansion, which entails lowering interest rates or buying assets like bonds, which causes their values to rise, thereby boosting the money supply. A fall in interest rates is the result of a rise in bond prices, as the two variables are inversely related. The second part of the system that transfers the effects of (monetary) policy tools will then be turned by a decrease in the rediscount rate, which will encourage commercial banks to turn to the central bank to obtain more liquidity. This is done by converting a portion of their financial assets into legal tender. Consequently, their cash reserves and their ability to create credit will increase, which will affect aggregate demand and thus increase the level of production. That is, a change in monetary policy instruments leads to changes in the money supply. It works by stimulating the elements that respond. Monetary policy measures are now closely tied to bolstering the objective of price stability, the level of employment, and economic growth in accordance with the growth of the gross domestic product and the inflation target. This is because interest rates are influenced by changes in the money supply, which in turn affects income and the level of the money supply **[7]**. This is particularly true in light of the economic transformations that Iraq witnessed after 2003, which included the liberalization of the financial sector, changes in exchange rate policies, fluctuating inflation rates, and other influential monetary variables. Hence, By examining, our study hopes to address some of that void and measuring the impact of some monetary policy variables (exchange rate, money supply, interest rates on agricultural loans) on Iraq's agricultural production growth rate during the period from 2003 to 2023. The study relies on an econometric approach using annual data and time series in order to learn how these factors interact with one another and determine whether this relationship is immediate or long-term. It also provides practical recommendations that can contribute to improving the performance by use of

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monetary policy instruments in the agriculture sector.

2. Materials and working methods

2.1. Vector (Error) Correction Model (VECM).

Assumption of a long-run equilibrium connection is fundamental to this model's premise. This relationship is real, but it doesn't happen very often. The inaccuracy in equilibrium is the sum of the two values subtracted at each time interval, over time, this mistake (or some portion of it) gets rectified Hence, this model is called an error correction model **[1].** Because of this, we refer to this model as a paradigm for correcting errors. Before you can use the vector (error) correction model (VECM), make sure that the variables that make up the model are cointegrated. To mitigate the effect of inaccurate descriptions, this VAR model uses an error correcting term. **[5].** There must be a long-term equilibrium connection if the variables under study are cointegrated. The Granger causality test reveals that there must be a causal link in at least one direction in this example. Nevertheless, the VECM **[4].** establishes the kind, strength, and direction of the causal relationship. All of the relationships, both immediate and distant between economic variables may be found using the VECM model. There are causal links, and in their short-run form, represented by the lags. In order to find out whether a parameter is significant in the short run, we use the Wald test to see if the null hypothesis, which says the estimated parameter isn't significant, is accepted or rejected. Examining the chi-square value's probability level does this. With a probability level below 5%, the calculated parameter is deemed significant; conversely, with a level over 5%, the null hypothesis is rejected. When compared, the long-term shape of the connection may be captured via cointegration. Here are two equations that reflect the VECM model **[2]**:

$$\Delta Y_t = a_1 + \sum_{i=1}^{n} a_j \, \Delta Y_{t-j} + \sum_{i=1}^{n} \beta_i \, \Delta X_{t-i} + P_1 \mu_{t-1}$$

$$\Delta X_t = a_2 + \sum_{j=1}^{n} \beta_i \, \Delta X_{t-j} + \sum_{j=1}^{n} \beta_j \, \Delta Y_{t-i} + P_2 v_{t-1}$$

Δ The variances of the variables are represented by, and the error correction term is symbolised by μ_(t-1) and v_(t-1).

An indication of a long-run equilibrium connection would be the presence of a statistically significant negative error correction term. The rate of adjustment of the short-term imbalance towards the long-term equilibrium value is monitored by the error correction term **[3]**.

2.2. Variables Description

The model can be described as follows: y=f (x1, x2, x3)

Where:

Y = Agricultural GDP growth rate in Iraq (%)

X1 = Limited monetary resources (in million dinars)

X2 = Exchange rate (in million dinars)

X3 = Agricultural loan interest rate (%)

To determine if each of the model variables have a long-run equilibrium relationship, we may perform a cointegration test once we have proven that the time period is stationary and that most of the study's variables are stable in the first difference.

3. Discussion and Results

3.1. Unit (Root) Test Results

Upon initial difference, or integration of order one, the majority of variables that were non-stationary at level became stationary, according to the ADF test findings shown in table (1) [I(1)]. Agricultural GDP growth and food price inflation required differencing. Interest rates and trade balance were stationary at level [I(0)]

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Table (1) Results of the unit root tests conducted using the ADF on the research variables from 2003 to 2023

UNIT ROOT TEST RESULTS TABLE (ADF)					
Null Hypothesis: the variable has a unit root					
At Level					
		Y1	X1	X2	X3
With Constant	t-Statistic	-1.5829	-1.3282	-2.2583	-2.4033
	Prob.	*0.4808*	*0.6068*	*0.1904*	*0.1478*
		n0	n0	n0	n0
With Constant & Trend	t-Statistic	-3.7021	-2.7728	-1.7376	-2.5103
	Prob.	*0.0355*	*0.2154*	*0.7122*	*0.3215*
		**	n0	n0	n0
Without Constant & Trend	t-Statistic	0.4433	0.7030	-0.0110	-4.9232
	Prob.	*0.8042*	*0.8631*	*0.6726*	*0.0000*
		n0	n0	n0	***
At First Difference					
		d(Y1)	d(X1)	d(X2)	d(X3)
With Constant	t-Statistic	-4.9568	-2.1495	-2.4698	-2.7123
	Prob.	*0.0003*	*0.0320*	*0.0149*	*0.0080*
		***	**	**	***
With Constant & Trend	t-Statistic	-4.9735	-2.7874	-4.8478	-2.6466
	Prob.	*0.0016*	*0.2102*	*0.0027*	*0.2633*
		***	n0	***	n0
Without Constant & Trend	t-Statistic	-5.0048	-2.8465	-7.7297	-2.6808
	Prob.	*0.0000*	*0.0611*	*0.0000*	*0.0867*
		***	*	***	*
Notes:					
a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant					
b: Lag Length based on SIC					
c: Probability based on MacKinnon (1996) one-sided p-values.					

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

3.2. Cointegration Analysis

Table (2) refer to the Johansen test revealed at least one cointegrating vector among the variables, confirming the existence of a long-run equilibrium relationship between monetary policy tools and the growth rate in agriculture. This justified the application of the VECM model.

Table (2) For the time span from 2003 to 2023, the research variables' Johansen-Juselius cointegration test results

Date: 07/01/25 Time: 19:46
Sample (adjusted): 2005S1 2023S1
Following these modifications, 37 observations were included.
Stance presumption: Stochastic linear trend
Series: Y1 X1 X2 X3
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.597787	73.33704	47.85613	0.0000
At most 1 *	0.461733	39.63842	29.79707	0.0027
At most 2 *	0.359443	16.72061	15.49471	0.0325
At most 3	0.006470	0.240161	3.841466	0.6241

Three cointegrating equations were found at the 0.05 level in the trace test; a
* indicates that the hypothesis was rejected at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values

Maximum Eigenvalue Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.597787	33.69861	27.58434	0.0072
At most 1 *	0.461733	22.91781	21.13162	0.0277
At most 2 *	0.359443	16.48045	14.26460	0.0220
At most 3	0.006470	0.240161	3.841466	0.6241

The max-eigenvalue test indicates that there are three cointegrating equation(s) at the 0.05 level.

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The symbol * indicates that the hypothesis is rejected at the 0.05 level.
The symbol ** indicates that the hypothesis is accepted. MacKinnon-Haug-Michelis (1999) p-values

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

3.3. Optimal Lag Test

Given the dynamic use of the error correction vector model to determine the short- and long-term relationship between economic variables, this model is sensitive to the number of lags of the explanatory variables in the causal relationship equations. Therefore, specific criteria are required to determine the appropriate lag period to include in the model to ensure the best estimates of the direction of the causal relationship between the variables in the short and long run.

To determine the optimal lag period, three tests with specific criteria were used:
Hanna-Quinn information criterion (HQ), Schwarz information criterion (SC), and Akaike information criterion (AIC).
All of these tests share the same principle: they determine that the optimal lag period is the one that yields the lowest value when applied, indicating that the chosen period is the most appropriate for analyzing the relationship between the variables. The optimal lag period is also shown in Table (3).

Table (3) Selecting the optimal deceleration period

Lag	LogL	LR	FPE	AIC	SC	HQ
0	131.7468	NA	110.4467	7.541489	7.717435	7.602899
1	139.3571	11.00450	81.94025	7.242064	7.469983	7.316372
2	120.0785	7.897634	64.69107	7.004471	7.283364	7.090679
3	115.9557*	6.642268*	54.48699*	6.830873*	7.160738*	6.928979*

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

Based on the data shown in Table (3), the researcher determined that three slowdowns would be the ideal length, using the (AIC and HQ) criterion into account for the preference of the results resulting from it.

Table (4) Results of long-term parameters of the VECM model

Cointegrating Eq	CointEq1
Y1(-1)	1.000000
X1(-1)	-0.003631 (0.00075) [-4.86944]
X2(-1)	0.714255 (0.15241) [4.68630]
X3(-1)	22.28292 (3.83315) [5.81234]
C	474.2624

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

Note: When interpreting the results of the VECM model, the signs of the model parameters are reversed in the long run.

From the results of Table (4), we note that the money supply had a significant and positive impact on the agricultural GDP rate in Iraq, with a value of t (4.86944), meaning that whenever the money supply increased by one unit, the agricultural GDP rate in Iraq increased by 0.003631 units, a result consistent with economic logic. The results further showed that the agriculture sector was severely impacted by the exchange rate GDP

rate in Iraq, with a value of t (-4.68630), meaning that whenever the exchange rate increased by one unit, the agricultural growth rate decreased by 0.714255. This can be explained by the decline in the value of the Iraqi dinar against foreign currencies, which increases the cost of imported agricultural supplies such as seeds, fertilizers, and agricultural machinery, leading to a decline in the agricultural production growth rate. The variable of the interest rate imposed on agricultural loans had a significant and negative impact on the growth rate of agricultural GDP in Iraq, i.e. whenever the value of the interest rate increases by one unit, the value of the agricultural growth rate decreases by (22.28292). This indicates an increase in the interest rate imposed on agricultural loans, such that the cost of obtaining financing becomes higher for farmers, and thus a decrease in investment in agriculture, which leads to weak agricultural production, which is negatively reflected in the growth rate of agricultural production.

3.4. Short-run Dynamics and Error Correction Term

Table (5) VECM estimation results and short-term parameters for the period (2003-2023)

Error Correction:	D(Y1)	D(X1)	D(X2)	D(X3)
CointEq1	-0.115863	-24.87008	0.223849	-0.018902
	(0.05680)	(16.7620)	(0.18959)	(0.00385)
	[-2.03969]	[-1.48371]	[1.18070]	[-4.90900]
D(Y1(-1))	0.530156	-18.11732	-1.103125	0.011942
	(0.21596)	(63.7258)	(0.72078)	(0.01464)
	[2.45492]	[-0.28430]	[-1.53046]	[0.81580]
D(Y1(-2))	-0.535902	62.13984	-0.148852	-0.000375
	(0.16216)	(47.8499)	(0.54121)	(0.01099)
	[-3.30486]	[1.29864]	[-0.27503]	[-0.03412]
D(Y1(-3))	0.243060	-60.53782	-0.713793	0.017618
	(0.18631)	(54.9785)	(0.62184)	(0.01263)
	[1.30457]	[-1.10112]	[-1.14787]	[1.39506]
D(X1(-1))	-4.30E-06	0.745031	0.000260	-6.28E-05
	(0.00061)	(0.17882)	(0.00202)	(4.1E-05)
	[-0.00709]	[4.16637]	[0.12865]	[-1.52797]
D(X1(-2))	-0.000786	-0.503745	-0.001755	6.25E-05
	(0.00076)	(0.22525)	(0.00255)	(5.2E-05)
	[-1.02941]	[-2.23637]	[-0.68876]	[1.20830]
D(X1(-3))	0.000634	0.288156	-0.001946	-5.10E-05
	(0.00073)	(0.21478)	(0.00243)	(4.9E-05)
	[0.87102]	[1.34167]	[-0.80096]	[-1.03403]
D(X2(-1))	-0.057242	-11.91619	0.724300	-0.006384
	(0.05858)	(17.2852)	(0.19551)	(0.00397)
	[-0.97721]	[-0.68939]	[3.70474]	[-1.60790]
D(X2(-2))	-0.023942	41.32056	-0.680984	-0.010702
	(0.06921)	(20.4223)	(0.23099)	(0.00469)
	[-0.34594]	[2.02331]	[-2.94812]	[-2.28118]
D(X2(-3))	-0.030989	-41.91093	0.606168	0.003026
	(0.06574)	(19.3993)	(0.21942)	(0.00446)
	[-0.47137]	[-2.16044]	[2.76262]	[0.67916]
D(X3(-1))	-0.913726	-570.1298	9.937161	0.401460
	(1.99013)	(587.260)	(6.64228)	(0.13490)
	[-0.45913]	[-0.97083]	[1.49605]	[2.97599]
D(X3(-2))	0.164620	-310.3261	-9.502025	0.338610
	(1.83854)	(542.527)	(6.13633)	(0.12462)
	[0.08954]	[-0.57200]	[-1.54849]	[2.71705]
D(X3(-3))	1.077553	702.6644	-1.144610	-0.074799
	(1.85919)	(548.620)	(6.20525)	(0.12602)
	[0.57958]	[1.28078]	[-0.18446]	[-0.59353]
C	0.344751	918.8491	14.25815	-0.093288

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	(2.22888) [0.15467]	(657.711) [1.39704]	(7.43913) [1.91664]	(0.15108) [-0.61746]
R-squared	0.866251	0.668827	0.613251	0.598530
Adj. R-squared	0.783455	0.463815	0.373836	0.350000
Sum sq. resids	5.177882	98127294	12553.47	1126.921
S.E. equation	0.496554	2161.649	24.44963	7.325498
F-statistic	10.46238	3.262377	2.561449	2.408285
Log likelihood	-16.22119	-309.4753	-152.6049	-110.4210
Akaike AIC	1.726925	18.48431	9.520282	7.109774
Schwarz SC	2.349064	19.10644	10.14242	7.731913
Mean dependent	-0.407143	2499.878	3.000000	0.431143

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

As shown in the results of Table (5), the correlation coefficient (R^2) reached 86%, and the weighted R^2 reached 78%. This means that the independent variables explain 78% of the variations in the dependent variable. However, greater attention and focus is placed on the F value, which also appeared significant, with a P-value of 0.0000, which is less than 5%, indicating the significance of the model as a whole. The error correction coefficient (c1) in the model reached -0.115863, which is negative, significant, and less than one. This indicates a long-term equilibrium relationship between the model variables and the agricultural GDP growth rate. The error correction coefficient (ecm) value also indicates that the system's adjustment to equilibrium is proceeding at a relatively slow rate of 11% per year.

3.5. Model quality test (unit root test)

Figure (1) shows that the model is stable since all of the points are inside the circle.

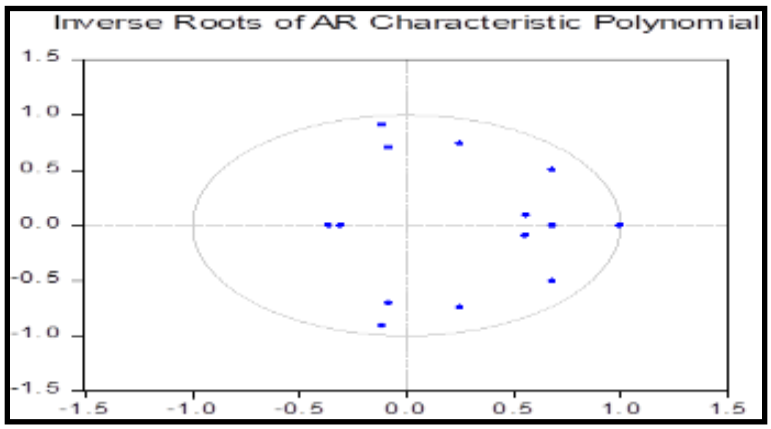

Figure (1) Model quality test results (unit root test)

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

3.6. VEC Residual (Serial) Correlation LM Tests

Table (6) shows that the F-statistic, with a probability value of 0.8190 and an F-value of 0.65, is more than 5%. This indicates that the model does not account for random residual autocorrelation, and the alternative hypothesis, which states that it does, is thus rejected.

issue of the intercorrelation of the random residuals

Table (6) : VEC Residual (Serial) Correlation LM Test Results

Lag	LRE* stat	df	Prob.	Rao F-stat	Prob.
1	12.86035	16	0.6829	0.788460	0.6896
2	18.88664	16	0.2755	1.247170	0.2841
3	10.91666	16	0.8146	0.656018	0.8190

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

3.7. Heteroskedasticity Test Results

The results in Table (7) indicate that the model is free from the problem of heteroscedasticity based on the Chi-sq value of (0.3367) which is greater than (5%). That is, the null hypothesis (which states that there is no problem of homoscedasticity) is accepted, and the alternative hypothesis is rejected, which indicates that the model is free from the problem of heteroscedasticity, which enhances the acceptability of the model results.

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Table (7) Results of Heteroskedasticity Test

Joint test	Chi-sq	Df	Prob.
	269.0487	260	0.3367

Source: Designed by (the researcher) using data extracted from the statistical software (Eviews12).

Conclusions

The study concludes from the positive relationship between money supply and agricultural output that an expansionary monetary policy provides greater liquidity in the market. This facilitates farmers' access to agricultural loans, which in turn stimulates investment in agricultural equipment, fertilizers, and seeds, and improves the ability to expand cultivated agricultural land or implement modern agricultural technologies. Furthermore, an increase in money supply increases consumers' purchasing power, which increases demand for agricultural products. This, in turn, encourages farmers to increase production.

From the inverse relationship between the exchange rate and the agricultural output growth rate, we conclude that the impact of the exchange rate on agricultural output in Iraq is determined by several economic channels, including the cost of production and the prices of imported goods. A decline in the exchange rate of the Iraqi dinar against the dollar leads to an increase in the cost of imported agricultural supplies, which raises production costs. This leads to lower profit margins and reduced agricultural investment, leading to a slowdown in agricultural growth. The decline in the value of the Iraqi dinar also increases the price of imported food, which increases inflation and weakens farmers' purchasing power. The rising cost of living weakens domestic consumption, which weakens agricultural growth. From the inverse relationship between interest rates imposed on agricultural loans and the agricultural growth rate, we conclude that this reflects the rising cost of financing, which leads to reduced agricultural investment, decreased agricultural production, and a diminished ability to cope with risks, ultimately resulting in a slowdown in the growth rate of agricultural production.

Recommendations:

1. Stimulating agricultural investment through monetary policy. It is recommended that monetary policy be directed towards encouraging investment in the agricultural sector by achieving a balanced interest rate regime, so that it is high enough to stimulate savings and investment, but without negatively impacting the ability of farmers and agricultural companies to obtain the financing needed to develop agricultural production. Low-cost financing should also be provided for agricultural projects through subsidized loans or special programs to support small and medium-sized enterprises in the agricultural sector.

2. Encouraging agricultural exports by improving the competitiveness of local agricultural products in international markets. Economic policies should focus on increasing agricultural productivity by improving production technologies and expanding investments in agricultural infrastructure. Exports should also be stimulated by providing incentives to farmers and exporters, such as tax exemptions or logistics cost subsidies, to facilitate access to international markets and increase the competitiveness of Iraqi agricultural products.

3. Stabilizing the exchange rate. It is recommended to maintain exchange rate stability through a balanced monetary policy to reduce fluctuations in the value of the local currency. Stable exchange rates enhance the competitiveness of agricultural products in global markets and contribute to improving the agricultural trade balance. Likewise,

encouraging monetary policy to direct funds toward agricultural investment can reduce exchange rate volatility and contribute to improving the trade situation.

4. Encourage local production through technology and infrastructure support. The government should provide technical and financial support to farmers to adopt modern technology and increase productivity. Investing in agricultural infrastructure, such as modern irrigation systems, advanced agricultural equipment, and research and development centers, can help boost local production and reduce dependence on agricultural imports.

5. It recommends the need to follow an expansionary monetary policy by increasing the money supply and reducing interest rates imposed on agricultural loans.

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