An Economic Study of Tomato Production in Iraq for the Period 1999–2024

M.M. Nubras Rabeaa Shaker

College of Agriculture – University of Tikrit

E-mail: nubras.r.shaker@tu.edu.iq

Abstract:

Tomatoes are a vegetable crop of high nutritional and dietary importance to a large proportion of the Iraqi population. The most important agricultural and economic factors influencing tomato production in Iraq between 1999 and 2024 were investigated in this study. The study's objectives are to ascertain the production function for tomatoes in Iraq, assess the current level of tomato production in the country, and identify and quantify the factors impacting tomato production. A number of conclusions were drawn, the most significant of which is that tomato output volume was positively impacted by the independent variables (area planted with tomatoes, local pricing, chemical fertilisers, and water imports).The coefficient of the independent variable for planted area (X1) is positive, at (2.784), indicating a direct relationship between planted area and tomato crop production; that is, a 1dunum increase in planted area leads to a 2.78 tons increase in production, and this variable is statistically significant at the 5% probability level. The coefficient for the local price (X2) is positive and equals 649.5, indicating a direct relationship between the local price and tomato production; a 1dinar/Kg increase in the local price leads to a 649.5 tons increase in production. This variable is statistically significant at the 5% probability level. The coefficient for the independent variable of chemical fertilisers (X3) is positive at 0.454, signifying a direct correlation between chemical fertilisers and production; specifically, a 1ton increase in fertiliser usage results in a 0.454 tons increase in production, which is statistically significant at the 5% probability level.

Similarly, the coefficient of the independent variable “water imports” was positive, with a value of (3043.5). This indicates a direct relationship between water imports and production; that is, a 1bilion m^3/year increase in water imports leads to a 3043.5 tons increase in production, The irrigation variable has a positive effect, but is not statistically significant according to the study sample. This may be due to waste in traditional irrigation or inefficiency in the distribution of water quotas. The study recommends that the

government provide support to the agricultural sector by supplying production input

s such as seeds, fertilizers, and pesticides at government-subsidized prices, as well as agricultural financing through agricultural loans and improved marketing mechanisms. It also recommends supporting security and economic stability in agricultural lands due to their direct impact on the stability of agricultural production and its efficiency, and the use of modern irrigation techniques to rationalize water consumption and increase efficient agricultural production. Efforts should also be made to reduce the quantity of imported tomatoes during local production seasons to

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protect domestic producers, and to conduct continuous benchmarking, statistical analysis, and time-series analysis to forecast agricultural production, which will aid in the development of future agricultural plans.

Keywords: (production, productivity, tomatoes)

Introduction:

Tomatoes are among the most important food crops both locally and globally, and they hold a prominent place in agriculture. With increasing cultural and socioeconomic progress, global population growth, and rising demand for this crop—for two main reasons—the first being the versatility of tomato consumption in various forms, such as fresh, canned, or for various culinary purposes in addition to their use in the production of tomato paste, ketchup, and other products. The second reason is their high nutritional value, as they contain vitamins (C, A, B6, B12) and a number of minerals, the most important of which are calcium, iron, and phosphorus (1). Tomatoes are a warm-season crop and require little space to grow; they are cultivated in winter in the far south, and from spring through fall in the southern and northern regions (2)

Tomato production constitutes an important part of local food security and plays an economic role by providing employment opportunities for farmers and agricultural workers and contributing to national income through domestic production and by reducing the need for imports.

Research Problem:

Despite the economic and nutritional importance of the tomato crop in Iraq, it faces significant challenges, including: (fluctuations in production and prices, instability in cultivated area, variations in profitability, a lack of time-series analyses, and scarcity of water resources)

Accordingly, the research problem lies in the need for a comprehensive economic study of the tomato crop based on time-series analysis to identify trends and fluctuations in production and prices and to assess the relationship between various economic factors, with the aim of providing scientific recommendations to improve productivity and economic returns

Research Hypothesis:

We hypothesize that the independent variables (area planted with tomatoes, local price, chemical fertilizers, and water imports) have a positive effect on tomato production.

Research Objective:

1- To identify and measure the factors affecting tomato production.

2 -To study the current state of tomato production in Iraq.

-3To estimate the production function for tomato production in Iraq.

Research Methodology

A descriptive-analytical approach was used to study the impact of certain economic variables on tomato production volume, and a quantitative approach was employed using economic and econometric analysis through the application of a multiple regression model to analyze the relationship between the variables.

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obtain the output. The production process is defined as all activities that lead to the generation of utility from agricultural products—that is, the transformation of matter or energy into utility that satisfies human needs.(4)

The agricultural production process is considered a process of transforming raw materials into services and goods; this transformation occurs by combining materials in varying quantities to meet different needs and uses. Combination involves the use of more than one or two variables in production, This highlights the role of production functions and their importance in identifying the most efficient production methods, through which the optimal policy for resource use is achieved.(5)

Production Objectives

Production contributes to meeting and satisfying the needs of society by efficiently and effectively transforming inputs into outputs based on quality standards, required quantity, timely delivery, low economic cost, and the generation of profits for organizations. It also provides employment opportunities, helps improve individuals' incomes, and contributes to economic development and the country's economic recovery**.**

The Importance of Production:

Production is the foundation of economic activities because it:

1- Raises the standard of living.
2- Contributes to economic development.
3- Increases national income.
4- Stimulates trade and investment.

Data Sources:

Ministry of Planning, Central Bureau of Statistics, Directorate of Agricultural Statistics.

The Concept of Agricultural Production:

Production is the creation or increase of utility. Any process that contributes to the realization of a specific benefit (from a person's perspective) is considered production (3), Agricultural production, on the other hand, is a process that is constantly evolving in line with modern technological developments. It consists of animal and plant products, their derivatives, and everything else produced in the field, This production results from various processes involving the inputs through which we

The Basic Elements of Production:

Production generally depends on four main elements (6), which are:

1- Labor: Human energy in the production process, whether physical or intellectual.
2- Capital: The funds, equipment, machinery, and tools used to produce goods and services.
3- Natural resources: These include land, water, energy, minerals, and others.
4- Organization and management: The process of coordinating the elements of production to achieve the highest possible efficiency.

Types of Production:

1- Goods production: such as the clothing and automotive industries.
2- Service production: such as education, transportation, and healthcare

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lead to fluctuations in agricultural production from one season to the next. Favorable conditions result in a significant increase in agricultural production, while unfavorable conditions lead to a decline in agricultural production. Therefore, price fluctuations directly affect farmers' incomes, unlike other commodities where production is more stable, as are prices, and consequently producers' incomes are more stable.

4- Government Intervention in Regulating Agricultural Prices: Fluctuations in farmers' incomes, as well as fluctuations in consumer welfare, result in government intervention to directly regulate agricultural prices through producer price support and consumer price subsidies.

-5The Concept of Time Series:

A time series for any phenomenon is a set of numbers resulting from tracking that phenomenon over a relatively long period of time and then recording observations or data at regular intervals. Time series are based on two variables, one of which is independent and the other dependent. Time series also imply that the phenomenon lacks an overall upward or downward trend over time, with seasonal variations present; that is, the characteristics of the series do not change with the passage of time .(9)

Time Series Stability Test:

The stability of a time series is important when analyzing time series prior to conducting statistical and parametric analyses, as well as in determining the appropriate mathematical model for it. It is divided into:

The Relationship Between Output and Productivity

Output is the quantity of goods and services produced (7), while productivity is the efficient use of resources to produce those goods and services.

Factors Affecting Production

The most important factors affecting agricultural production are as follows(8) :

1- Agricultural Production and Biological Nature: Agricultural production is realized only after a full growing season has elapsed, and agricultural commodities go through various stages of growth before they become ready for consumption. Therefore, prices of agricultural commodities cannot be raised immediately; they can only be increased after a full growing season has elapsed. This creates a time lag between price increases and the market's response to those increases.

2- Agricultural Commodities and the Inelasticity of Supply and Demand: Given the biological nature of agricultural commodities, it is not possible to increase the quantity supplied of agricultural commodities when their prices rise; therefore, they exhibit low price elasticity. Similarly, the quantity demanded of these commodities also exhibits low elasticity, as most agricultural commodities are considered essential and important to human life.

3- Price Fluctuations in Agricultural Production: External factors such as pests, insects, and weather conditions, as well as the biological nature of agricultural commodities,

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these variables, even though the trend itself is the only common factor. In general, spurious regression occurs when the OLS estimate of this regression yields a result that is completely erroneous, misleading, and incorrect if both X and Y contain a unit root.(11) .

-3Stability Tests for Time Series.

There are a number of criteria that can be used to test the stability or steady-state properties of time series, and these criteria are:

Graphical Analysis of Time Series:

1- From an applied perspective, a preliminary understanding of the stationarity of a time series of arbitrary variables can be obtained by plotting the time series. The time period(12)
2- Unit Root Test:

The unit root test is one of the most important and widely used tests for determining the stationarity of a time series, because a time series is stationary when it does not contain a unit root and is non-stationary when it does. The Phillips-Perron test and the formulas on which these two tests are based are presented in three alternative cases.(13) .

$\Delta Yt = \partial Yt\text{-}1 + \mu t$ …….(3(

$\Delta Yt = \beta 1 + \partial Yt\text{-}1 + \mu t$ …….(3 (

$\Delta Yt = \beta 1 + \beta 2\ t + \partial Yt\text{-}1 + \mu t$ …….(3 (

Equation (1) represents the variable YtΔ without bounds or a constant trend—that is, a “Random Walk Only” model. Equation (2) includes a constant term (drift) β1 in the series,

Stationary Series: These are series whose levels vary over time, but whose mean remains constant over the long term; that is, there is no general trend of decrease or increase (with the exception of the unit root).

Non-stationary time series: These are time series whose mean changes continuously, either decreasing or increasing (including the unit root).

Before estimating and selecting relationships between economic variables, time series must be analyzed to ensure that these variables are stationary, that they are not affected by unit roots, and that their statistical properties are known. The condition that a time series is perfectly stationary is satisfied if the following conditions are met:(10)

Stability of the mean over time: E(Xt) = u

1- Stability of the variance over time: Var(Xt) = σ2x
2- That is, the covariance between any two values of the same variable depends on the time interval between the two values, not on the actual value at the time the covariance is calculated. This means that for the two series (X_t and X_(t+k)) with a common correlation coefficient K, the covariance is: (Y_k = Cov(X_t, X_(t+k)) = E(X_(t-u))(X_(t+k-u((
3- In the case of non-stationary time series, we encounter a problem called spurious regression. Spurious regression means that there is a general trend in the variables in the time series; however, this general trend may lead to a significant relationship between

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≠ 0) means, however, that the series is stationary. If β is significant and less than zero, we will accept the alternative hypothesis; there is no unit root, which means the variable is stationary. The time variable (t) can be incorporated by adding it to the previous equation. If the error term in the model above (μt) suffers from autocorrelation, it can be corrected by adding an appropriate number of lag terms. Therefore, the unit root test equation is as follows :

$$\Delta Y_t = \beta_1 + \beta_2 t + \partial Y_{(t-1)} + \Delta Y_{(t-1)} + \mu_t$$

This model is called the Augmented Dickey-Fuller (ADF) test, where (μt) becomes autocorrelated and exhibits the desired properties. However, if the calculated value of (t) is less than its critical value, we accept the null hypothesis and conclude that the series is non-stationary; it will take the first difference.
advanced extension of the Dickey-Fuller test.(16)

Third: Selecting Standard Models*:*

Modern time series analysis, specifically the test for stationarity of time series (the unit root test), is a necessary condition for selecting a parametric model. It is one of the most important tests that leads us to the next stage, which is model selection. If the data is unstable, using a proportional model—such as the OLS method without considering the stability test—may yield ambiguous and inaccurate results. Although a significant relationship may exist, it is a

and Equation (3) includes both a constant term and a trend, where t represents time or the trend variable. In these three cases, if the time series of the variable (Yt) is non-stationary, we choose the null hypothesis (H0: b = 0); we reject the null hypothesis—that is, we accept the alternative hypothesis (H1: b ≠ 0)—when the time series of the variable (Yt) is stationary. Note that the critical value of (t) differs in each of the above cases.

A. The Augmented Dickey–Fuller (ADF) test.(14) ,

It is one of the important tests for detecting a unit root in time series. The Dickey–Fuller (ADF) test can be expressed by the following equation: $\Delta Yt = \beta 1 + \partial Yt\text{-}1 + \mu t$

where (Δ) denotes the first difference of the time series (Yt). The null hypothesis (H0: b = 0) is chosen, implying that the series has a unit root and is not stationary. On the other hand, the alternative hypothesis (H1: b

A. Phillips-Perron (PP) Test :

This test is based on the same test and model as the Augmented Dickey-Fuller (ADF) test, but differs from it in that it accounts for heteroscedastic errors by performing a nonparametric correction to the ADF statistic, assuming that the time series are generated by an autoregressive process, whereas the Phillips-Perron (PP) test is based on a more general assumption, namely that the time series is generated by an autoregressive integrated moving average (ARIMA) process. The Phillips-Perron test has better testing power and greater accuracy than the augmented Dickey-Fuller test, especially with small sample sizes (15). The ARCH test is a more

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T = the number of years.

The Reality of Tomato Production

Tomatoes are considered one of the vegetable crops of nutritional, economic, and social importance in Iraq, given their daily consumption—they constitute an essential part of the Iraqi diet—and their use in numerous food industries, in addition to their contribution to increasing farmers' income and raising their standard of living. It holds a prominent position in terms of production and cultivated area among vegetable crops, making it a strategic crop that contributes to supporting the agricultural sector and economic activity in rural areas .

Table (1): Shows the production, cultivated area, and local price of tomatoes, as well as chemical fertilizers and water imports in Iraq for the period(2024–1999)

spurious and inaccurate relationship that cannot be used for analysis .

1- Fully Corrected Least Squares Method ((FMOLS.

Fully corrected least squares (FMOLS), developed by Pedrony, is one of the methods for estimating joint integration that does not require standard conditions or constraints such as those of the OLS method, and is characterized by its ability to solve the problem of autocorrelation and bias (17). The regression equation is obtained in the following form according to the FMOLS method***(18) .***

$$\beta^* = (X_i' X_J)^{-1} (X_i' y_i^* - T\delta)$$

Where:

y* = the transformed endogenous variable.

δ = the adjusted autocorrelation coefficient.

Water Imports)billion m^3/year(	Chemical Fertilizers)metric tons(	Domestic Price)dinars/kg(	Production)metric tons(	Cultivated Area (dunams)	Year
65	416178	125	913000	277500	1999
41.34	621328	140	989000	267000	2000
30.72	550342	145	958000	298700	2001
53.6	349066	180	906500	334300	2002
76.82	396460	250	779000	262800	2003
66.05	255293	300	988200	266000	2004
55.67	438985	320	939400	268200	2005
65.3	273694	336	1042200	263300	2006
59.01	228060	353	954900	238500	2007
55.8	250966	521	802400	210600	2008
49.36	334807	529	913500	218400	2009

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60.15	324911	547	1013200	212800	2010
47.24	550342	572	1059500	244200	2011
51.17	349066	579	768400	235800	2012
44.95	396460	591	903809	208400	2013
47.2	228918	523	770600	139300	2014
34.81	236584	555	388700	92000	2015
54.75	274307	435	286600	57100	2016
40.53	238868	462	123600	55500	2017
55.41	503055	469	467600	69700	2018
45.43	486294	485	619500	91600	2019
49.59	523854	496	754800	127900	2020
44.97	425399	505	744200	131000	2021
43	234764	514	630160	122428	2022
43.98	394672	524	534821	68700	2023
43.494	448712	532	636394	107376	2024

Source (19): Central Bureau of Statistics

tomatoes; the largest planted area (334,300) dunams was recorded in 2002. The lowest area was recorded in 2017, when the cultivated area stood at 55,500 dunams, due to the security situation that year, as shown in Figure 1**:**

Trends in the Area Planted with Tomatoes for the Period(2024–2000)

A review of Table (1) reveals fluctuations in the area planted with

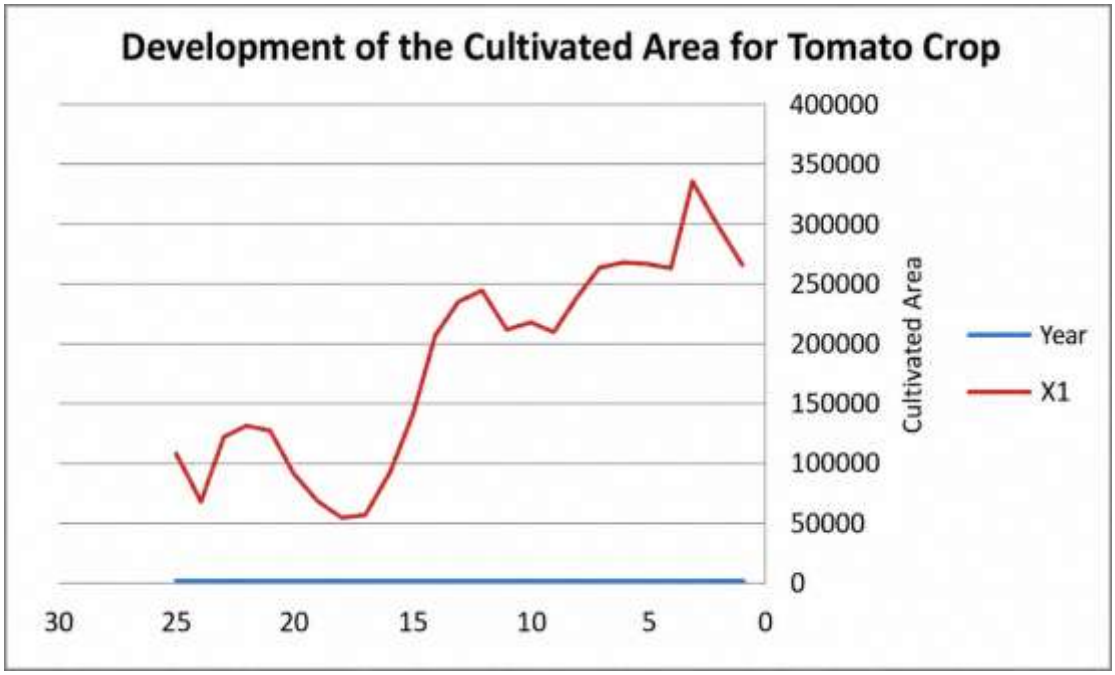


Figure (1): Shows the trend in the area planted with tomatoes

Table (1) shows that the highest production was in 2010, when tomato production reached (1,013,200) metric tons, while the lowest production was (123,600) metric tons in 2017. This decline is attributed to the reduction in cultivated area that year, as illustrated in Figure.(2)

Trends in Tomato Production :(2024–1999)

It is well known that tomato production varies with changes in the area under cultivation; it increases with the expansion of cultivated land and higher yields per dunam when modern methods and technologies are used, which contribute to higher yield rates .

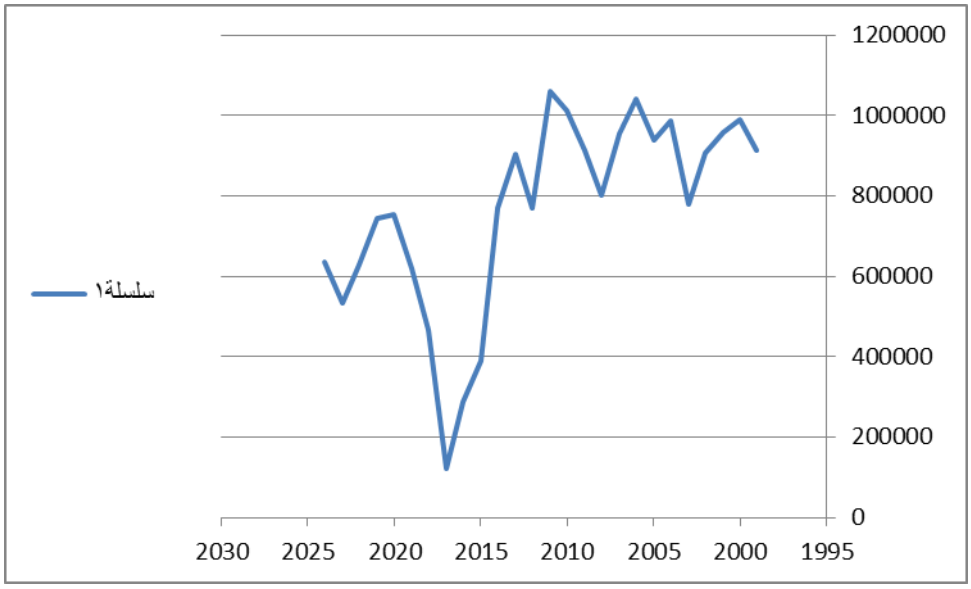


Figure (2) illustrates the trend in tomato production

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Table (2) shows that the highest tomato crop productivity reached (7.785) metric tons per dunam in 2023, attributable to the use of modern methods, technologies, and economic policies. The lowest productivity of the tomato crop was (2.227) metric tons per dunam in 2017, as shown in Figure 3

Trends in Tomato Crop Yields for the Period (2024–1999)

Yield is the ability of production factors to achieve the highest possible output efficiently; it is considered a measure of the efficiency of resource use in the production of goods and services—that is, the amount of output achieved relative to the inputs used.

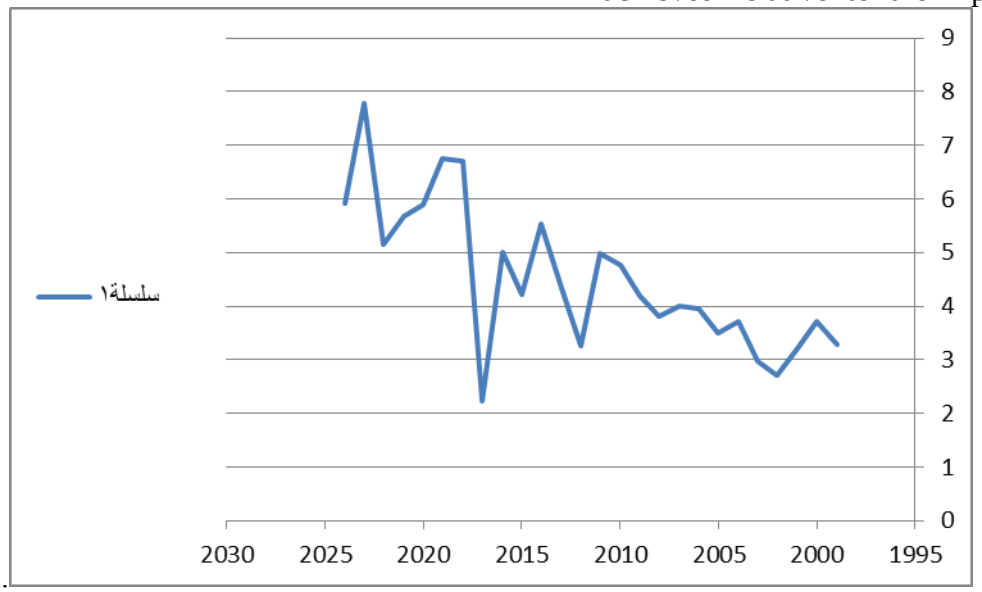


Figure (3) illustrates the trend in tomato crop yields

tomatoes in Iraq for the period (2024–1999)

Table (2): Shows the production, cultivated area, and yield of

Yield)metric tons/dunam(	Cultivated Area)dunams(	Production)metric tons(	Year
3.290	277500	913000	1999
3.704	267000	989000	2000
3.207	298700	958000	2001
2.712	334300	906500	2002
2.964	262800	779000	2003
3.715	266000	988200	2004
3.503	268200	939400	2005
3.958	263300	1042200	2006

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4.004	238500	954900	2007
3.810	210600	802400	2008
4.183	218400	913500	2009
4.761	212800	1013200	2010
4.979	244200	1059500	2011
3.259	235800	768400	2012
4.337	208400	903809	2013
5.532	139300	770600	2014
4.225	92000	388700	2015
5.019	57100	286600	2016
2.227	55500	123600	2017
6.709	69700	467600	2018
6.763	91600	619500	2019
5.901	127900	754800	2020
5.681	131000	744200	2021
5.147	122428	630160	2022
7.785	68700	534821	2023
5.927	107376	636394	2024

Cultivated area (dunams) = X1

Local price of tomatoes (dinars/kg) = X2

Chemical fertilizers supplied to farmers (metric tons) = X3

Water inflows from the Tigris and Euphrates rivers (billion cubic meters) = X4

First: Time Series Graphs:

Prior to analysing a time series, it is essential to graph it against time to ascertain its kind and characteristics. If the curve exhibits a consistent upward

Results and Discussion

The relationship between the variables affecting tomato production is described as follows:

Y = f(X1, X2, X3, X4)

By converting the above equation to the following standard form:

Y = ß0 + ß1X1 + ß2X2 + ß3X3 + ß4X4 + ui

Where:

Tomato production (metric tons) = Y

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indicating that the time series of the two variables are integrated of order zero (I(0)). The other variables (Y, X1, X2, X3, X4) exhibited stationarity upon taking the first difference and were integrated of order I.

.(1)

or downward trajectory, it signifies that its mean fluctuates with time, indicating that the time series is non-stationary. The graph of the dependent variables in linear form, as illustrated in Figure ( ), demonstrates that variable (X3) was stationary at a specific level,

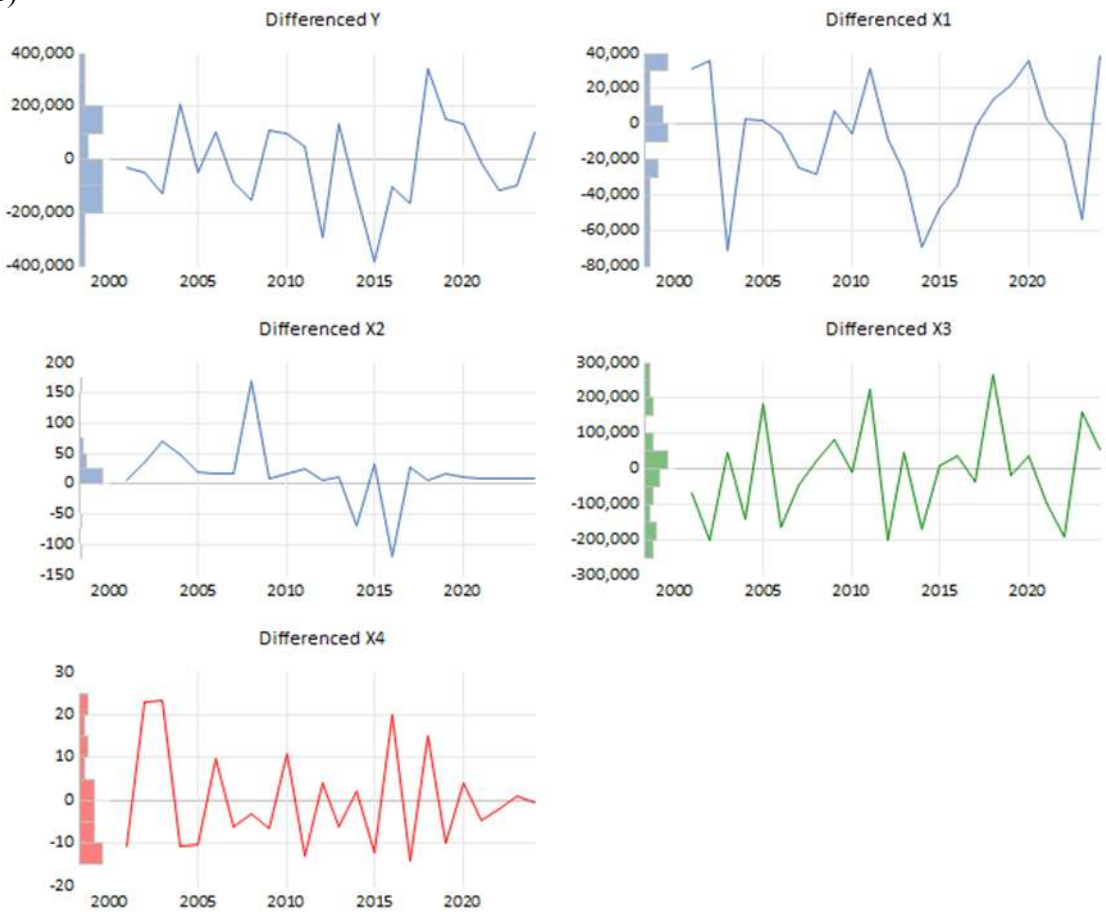


Figure (4) graph method for detecting the stability of time series of variables used at the level

rank of each variable N Table (3) shows the results of stability by the extended Dickie Fuller method (ADF) for the study variables,where the null hypothesis (H0:B=0) includes the instability of time series versus the alternative hypothesis (H1:=0), which states the stability of time series,where the results indicate the instability of time series of variables (X3,X4) at the level the variables (X1, X2, X3, X4) have become stable from the first

Source: prepared by the researcher based on the outputs of the program .(Eviews12)

Unit root testing for the stability of time series .

The unit root test aims to examine the time series of each of the variables of the function under study and confirm the stability of the economic time series and determine the integration

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as the study variables are different in their stability ranks, so the models will be estimated according to the fully corrected squares method (FMOLS).

Table (3): shows the results of stabilization by the extended Dickey-Fuller method

Study variables(MDF)

UNIT ROOT TEST RESULTS TABLE (ADF)
Null Hypothesis: the variable has a unit root

		Y	X1	X2	X3	X4
		At Level				
With Constant	t-Statistic	-1.7399	-1.4819	-2.2120	-3.7999	-2.7292
	Prob.	*0.3995*	*0.5246*	*0.2073*	*0.0087*	*0.0845*
		n0	n0	n0	***	*
With Constant & Trend	t-Statistic	-2.0819	-2.2292	-1.4734	-3.6505	-4.8900
	Prob.	*0.5293*	*0.4527*	*0.8105*	*0.0464*	*0.0037*
		n0	n0	n0	**	***
Without Constant & Trend	t-Statistic	-0.9418	-1.3246	0.9083	-1.2079	-0.1221
	Prob.	*0.2989*	*0.1663*	*0.8972*	*0.2014*	*0.6308*
		n0	n0	n0	n0	n0
		At First Difference				
		d(Y)	d(X1)	d(X2)	d(X3)	d(X4)
With Constant	t-Statistic	-4.4117	-3.8618	-4.8413	-6.5876	-7.2400
	Prob.	*0.0022*	*0.0078*	*0.0008*	*0.0000*	*0.0000*
		***	***	***	***	***
With Constant & Trend	t-Statistic	-4.3095	-2.9246	-5.4665	-6.7094	-7.4102
	Prob.	*0.0125*	*0.1751*	*0.0011*	*0.0001*	*0.0000*
		**	n0	***	***	***
Without Constant & Trend	t-Statistic	-4.4877	-2.9723	-4.4232	-6.7259	-7.3953
	Prob.	*0.0001*	*0.0050*	*0.0001*	*0.0000*	*0.0000*
		***	***	***	***	***

Notes:
a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

difference (1) at a level of 1%, indicating the possibility of rejecting the hypothesis of nothingness and accepting The alternative hypothesis is that the strings of the variables of the function are stable and do not contain the root of unity . These results are consistent with the graph method, and it is not possible to use the ordinary least squares method (OLS) as long

approximately 78% of the variance is accounted for by the changes in the independent variables included in the estimated model, while 22% remains unexplained, attributable to variables not incorporated in the model and represented by the random variable.

Area and tomato production are directly correlated, with a 1dunum increase in area translating into a (2.78)tons increase in production, according to the coefficient of the independent variable area (X1), which is 2.784. Economically reasonable, this variable is important at the 5%

Source: prepared by the researcher based on the outputs of the program .(Eviews12)

Evaluation and analysis of the estimated regression function model based on the methodology: Fully Modified Ordinary Least Squares (FMOLS)

To estimate the production function of the tomato crop, the model is evaluated using the Fully Modified Ordinary Least Squares (FMOLS) approach. Table (4) reveals that the value of the adjusted determination coefficient (Adjusted R^2) is 0.78, indicating that

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(0.454)tons increase in production. This variable was significant at the 5% probability level, aligning with general economic principles.
The coefficient for the independent variable, water imports (4X), was positive, attaining a value of 3043.5. This indicates a direct correlation between water imports and tomato production, suggesting that a 1bilion m^3 /year increase in imports results in a (3043.5) tons increase in tomato production. However, this variable was not statistically significant at the 5% probability level.

probability level. Additionally, the coefficient for the independent variable local pricing (X2) is (649.5), indicating a direct correlation between tomato production and local price, with a 1Dinar/Kg increase in local price resulting in a (649.5) tons increase in production. Additionally, this variable has a 5% likelihood of being significant.
The parameter of the fertiliser independent variable (3x) was found to be positive, with a value of (0.454), indicating a direct correlation between fertilisers and production. Specifically, a 1ton increase in fertiliser results in a

Table (4) unit root testing using the Phelps-Peron method.

Dependent Variable: Y
Method: Fully Modified Least Squares (FMOLS)
Date: 12/01/25 Time: 21:01
Sample (adjusted): 2001 2024
Included observations: 24 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X1	2.784498	0.323690	8.602353	0.0000
X2	649.5278	207.1316	3.135821	0.0054
X3	0.454694	0.202988	2.240008	0.0372
X4	3043.519	2379.966	1.278808	0.2164
C	-365174.7	202821.0	-1.800478	0.0877

R-squared	0.822417	Mean dependent var	749416.0
Adjusted R-squared	0.785031	S.D. dependent var	248087.4
S.E. of regression	115025.1	Sum squared resid	2.51E+11
Long-run variance	1.06E+10		

Test for self-correlation: Q-statistical

To detect the problem of self-correlation, this test must be followed and it is shown through Table (5) that the values of the coefficients of self-correlation and partial self-correlation lie entirely within the confidence interval (), which means that the errors of the model represent random changes and the model is free from the problem

Diagnostic tests: diagnostic tests

Subsequent to estimation utilising the fully modified least squares approach (FMOLS). In instances where this method addresses discrepancies in the stability ranks of the variables, we will assess the study model to determine its efficacy. Several diagnostic tests are employed in this method to ascertain the validity of the utilised model.

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that there is no problem of self-correlation

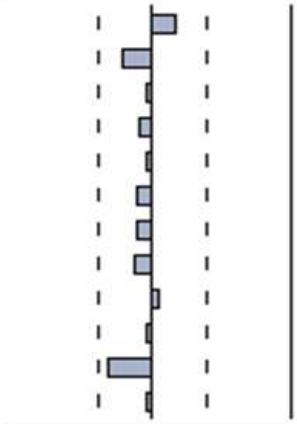
.

of self-correlation, from which we accept the hypothesis of nothingness

Table (5):) test for self-correlation

Correlogram of Residuals

Date: 12/01/25 Time: 21:08
Sample (adjusted): 2001 2024
Included observations: 24 after adjustments



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.186	0.186	0.9389	0.333
		2	-0.229	-0.273	2.4240	0.298
		3	-0.047	0.065	2.4901	0.477
		4	-0.091	-0.176	2.7466	0.601
		5	-0.048	0.020	2.8233	0.727
		6	-0.111	-0.195	3.2478	0.777
		7	-0.108	-0.051	3.6783	0.816
		8	-0.117	-0.212	4.2147	0.837
		9	0.061	0.105	4.3687	0.886
		10	-0.029	-0.257	4.4054	0.927
		11	-0.333	-0.324	9.7146	0.556
		12	-0.025	-0.064	9.7462	0.638

*Probabilities may not be valid for this equation specification.

Source: prepared by the researcher using the program's results.(Eviews12)

both tests remain within the critical boundaries at the 5% significance level, it indicates that all parameters are stable. The estimate remains static, exhibiting no structural alterations. Figure 5 illustrates the cumulative sum of the residuals, which remains within critical limits at a significance level of 5%. This indicates the absence of structural changes, confirming that long-term parameters align with short-term parameters. Additionally, Figure 5 reveals that the cumulative sum of the squares of the residuals (CUSUM Sq) indicates parameter stability throughout the study period, although deviations from critical limits at the 5% level occurred in 2014 and 2015, signifying structural changes in tomato production.

The estimated model's stability was tested using the CUSUM Squares test, CUSUM for the impact of tomato production in Iraq during that time.(2001–2024).

The structural stability assessment of the FMOLS estimated model concerning short- and long-term relationships, utilising the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUM of squares), is a pivotal examination in this domain. It serves to confirm two critical aspects: firstly, the data employed in the study are devoid of structural changes; secondly, if the graphs of



Figure (5) Stability assessment of the estimated model utilising the CUS and CUS Squares tests for the tomato production function in Iraq from 2001 to 2024.

As shown in Figure (6), the JB test verified that the residuals had a normal distribution. With a JB statistic of 0.498, the likelihood level was more than 5%. As a result, we accept the null hypothesis that the residuals of the model have a normal distribution.

Testing the normal distribution of residues (JB)

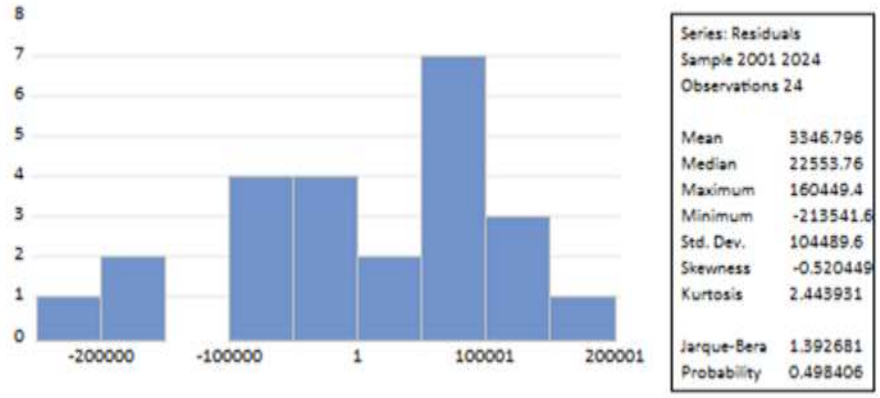


Figure (6): testing the normal distribution of residues

Conclusions :

1. Through the data of Table (1), it was shown that there is a clear fluctuation in the production of tomato crop during the study period due to the impact of production by economic, climatic and marketing factors.
2. There is a noticeable decrease in production during the years (2014, 2015, 2016) due to the security conditions (the period of military operations against the Islamic State) of some provinces.
3. The research confirmed that the increase in production is not limited to horizontal expansion, but is also associated with the efficient

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series continuously to predict agricultural production, which helps to develop agricultural plans in the future.

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use of agricultural resources .

4. The results showed that it is possible to increase the production of tomato crop in the future if government support is provided, modern technologies are used and agricultural and marketing services are improved for farmers.
5. The study confirmed that the adoption of standard analysis methods and time series is very important for predicting tomato crop production and developing agricultural plans in the future.

Recommendations:

1- the state should provide government support to the agricultural sector by providing production requirements at government subsidized prices, such as seeds, fertilizers and pesticides, as well as agricultural financing through granting agricultural loans and improving marketing mechanisms

2- Support the security and economic stability in agricultural lands due to their direct impact on the stability of agricultural production and increase

3- using modern irrigation technologies to rationalize water consumption and increase efficient agricultural production.

4- work to reduce the amount of imported tomatoes during the local production seasons to protect the national product

5- carrying out standard and statistical analysis and time

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