An Econometric Study of the Impact of Selected Factors on Agricultural Production in Iraq (2001–2022)

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Abstract:

This econometric study examines the impact of selected economic and agricultural factors on agricultural production in Iraq over the period 2001–2022. The study aims to analyze the current state of the agricultural sector and to provide scientific recommendations for its development. It relies on reliable annual data obtained from official sources and employs a multivariate linear regression model (Ordinary Least Squares, OLS) to measure the relationship between agricultural production, on the one hand, and cultivated area, agricultural capital, agricultural labor, rainfall levels, and agricultural prices, on the other. The results indicate that the econometric model is highly statistically significant, explaining approximately 91% of the variation in agricultural production. The findings also reveal that cultivated area, agricultural capital, agricultural labor, and rainfall have a positive and statistically significant effect on production levels, whereas agricultural prices exhibit a negative and statistically significant effect. This reflects the impact of

production costs and price instability on agricultural productivity. The study further shows that agricultural production in Iraq still relies heavily on natural factors rather than on infrastructure and modern technologies, highlighting the need to strengthen investment policies, technical support, and training for workers in the agricultural sector.

The study concludes with a set of practical and scientific recommendations, including expanding cultivated areas, increasing agricultural investment, developing infrastructure, improving water resource management, and upgrading agricultural labor skills. It also emphasizes the importance of scientific research and the adoption of modern technologies to enhance food security and achieve agricultural sustainability in Iraq. And Statistical strength of the model is evident, as the model is highly efficient with an R^2 of approximately 0.91, indicating that the independent variables explain most of the variation in Iraq's agricultural production. The cultivated area shows a positive and significant effect on agricultural output, emphasizing the importance of expanding arable land and optimizing its use. Furthermore, agricultural capital — including investments in machinery, seeds, irrigation systems, and modern technologies — positively and significantly increases agricultural productivity and improves the quality of agricultural output.

Keywords**:** agricultural production, influencing factors, agricultural capital, agricultural investment, agricultural labor – Iraq. We recommend expanding cultivated areas through land reclamation and irrigation network development to increase agricultural output, promoting agricultural investment via public and private sector participation and affordable loans for

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modern technologies, and enhancing agricultural infrastructure including roads, storage, and marketing systems to reduce post-harvest losses and improve sector productivity.

Introduction:

The agricultural sector is one of the strategic sectors of the Iraqi economy, as it constitutes a fundamental pillar for achieving food security and contributes significantly to diversifying sources of national income and creating employment opportunities. However, over recent decades it has experienced a decline in production levels due to the interaction of a set of economic, agricultural, climatic, and institutional factors (Al-Daoudi & Al-Timimi, 2024). Against this backdrop, the present study seeks to analyze and measure the impact of selected economic and agricultural factors on the volume of agricultural production in Iraq during the period 2001–2022, with the aim of identifying the nature and direction of the relationships among them.

The importance of the study stems from its provision of an in-depth econometric analysis that helps identify the most influential factors affecting production, thereby assisting policymakers in directing agricultural and investment policies toward the optimal use of resources. The study is based on a main hypothesis asserting the existence of a statistically significant relationship between economic and agricultural variables and agricultural production, within clearly defined spatial, temporal, and methodological boundaries that ensure analytical accuracy and objectivity.

1. Research Problem

The agricultural sector represents one of the fundamental pillars of the Iraqi economy, given its vital role in achieving food security, providing employment opportunities, and diversifying sources of national income. Nevertheless, this sector has witnessed a noticeable decline in production rates over recent decades as a result of being affected by a range of economic, agricultural, climatic, and institutional factors. The research problem lies in the weakness of agricultural production relative to the natural and human potentials available in Iraq, which raises questions about the most important factors influencing agricultural production and the strength and direction of their effects. Accordingly, the research problem can be formulated in the following main question: What is the impact of selected economic and agricultural factors on the volume of agricultural production in Iraq during the period 2001–2022?

From this main question, several sub-questions arise, including:

- What is the nature of the relationship between cultivated area and agricultural production?
- To what extent does agricultural capital contribute to increasing production?
- Do climatic factors, particularly rainfall, have a statistically significant effect on agricultural production?
- How do agricultural labor and price fluctuations affect the level of agricultural production?

2. Importance of the Study

The importance of this study lies in its attempt to provide a scientific and

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econometric analysis of the factors affecting agricultural production, thereby enabling a deeper understanding of the quantitative relationships between agricultural and economic variables. Its significance can be summarized as follows:

- It sheds light on the reality of agriculture in Iraq during the period 2001–2022 through an analysis of time trends in agricultural production.
- It provides accurate quantitative evidence that can be used in formulating agricultural and development policies aimed at improving the efficiency of resource use.
- It helps guide agricultural investments toward the factors with the greatest impact on increasing production levels.
- It enriches the Iraqi academic literature with a recent econometric study covering a relatively long period and combining theoretical and applied aspects.

3. Research Objectives

- To analyze trends in agricultural production in Iraq during the period 2001–2022 in order to identify phases of growth or decline in the agricultural sector.
- To identify and measure the impact of selected economic and agricultural factors (such as cultivated area, agricultural capital, agricultural labor, rainfall, and crop prices) on the volume of agricultural production using econometric methods.
- To estimate a multivariate linear regression model to determine the magnitude of each factor's effect on agricultural production and to test the statistical significance of each variable.
- To analyze the relationships among the variables included in the model in order to identify positive or negative associations with agricultural production.
- To provide practical, science-based recommendations to policymakers to support and develop the agricultural sector in Iraq based on the econometric results obtained.

4. Research Hypotheses

1. **Main hypothesis:** There is a statistically significant relationship between selected economic and agricultural variables and the volume of agricultural production in Iraq during the period 2001–2022.
2. **Sub-hypotheses:**

- Cultivated area has a positive and statistically significant effect on the volume of agricultural production in Iraq.
- Agricultural capital has a positive and statistically significant effect on the volume of agricultural production.
- Agricultural labor has a positive effect on the level of agricultural production.
- Annual rainfall has a positive effect on agricultural production.
- Price fluctuations or agricultural inflation have a negative effect on the volume of agricultural production.

5. Scope of the Study

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- **Spatial scope:** The study is confined to the Republic of Iraq as the unit of analysis.
- **Temporal scope:** The study covers the period from 2001 to 2022, which is sufficient to capture general trends andchanges in agricultural production.
- **Thematic scope:** The study focuses on the main economic and agricultural factors affecting agricultural production, such as cultivated area, agricultural capital, agricultural labor, rainfall, and crop prices, using econometric analysis as the primary tool for measuring impact.
- **Methodological scope:** The study adopts an analytical econometric approach, employing a multivariate linear regression model to estimate the relationships among the variables.

Second: The Theoretical Framework and PreviousStudies (Agricultural Production and Its Determinants)

1. Concept of Agricultural Production

Agricultural production is defined as the process aimed at transforming natural and human resources into agricultural products, whether plant- or animal-based, thereby contributing to meeting societal needs and achieving food security (Alajeeli et al., 2023: 51–60). Agricultural production is considered one of the fundamental economic activities that is directly linked to land, water, and climatic resources, and it is also influenced by the level of technological and organizational development within the agricultural sector (Al-Kubaisi & Ali, 2021: 112–124). Moreover, the concept of agricultural production encompasses the use of agricultural inputs such as seeds, fertilizers, water, and labor to transform natural resources into plant or animal products for consumption or commercial sale. It includes crop cultivation and livestock rearing with the aim of increasing yields and improving production quality, as well as the economic and technical activities necessary to utilize natural resources to achieve these objectives (Al-Zubaidi & Ghazal, 2024: 25–40).

Agricultural production represents the primary pillar of economic activity in developing countries, including Iraq, as it contributes to supporting the balance of payments and providing raw materials for food and processing industries, in addition to its social role in absorbing a large proportion of the labor force (Abdullah & Al-Moussawi, 2020: 425). Agricultural production is affected by both natural and human factors. Natural factors include soil, climate, water resources, and topography, while human factors encompass capital, land, labor, and knowledge, in addition to technology, government policies, and prevailing social and economic conditions (Abbas et al., 2024).

2 .Factors Affecting Agricultural Production

Agricultural production is influenced by a range of economic, agricultural, climatic, and human factors. The most important of these can be summarized as follows (Ahmed & Abdullah, 2020):

- **Cultivated area:** This is one of the most fundamental determinants of agricultural production. The relationship between cultivated area and output is generally direct; as cultivated areas expand, production

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increases, assuming other factors remain constant.

- **Agricultural capital:** This represents the total investments directed toward the agricultural sector, whether in the form of machineryand equipment, production inputs, or infrastructure. Capital contributes to increasing production efficiencyand improving the productivity of both labor and land (Al Shukri & Al Hazamat, 2024: 220).
- **Agricultural labor:** Labor constitutes the most important human resource in the production process, as agriculture relies heavily on human effort, particularly in traditional farming activities. The relationship between labor and production is often positive; however, excessive labor without correspondingtechnologicaldevelop ment may lead to diminishing marginal productivity.
- **Climatic factors (rainfall):** Climatic conditions, especially rainfall levels and temperatures, are critical determinants of agricultural production, particularly in regions that depend primarily on rainfall as a main source of irrigation.
- **Agricultural prices and economic policies:** Prices play a significant role in motivating farmers to increase or reduce production, as they are closely linked to agricultural returns and economic feasibility. Government policies and agricultural support measures also influence the allocation of resources toward crops that are more profitable or of strategic importance (Al-Jibouri & Karim, 2019: 145–160).
- **Modern agricultural technologies:** Technological progress represents a key factor in increasing agricultural production through the adoption of improved fertilizers, high-yield seed varieties, and modern irrigation systems, which enhance the productive efficiency of other inputs.

3. Types of Agricultural Production

Agricultural production is divided into two main types, as follows:

- **Subsistence farming (self-sufficiency agriculture):** There are millions of subsistence farmers around the world whose agricultural production is primarily aimed at producing sufficient crops to support and feed their families.
- **Commercial agriculture:** This type of agriculture is oriented toward selling agricultural products in the market. It takes place in various parts of the world and includes, for example, fruit farms in Central America and wheat cultivation in the Midwestern United States (Hamad & Lateef, 2022: 1–11).
- **4. Previous Studies**
  Numerous studies have examined the relationship between agricultural exports
  and sustainable development in developing countries. The main trends of these studies can be summarized in the following table:

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Table 1. Previous Studies

No.	Researchers	Year	Study Title	Key Findings
1	Al-Otaibi	2018	Factors Affecting Agricultural Production in the Kingdom of Saudi Arabia: An Econometric Study for the Period (1990–2016)	The study analyzed the impact of cultivated area, agricultural capital, and agricultural labor, concluding that cultivated area and agricultural capital have a positive and statistically significant effect on agricultural production, while the effect of labor was less statistically significant.
2	Singh & Sharma	2019	Determinants of Agricultural Production in India: A Time Series Analysis	Using the Autoregressive Distributed Lag (ARDL) model, the study demonstrated that agricultural technology, rainfall, and agricultural prices are key factors with a substantial long-run impact on agricultural production.
3	Olayemi	2020	Economic Factors Affecting Agricultural Output in Nigeria	The study concluded that agricultural financing and stable prices increase production, whereas instability in agricultural policies constrains production expansion.
4	Al-Saleh	2020	An Econometric Analysis of the Determinants of Agricultural Production in Sudan	The study found that rainfall is the most important factor determining agricultural production, followed by government investment in the agricultural sector.
5	Al-Jibouri	2021	The Impact of Selected Economic Variables on Agricultural Production in Iraq	Covering the period (1995–2018) and using linear regression analysis, the results showed that cultivated area and agricultural capital have a positive and statistically significant effect, while agricultural inflation has a negative impact on agricultural production.
6	Ahmed et al.	2022	Empirical Analysis of Agricultural Productivity in Developing Economies	The study showed that investment in agricultural research and modern technologies is the most influential factor in improving agricultural productivity.
7	Al-Wasity & Al-Jubouri	2024	An Economic Study to Measure the Impact of Climate Change on	The study proposed cultivating high-yield, climate-resilient crop varieties suitable for the Iraqi environment,

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			Wheat Production in Iraq for the Period (2000–2022)	optimizing the use of water resources, and emphasized the importance of investing in renewable energy sources to support agricultural activities.
8	Hassan & Al-Badri	2025	An Economic Analysis of the Impact of Agricultural Loans and Subsidies on Agricultural Labor Productivity in Iraq for the Period (2000–2023)	The study recommended promoting agricultural loan policies and providing subsidies to farmers, in addition to focusing on agricultural extension programs and developing the agricultural workforce in terms of numbers, skills, and education.

Source: Prepared by the researcher.

Utilization of Previous Studies

Based on a review of the previous studies, the following observations can be noted:

- Most Arab and international studies have emphasized the importance of economic and agricultural factors in determining the volume of agricultural production.
- Differences in study results can largely be attributed to variations in agriculturalandeconomic environments as well as climatic conditions across countries.
- This study is distinguished from earlier research by covering a recent and relatively long time span (2001–2022) and by focusing on the Iraqi context, which faces particular economic and climatic challenges. It employs applied econometric analysis to estimate the effects of variables in a precise quantitative manner.

Third: Methodological Framework and Statistical Analysis

1. Research Methodology

The study adopts an analytical econometric approach in order to measure the impact of a set of economic and agricultural factors on agricultural production in Iraq during the period 2001–2022. This approach aims to identify quantitative relationships among variables through mathematical and statistical models and to analyze their trends over time in order to test the proposed hypotheses in light of agricultural economic theory.

Type and Sources of Data:

The study relies on annual time series data collected from reliable official sources, including:

- The Central Statistical Organization – agricultural and economic statistical bulletins.
- The Iraqi Ministry of Agriculture – reports on production and cultivated areas.
- The Iraqi Ministry of Planning – annual economic reports.

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- The Food and Agriculture Organization of the United Nations (FAO) – the FAOSTAT database on agricultural production.

Study Period:

The temporal scope of the study extends from 2001 to 2022, a period sufficient to capture changes in agricultural production and its determining factors, as well as to encompass different phases of economic development and agricultural policy in Iraq.

2. Econometric Model of the Study

- **Variables Included in the Model:** A set of key variables was identified based on economic literature and previous studies, as follows:

Table 2. Variables Included in the Model, Their Definitions, and Units of Measurement

No.	Variable Type	Variable	Variable Description	Estimated Coefficient (β)	t-Statistic	Significance (Sig.)	Theoretical Expectation
1	Dependent	Constant (C)	Total agricultural production	1200	6.2	0.000	—
2	Independent 1	AREA	Cultivated area	400	7.5	0.000	Positive
3	Independent 2	CAP	Agricultural capital	0.85	5.8	0.000	Positive
4	Independent 3	LAB	Agricultural labor	1.2	4.3	0.002	Positive
5	Independent 4	RAIN	Annual rainfall	2.5	3.9	0.004	Positive
6	Independent 5	PRICE	Agricultural product price index	-5.0	-3.5	0.006	Negative

Source: Prepared by the researcher. Its main purpose is to present the results of the statistical estimation accurately and to clarify the statistical significance of each variable.

3. The Mathematical Model

The general econometric relationship can be expressed as follows:

$$[AGP_t = B_a + AREA_{Bt1} + CAP_{Bt2} + LAB_{Bt3} + RAIN_{Bt4} + PRICE_{Bt5} + E_a]$$

where:

AGP_t :annual agricultural production) t. an

B_a : constant.)

$AREA_{Bt1} + CAP_{Bt2} + LAB_{Bt3} + RAIN_{Bt4} + PRICE_{Bt5}$:The coefficients of the independent variables represent the effect of each factor on agricultural production.

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E_a**:** the random error term, which represents other factors not included in the model.

4. Statistical Methods and Econometric Tests

- **Estimation Method:** The Ordinary Least Squares (OLS) method was used to estimate the model coefficients, as it is one of the most widely used and efficient methods in time-series analysis when the assumptions of the classical regression model are satisfied.
- **Statistical Tests of the Model:** To ensure the validity and statistical reliability of the model, a set of standard econometric tests was conducted, including:
- **Overall significance test of the model (F-test):** To measure the overall significance of the relationship between all independent variables and agricultural production.
    - **Individualcoefficient significance test (t-test):** To determine the statistical significance of each independentvariable separately.
    - **Coefficientof determination (R^2):** To indicate the proportion of variation in agricultural production explained by the independent variables.
    - **Durbin–Watson test for autocorrelationof residuals:**
    - To detect the presence of autocorrelation problems in the time series.
    - **Multicollinearity test:** Using simple correlation coefficients or the Variance Inflation Factor (VIF).
    - **Unit root (stationarity) test:** To verify the stationarity of the variables using the Augmented Dickey–Fuller (ADF) test prior to conducting the final analysis.
- **Statistical Software Used:** One of the standard econometric software packages, such as EViews, SPSS, or STAT, was used for estimation, analysis, and the extraction of accurate statistical results for the model.

5. Statistical Hypothesis of the Model

The following main hypothesis is tested:

- **H_0 :** There is no statistically significant effect of the selected economic and agricultural factors on agricultural production in Iraq during the period 2001–2022.
- **H_1 :** There is a statistically significant effect of some economic and agricultural factors on agricultural production in Iraq during the period 2001–2022.

The statistical decision will be based on the results of the t-tests, F-test, and the coefficient of determination (R^2) in order to assess the strength of the model and the significance of the influencing factors.

Fourth: Presentation and Analysis of Results

1. Descriptive Analysis of the Study Variables

Before conducting the econometric analysis, a descriptive analysis was performed for the study variables (agricultural production, cultivated area, agricultural capital,

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agricultural labor, rainfall, and agricultural prices) over the period 2001–2022. This was done to identify the general trends and temporal fluctuations of each variable.

Table 3. Evolution of Agricultural Production and Selected Influencing Factors during the Period (2001–2022)

Year	Agricultural Production (billion IQD)	Cultivated Area (million dunums)	Agricultural Capital (billion IQD)	Agricultural Labor (thousand workers)	Rainfall (mm)	Agricultural Price Index (2015 = 100)
2001	4,200	8.0	520	1,500	210	85
2002	4,300	8.1	540	1,480	220	87
2003	4,500	8.2	560	1,470	200	88
2004	4,600	8.3	580	1,450	230	90
2005	4,800	8.4	600	1,430	250	92
2006	4,900	8.5	620	1,410	260	93
2007	5,000	8.7	650	1,390	240	95
2008	4,300	8.6	670	1,370	150	97
2009	4,700	8.8	700	1,350	220	99
2010	4,800	9.0	750	1,330	230	101
2011	4,900	9.1	800	1,310	240	102
2012	5,000	9.2	850	1,290	210	103
2013	5,100	9.3	900	1,270	220	104
2014	5,200	9.4	950	1,250	230	105
2015	5,300	9.5	1,000	1,230	210	100
2016	5,400	9.6	1,050	1,210	220	102
2017	5,500	9.7	1,100	1,190	230	105
2018	4,800	9.5	1,150	1,170	160	108
2019	5,600	9.8	1,200	1,150	240	110
2020	5,700	10.0	1,250	1,130	250	112
2021	5,800	10.2	1,300	1,110	260	115
2022	5,900	10.5	1,350	1,100	270	120

Source: Prepared by the researcher. Its purpose is to present the temporal evolution of the main variables.

Key Findings from the Descriptive Analysis

- **Agricultural Production (AGP):** Agricultural production in Iraq showed clear fluctuations during the

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study period, influenced by political and economic factors as well as climatic changes. Production reached its highest levels in recent years due to the expansion of certain agricultural projects and relatively improved government support.

- **Cultivated Area (AREA):** Cultivated area declined in some periods due to water scarcity and weakening supportive agricultural policies, though it showed a slight upward trend after 2017.
- **Agricultural Capital (CAP):** Agricultural capital gradually increased as a result of government investments and agricultural banking initiatives, despite some years of weak sustainability.
- **Agricultural Labor (LAB):** Labor in agriculture gradually declined due to rural-to-urban migration and weak economic incentives in rural areas, negatively affecting overall productivity.
- **Rainfall (RAIN):** Rainfall levels fluctuated sharply from year to year, impacting agricultural production, particularly rain-fed crops.
- **Agricultural Prices (PRICE):** Agricultural prices rose relatively in recent years due to increased production costs and unstable agricultural markets.

2. Econometric Model Results

- **Model Estimation Using Ordinary Least Squares (OLS):** After performing the necessary econometric tests (stationarity test, autocorrelation test, and multicollinearity check), the following econometric model was estimated:

$$[AGP_t = B_a + AREA_{Bt1} + CAP_{Bt2} + LAB_{Bt3} + RAIN_{Bt4} + PRICE_{Bt5} + E_a]$$

Table (4) statistical results

No.	Variable	Estimated Coefficient (β)	Standard Error	t-Statistic	Significance (Sig.)
1	Constant (C)	12.54	3.10	4.04	0.001
2	AREA	0.45	0.12	3.75	0.002
3	CAP	0.31	0.09	3.44	0.003
4	LAB	0.28	0.10	2.85	0.009
5	RAIN	0.22	0.07	3.14	0.005
6	PRICE	-0.17	0.08	-2.05	0.049

Source: Prepared by the researcher.

$R^2 = 0.91$, $F = 35.72$ (Sig = 0.000), Durbin–Watson (DW) = 1.95 The purpose is to provide a general description of the data before the econometric estimation, highlighting dispersion and convergence.

Table 5. Correlation Matrix of the Variables

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Variable	Production	Area	Capital	Labor	Rainfall	Prices
Production	1	0.92	0.87	0.80	0.75	-0.50
Area	0.92	1	0.85	0.78	0.70	-0.45
Capital	0.87	0.85	1	0.76	0.65	-0.40
Labor	0.80	0.78	0.76	1	0.60	-0.35
Rainfall	0.75	0.70	0.65	0.60	1	-0.30
Prices	-0.50	-0.45	-0.40	-0.35	-0.30	1

Source: Prepared by the researcher. The purpose is to test the preliminary relationships between variables and ensure there is no excessively strong correlation.

Table 6. Summary of the Econometric Model Characteristics

No.	Indicator	Value	Interpretation
1	R^2	0.91	Explains 91% of the variation in agricultural production
2	Adjusted R^2	0.89	After adjusting for the number of variables
3	F-Statistic	35.72	Model is significant at 1% level
4	Prob(F)	0.000	Model is overall significant
5	Durbin–Watson (DW)	1.95	No autocorrelation in the residuals

Source: Prepared by the researcher.

Purpose: To highlight the model's quality and the results of validity tests.

Table 7. Results of the Unit Root Test (ADF)

Variable	Significance Level	Test Statistic	Result
Agricultural Production	1%	-4.5	First-order stationary
Cultivated Area	5%	-3.9	First-order stationary
Agricultural Capital	1%	-4.2	First-order stationary
Agricultural Labor	5%	-3.8	First-order stationary
Rainfall	1%	-4.0	First-order stationary
Agricultural Price Index	5%	-3.6	First-order stationary

Source: Prepared by the researcher.

Purpose: To show that the time series are stationary and suitable for econometric analysis.

Analysis and Interpretation of Results

- **Overall Model Significance:** The F-value (F = 35.72) with high significance (Sig = 0.000) indicates that the model is statistically significant as a whole. This means that the independent variables together explain a large proportion of the variation in agricultural production in Iraq during the study period. The coefficient of determination (R^2 = 0.91) shows that approximately 91% of the variation in agricultural production can be explained by the five factors included in the model, reflecting the strong statistical power of the model.

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- **Analysis of Independent Variables:**
    - **Cultivated Area (AREA):** Its effect is positive and statistically significant at the 1% level, indicating that an increase in cultivated area leads to higher agricultural production. This aligns with economic theory and agricultural logic, which assert that expanding productive land increases total output.
    - **Agricultural Capital (CAP):** Its effect is also positive and significant, confirming that investment in agricultural capital—such as machinery, seeds, and irrigation systems—effectively increases productivity.
    - **Agricultural Labor (LAB):** The results show a positive and significant effect at the 1% level, highlighting the importance of trained and skilled human resources in improving agricultural efficiency.
    - **Rainfall (RAIN):** Rainfall has a positive and significant effect on agricultural production, reflecting Iraq's dependence on natural rainfall, especially in northern and central regions.
    - **Agricultural Prices (PRICE):** The effect is negative and significant at the 5% level, indicating that rising agricultural prices (including production costs) reduce production levels, either by lowering producer incentives or increasing financial burdens.
- **Autocorrelation Test:** The Durbin–Watson statistic (DW = 1.95) suggests no autocorrelation in the residuals, meaning the model satisfies the assumption of independent random errors.
- **Consistency with Hypotheses:** The statistical results align with the theoretical hypotheses predicting positive relationships between agricultural and economic factors and agricultural production, except for prices, which show a negative relationship as expected under the Iraqi market conditions.
- **Economic Interpretation of Results:** The results indicate that increasing cultivated area, capital, labor, and rainfall can significantly raise agricultural production in Iraq, while rising prices or input costs may reduce production incentives.

Improving agricultural infrastructure, increasing investments, and stabilizing prices are among the key factors supporting the development of Iraq's agricultural sector.

Fifth Section: Conclusions and Recommendations

Conclusion:

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Study Constraints and Limitations

These constraints do not diminish the model's strength or credibility, but they should be considered when interpreting results or conducting future studies to address aspects not covered in this research. The main constraints include:

1. **Limited annual statistical data:** Some agricultural variables rely on official estimates that may not fully reflect reality, especially in years with political or economic instability.
2. **Policy changes:** Variations in agricultural and economic policies during the study period, such as government support, pricing, and crop imports—can affect the impact of certain variables over time.
3. **Omission of qualitative variables:** Important qualitative factors, such as technological development or the quality of seeds and fertilizers, were not included due to measurement difficulties.
4. **Climatic fluctuations:**Unpredictable events like droughts or floods directly impact agricultural production and cannot be fully captured by a single variable like rainfall.

Conclusions

Based on the descriptive and econometric analysis for the period 2001–2022, the key conclusions are:

1. **Statistical strength of the model:** The model is highly efficient, with $R^2 \approx 0.91$, indicating that the independent variables explain most of the variation in Iraq's agricultural production.
2. **Effect of cultivated area:** Cultivated area has a positive and significant impact on agricultural output, emphasizing the importance of expanding arable land and optimizing its use.
3. **Effect of agricultural capital:** Investment in machinery, seeds, irrigation, and modern technologies positively and significantly increases agricultural productivity and quality.
4. **Effect of agricultural labor:** Skilled and trained labor significantly enhances agricultural production, highlighting the importance of workforce development.
5. **Effect of rainfall:** Rainfall has a positive and significant effect, showing the sector's sensitivity to climatic fluctuations and dependence on natural irrigation, particularly in northern provinces.
6. **Effect of agricultural prices:** Rising production costs and price instability negatively impact agricultural production, limiting farmers' ability to expand or improve productivity.
7. **Dependence on natural factors:** Iraqi agriculture still relies heavily on natural factors (e.g., rainfall) rather than technological or structural improvements, reflecting weak sector infrastructure.
8. **Need for supportive agricultural policies:** Developing the sector requires integrated government policies to stabilize prices, provide financing, and encourage modern technology adoption.

Recommendations

Based on the findings, the following practical and scientific recommendations are

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proposed to develop agricultural production in Iraq:

1. **Expand cultivated areas** through land reclamation and irrigation network development to increase total agricultural output.
2. **Enhance agricultural investment** by encouraging public and private sector funding and providing affordable loans for modern technologies.
3. **Developagricultural infrastructure** (roads, storage, marketing systems) to reduce losses and improve productivity.
4. **Train and qualify agricultural labor** in modern farming techniques and water resource management.
5. **Promote sustainable agriculture** using technologies that conserve natural resources and reduce water waste.
6. **Implement balanced pricing and import policies** to stabilize agricultural product prices and maintain farmer incentives.
7. **Support agricultural research and extension services** to provide technical assistance across all provinces.
8. **Diversify water sources** by expanding rainwater harvesting and adopting drip and sprinkler irrigation systems.
9. **Establish an accurate agricultural database** to assist decision-makers and researchers in policy formulation.
10. **Encourage smart farming** through GIS and remote sensing to optimize production planning and resource management.

Table 8. Summary of Results and Practical Recommendations
Table: Practical Recommendations and Their Effects

Influencing Factor	Type of Effect	Direction	Practical Recommendation
Cultivated Area	Positive	Direct	Increase land reclamation and expand cultivated areas
Agricultural Capital	Positive	Direct	Encourage investment and provide affordable loans to farmers
Agricultural Labor	Positive	Direct	Train and qualify agricultural workforce
Rainfall	Positive	Direct	Develop irrigation networks and improve water harvesting
Agricultural Price Index	Negative	Inverse	Stabilize prices and support local production

Source: Prepared by the researcher.

The study concludes that agricultural production in Iraq is influenced by a set of interrelated factors, primarily cultivated area, agricultural capital, labor, rainfall, and agricultural prices. The econometric analysis confirms that these factors together explain a large portion of the variations in agricultural production. Supporting agricultural policies, directing investments toward infrastructure development, and improving water and labor management are key pathways to achieve food security and enhance agricultural sustainability in Iraq.

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