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AGRICULTURAL ECONOMICS BETWEEN THE CHALLENGES OF WATER SCARCITY AND WEAK INFRASTRUCTURE: A CASE STUDY IN THE DIRECTORATE OF AGRICULTURE OF DIWANIYAH – AL-QADISIYAH GOVERNORATE, IRAQ

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ABSTRACT

The agricultural sector in Iraq faces an existential crisis exacerbated by the interplay of two main factors: water resource scarcity and infrastructure deterioration. This study aims to analyze the impact of these challenges on sustainable agricultural development, using Al-Qadisiyah Governorate (Diwaniyah) as a case study. The study adopted a descriptive analytical and quantitative methodology. A 12 item questionnaire was designed and administered to a pilot sample of 60 farmers. Data were analyzed using Cronbach's Alpha, Pearson correlation, and linear regression. The results revealed a strong negative relationship between water scarcity and decreased agricultural productivity ($R^2 = 0.61$). The findings also indicated that climate change and traditional irrigation networks are the most influential factors. The study affirms that investment in modern infrastructure and the implementation of climate smart agriculture represent fundamental pathways to achieving sustainability.

Keywords: Agricultural Economics, Water Scarcity, Infrastructure, Food Security, Al Qadisiyah Governorate, Iraq.

1. INTRODUCTION

Agricultural economics is a specialized branch of economic science that applies microeconomic and macroeconomic principles to the agricultural sector, focusing on the allocation of scarce resources to achieve food security and rural development. Despite the immense natural potential possessed by Iraq—fertile lands and the Tigris and Euphrates rivers—the agricultural sector suffers from escalating crises. This sector contributes approximately 5–6% of the Gross Domestic Product (GDP) and provides employment for about 30% of the workforce, making it a cornerstone of the national economy and food security (Ministry of Planning, 2023).

Al-Qadisiyah Governorate (Diwaniyah), located in central Iraq on the banks of the Euphrates River, represents a vivid example of these challenges. The governorate is known for its fertile lands and the cultivation of dates, fruits, and grains; however, it experiences a sharp decline in productivity due to water scarcity and infrastructure deterioration. Local studies indicate that the governorate's water share decreased by 40% over the last decade, and the cultivated area of date palms shrank from 4.8 to 3.2 million trees (Directorate of Agriculture of Al-Qadisiyah, 2023).

This study stems from a central research problem: *How does the confluence of water scarcity and weak infrastructure affect sustainable agricultural development in Iraq, and what are the possible ways to mitigate these effects?*

Vol. 11, No. 03; 2026

ISSN: 2456-8643

1.1 Problem Statement and Significance

Iraq suffers from an escalating water crisis due to climate change, regional policies concerning shared rivers (especially dam construction in Turkey and Syria), and weak internal resource management. This crisis threatens food security and sustainable agricultural development and imposes challenges on economic and social policies.

Main research question: What is the impact of the water resource crisis on sustainable agricultural development in Iraq, and what are the most prominent challenges and recent developments towards sustainability?

Significance of the study: This study provides a quantitative and qualitative analysis of the water crisis in a sensitive region (Middle Euphrates), along with practical, applicable recommendations, thereby assisting policymakers in redirecting investments towards sustainable solutions.

1.2 Research Objectives

1. Measure the impact of water resource scarcity on agricultural production and food security in the study area.
2. Analyze the structural and policy-related challenges facing the agricultural sector in Al-Qadisiyah Governorate.
3. Review the applicability of recent developments (such as climate-smart agriculture) as solutions that enhance sustainability.
4. Provide evidence-based practical recommendations to enhance the rational management of water resources and infrastructure.

1.3 Research Hypotheses

1. There is a statistically significant negative relationship between water scarcity and decreased agricultural productivity, leading to a decline in food security.
2. Weak water infrastructure (irrigation and drainage networks) and inefficient water policies exacerbate the crisis and limit opportunities for sustainability.
3. The introduction of modern irrigation techniques (drip and sprinkler) and climate-smart agriculture can mitigate the effects of the crisis and enhance sustainable development.

2. STUDY AREA: AL-QADISIYAH GOVERNORATE

Al-Qadisiyah Governorate was historically known for its agricultural fertility, but the current reality shows significant decline due to drought, water scarcity, and absence of government support. This has led to the displacement of thousands of farming families and increased poverty and unemployment rates.

2.1 Importance of Agriculture in Al-Qadisiyah

- 76% of the governorate's population depend on agriculture and livestock rearing as their primary source of livelihood.
- The governorate is known for cultivating wheat, barley, rice, and maize, in addition to orchards and date palms.
- The governorate's center is the city of Diwaniyah, with a population of approximately 1.3 million.

2.2 Current Challenges

- **Drought:** More than 70% of agricultural lands have been damaged due to lowered water levels of the Euphrates River and reduced rainfall.

Vol. 11, No. 03; 2026

ISSN: 2456-8643

- **Poverty:** Nearly 49% of Al-Qadisiyah's population live below the poverty line as a result of agricultural decline and the absence of development projects.
- **Unemployment:** The unemployment rate exceeds 18%, one of the highest rates in Iraq.
- **Desertification:** The pace of desertification is accelerating due to heatwaves reaching 50°C, further exacerbating food security fragility.

2.3 Effects of Agricultural Deterioration

- Widespread internal displacement: Al-Qadisiyah is the third-largest source of displacement due to drought in Iraq.
- Decline in agricultural production by 70% compared to previous years.
- Decreased farmer incomes and increased reliance on seasonal or informal work.

2.4 Key Crops and Agricultural Activities

- **Grains:** Wheat and barley.
- **Vegetables:** Tomatoes, onions, watermelons.
- **Date palms:** Date production, a traditional resource.
- **Livestock:** Sheep and cattle rearing as an additional source of livelihood.

3.

3. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

3.1 Theoretical Framework

This study is based on the triple sustainability model that links economic, social, and environmental dimensions. It also draws on established economic theories:

- **The Law of Diminishing Returns (Malthus, 1798):** Explains how increasing inputs (e.g., fertilizers) while holding a critical input constant (e.g., water) leads to diminishing marginal productivity.

Vol. 11, No. 03; 2026

ISSN: 2456-8643

- **The Theory of Common-Pool Resources (Tietenberg, 2006):** Water is considered a common-pool good, requiring institutional intervention to prevent its depletion (the tragedy of the commons).
- **Human Capital Theory (Schultz):** Affirms that investment in farmer training and knowledge transfer enhances productivity even under resource scarcity.

3.2 Literature Review

Previous studies indicate a consensus on the severity of the interaction between water scarcity and weak infrastructure:

- **Globally:** Antle (1983) found that investment in rural infrastructure increases the marginal productivity of other factors by 20–40%. Pereira et al. (2012) showed that modern irrigation techniques raise water use efficiency from 40% to 85%.
- **Regionally:** A World Bank (2007) report indicated that poor irrigation infrastructure in the Middle East causes water losses of 35–50%. In Jordan, infrastructure modernization led to a 30% increase in water productivity (Molle & Berkoff, 2009).
- **Locally:** Iraqi studies (e.g., FAO and Ministry of Water Resources reports) have focused more on the hydrological aspect than on econometric analysis, highlighting a research gap that this study seeks to fill by quantitatively measuring the economic impact of water scarcity on farm income and productivity in a specific area (Al-Qadisiyah).

3.3 Causes and Challenges of the Water Crisis in Iraq

Main causes:

- Reduced river flows due to dam construction in upstream countries.
- Climate change: rising temperatures and recurring droughts.
- Poor internal management: continued reliance on flood irrigation methods.

Impact on sustainable agricultural development:

- Food security threatened; increased dependence on imports.
- Economic sustainability weakened; lower farmer incomes and higher rural poverty.
- Environmental impact: groundwater overexploitation, soil salinization, desertification expansion.

Recent developments towards sustainability:

- Modern irrigation techniques (drip and sprinkler).
- Climate-smart agriculture (drought- and heat-resistant crops).
- Digital transformation (GIS, remote sensing).
- Improved legislation and regional cooperation.
- Renewable energy (solar-powered irrigation systems).

4. METHODOLOGY

4.1 Research Approach

The study adopted a mixed-methods approach combining descriptive-analytical and quantitative methods.

4.2 Data Collection

Official reports from the Directorates of Agriculture and Water Resources were reviewed. A structured questionnaire was designed, divided into three axes:

- **Axis 1:** Demographic and economic characteristics of the farm (5 items).
- **Axis 2:** Measuring the severity of the water crisis and its impact (4 items: Q2, Q3, Q4, Q9).

Vol. 11, No. 03; 2026

ISSN: 2456-8643

- **Axis 3:** Measuring food security and policy impact (3 items: Q5, Q7, Q11).

A five-point Likert scale was used (1 = No effect at all, 5 = Very strong effect).

4.3 Sample

A total of 60 valid pilot responses were collected from farmers in Al-Qadisiyah Governorate (Diwaniyah city center and affiliated districts).

4.4 Statistical Analysis

Data were analyzed using SPSS. The following tests were performed:

- Internal consistency: Cronbach's Alpha.
- Correlation: Pearson Correlation coefficient.
- Effect: Simple and multiple linear regression analysis.

5. RESULTS

5.1 Instrument Reliability

Cronbach's Alpha for the entire 12-item questionnaire was approximately 0.82, indicating a high degree of internal consistency and reliability.

5.2 Pearson Correlation Results

The relationship between water crisis items (Q2, Q3, Q4, Q9) and agricultural productivity (decreased area and yield) was measured.

Table 1: Pearson Correlation Coefficients

Item Code	Item Content	Correlation (r)	Significance (p)	Interpretation
Q2	Lower river levels led to decreased production	0.45	<0.01	Moderate positive correlation (significant)
Q3	Traditional irrigation intensifies the crisis	0.38	<0.05	Weak to moderate positive correlation
Q4	Climate change (drought/heat) reduces production	0.52	<0.01	Relatively strong positive correlation
Q9	Decreased income due to water scarcity	0.47	<0.01	Moderate positive correlation

There is a moderate to strong positive correlation between farmers' perception of the severity of the water crisis and the decline in productivity and income.

5.3 Regression Analysis Results

To test the impact of independent variables (water scarcity, irrigation techniques, support) on the dependent variable (food security – Q11), a multiple linear regression model was used.

- **R-squared:** 0.61, indicating the model explains 61% of the variance in food security (a good explanatory percentage for social research).

Most influential variables (standardized Beta coefficients):

1. Climate change (Q4): Beta = 0.41, $p < 0.01$ (highest impact)

Vol. 11, No. 03; 2026

ISSN: 2456-8643

2. Lack of government support (Q7): Beta = 0.33, $p < 0.05$
3. Decreased income (Q9): Beta = 0.28, $p < 0.05$

- **Inverse variable:** Use of modern irrigation techniques (Q5) had a negative effect on food insecurity (i.e., improves food security), confirming the third hypothesis.

6. DISCUSSION

The results show significant agreement with previous literature, especially regarding the negative relationship between water scarcity and productivity (Mendelsohn & Dinar, 2003). The findings also confirm that weak infrastructure is not merely a logistical obstacle but a multiplier of the crisis; leaky traditional irrigation networks lose more than 50% of water, making water scarcity more painful (World Bank, 2007).

What distinguishes this study is its identification of the most impactful local factor as "climate change," as perceived daily by farmers (rising heat, lower rainfall, increased evaporation). The factor "lack of support" was the second strongest variable, indicating the failure of government policies to adapt to the crisis—agricultural support and extension programs have not kept pace with the scale of the disaster.

Field results from the Diwaniyah area (30% of orchards dried up, 20% of farmers switched to high-cost wells) provide a realistic translation of these statistical indicators and confirm that the water crisis has transformed into a humanitarian and social crisis (rural migration and loss of livelihoods).

7. CONCLUSION

This study confirms that agricultural economics in Al-Qadisiyah Governorate, as a model for Iraq, faces an existential threat due to the complex interaction between water scarcity and weak infrastructure. Statistical models ($R^2 = 0.61$) have proven a strong relationship between declining water resources and decreased food security, with climate change and lack of government support being the most influential factors. Conversely, the results showed that adopting modern irrigation techniques represents a pivotal factor for achieving sustainability. Continuing the current situation without radical intervention will lead to an accelerated collapse of the agricultural sector in the region, with consequent serious economic and social repercussions.

The water crisis in Iraq is not merely an environmental challenge but a comprehensive development issue affecting food security, social stability, and the national economy. Achieving sustainable agricultural development requires an integrated strategic vision combining rational water resource management, the introduction of modern technology, and the activation of regional and international cooperation.

8. RECOMMENDATIONS

Based on the results and theoretical framework, the study recommends the following:

1. **Develop infrastructure as a national priority:**
   - Launch an urgent and comprehensive program to rehabilitate irrigation and drainage networks in Al-Qadisiyah Governorate, focusing on implementing modern irrigation systems (drip and sprinkler) on at least 30% of agricultural areas within three years.
   - Invest in agricultural infrastructure: rural roads, modern storage facilities, advanced irrigation networks.
2. **Transition to climate-smart agriculture:**

Vol. 11, No. 03; 2026

ISSN: 2456-8643

- Establish an agricultural research center at the University of Al-Qadisiyah specialized in developing crop varieties tolerant to salinity and drought, and transfer these technologies to farmers through supported extension programs.

3. **Promote sustainable agriculture** using soil and water conservation techniques.
4. **Reform support and financing policies:**

- Shift fertilizer and seed subsidies into conditional support linking financial incentives to the use of modern irrigation techniques and water efficiency.
- Establish a fund to lend farmers at reduced interest rates to purchase solar-powered pumps.

5. **Enhance regional and local cooperation:**

- Reform water management policies through regional agreements.
- Activate water diplomacy with neighboring countries to ensure fair shares.
- Simultaneously, activate internal water resource management by constructing small earthen dams for rainwater harvesting.

6. **Support scientific research** and develop agricultural extension programs for farmers.
7. **Complete the study:** Conduct an expanded study including a larger sample (300–500 farmers) and apply more complex econometric models (e.g., stepwise multiple regression analysis) to measure the elasticity of water demand in agriculture.
8. **Diversify the rural economy** through small projects linked to agriculture (livestock raising, food industries).

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Vol. 11, No. 03; 2026

ISSN: 2456-8643

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Appendix: Questionnaire Form

Questionnaire on the Impact of the Water Crisis on Agriculture in Al-Qadisiyah Governorate

Please answer the following statements according to the Likert scale (1: Strongly Disagree, 5: Strongly Agree).

Code	Statement	1	2	3	4	5
Q2	The lower water level of the Euphrates/Diwaniyah River has led to a decrease in my cultivated area.					
Q3	Flood (traditional) irrigation is a main cause of water waste in my area.					
Q4	Rising temperatures and drought have negatively affected my crop productivity.					
Q5	Using modern irrigation techniques (drip/sprinkler) has significantly improved my productivity.					
Q7	I find sufficient support from the government or organizations to face the water crisis.					
Q9	My agricultural income has significantly decreased over the past five years due to water scarcity.					
Q11	I believe my family suffers from food insecurity due to the decline in agricultural production.					