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Identifying the role played by climate change in agricultural productivity: evidence from Iraq

Fakhri Alajeeli*
Department of Medical Laboratories Technology, Al-Hadi University College, Baghdad, 10011, Iraq
Email: dr.fakhri.alajeeli@huc.edu.iq

Amenah Muayad Abdullah
College of education/ Al-Farahidi University, Baghdad , Iraq

Hussein Humedy Chlib Alkaaby
Department of Medical Laboratories Technology, Al-Manara College For Medical Sciences/ (Maysan)/Iraq
Email: usseinhumedy@uomanara.edu.iq

Ali Afrawi Fahad
Department of Education/ Mazaya university college /Iraq
Email: aliafrawi@hotmail.com

Ghaleb Yassin Farhan Matalak
college of education/ Al-Kitab University/ Iraq
Email: ghalib.yaseen@uoalkitab.edu.iq

Abas O. Hadi
Department of Optics, College of Health & Medical Technology, Sawa University, Almuthana, Iraq
abbas.omran.a@sawa-un.edu.iq

Akhlas Na'ama khudair
Medical laboratory technology/ Ashur University College/Baghdad/ Iraq
Email: akhlas.n.k@au.edu.iq

Ahmed Razzaq Al-Adday
Department of Computer Technical Engineering, Technical Engineering College, Al-Ayen University, Thi-Qar, Iraq
Email: aladday@alayen.edu.iq

Shaymaa Abdulhameed Khudair
Department of Medical Laboratories Technology, AL-Nisour University College/ Baghdad/ Iraq
Email: shaymaa.h.path@nuc.edu.iq

Ahmed Ayad Abdo Al-qader
College of Pharmacy/ National University of Science and Technology, Dhi Qar, Iraq
Email: ahmed.ayad@nust.edu.iq

Corresponding author:
Fakhri Alajeeli;
Email: r.fakhri.alajeeli@huc.edu.iq

This research focuses on examining the impact of climate change on agricultural productivity (AP) in Iraq, considering factors such as CO_2 emissions (EQ), average rainfall (RAIN), temperature (TEMP), arable area (AA), energy consumption (EC), and agricultural employment (EA). GDP per capita (GDPC) and urbanization (UP) are also studied as control variables. The study employs quantitative secondary research using time series data from 2000 to 2021 and utilizes ordinary least squares to analyze the data collected from the World Development Indicators. EA has a positive but insignificant influence on agricultural productivity, while EC and its lagged value show negative and insignificant impacts. Conversely, the present value of EQ negatively impacts AP, while lagged value has a positive impact on AP. Both results are significant. Additionally, RAIN, REA, and AA are found to have positive impacts on AP, with RAIN and AA showing significance. GDPC, UP, and temperature exhibit insignificant impacts on AP. The study contributes to understanding the complex relationship between climate change and agricultural productivity in Iraq.

Keywords: Agricultural productivity, Climate Change, Carbon emissions, Rainfall, Iraq

1. Introduction

Iran, being the land of two rivers, is recognized as a significant contributor to agro production in the Middle East. For ages, the country's agricultural sector relied on natural sources and measures to maximize the production of agro products. Undeniably, the Republic of Iraq's food and agriculture sector can contribute to the GDP and national/economic growth. Creating and exploiting agro opportunities in the country is clear evidence of government aims and ambitions to optimize agricultural productivity (Alhassany et al., 2022). However, the severe climate adversity in this region affected the production and growth and left the farmers with no option other than artificial choices with severe environmental concerns. As indicated by Morgan (2022), the climate changes in Iraq are observed in the form of severe water crisis. The food insecurity raised in Ukraine-Russia has worsened the agro and food conditions in the Middle East. Due to climate change, the water scarcity in the Nineveh province, which is one of the leading wheat production parts, is raising multiple challenges for the agriculture sector of Iraq. The country-level analysis also revealed that significant agro areas are confronting job creation and income generation-related problems (World Bank, 2018). Neglecting the economic and ecological dimensions in the Iraq agro sector can have profound future implications if not taken keen fully by the respective stakeholders.

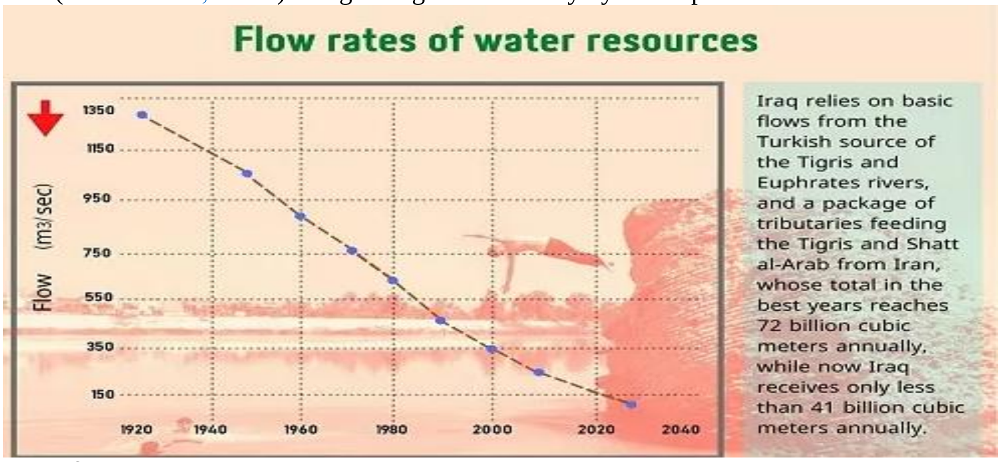

Figure 1: Flow rates of Water Resources
Source: UN-ESCWA

2. Literature Review

Climate change and governance issues are putting the country at the edge of agricultural threats. The prevailing water quality conditions and poor availability of resources are hampering the country's agricultural development. As presented by Barhoum and Nalbandian (2022), the agriculture sector of Iraq is the second largest contributor to GDP after the contribution of oil revenues. The loss of agricultural productivity due to these issues has remained unsolved and will be a severe matter of concern in the coming future. It is also observed that agricultural employment is affected due to the increasing agrarian challenges provoked by climate change. By providing empirical evidence, Jongerden et al. (2019) confirmed that the market and labor are becoming the most problematic issue in the context of climate change. With the intensification of water and land issues, employment is discouraged and affects the choices of the farmers. In the face of economic and environmental crisis, the agricultural sector is therefore at the edge of collapsing and need urgent and critical consideration by the government.

The previous literature produced on this matter dealt with the issues from multiple perspectives. The study by Eklund, Abdi, and Islar (2017) highlighted the challenges and opportunities in the agriculture sector of Iraq for productivity and growth. High population, urbanization, water scarcity, and rural land management challenges obstruct the farmer from yielding maximum growth. The evidence provided by Adamo et al. (2018) highlighted the water scarcity issue in the northern part of the country, adversely impacting the irrigated lands. A similar perspective is shared by Abbas, Wasimi, and Al-Ansari (2016), who opinionated that the water resources in the Diyala River Basin are badly affected by climate changes and predicted poor agro growth in the respective areas. Moreover, these conditions are pushing back the potential farmers resulting in an employment crisis. Despite covering the issues, the scarcity of literature on agro-growth-related factors leads the research to explore the relevant issues in the context of Iraq. The study, therefore, considers the significance of CO_2 emission, average rainfall, temperature, arable area, agricultural employment, and energy consumption in determining the agricultural productivity in Iraq. The study follows quantitative research method and utilizes secondary databases to investigate the issues. Covering the research gaps will be valuable in the contemporary research stream on agro-production and climate change issues in Iraq and the Middle East.

2.1 Theoretical Framework

The literature contains several theories concerning land, agriculture, and climate change. The central theories literature has provided that come under the head of land and climate change were the economic approach, cellular automata, optimization techniques, rule-based simulation, multi-agent model, and microsimulation (Koomen et al., 2007). These theories' concepts were acknowledged, and the best-fit theory was the cellular automata approach that this study used for its theoretical framework. This approach has two frameworks, and the implemented framework for this study was the MOLAND [monitoring land use cover dynamics] framework. This model has been explained as a part of different methodological tools for spatial planning that can be used for assessing, observing, and structuring the development of urban and regional environments (Lavalle et al., 2004).

This framework has been used in several studies covering the concepts related to the land and its changing factors; an investigation has been based on the MOLAND model and has developed four factors related to future urban growth, and their analysis provided a very effective starting point for the discussion of the development of tourist areas of Europe (Petrov, Lavalle, & Kasanko, 2009), a recent study has investigated the rate of conversion of bare land and agricultural parts in the urban developed sectors and the future plan pattern to manage these changes, and they have revealed the major challenge of the rapid changing and reduction in the bare and agricultural lands and have provided future directions and pattern to maintain the speed of urbanization based on the MOLAND framework (Feizi & Shahabian, 2021).

2.2 Impact of Co2 emissions, average rainfall, temperature, arable area, energy consumption, and agricultural employment on agricultural productivity:

2.2.1 Impact of climate factors on agricultural productivity

Climate change mainly refers to the changes and alterations in the atmosphere due to Co2 emission, greenhouse gases, and high solar radiation abundance on the land surface that alter the natural balance of energy in the climate system (Change, 2007). Climate change has emerged and accumulated due to factors like socio-economic development, increased transport and Co2 emission, deforestation and global warming, land irrigation projects, and different political and military practices for human evacuation (Gould & Higgs, 2009). A systematic review has done a global assessment of the elements and procedures that influence potential agricultural productivity and have investigated the critical areas of uncertainty regarding meteorological, hydrological, and physical plant quantities based on the climate change model (Neenu, Biswas, & Rao, 2013). In their findings, they have provided multiple implications for agricultural productivity. In the US, climate change has been mainly tested and linked with partial productivity of local efforts, yet when it was studied by combining it with the total factor productivity at the national level, it revealed the crucial limitation in the future planning for different agricultural regions faced with different climate epidemic scenarios, reflected the deliberateness of the US agricultural productivity due to climate changes (Liang et al., 2017). The climate change factors have been investigated quantitatively, and their impact on agricultural productivity in the short- and long-run has been examined, revealing the long-run association of Co2 emission, high temperature, lack of rain [drought], and precipitation regime and the natural disasters in reducing the agricultural productivity (Ozdemir, 2022a), in contrast, Co2 emission has reflected a short-run influence on agricultural productivity to some extent as well. The role of land surface temperature has been empirically proved to play a prominent role in the land usage rate in China (Wang et al., 2020).

A systematic review (Praveen & Sharma, 2019) has provided summarized knowledge from different sources that have addressed the impact of climate change factors on agricultural productivity, they have mainly highlighted the emission of different hazardous gases that reduce the productivity of crops, and they primarily highlighted the Co2 gas emission against the productivity reduction. A recent study has targeted the climate change factors, i.e., temperature and rainfall, on the productivity of 15 different food crops and investigated their role in productivity; their result has shown the adverse effect of climate changes on agricultural productivity and food availability to low and middle families and the drop of productivity rate by the increase in the temperature (Bocchiola et al., 2019). The climate factor of deforestation has been noticed itself as a cause of many climate changes, as it has been examined and provided empirical evidence on the negative impact of deforestation on the decrease in the rainfalls, which reduce the irrigation properties of land, ultimately causing the drastic falls in the productivity of the agriculture sector (Leite-Filho et al., 2021). In Iraq, agricultural productivity has been observed as not safe from the harmful effects of climate change as well, and a recent study has targeted three climate factors; rainfall, temperature, and agricultural area with the productivity of Iraqi farm regions, and they have manifested the extensive dependence of crops on the surface water, and less influence of temperature on the productivity of lands (Jabal, Khayyun, & Alwan, 2022). By following the information from past studies, the following hypothesis has been derived for testing:

H1: *There is a significant relationship between climate factors and agricultural productivity.*

2.2.2 Impact of economic factors on agricultural productivity

There have been mentioned some economic factors that have been addressed have a strong correlation with agricultural productivity. These factors have significant direct or indirect influences on agricultural productivity; in this dimension, Faridi and Murtaza (2013) have investigated the role of energy consumption factors on economic growth and agricultural productivity; their results have shown the negative association between electricity consumption and economic and agricultural growth because of its shortage and favorable support of gas and oil consumption for the agricultural productivity. The use of either renewable or non-renewable energy resources is influenced by energy prices and fluctuations in prices, and it ultimately defines the impact of energy consumption on agricultural productivity and growth (Ma et al., 2022).

The impact of renewable and nonrenewable resources has been considered in the agricultural productivity context; they have compared the short-run and long-run casualties between the targeted variables (Ben Jebli & Ben Youssef, 2017), and in their results, they have discussed the short-run causality between the agricultural value-added and renewable energy resources and the GDP, shedding light on the positivity and benefit of renewable resources for agricultural productivity. A recent study has examined the impact of renewable energy resources on agriculture and economic growth, and they have provided positive insight into the value of renewable energy resources for reducing Co2 emissions that will indirectly boost agricultural productivity.

The agricultural productivity linked with energy consumption of renewable and non-renewable resources has been noticed in the discussion of the literature in different studies targeting different countries like Raihan and Tuspekova (2022) have investigated the interdependence of energy use, agricultural productivity, economic growth, and Co2 emission in the agriculture sector of Nepal, Kumar, Scott, and Singh (2013) investigated different strategies of energy consumption on the agricultural productivity in India, and Raihan (2023) have argued about the increase in renewable resource consumption have increased the agricultural productivity that reduces the environmental depleting factors in Egypt. These studies have highlighted the popularity of the targeted concept of this study and its significance from the research point of view in different countries.

The other economic factor for agricultural output includes agricultural employment. Studies have mentioned the reduction in the demand for labor force after extensive technological adoption in the agricultural procedures and steps, and the rate of agricultural employment has experienced a significant drop (Sidhu & Singh, 2004). After some gap, studies have elaborated on the division of income in rural areas highlighting the significant portion of the income stream from agricultural employment (Vatta & Sidhu, 2010). But over time, with the implementations and adoption of advanced digitalized machines, the question about the loss of employment in agriculture has been questioned again. To answer this question, a recent systematic review study has engraved three issues regarding agriculture and employment; high costs of land and digitization, low-skilled workers in the labor market, and the issues related to digital data (Rotz et al., 2019). Another study (Marinoudi et al., 2019) has investigated the role of automation and labor power collectively on crop production, and they have suggested a proposed ideology for the equilibrium of labor and robots to boost agricultural productivity and has focused on the training of the existing labor to improve their efficiency of technology use for robust agricultural production. To address this highlighted gap in the literature, the following hypothesis has been synthesized:

H2: Economic factors like agricultural employment and energy consumption have significant association with agricultural productivity.

3. Research Methodology

The present research deals with identifying the impact of climate change on the agricultural productivity of Iraq through CO2 emissions, average rainfall in Iraq, Temperature of the country, arable area, energy consumption and agricultural employment. In this study, GDP per capita and urbanization have been studied as control variables. The researcher has applied "quantitative secondary research" within the time series of 2000-2021. For this purpose, various effective statistical techniques have been implemented. Data has been collected from world development indicators. It is because WDI entails the trait of keeping adequate data. WDI help the researchers explore information related to all the developmental aspects, including the recent and previous years (Swanson, 2006). This also aids in assessing the gradual improvement or degradation related to any explored factor as this study aims to collect data regarding carbon dioxide emissions, average rainfall, temperature, arable area of Iraq's agriculture energy consumption and agricultural employment. So keeping in view the nature of the research and the variable under study, WDI has been explored by the researcher.

3.1. Description of variables

3.1.1. Climate change in agricultural productivity (Dependent Variable)

In the present research, climate change in agricultural productivity has been studied as the dependent variable. Climate change can disrupt food availability, and access to food and food quality can be affected. So increased temperatures and changes in extreme weather events result in diminished agricultural productivity (Nastis, Michailidis, & Chatzitheodoridis, 2012).

3.1.2. CO2 emissions (Independent Variable)

According to Friedlingstein et al. (2010), CO2 emissions are those emerging from fossil fuels or types of cement manufacturing.

3.1.3. Average rainfall (Independent Variable)

Average rainfall can be understood as a calendar year of rain excluding snow. So Average rainfall has been studied in this research as the annual rainfall in a year within a location (Chèze & Sauvageot, 1997).

3.1.4. Temperature (Independent Variable)

Temperature is a physical quantity that shows quantitatively the perception of coldness and hotness (Precht, 2013).

3.1.5 Arable area (Independent Variable)

According to Robertson (1956), arable land can be considered "temporary crops."

3.1.6. Energy consumption (Independent Variable)

The total energy needed in a given process is called energy (Chen & Chen, 2011).

3.1.7. Agricultural employment (Independent Variable)

Agricultural employment can be a farm service undertaken by an employee on a farm regarding soil cultivation, harvesting, or raising the agricultural commodity (Aliber, Baipheti, & Jacobs, 2009).

3.1.8. GDP Capita (Control Variable)

According to Kravis, Heston, and Summers (1978), GDP per capita is the sum of "gross value" added by all the "resident producers in the economy".

3.1.9. Urbanization (Control Variable)

Urbanization means the concentration of the "human population" in "discrete areas" (Ritchie & Roser, 2018).

4. Model Estimation

Researcher uses different tests, including the descriptive test, to assess the descriptive summary of the data (Nimon, 2015). The researcher has also performed heteroscedasticity and Serial correlation tests (Baltagi & Li, 1991; Glejser, 1969). The following equation is the regression equation for the model showing the impact of different variables involved in this research on agricultural productivity.

$$AP_t = \beta_0 + \beta_1 CO2EM_t + \beta_2 AR_t + \beta_3 TEMP_t + \beta_4 AA_t + \beta_5 EC_t + \beta_6 AE_t + \beta_4 GDPCAP_t + \beta_5 URB_t \varepsilon_t$$

In the above equation, the model intercept is shown by β_0 and error term is illustrated by ε_t.

The researcher has implemented "ordinary least square" method to assess the relationship among variables. According to Craven and Islam (2011), OLS is an effective and common method used for the estimation of "linear regression equations", which explains the association between one or more independent quantitative variables (climate change in the agricultural productivity of Iraq through the CO2 emissions, average rainfall in Iraq, Temperature of the country, arable area, energy consumption and agricultural employment) and a dependent construct which is agricultural productivity in this study. The following equation shows the long-term influence of independent variables on the dependent constructs.

$$\Delta AP_t = \alpha + \sum_{i=1}^{u} \beta_1 \,\Delta AP_{t-1} + \sum_{i=1}^{u} \beta_2 \,\Delta CO2EM_{t-1} + \sum_{i=1}^{u} \beta_3 \,\Delta AR_{t-1} + \sum_{i=1}^{u} \beta_4 \,\Delta TEMP_{t-1} + \sum_{i=1}^{u} \beta_5 \,\Delta AA_{t-1} + \gamma_1 EC_{t-1} + \gamma_2 AE_{t-1} + \gamma_{23} GDPCAP_{t-1} + \gamma_4 URB_{t-1} + \varepsilon_t$$

The above equation Δ represents the "constant for long-run predictors," and γt represents the "co-efficient for these predictors". In the existence of heteroscedasticity and autocorrelation problems, the above-stated equation will be converted into a "natural logarithm." This will efficiently eliminate the incidence of heteroscedasticity and increase the "estimates' robustness and efficiency" (Dismuke & Lindrooth, 2006; Ozturk & Acaravci, 2013).

5. Empirical Findings

5.1 Descriptive Summary

Table 1 presents descriptive statistics to assess various data measures, such as mean, skewness, kurtosis, and Jarque-Bera, which are utilized to examine the normality of the data. The Jarque-Bera test, considering both skewness and kurtosis, was utilized for the assessment of normality. As per the Jarque-Bera test, values that are closer to 0 indicate the normality of the data. AP has a p-value of 0.41 with a JB statistic of 1.74; hence, it is normally distributed. Similarly, EA, EC, REA, UP and TEMP have a normal distribution as the p-values surpassed 0.05. On the other hand, AA, EQ, GDPC and RAIN do not exhibit normality as the p-values < 0.05.

Table 1: Descriptive Statistics

	AP	AA	EA	EC	EQ	GDPC	RAIN	REA	UP	TEMP
Mean	5.130541	10.11329	23.84362	744.4403	3.341865	1.630461	206.1818	1.026818	69.45441	23.20000
Median	4.848924	10.62968	23.92293	936.9309	3.509095	2.320246	216.0000	1.020000	69.18550	23.04000
Maximum	8.562672	11.88925	27.58526	1391.032	4.347264	49.03164	216.0000	2.560000	71.11900	24.35000
Minimum	2.815818	0.000000	19.81721	0.000000	0.000000	-38.56172	0.000000	0.000000	68.49600	22.36000
Std. Dev.	1.608329	2.464209	2.829292	541.4351	0.865040	14.91700	46.05135	0.687600	0.825629	0.526407
Skewness	0.669440	-3.301327	-0.018878	-0.534752	-2.671041	0.559693	-4.364358	0.710974	0.623432	0.802098
Kurtosis	2.659228	14.22161	1.449809	1.610853	11.30609	7.834149	20.04762	2.863712	2.077496	2.888811
Jarque-Bera	1.749666	155.3930	2.204142	2.817440	89.40150	22.57018	336.2441	1.870466	2.205209	2.370325
Probability	0.416932	0.000000	0.332182	0.244456	0.000000	0.000013	0.000000	0.392494	0.332005	0.305697
Sum	112.8719	222.4923	524.5597	16377.69	73.52102	35.87015	4536.000	22.59000	1527.997	510.4000
Sum Sq. Dev.	54.32114	127.5189	168.1027	6156190.	15.71418	4672.857	44535.27	9.928677	14.31492	5.819200
Observations	22	22	22	22	22	22	22	22	22	22

5.2 Correlation

The correlation matrix is shown in Table 2, which allows researchers to assess the association between variables with the coefficients. The coefficients indicate the strength of the relationships between the variables, ranging from -1 to +1, where a value of 1 represents a perfect positive correlation, while -1 indicates a perfect negative association.

According to the table, AP shows a positive correlation with AA (r = 0.1861), whereas AP is negatively correlated with EQ (r = -0.0015) and GDPC (r=0.2502). AA displays negative correlations with GDPC (r = -0.0229), UP (r = -0.2102), and TEMP (r = -0.3341). Additionally, TEMP exhibits negative correlations with all variables except UP. Similarly, UP is negatively correlated with all variables, as shown in the table. These negative correlations indicate that these variables move in opposite directions.

Table 2: Correlation Analysis

	AP	AA	EA	EC	EQ	GDPC	RAIN	REA	UP	TEMP
AP	1.0000									
AA	0.1861	1.0000								
EA	0.7422	0.1236	1.0000							
EC	0.4389	0.0546	0.6502	1.0000						
EQ	-0.0015	0.8417	-0.0695	0.0750	1.0000					
GDPC	-0.2502	-0.0229	0.0520	0.0863	0.0200	1.0000				
RAIN	0.2527	0.9167	0.3179	0.3071	0.8629	0.0348	1.0000			
REA	0.0162	0.3606	0.1432	0.2757	0.0768	0.0428	0.3335	1.0000		
UP	-0.6292	-0.2102	-0.9563	-0.7640	-0.0683	-0.1160	-0.4503	-0.2227	1.0000	
TEMP	-0.4396	-0.3341	-0.5818	-0.5332	-0.1361	-0.0873	-0.4328	-0.2481	0.6175	1.0000

5.3 Regression Results

To test the impact of the explanatory variables on agricultural productivity, the ordinary least square method was utilized, and the results are displayed in Table 3. The study presumed that economic and climate factors have a significant impact on agricultural productivity in Iraq. Firstly, it can be observed that EA has a positive influence on AP wit the β coefficient of 0.32. However, the association is considered insignificant, with a p-value of

0.4225. Secondly, EC is found to negatively affect AP; however, with a p-value of 0.5476, the impact is insignificant. Additionally, the previous value of EC also negatively but insignificantly impacts AP. The results showed that the present value of EQ has a negative impact on AP, and the association is significant at a 5% significance level. However, the lagged value of EQ positively impacts AP with a p-value of 0.0054.

In addition, the current and previous values of GDPC have a positive and insignificant impact on AP. RAIN is found to positively and significantly influence AP with a p-value of 0.0285. REA has a positive impact on AP; however, the impact is insignificant as the p-value > 0.05. In addition, the findings revealed a negative and insignificant impact of UP on AP. Temperature positively impacts AP, but an insignificant impact is reported with a p-value of 0.35. Lastly, AA is found to negatively and significantly influence AP at a lower level of significance, i.e., a 10% significance level. The R-sqaured value indicates that 94% of the variation in AP is accounted by the explanatory factors.

Table 3: OLS Analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EA	0.329998	0.390367	0.845351	0.4225
EC	-0.000460	0.000732	-0.627801	0.5476
EC(-1)	-0.000623	0.000710	-0.877225	0.4059
EQ	-3.211080	1.293651	-2.482184	0.0380
EQ(-1)	6.039777	1.598046	3.779476	0.0054
GDPC	0.026794	0.016891	1.586267	0.1513
GDPC(-1)	0.000981	0.015279	0.064207	0.9504
RAIN	0.081958	0.030744	2.665855	0.0285
REA	0.289149	0.423039	0.683505	0.5136
UP	-1.667190	1.889161	-0.882503	0.4032
TEMP	0.415751	0.422188	0.984753	0.3536
AA	-0.528390	0.278165	-1.899556	0.0940
C	82.09710	135.6201	0.605346	0.5617
R-squared	0.941840	Mean dependent var		5.154150
Adjusted R-squared	0.854600	S.D. dependent var		1.644135
S.E. of regression	0.626930	Akaike info criterion		2.177051
Sum squared resid	3.144331	Schwarz criterion		2.823660
Log likelihood	-9.859035	Hannan-Quinn criter.		2.317382
F-statistic	10.79600	Durbin-Watson stat		2.129777
Prob(F-statistic)	0.001137			

The distribution of the residuals is shown in the figure below, demonstrating that the histogram exhibits a bell-shaped curve. A normal distribution is validated with a small JB value of 0.762 and a p-value exceeding 0.05.

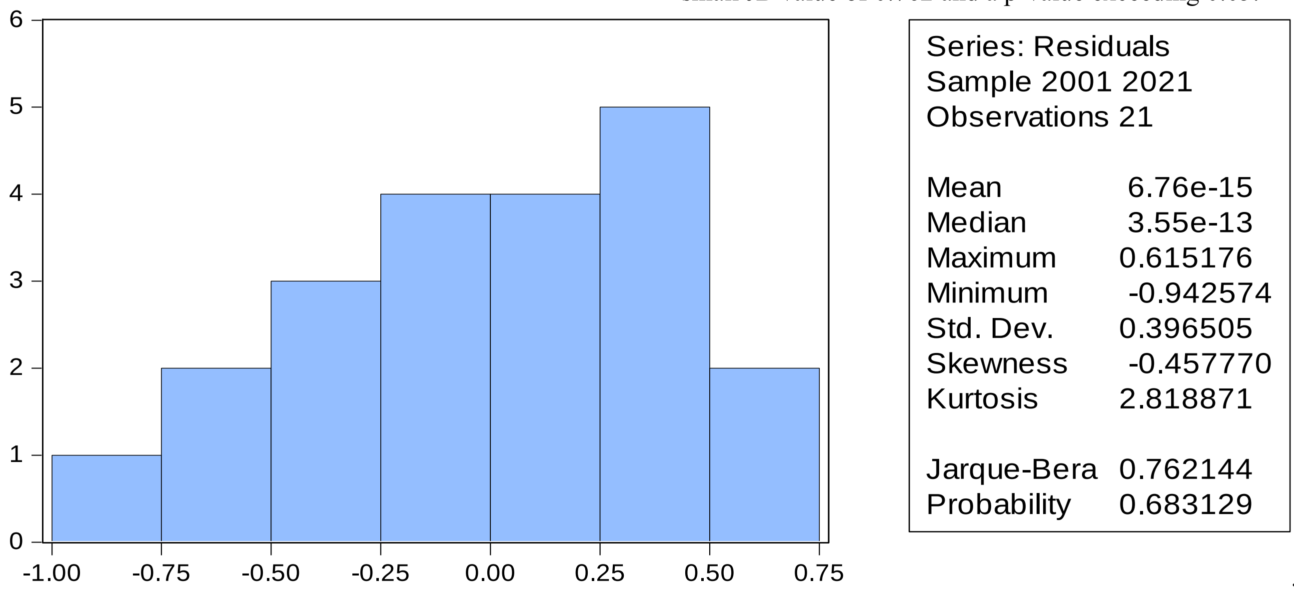

Figure 3: Regression Standardization Residuals

The LM test was employed to examine serial correlation, and the outcomes presented in Table 4 indicate that the p-value for F-statistic is 0.15. Hence, the null hypothesis is rejected at the 5% significance level. This rejection implies that there is no issue of autocorrelation among the residuals.

Table 8: Breusch-Godfrey Serial Correlation LM Test

F-statistic	2.618214	Prob. F(2,6)	0.1523
Obs*R-squared	9.786472	Prob. Chi-Square(2)	0.0075

In addition, the researcher evaluated whether the variance of the residuals is constant using the null hypothesis of homoskedasticity. Since the p-values exceed the significance level of 0.05 in Table 9, we do not reject the null hypothesis. As a result, we can conclude that the residuals are not heteroscedastic.

Table 9: Heteroskedasticity Test

F-statistic	2.171406	Prob. F(1,18)	0.1579
Obs*R-squared	2.152955	Prob. Chi-Square(1)	0.1423

6. Discussion

The primary focus of the researcher was on climate change and its impact on agricultural productivity in Iraq. The adverse climate impacts, the scarcity of water, and the poor employment opportunities raised serious concerns about tackling the issues. The researcher took into consideration the explanatory factors, i.e., CO2 emission, temperature, average rainfall, energy consumption, arable area, and agricultural employment in relation to agricultural productivity. The researcher hypothesized that the economic and climate factors have a significant role in determining the country's agricultural productivity. According to the results, employment quality significantly negatively impacts agricultural productivity. At the same time, rain is found to significantly impact agricultural productivity. The results are consistent with the previous research findings. The study by Abiye (2022) highlighted that the soil and water availability in the rain and other reserves significantly improve agronomic practices and boost agricultural growth. Therefore, the positive correlation between rain and agricultural growth is confirmed irrespective of the spatial and regional variance. However, in the context of Asia, the proposition is nullified by Ozdemir (2022b). According to him, the annual rainfall in Asia is insignificant in determining agricultural productivity. This contradiction implies that rain's effect on agricultural productivity depends on the agro factors, i.e., resource availability, agricultural policies, and production methods. Leite-Filho et al. (2021) added an additional perspective that deforestation impacts rainfall, lowering agricultural revenues by obstructing agricultural growth. The consequences of climate change are thus undeniable, especially in the form of essential agricultural sources, i.e., land and water.

The results also highlighted a significant positive relationship between arable areas and agricultural productivity. The presence of arable lands provides better growth opportunities which resulted in the form of improved growth and development. These results are supported by some of the previous research studies in this area. According to Prăvălie et al. (2021), arable land is connected to more production in minimum resources. The land degradation footprints on the global arable land is a serious environmental and agricultural issue that encompasses multiple phenomena, including soil erosion, salinization, and vegetation decline, which determines the relation between agricultural productivity and the quality of arable lands. The empirical evidence thus made the proposition true that arable land is only significant when it does not subject to the degradation process. The results are also strengthened by the findings of He et al. (2019). The dramatic change in production has not only influenced the requirements for arable land but also paved the room for other sustainable sources in optimizing agricultural production. The demand for arable land, together with sustainable tools and instruments, holds the potential to elevate productivity and development in agriculture. Besides these variables, no other factors are found significant in relation to agricultural productivity. CO2 emission, energy consumption therefore do not have any significant association with the agricultural productivity of Iraq’s agricultural sector.

6.1. Conclusion

Climate change in recent years has adversely impacted the agriculture business all over the world. In the Middle East, the scarcity of water due to climate changes raised big troubles for the farmers to ensure agro growth and production. The previous studies and surveys highlighted the threats and alarming situation caused by climate change and the possible future implications it has. The attention is also drawn towards the economic and climate factors that are possible to influence the agriculture growth in this region. The focus of the present study is the agricultural growth and productivity of Iraq. The researcher acknowledged the current agricultural issues and examined the associated factors that are responsible for them. As some of the arable provinces of the country get hit by drought, the attention is diverted towards employment, energy consumption, and natural resource management in maintaining the sustainability and growth of the agricultural sector. The explanatory factors that are analyzed by the researcher include CO2 emission, average rainfall, arable areas, temperature, energy consumption, and agricultural employment. The GDPC and urbanization are observed as the control variable. The quantitative research approach was adopted, and the data was collected from 2000-2021. According to the findings, the EA has a positive and insignificant impact on agricultural productivity. Employment quality negatively impacts agricultural productivity. While rain, renewable energy consumption, and arable land have a significant association with agricultural productivity.

6.2. Research Implications

The researcher analyzed the factors that hold sheer significance in the context of Iraq’s environmental conditions. The data extracted from the secondary sources provided an in-depth analysis of the energy consumption methods and their role in environmental degradation in the last several years. The periodic changes over time depict the credibility and suitability of energy consumption methods and their diverse impact on the environment. Theoretically, the study contributes to the past literature present on environmental degradation and energy consumption behaviors. By explaining the environmental consequences, the study develops a theoretical understanding of the issues under discussion.

The findings also have several policy ramifications. It implies that natural resource sufficiency boosts renewable energy consumption and lowers environmental degradation. Moreover, it is also occurred that renewable energy is significantly associated with environmental degradation. The adoption of sustainable and renewable ways reduces the ecological imprints and therefore holds value in the longer term. The researcher also proposed that the mediating role of energy resource sufficiency is significant in the understanding of energy consumption in Iraq and the environmental implications it has. The data can be utilized by government bodies to revise energy production and consumption policies in order to maintain sustainable standards in this region.

6.3. Limitations and Future Indication

The study holds research significance and has value in contemporary research debates on sustainable agriculture. However, there are certain limitations that restrict the scope and utility of this study. The researcher focused on the agricultural sector of Iraq. As climate change is a universal issue and impacts countries on different levels, the specific country context is not enough to understand the impact of climate change on agriculture on a broader level. Future studies can be expanded in a wider regional context by analyzing the climate effects in different Middle East countries. Moreover, the researcher opted quantitative research method and utilized the data from secondary sources, i.e., reports and academic material. Due to the diversity of the issues, they can be examined by adopting qualitative research methods, which can provide a broader perspective on the issues. The explanatory factors are also limited; besides these factors, sustainable innovation adoption of sustainable technology is also affecting the relationship between climate change and agricultural transformation.

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