

Estimating and Analyzing the Demand Function for Rice in Iraq for the Period (2000-2023) using the Double Logarithmic Regression Model

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Abstract -

Rice is a major cereal crop, ranking second only to wheat in importance in Iraq. Due to the increasing demand for it, coupled with the rise in Iraqi per capita income, as well as the continuous population growth, rice farmers are unable to meet the growing demand for this crop. Therefore, this research aims to study and measure the annual growth rates of rice production and estimate and analyze the most important factors influencing demand for rice in Iraq for the period (2000-2023). It also aims to measure the income, price, and cross-price elasticity's of demand to inform rice consumption planning. The double logarithmic model was used to analyze and interpret the relationship between the independent and dependent variables. The research reached several conclusions, the most important of which was the low income elasticity of demand for rice, which indicates that rice is a highly essential commodity for Iraqi consumers.

الملخص:

يعد الرز من محاصيل الحبوب الرئيسية و يحتل المرتبة الثانية بعد القمح من حيث الاهمية في العراق، ونظراً للطلب المتزايد عليه مع ارتفاع في معدل الدخل الفرد العراقي، فضلاً عن الزيادة المستمرة في السكان، و عدم قدرة مزارعي الرز على الاستجابة لتلبية الطلب المتزايد على هذا المحصول، لذا فان البحث يهدف الى دراسة و قياس معدلات النمو السنوي لمحصول الرز و تقدير و تحليل اهم العوامل المؤثرة على الطلب على الرز في العراق للمدة (2000 - 2023) بالإضافة الى قياس مرونة الطلب الدخلية و السعرية و التقاطعية للاستفادة منها في تخطيط استهلاك الرز .

وقد تم الاعتماد على النموذج اللوغاريتمي المزدوج في تحليل و تفسير العلاقة بين المتغيرات المستقلة و المتغير المعتمد . و توصل البحث الى عدة نتائج كان من اهمها انخفاض مرونة الطلب الدخلية على الرز مما يعني ان الرز سلعة ضرورية جداً للمستهلك العراقي .

I.Introduction

The agricultural sector is of great importance, especially since it is the largest non-oil economic sector and contributes approximately 25% of the country's workforce and between 5% - 10% of the gross domestic product. Since the per capita share of agricultural GDP in Iraq is relatively low compared to most developing countries that have similar agricultural opportunities and conditions to what Iraq has, this sector must regain its strength in order to provide the country with the food it needs to enjoy prosperity and stability, as this sector has faced difficulty in achieving a balance between food demand and supply due to the decline in local production on the one hand and the increase in demand on the other hand as a result of the increase in population, in addition to other factors, namely the increase in average per capita income. Rice is one of the main grain crops in the world, and the main food for about half of the world's population. Rice is the main food in Iraq after wheat, and its cultivation is concentrated in the central and southern regions, and it is also cultivated on a small scale in the northern regions. Iraqi rice (amber) is one of the best and most delicious types of rice in the world. The importance of rice is due to its consumption pattern that distinguishes it from other grains. The average area cultivated with rice in the world is about (140) million hectares, distributed in more than (100) countries, most of which are located in tropical and semi-tropical regions. A few million hectares are cultivated in temperate regions ([Food and Agriculture Organization](#)) . Despite the importance of this crop, the prevailing cultivation pattern is still below the required level, and it is considered one of the very important crops in terms of the food consumption pattern in Iraq, and although Iraq is one of the countries known for growing rice since ancient times, in addition to the fact that the environmental conditions in Iraq are suitable for growing this crop .

Importance of the research: The importance of this crop is highlighted by the fact that it constitutes a portion ranging between 20-50% of the consumer's food budget. In this regard, we find that numerical evidence confirms the importance of this crop in the Iraqi consumer's budget table. The study here indicated that the time trend of the rates of change in the quantities available for rice consumption during the study period was positive, in addition to the fact that government reports indicate that rice consumption amounts to one million tons annually, which gives an impression of the importance of this crop to the Iraqi consumer .

II. Research problem;

The increasing demand for agricultural and essential goods is one of the most important phenomena of the agricultural problem in Iraq, as a result of the significant increase in incomes and the continuous increase in population and the failure of agricultural supply to respond to this constantly increasing demand.

III. Research hypothesis;

The significant increase in the price level has led to a decline in consumption levels in general. This requires increasing the quantity of rice supplied, in addition to the presence of some economic factors that have affected the rice consumption function in Iraq and working to increase local production to meet the increasing requirements of society in order to overcome the stage of deficit in local production and reach self-sufficiency.

IV. Research objective:

The research aims to;

- 1- Measure the annual growth rates of rice production in Iraq for the period 2000 – 2023.
- 2 - Estimate the individual demand function for rice for the period (2000 - 2023), and measure the average individual consumption during the research period.

V. Research Methodology:

The research relied on two analytical methods;

1 - Descriptive analysis method

Through this analysis, the reality of rice production in Iraq and the quantities available for consumption for the period (2000-2023) were observed in order to identify the most important factors affecting the demand for this crop in order to be used as indicators that can be used in setting agricultural policies by the relevant parties.

2 - Standard analysis method

The research relied on estimating and analyzing the demand function for rice crop in Iraq for the period (2000-2023), and the multiple linear regression method was used. The researcher also relied on many sources to collect data related to the research and necessary to conduct the mathematical analysis of the available data. The data related to the required variables for the time series in Iraq were obtained from several sources, including the Arab Organization for Agricultural Development, the Food and Agriculture Organization of the United Nations (FAO) and data published on the Internet on the website www.faostat.com [1] and the annual

statistical collection of the Ministry of Planning during the research period. Thus, the required data was obtained, then it was classified, separated and analyzed on the electronic computer.

The research came in three sections, where we explained the reality of rice production in Iraq in the first section, while we explained in the second section on estimating and analyzing the demand function for rice crop in Iraq for the period (2000-2023), and the method was used by the least squares method .

- Economics and Reality of Rice Production

❖ The nutritional and economic importance of rice crop

Rice is one of the important strategic economic crops that the vast majority of the world's population depends on for their nutrition, according to statistics from the Food and Agriculture Organization (FAO) for the year 2010 [2] . Iraqis have eaten it as an essential part of food since the Sumerian civilization, and no home can do without it. Some homes repeat this meal twice, either for economic reasons or as part of their habit of a certain dietary pattern .

Studies indicate that 100 grams of rice yields (7) grams of protein, (80) grams of starch, (24) mg of calcium, (94) mg of phosphorus, (2.9) mg of iron, (0.14) mg of vitamin B1, (0.03) mg of vitamin B2, (35) mg of thymine, and (363) calories. Iraq ranks third in terms of production rate, cultivated area rate, and productivity rate at the level of the Arab world and the surrounding countries, as the production rate reached (3,308,300) tons, the cultivated area rate (4,972,125) thousand acres, and the average productivity (2,157,883) kg/acre for the period (2000-2023). * Source: - Food and Agriculture Organization (FAO) Data taken from the Internet on the website [1] www.faostat.com

❖ The reality of rice cultivation in Iraq during the period (2000-2023)

Agricultural production in Iraq is characterized by its clear fluctuations and is attributed in its entirety to environmental conditions that are difficult to control, in addition to other factors, including legislative decisions that negatively or positively affect agricultural production. Table (1) indicates the production position of rice crops at the country level for the period (2000-2023)

Table (1) Cultivated area, total production and average productivity of rice crop for the period (2000-2023) at the level of Iraq

Years	Cultivated area/thousand dunums	Total production thousand tons	Productivity kg/acre
2000	168	124	738
2001	113	50	436
2002	2165	1938	903

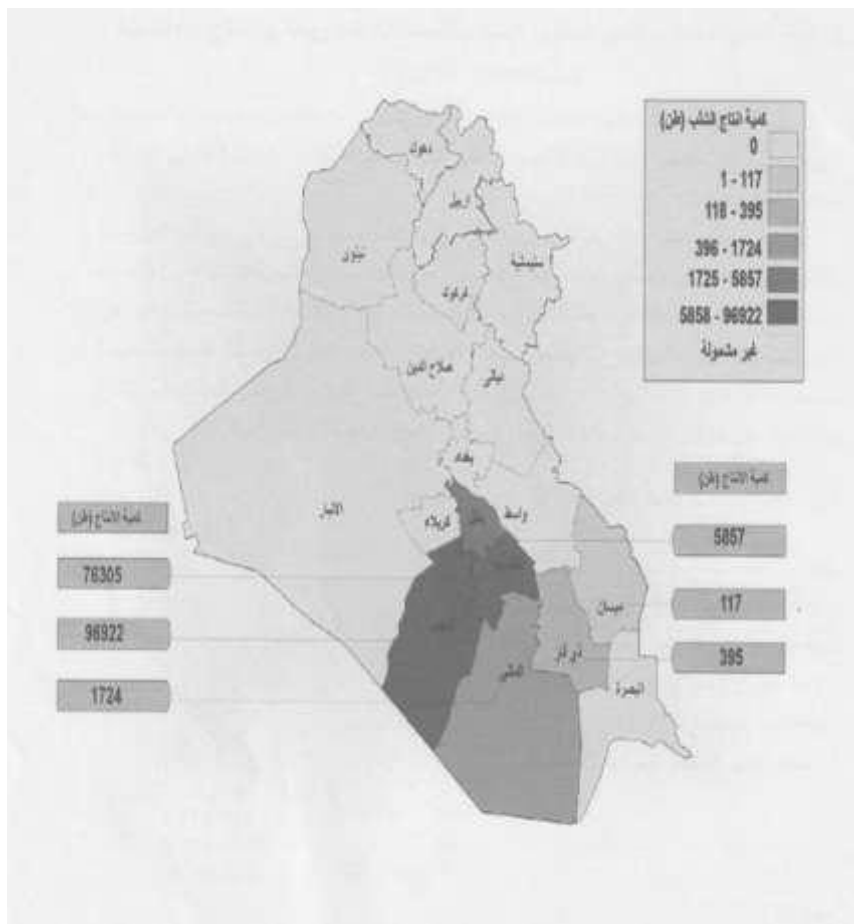
2003	1225	813	664
2004	3518	2503	711
2005	4282	3087	721
2006	5026	3633	723
2007	4974	3928	790
2008	3390	2482	732
2009	2197	1731	787
2010	1919	1558	812
2011	2638	2351	891
2012	3188	3613	1133
2013	3838	4518	1177
2014	3172	4030	1270
2015	2439	1092	4477
2016	3856	1813	4702
2017	5552	26585	4788
2018	5423	18196	3355.34
2019	12767	54771	4501.38
2020	10172	46414	4563.28
2021	9619	42246	4392.19
2022	13084	67347	4275.91
2023	14588	63854	4245.09

Source: - *German Ministry of Planning and Cooperation - Central Agency for Statistics[3] and Information Technology. And also * Arab Organization for Agricultural Development, Yearbook of Arab Agricultural Statistics[4] .

This data indicate that agricultural production rates were low in 2000 and 2001, respectively, and then production began to rise until it reached (1938) thousand tons in 2002, which is the result of the increase in areas allocated for rice cultivation, which reached (6385.4) thousand dunums in 2023 .

Thus, we find that production increases at times and decreases at other times, affected either by a decrease in the cultivated area or a decrease in productivity. Accordingly, the increase or decrease in production will necessarily be affected by the extent of the effect of the increase and decrease in area and productivity on production. In other words, if the effect of the decrease in productivity is greater than the increase in area, the result will be in favor of the effect of the decrease in productivity, and so on. Production reached its highest level in 2023 at about (638.54) thousand tons, while production reached its lowest level in 2001, reaching about (50) thousand tons. Through the historical records of agricultural production, it is clear that Najaf Governorate is characterized by the highest production of rice crops, due to the nature of the

lands allocated for the cultivation of this crop, as this crop requires soft lands flooded with water, in addition to the availability of a large amount of labor in the cultivation of this crop, which is characterized by high experience in its cultivation, as it has been accustomed to cultivating this crop for long periods of time, which made this governorate rank first in Iraq in the production of this crop, which is considered one of the best types of rice in the world ,



Map of governorates classification according to rice production quantity in Iraq for the year 2023.

- ❖ Measuring the compound annual growth rates of cultivated areas, production and productivity for the period (2000-2023) ;

Researchers pay great attention to the growth rate of agricultural output as it reflects the extent of the success of agricultural policies adopted to meet the continuous increase in demand for food commodities, and the possibility of reducing imports and increasing exports .

The growth rate is affected by three factors that are interconnected with each other: the first is the extent of expansion in the cultivated area, the second is the extent of change in total production, and the third is the extent of improvement in productivity. To know the status of growth and its direction, and to predict its levels, we obtained in this study time series data for the rice crop in Iraq, which included area, production and productivity, and by estimating the general trend equation and using the regular least squares method, the compound annual growth rate of area [7], production and productivity was obtained at the level of Iraq using the following exponential equation

$$Y = b_0 e^{b_1 T}$$

Which will have the following linear formula ;

$$\ln y = b_0 + b_1 T$$

Where;

Y = area or production or productivity

b_1 = compound annual growth rate

T = time (number of years)

constant of the equation = b_0

A- Compound annual growth rate of area ;

$$\ln Y = 8.369 - 0.040 T$$

$$t(16.91)(-1.62)$$

$$F = (1.885)^*$$

$$R^2 = 0.051 \quad D.W = 0.922$$

Where ;

Y = Refers to the net cultivated area of rice crop in dunums .

T = refers to the element of time .

By calculating the time trend equation for the area variable, the above equation recorded that there was an annual decrease of 4% for the study period, and the coefficient of determination (R^2) was 0.051 of the changes in the cultivated area reflected by time and the rest is due to

other factors, including economic factors such as farm profits and production costs in addition to farm prices .

B - Compound annual growth rate of production

Where;

Y = refers to the total production of rice crop .

T =: refers to the time element .

The time trend equation for the total production of rice crop for the above period was ;

$$\ln Y = 7.635 - 0.014 T$$

$$t (14.88)^* (-0.65)^*$$

$$F = (1.126)^*$$

$$R^2 = 0.007 \quad D.W = 1.058$$

The slope of the regression curve shows us that there is a negative annual rate of change in production of (14%), as shown in the equation above. This decline is a negative indicator because it will push the state to take a set of measures to meet the population's growing need for consumption, which is already affected by the high population growth rate, by importing what covers the deficit between production and consumption .

C- Compound annual growth rate of productivity ;

$$\ln P = 9.029 + 0.025 T$$

$$t (78.132)^* (4.009)^*$$

$$F = (16)^*$$

$$R^2 = 0.45 \quad D.W = 2.540$$

By calculating the time trend equation for productivity rates, the above equation recorded that there was an annual increase in productivity rates of 0.25%, but this growth did not have an effective impact on production, as the decrease in cultivated areas was greater than the annual increase in productivity [5] .

The investigation into the reasons for the decline in the areas planted with rice will cast its shadow on the problems of agricultural lands in general in Iraq, and at the forefront of them is the problem of soil salinity and water scarcity, which are among the main problems that led to the deterioration of the agricultural sector and the decline in its productivity. Reports indicate that this problem is approximately 65% of agricultural lands in the center and south (areas

where rice cultivation is concentrated). A report by the Food and Agriculture Organization of the United Nations indicated that it was noted that there were large areas in the central and southern regions, where an area of about (300) thousand hectares of previously reclaimed land was left due to the high salinity of the soil, and the high percentage of salinity in the soil does not mean that it was a cause of the deterioration of uncultivated lands only, the loss of more agricultural lands, but rather the impact on the productivity of agricultural land, as the signs of soil salinization appear for a long period of time before reaching the state in which cultivation is impossible [6] .

- ❖ - Mathematical description of the demand function for rice crop in Iraq for the period (2000-2023)

Dependent variables in the demand function for rice .

$$\text{Lin}Qd_x = \text{Lin}b_o + b_1\text{Lin}p_{Qdx} + b_2\text{Lin}p_{Qdw} + b_3\text{Lin}p_{po} + b_4\text{Lin}I$$

Whereas ;

$\text{Lin}Qd_x$ = Natural logarithm of individual rice consumption .

$\text{Lin}p_{Qdx}$ = Natural logarithm of rice crop price .

$\text{Lin}I$ = Natural logarithm of average per capita income.

$\text{Lin}N$ = natural logarithm of population

$\text{Lin}p_{Qdw}$ = Natural logarithm of wheat crop price .

The time series data for the period (2000-2023) were adopted. It is worth noting that the index numbers were used to express the variables included in the research model and not their absolute values. The reason for this is that in the treatments of topics related to prices, we notice that there is no single price for this commodity in practical reality, as the types of the commodity and the quality levels of these types are multiple, on the one hand, and on the other hand, the range in the price of one of the commodities may expand at the beginning of the time series from its middle and its end, which generates a huge difference due to inflationary effects, which will affect the standard analysis to one degree or another, especially, and this analysis is sensitive to these changes and large differences, so it is preferable to use one of the types of index numbers such as the relative price to express the values of the variable in another way. The other reason that forces the researcher to use this method of transformations is that theoretical economic hypotheses often revolve around real changes and not monetary changes. In other words, it deals with relative changes in some phenomena and their effect on the variables dependent on them, and this appears clearly when we say that the demand for a

particular commodity expands Or it shrinks if its price changes while other factors remain constant, which means that the change in demand for the commodity .

There is a change in the price of the commodity under study in relation to the prices of other commodities. When determining the form of the equation chosen by the researcher, consideration should be given to the fact that it should be easy to determine mathematically and that this equation should be consistent with the economic concepts and theoretical hypotheses related to the subject of the research .

The results of the analysis were summarized in adopting the double logarithmic model in expressing the relationship between the dependent variable and the independent variables and outperforming other models such as the normal linear model, the semi-logarithmic model, and the inverse semi-logarithmic model. This superiority came due to the results obtained in terms of the values of the coefficients, their signs, their morale, and the morale of the model as a whole, in addition to passing the first and second degree tests or the lack of danger of some of them in the event that they appear. Also, passing the logarithmic form, especially in demand research, is successful compared to other forms, especially the normal linear form (the normal first degree equation), and the preference for the logarithmic form is attributed to the fact that it does not lead us to negative values for demand or for the independent variables, so we can rely on it as it gives us logical results. We note that the elasticity measures are constant regardless of the extent of change in the independent variables, in addition to the fact that the logarithmic model reduces the chances of the emergence of a problem. Heteroscedasticity. The results of the analysis came as follows ;

$$\text{Lin}Qd_{\text{rice}} = 4.33 - 0.208\text{Lin}P_{\text{rice}} + 0.217\text{Lin}I - 0.290\text{Lin}N - 0.752\text{Lin}P_{\text{wheat}}$$

$$t = (4.22)*(-1.51)(2.13)*(-1.59)*(-2.41)*(2.86)*$$

$$R^{-2} = 55 \quad F = 3.65 \quad D.W = 0.99$$

The above shows that the model is consistent with the economic, statistical and standard indicators, as the estimated equation for the price of rice was negative (-0.208) to indicate the inverse relationship between the price of rice and the required quantity represented by the individual consumption rate. The estimated equation was significant at the 5% level, and the estimated equation for the average individual income was positive (0.217) which is significant below the 5% level to explain the direct relationship between the required quantity of rice and the consumer income. The estimation results showed the inverse relationship between the number of people and the required quantity of rice, as its value reached (-0.290) which is significant below the 1% level. The reason for this is the limited production of rice in Iraq due to its production being confined to limited areas in the southern governorates of Iraq, especially in Najaf Governorate. Therefore, the increase in the number of people leads to increased competition for the quantities consumed in this crop, which reflects its effect in reducing the

quantities consumed from it, and this is the inverse relationship. As for the wheat price equation sign and its relationship to the required quantity of rice, its sign was negative and significant below the 1% level, as its value reached (-0.752). Perhaps the appearance of the negative sign contradicts what is known about the nature of the relationship between rice and wheat, that it is reciprocal or competitive, but it appeared complementary. Perhaps the explanation of this from the research point of view shows the usual dietary pattern of the Iraqi family in the necessity of having bread and rice together on the Iraqi family table, although it is a wrong dietary pattern according to health standards, it is a common pattern that no two people disagree on, and thus the appearance of the negative sign and the significance of the equation proves the complementary relationship between rice and wheat .

Regarding the value of the coefficient of determination, which is (0.55), meaning that the independent variables are responsible for 55% of the changes in the dependent variable, and the remaining 45% is due to other variables that were not included in the model and their effect was absorbed by the random variable. Here we must clarify that the model did not contain some factors affecting the demand function, which are sometimes difficult to measure or there is not enough information about them, in addition to the model including different periods from each other, the first of which was represented by the nineties of the economic blockade, which extended to a later stage until 2003, while the second period was represented by the situation that Iraq went through until 2023. The significance of the model, which is below acceptable levels, confirms the correctness of choosing these variables .

The reliance on the double logarithmic model means that the estimated equations express price, cross- and income elasticity's of demand, and the importance of these elasticity's in determining pricing policies and providing those responsible for implementing policies with important information about the impact of price, income and cross-price changes on the quantities demanded of rice or determining the individual share of general rice consumption in Iraq. The estimated parameter for the price of rice, which is (-0.208), indicates the price elasticity of demand, i.e., a 10% increase in the price of rice while keeping the rest of the variables constant, will lead to a 2.08% decrease in the quantities demanded. We note here that the response of quantities to changes in prices was weak, or in other words, that changes in prices are greater than changes in quantities. Perhaps this reflects the importance of this commodity to the Iraqi consumer, who tries to obtain appropriate quantities of it even in light of its high prices or works to rationalize his consumption of it to the extent that makes him obtain the greatest amount of satisfaction from rice .

As for the estimated parameter of income (0.217), it reflects the value of income elasticity of demand, which indicates that a 10% change in income leads to a 2.17% change in demand, which means that rice is a natural and necessary commodity. Since income elasticity is less than 1, this means that rice has shown an inelastic response to income changes. The values of

the estimated equations for wheat prices reflect the cross-elasticity of demand in its integral form for wheat (0.752) .

VI. Conclusions ;

- 1- It was shown through the reality of rice production in Iraq that the areas allocated for rice cultivation are allocated to few areas, although they are suitable for a larger number of Iraqi governorates .
- 2- The low income elasticity of demand, which is 0.217, indicates that the satisfaction obtained from the Iraqi individual's consumption of rice is high, and this naturally explains the Iraqi consumer's desire to consume rice even in light of its high prices, which was explained by the weak response of the consumer to changes in prices, i.e. he is trying to obtain the greatest possible satisfaction from rice despite its high prices, and this was explained by the value of the price elasticity of demand, which is (0.208), in addition to the positive sign of the income elasticity of demand giving the impression that rice is a natural and necessary commodity .
- 3- The cross elasticity's showed an integrative relationship between rice and wheat, but the nature of this relationship remains weak, i.e. the rise in wheat prices will not push the consumer to reduce his rice consumption by the same percentage that prices rose, which explains that the integration between the two commodities is not strong enough, considering that the consumer will complete the reduction in his wheat (bread) consumption by increasing his rice consumption. Here, once again, the importance of this commodity is emphasized .

Suggestions ;

According to the conclusions presented above, the research presented a set of proposals, which we present as follows ;

- 1- Paying attention to the rice crop, starting from its cultivation in the land until its final consumer. This necessarily requires overcoming the problems that hinder its presence on the consumer's table on a permanent basis and at reasonable prices. Therefore, it requires the cooperation of all parties related to the crop. The farmer, for his part, must follow scientific methods in cultivating the crop, because otherwise it will lead to harming the agricultural land, especially since the nature of cultivating the crop requires the use of large quantities of water, and without scientific use of it, this exposes the soil to problems that ultimately lead to a decrease in the productivity of the crop, which in turn is reflected in the quantities available for local consumption .
- 2- Placing the burden on farmers alone to bear the responsibility of promoting rice cultivation in Iraq would be a great injustice to this segment, and here comes the role of the government, as its role is limited to the necessity of adopting a fair pricing policy, knowing that this requires broad support from all relevant ministries and adopting certain measures represented by the following ;
 - A- The government's support for farmers and farmers by providing loans on easy terms with an extension of the payment period .
 - B- By providing seeds of good varieties, pesticides and their requirements .
 - C- Increasing its production of compound fertilizer and urea to cover the shortage in the market, which is covered by importing from sources with poor specifications .
 - D- Addressing the problem of power outages, which has become an intractable problem for the concerned ministry .
 - E- The Ministry of Oil's contribution to providing farmers with a share of fuel and oils to operate pumps and equipment at reasonable prices .

Sources ;

FAO. (2023). *FAOSTAT Database: Food Balance Sheets and Price Indices*. Food and Agriculture Organization of the United Nations. Available at: www.fao.org

Arab Organization for Agricultural Development (AOAD). (2023). *Yearbook of Arab Agricultural Statistics*. Khartoum, Sudan.

Central Statistical Organization (CSO). (2022). *Annual Abstract of Statistics 2021-2022* . Ministry of Planning, Baghdad, Iraq.

Gujarat , Domodar . 1985 . *Basic econometric MC* – Graw – Hill . USA.

Al-Shaikhli, Adel Abbas, 2009, *Opinions on the problems and agricultural development in Iraq* .

Muthayya, S., et al. (2014). "The global rice landscape: 2010-2050." *Global Food Security*, 3(1), 11-20.

IRRI. (2024). *World Rice Statistics (WRS) Online Query Database*. International Rice Research Institute. Available at: ricestat.irri.org