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ESTIMATION OF THE TECHNICAL EFFICIENCY OF WHEAT FARMS UNDER THE SUPPLEMENTARY IRRIGATION SYSTEM USING THE STOCHASTIC FRONTIER APPROACH (NINEVEH GOVERNORATE- ALBAAJ DISTRICT AS A MODEL)

Emad A. Ahmed , Mohammed H. Ahmed , Osama L. Mohamed , Ahmed H. Ali
Department of Agricultural Economics, College of Agriculture and Forestry, University of Mosul, Mosul, Iraq 1,2,3,4

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Correspondence Email:
Imadabdulaziz79@uomosul.edu.iq

ABSTRACT

Wheat production in Iraq under permanent farming systems faced sharp seasonal fluctuations during the previous years resulting from Climate fluctuations that affected the output , and for the rational use of scarce water resources, an effective system to improve irrigation, and the research aimed To estimate the technical efficiency of wheat farms by means of random correlation analysis using the logarithmic production function, based on field data for a random sample of 30 farms in the district of Al-Baaj Nineveh Governorate for the agricultural season 2020-2021. The results of estimating the technical efficiency showed that the research sample achieved a technical efficiency of 94%, which means that a waste of resources was 6%, so it is the responsibility of this sample to produce the same amount of wheat using only 94% or less of the inputs to reach the optimum efficiency. Also, there is a positive relationship between the number of irrigations, the amount of pesticides, the area, and the yield of wheat, while this output is associated with an inverse relationship with agricultural work, the amount of seeds and fertilizers, as an increase in the amount of fertilizers, the quantity of seeds, and agricultural work by 1% leads to a decrease in wheat production by 0.261% and 0 723% and 0.159%, respectively. This may be attributed to the use of these resources at a rate that exceeds the plant's need for these resources, and this in turn led to waste in resources and thus a decrease in technical efficiency below the optimal level.

INTRODUCTION

Iraq is located within the arid and semi-arid areas in a large part of its area, and they are called the bloody areas in which production is surrounded by great risks due to their being subject to environmental conditions, and what we notice is a great expansion in the use of supplementary irrigation systems in Iraqi agriculture and the consequences of reducing government support for production inputs and then The rise in its prices, so it moved away from abundance to scarcity was one of the reasons and incentive to estimate the technical efficiency of wheat farms in Irrigated agriculture and to infer the rationality of the use of productive resources and knowledge of the extent of efficiency at the farm level and to give the appropriate recommendation that enables improving the use of resources, The importance of the study came because wheat is a necessary food commodity On the one hand, and from the specialization of Nineveh Governorate in its cultivation on the other hand, and since the amounts of rainfall in most seasons are not sufficient to provide the water needs of crops, supplementary irrigation as a technique has become one of the most important tributaries to complete these needs as a production element that contributes to achieving marginal product and marginal cost, and it is necessary Measuring the efficiency of the use of productive elements in wheat farms with the presence of this technique in order to achieve the goal of guidance in the use of a combination Available resources, and the results of the research are an important indicator for the purposes of the agricultural and water policy necessary to improve resource management in a way that encourages the adoption of modern irrigation technologies in sustainable agriculture, raising the level of wheat production and its stability, and achieving food security for the country (Al-Hamarna, 1994). The research adopts a hypothesis that emphasizes that the optimal technical efficiency Achieved for all wheat farms in the research sample used for supplemental irrigation at different levels and the inefficiency is zero (ui=0). The research aims to estimate technical efficiency (TE) in a stochastic parametric analysis method using the logarithmic production function and focusing on the basic production inputs to identify the amount of the inefficiency parameter for each farm represented by the random variable (ui). Technical efficiency, and the second quantitative, relates to measuring the technical efficiency of the sample farms in Al-Ba'aj district of Nineveh Governorate, which amount to (30) farms, as well as relying on the results of studies published by Arab organizations and on the international network of information, frameworks, messages and research related to this topic.

Theoretical framework and review of technical references:

Many developing countries, including Iraq, in which suffer from the misuse of the resources available to it, which leads to a low economic efficiency of the farm. Technical efficiency is defined as the efficiency of resource investment from a technical point of view, and the degree to which these uses are close to ideal levels from a scientific point of view, to reach optimal levels in the field of resource investment and achieve desirable goals and objectives. If the achieved production (actual) is equal to the optimal production, this means that the farm is fully efficient, but if the actual production is less than the optimal production, the farm is technically inefficient. Farrell's 1957 definition of technical efficiency led to the development of methods for estimating farm efficiency, in order to achieve technical efficiency, there must be efficiency in the use of technical means at the lowest possible cost. (Png and Cheng, 2001)

Random Parametric Analysis Method:

Stochastic parametric analysis has become a tool that has its proponents, as well as the special feature it has which is the ability to form a model that explains the relationships and determinants of inefficiency at a single stage. (NIESR, 2004) This model is used to measure the level of technical and allocative efficiency of the farm, and thus estimate the economic efficiency. (Kolaole and Ojo , 2007) and stochastic border analysis is performed using a computer program called (Frontier), which is the most common program as an easy tool for estimating random limits in the production function and costs at all times, whether when the efficiency is fixed or varying, and there are two ways to estimate the inefficiency either One step, by finding the technical efficiency of each farm or two steps, in this case we will find asymmetry in the assumptions about the distribution of the error independently, because the function consists of a number of limiting factors (Herrero and Pascoe, 2002). Efficiency is estimated using stochastic analysis (Parametric Methods) either by the production function or the stochastic boundary cost function: The stochastic boundary production function: The stochastic boundary production function was independently proposed by (Aigner, Lovell, Meeuse(and (Croppenstedt, 2005), that the stochastic boundary model allows estimating the standard error, and accordingly, statistical tests for the hypothesis can be done using one of the analytical methods such as (Maximum Likelihood). (Shabib, 2005) that the measure of TE at the farm level is TEi = exp (-ui), and this definition contains the effect of technical inefficiency, which is unobservable. Even if the parameters of the model (the vertical vector β) are known, the only part that can be obtained or computed from the model is the difference between ei = vi - ui (Shabib, 2005). This model was used by many researchers, including(Mariam and Coffin, 2006) in estimating the efficiency of production and agricultural technology in Ethiopia, and the researchers (Yao and Liu, 1998) used the stochastic boundary production function to determine the effects on grain production and technological efficiency in China, and measured , The technical efficiency of a sample of wheat seed producers of the improved variety Tammuz/2 in Al-Qadisiyah Governorate, and the researchers used the random boundary production function in the estimation as it is suitable for studying the Production efficiency of sectors has big problems discrepancies in the data, as this model was used In order to measure the effect of efficiency and technological change in farming Botswana as well as researchers (Liu and Wang , 2005), Cobb-Douglas production function is used to determine the stochastic boundary production function (SFPF) model that was used to estimate the technical efficiency of farms in developing and developed countries, which is During which the stochastic boundary cost function is derived. The following are the most important of those studies: (koLowole and ojo, 2007) estimated the economic efficiency of small enterprises for the production of food crops in Nigeria / the random border method. The researchers concluded that the RTS amounted to 1.113, and the average value of the total production of the farms reached 83,433, and the highest value of technical efficiency reached 92.87.48. As for the minimum value, it reached 56. and (Shideed et al., 2005) by studying the efficiency of water use at the farm level in wheat production in Iraq. Which were collected from 800 farms of irrigated wheat farmers in Egypt for the agricultural season 97-98, and the researcher used in measuring the technical efficiency the stochastic boundary production function model. In the district of Hawija / Kirkuk, a sample of 60 farmers.

MATERIALS AND METHODS

The research relied on the initial data obtained from its field sources as a random sample of 30 farms, representing about 85% of the total farms for wheat producers using supplementary irrigation technology in the Ivory District and for the agricultural season: (2020-2021)

X1: The area planted with wheat dunum .

x2: seeds kg

X3: fertilizer kg

X4: The amount of pesticides measured in liters .

X5: The number of irrigations measured in dunums per hour

x6: number of workers (worker/day)

METHOD OF ANALYSIS

Characterization of a stochastic parametric analysis (SFA) model according to the superior logarithmic production function (Transcendental Logarithmic Function) **:**
Within the SFA method and according to the superior logarithmic production function TL, the technical efficiency TE of wheat farms is estimated to know the efficiency achieved by the presence of supplementary irrigation technology. In this method, the focus will be on the basic inputs in production that the farmers used in the research sample. In calculating and estimating the technical efficiency, the Frontier program was used, which allows estimating random production limits and obtaining estimates for the maximum parameters of the function. The estimation process goes through three steps: (Herrero and Pascoe, 2002)

-The first step: The Ordinary Least Squares (OLS) method is used to obtain unbiased linear parameters (blue) for the standard model, except for the discontinuous part of the y-axis ( ), which is biased **.**

- The second step: The corrected ordinary least squares (COLS) method is used to obtain unbiased linear parameters, including them. and the production limits function in the (Cobb-Douglas) formula, which is estimated by the previous methods, takes the following formula: Yi = Xi – Ui ……………………… (1)

Where: Yi: the output of the farm i **.**

Xi: K×1 expression vector for farm inputs **.**

β : vector of the estimated model parameters **.**

Ui: a random variable, related to the technical inefficiency of the farm **.**

Technical efficiency TE in this case is defined as the ratio of actual production to expected production, which takes values between zero and one (Kolawole and Ojo, 2007). It is obtained as in the following equation ……………………… (2)

And the random boundary production function differs from the production boundary function in the (Cobb-Douglas) formula by adding a random error representing the measurement error (Vi) to the random error (Ui) representing inefficiency (Shabib, 2005). Thus, the stochastic boundary production function takes the following form:
Yi = Xi + (Vi – Ui) ……………………… (3)

Since: Vi: is a random variable or measurement error with identical independent distribution (I.I.d) and mean (mean) equal to zero, and constant variance and independent of (Ui) non-negative, which also has an independent distribution and an arithmetic mean equal to zero and a constant variance. By taking the logarithm of the function in equation (3), the model becomes as follows: LnYi = iLnXi + (Vi – Ui) ……………………… (4)

Equation (4) can be written in another form as follows: LnYi = iLnXi + ei ……………………… (5)

As ei is the random variable or the so-called error term consisting of two parts (Mariam and Coffin, 2006)

-The third step: Where estimates are obtained for the parameters of the production function of the random bounds by the method of maximum likelihood method according to the hyper-logarithmic production function, which is one of the most widely used functional formulas presented by the economist (Christensen et al, 1973) and it is superior to the rest of the other productive functions. Especially when we have more than two production workers (Al-Jalili, 2010) and the (Translog) function adopted in estimating the technical efficiency takes the following formula **:**

LNYI = bO + b1 LN X1 + b2 LN X2 + …… + b5 LN X5 + b11 (LN X1)2 + b22(LN X2)2 + …… + b55 (LN X5)2 + b1→5 LN X1 LN X2 LN X3 LN X4 LN X5+ (VI–UI) ……………………… (6)

Where:

Y: the dependent variable and represents the production of the wheat crop in tons.

β_0: fixed limit.

βm: parameters.

Xm: independent variables, including:

X1: The area planted with wheat, and for each farm, the unit of measurement is the dunum.

x2: seeds kg

X3: fertilizer kg

X4: The amount of pesticides measured in liters.

X5: The number of irrigations measured in dunums per hour

x6: number of workers (worker/day

RESULTS & DISCUSSION:

The technical efficiency TE was found using the (Stochastic Frontier Approach) method for wheat farms under the supplemental irrigation technique: the technical efficiency was estimated by the method of random boundary analysis according to the logarithmic production function (TL), by focusing on the basic and used inputs from all wheat-producing farms for the research sample to obtain Technical efficiency estimates and values for the parameters of the independent variables of the logarithmic production function using the (maximum probability) method, Log ML test, and the estimation results are shown in the following table:

Table No. (1) shows the value of the coefficient of the production function Translog using (OLS), and after correcting its value in the (ML) method, the values of its coefficients will be relied on to explain the relationship between the independent variables in the function and the output (wheat) of the dependent variable, and it represents the parameter value of the variable in the function Production Translog Flexibility Productivity of the portal (resource). The cultivated area X1 dunums: It was shown through the (t) test that this variable was significant, and then the effect of this variable and its relationship with a positive relationship with the output, as the increase in the demand of farmers to adopt and use mechanical technology in the democratic areas by 1% leads to an increase of 1.039% in the volume of output of wheat.

2. Seeds kg X2: This variable was found to be insignificant through the (t-test), and its elasticity value was about (-0.589), indicating the inverse relationship between agricultural work and the output of irrigated wheat, that is, an increase in working days for workers by 1% leads to Production decreased by 0.589%, which means that the number of working days used by farmers exceeds the level required to perform the production process.

3. Fertilizers kg X3: The importance of this variable was not shown by (t) test, but it has an inverse relationship with irrigated wheat through the negative sign of its elasticity value, which means that it increases the amount of irrigation water given to

the wheat crop in rainy areas in a way that exceeds the crop's need of water by 1%, 0.808%, and this indicates that the wheat obtained irrigation water that is not consistent with the need of the crop, which negatively affects the production and thus does not achieve the technical efficiency of irrigation when comparing the amount of irrigation water given. The actual need to produce this quantity of the crop, and this is a reason why farmers seek to know the necessary quantity and the appropriate time to add each irrigation to wheat and meet its water needs.

4. The amount of pesticides liter x4 the value of the elasticity for this variable in the logarithmic production function of the research sample is about 0.659, as it indicates a direct relationship between the seeds and the yield of the crop. When the seeds are increased (without plant intensification) by 1%, the wheat production increases by 0.659%, The significance of this variable was not shown by (t) test.

5. The number of irrigation hours X5: The significance of this variable appeared by comparing the value of (t) achieved with its tabular value, and the elasticity value of this variable shows the direct relationship between the area and the yield of wheat, which means that increasing the area planted with wheat crop by 1% leads to an increase Production by 1.119%, and this is in agreement with the expectations and concepts of economic theory,

6. The number of workers on 6 X: It was also shown that the logarithm square of the independent variables was not significant, and the logarithmic function of the maximum probability reached negative values -24.56, indicating that there are technical changes that negatively affect the random variable, and then agricultural production and finally the effect on technical efficiency. After that, the production function (TL) was used to estimate technical efficiency, and the results of the estimate were fixed in Table (2)

Table (1): Estimation of the superior logarithmic production function (TL) using the maximum likelihood method to measure technical efficiency

B	Estimation of parameters using the CLOSE method	Estimation of parameters by ML method	a test t
beta 0	0.12954	0.130126	0.11182
beta 1	0.78907	0.789077	0.31089
beta 2	- 0.72332	- 0.723320	- 0.26142
beta3	- 0.15982	- 0.159822	- 0.98024
beta 4	0.18877	0.188774	0.19879
beta 5	0.48325	0.483259	0.13863
beta 6	- 0.26154	- 0.261545	- 0.28604
beta 7	- 0.10437	- 0.104378	- 0.30545
beta 8	0.51125	0.511257	0.26504
beta 9	0.10301	0.103019	0.96424
beta10	0.91450	0.914504	0.22957
beta11	- 0.85818	- 0.858189	- 0.13986
beta12	0.62443	0.624436	0.21077
beta13	0.47356	0.473565	0.12012

Log Likelihood function = 19.43

Source : prepared by the research based on the results of the analysis .

Table (2) The technical efficiency of wheat farmers for the research sample for the agricultural season 2020-2021

Technical competency	Sequencing	Technical competency	Sequencing
0.693	16	0.771	1
0.787	17	1	2
1	18	1	3
1	19	0.789	4
0.599	20	1	5
1	21	0.798	6
1	22	1	7
0.923	23	0.860	8
0.895	24	0.729	9
1	25	0.868	10
1	26	0.635	11
0.697	27	1	12
0.716	28	0.875	13
0.912	29	1	14
1	30	0.875	15
average efficiency	0.944		
Minimum	0.599		
the highest rate	1		

Source: prepared by the research based on the results of the analysis.

CONCLUSIONS

It is clear that the farms that achieved the highest value of technical efficiency (1) are (2-3-5-7-12-14-18-19-21-22-25-26-30) in the previous table, which means that these farms were Technically efficient and accounted for about 43% of the sample farms, the inefficiency condition which is the user interface element is equal to zero (ui = zero), and through the overall average efficiency, it was found that the research sample generally achieved an average technical efficiency of about 94% , that is, the effect of technical inefficiency was equal to the correct one (ui = 1), and for this reason this sample is required to produce the current quantity or more of irrigated wheat using only 94% or less of the inputs used to reach the optimum technical efficiency, by taking advantage of This is consistent with the hypothesis of the research that the technical effect is to achieve efficiency in varying proportions for all wheat farms, and the research sample used for supplemental irrigation in the Al-Baaj region and that the effect of inefficiency depicted by the element ui equals zero (ui). = 0).

Based on the above, the study concluded:

.1The negative sign of the variables of seeds and fertilizers as basic inputs in the production process. Therefore, it is necessary to use agricultural production inputs in the quantity and manner recommended scientifically, especially supplementary irrigation water, in a way that is appropriate to the crop’s need to reach an optimum degree of efficiency.

2. The negative sign of human labor contributed to the deterioration of the percentage of technical competence at the level of the farm, stressing the rationalization of its use according to its optimal needs, leading to the desired efficiency of its employment in the production process.
3. Among the average levels of efficiency achieved in most of the farms, there is an indication of the need to expand the size of the farms to accommodate the surplus inputs that caused a decline in technical efficiency.

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CONFLICT OF INTEREST

Author declares no conflicts of interest regarding he publish this article.

تقدير الكفاءة الفنية لمزارع القمح تحت نظام الري التكميلي باستخدام برنامج *Stochastic Frontier Approach* (محافظة نينوى - قضاء البعاج أنموذجا)

عماد عبد العزيز احمد[1] ,محمد حامد احمد[2] ,أسامة ليث محمد[3] ,احمد هاشم علي[4]
قسم الاقتصاد الزراعي / كلية الزراعة والغابات / جامعة الموصل [4,3,2,1]

الخلاصة

واجه إنتاج القمح في العراق تحت أنظمة الزراعة الديمية تذبذبات موسمية حادة خلال السنوات السابقة ناتجة عن تقلب الظروف المناخية التي أثرت في الغلة والإنتاج , ويتطلب من اجل الاستخدام الرشيد لمصادر المياه الشحيحة وجود نظام فعال لتحسين الريّ، واستهدف البحث تقدير الكفاءة الفنية لمزارع القمح بطريقة التحليل الحدودي العشوائي وباستخدام دالة الانتاج اللوغاريتمية المتفوقة وذلك بالاعتماد على البيانات الميدانية لعينة عشوائية بلغت 30 مزرعة في قضاء البعاج محافظة نينوى للموسم الزراعي 2020-2021 ، وأظهرت نتائج تقدير الكفاءة الفنية بأن عينة البحث حققت كفاءة تقنية بلغت94% وهذا يعني أنّ هدر في استخدام الموارد بنسبة 6%، لذلك يقع على عاتق هذه العينة أنْ تنتج نفس الكمية من القمح باستخدام 94% فقط أو أقل من المدخلات للوصول إلى الكفاءة المثلى ، وتبين أيضا وجود علاقة ايجابية ما بين عدد الريات وكمية المبيدات والمساحة والناتج من القمح في حين أن هذا الناتج يرتبط بعلاقة عكسية مع العمل الزراعي وكمية البذور والاسمدة ، حيث بزيادة كمية الاسمدة وكية البذور والعمل الزراعي بنسبة 1% تؤدي الى انخفاض الانتاج من القمح بنسبة 0.261% و0.723% و0.159% على التوالي وقد يعزى هذا الى استخدام هذه الموارد بنسبة تفوق حاجة النبات من هذه الموارد وهذا بدوره أدى إلى الهدر في الموارد وبالتالي انخفاض الكفاءة الفنية دون المستوى الأمثل.

الكلمات المفتاحية: الكفاءة الفنية، دالة الحدود العشوائية، الري التكميلي.

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