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Estimating the efficiency of wheat production in Assiut Governorate

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Abstract: The research aims to estimate the technical efficiency of wheat production in the centers of Assiut Governorate using the methods of random frontier analysis and data envelope analysis. The research relied mainly on the use of stochastic frontier analysis to estimate the wheat production function using Frontier 4.1c program, and data envelope analysis to measure the technical, distributional and economic efficiency of wheat production in the centers of Assiut Governorate using DEAP ver.2.1 program. The research results showed that there were significant differences between the productivity of the feddan of wheat crop in the centers of Assiut Governorate during the period (2021-2023), and the existence of this variation requires knowing whether this variation is due to inefficiency or due to random error, and to find out this, random bounds analysis was used. To estimate the random boundary production function for wheat crop in Assiut Governorate for the average period (2021-2023), the double logarithmic production function (Cobb-Douglas) was used. The results showed that despite reducing the amount of nitrogen fertilizer, pesticides, and the number of automated working hours by 1%, the previous increase over the stagnant amount of these resources led to an increase in wheat crop production by 0.82%, 0.23%, and 0.39%, respectively. This may be due to the existence of waste or surplus in the use of these resources, and that these resources used are more than what the land needs to grow wheat crops, which means that the use of these resources falls in the third production stage, which is an irrational production stage, which means that there is waste in the use of these production resources and the quantities used must be reduced. Meanwhile, the results showed that increasing the number of workers by 1% leads to an increase in wheat crop production by 0.51%, which is a value less than one and greater than zero, which means that the use of this resource falls in the production stage. The second is the rational production stage. It was also shown that the gamma value was about 0.94, and this value is closer to one than to zero, which means that 94% of the deviations are due to the effect of inefficiency and not to random error. After verifying through the use of the random frontier production function that the changes are due to inefficiency and not to random error, the data envelope is used. Although it cannot distinguish between inefficiency and random error, it provides more details, as the random frontier production function cannot determine the sources of inefficiency as well as the amount of inefficiency, and therefore does not provide detailed data that helps in taking corrective measures for units that suffer from inefficiency. By estimating the technical efficiency of wheat production in Assiut Governorate centers according to the data envelope analysis method for the average period (2021-2023), and through the concept of constant return on capacity, 4 centers achieved the maximum efficiency in wheat production, representing about 36.36% of the total number of centers. As for the concept of changing return on capacity, 7 centers achieved the maximum efficiency in wheat production, representing about 63.64% of the total number of centers. It was also shown through the capacity efficiency index that 4 centers achieved full efficiency, i.e. the correct one, which means that the actual combination of resources used is the same as the optimal combination. It was also found that the most reference centers for inefficient centers according to the technical efficiency index in the case of a stable return on capacity in wheat production in Assiut Governorate for the average period (2021-2023) are Sahel Selim and El-Quseya centers, which were repeated seven times, while the most reference center for inefficient centers according to the technical efficiency index in the case of a change in the return on capacity is El-Fatah Center, which was repeated four times. It was also shown that the largest percentage of increase in the wheat crop production requirement to achieve optimal economic efficiency was in the amount of pesticides, with an increase of about 53.68%, in Sahel Selim Center, which also had the lowest percentage of increase in the wheat crop production requirement to achieve optimal economic efficiency, which was in the amount of nitrogen fertilizer, with an increase of about 0.03%. It was also shown that the largest percentage of decrease in the wheat crop production requirement to achieve optimal economic efficiency was in the amount of organic fertilizer, with a decrease of about 25.96%, and it was in Manfalout Center, while the lowest percentage of decrease in the wheat crop production requirement to achieve optimal economic efficiency was in the amount of nitrogen fertilizer, with a decrease of about 0.88%, and it was in El-Fatah Center.

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Keywords: Stochastic frontier analysis, data envelopment analysis, technical efficiency, capacity efficiency, allocative efficiency, economic efficiency.

Introduction:

Wheat is considered the most important winter crop in Assiut Governorate, as the cultivated area amounts to about 208.14 thousand feddans, representing about 67.28% of the total area of winter crops, which amounts to about 309.36 thousand feddans for the average period (2021-2023) (Directorate of Agriculture in Assiut Governorate).

Wheat production is affected by the level of employment of economic resources and the level of their production efficiency and because of the scarcity of these resources compared to their multiple uses, it has become necessary to study the efficiency of production of this important crop by identifying the economic efficiency and its technical and distributional components as the most important measure of the efficiency of economic performance and then identifying the extent to which wheat producers are close or far from achieving economic efficiency.

Wheat production efficiency includes technical, distributional and economic efficiency. Estimating wheat production efficiency is an important issue in increasing crop production. Through estimating efficiency, useful information can be obtained that helps in making decisions related to the distribution and use of resources and setting appropriate agricultural policies for this, as the deviation of the actual use of resources from their optimal use means a shortage in production and a waste of resources. In light of the relative scarcity of resources and the low opportunities to obtain advanced technology, studying efficiency is of great importance because it will be able to show the possibility of increasing production by improving the efficiency of resource use (El-Youssef et al., 2018).

Research problem:

The research problem is that wheat producers in Assiut governorate centers are trying to increase their production by raising the efficiency of crop production, and in their attempt to do so, there may be a deviation from the level of optimal use of resources, and thus a waste of resources, as the issue of efficiency is one of the important issues, as raising the efficiency of wheat production means reducing its production costs or increasing production with the same amount of costs, which means increasing the profit of wheat farmers and thus the demand for it and expanding its cultivation, which increases the amount of production and reduces the amount of imports, which leads to providing foreign currency on the one hand, and reducing the food gap for wheat on the other hand.

Research objective:

The research aims to estimate the efficiency of wheat production in Assiut Governorate, by studying the following sub-objectives:

1- Identifying the development of some productive and economic indicators of wheat crops in Assiut Governorate.
2- Estimating the random boundary production function for wheat crop in Assiut Governorate.
3- Estimating the technical efficiency of wheat production in Assiut Governorate centers using random frontier analysis.
4- Measuring the technical efficiency of wheat production in Assiut Governorate centers using data envelopment analysis.
5- Measuring the distributional and economic efficiency of wheat production in the centers of Assiut Governorate using data envelopment analysis.
6- Estimating the optimal quantities of resources to achieve economic efficiency in wheat production in Assiut Governorate centers using data envelopment analysis.

Research method and data sources:

The research relied on descriptive and quantitative analyses to achieve its objectives to analyze data related to the research topic by using some mathematical and statistical methods such as arithmetic averages, percentages, and regression analysis to estimate the general time trend, variance analysis, and random bounds analysis to estimate the wheat production function using Frontier 4.1c program, and data envelope analysis to measure the technical, distributional, and economic efficiency of wheat production in Assiut Governorate centers using DEAP ver.2.1 program.

The research used secondary statistical data for the period (2005-2023) available from the Economic Affairs Sector of the Ministry of Agriculture and Land Reclamation, the Directorate of Agriculture in Assiut Governorate, and the records of the Statistics Department in the centers of Assiut Governorate, in addition to scientific references related to the research topic.

Search results:

Before estimating the efficiency of wheat production in Assiut Governorate, it is necessary to first identify the production and economic indicators of wheat crop in Assiut Governorate, which helps to give an accurate view of the

development of indicators related to the crop, and sheds light on the changes that occurred during the study period. Below we will learn about the development of these indicators:

First: The development of some production and economic indicators of the wheat crop in Assiut Governorate during the period (2005 - 2023):

A- Development of some production indicators of wheat crop in Assiut Governorate:

1- Development of the cultivated area:

By studying the development of the cultivated area of wheat crops in Assiut Governorate during the period (2005-2023), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 162 thousand feddans in 2007, and a maximum of about 241 thousand feddans in 2020, i.e. an increase rate of about 48.77% over the minimum, and about 39.90% over the average cultivated area of wheat crops in Assiut Governorate, which is estimated at about 198 thousand feddans.

Table (1): Development of some production and economic indicators of wheat crops in Assiut Governorate during the period (2005-2023).

Year	Productivity indicators			Economic indicators			
	Cultivated area (thousand feddans)	Feddan productivity (tons)	Total production (thousand tons)	Farm price (pounds per ton)	Cost of production per feddan (pounds)	Total revenue per feddan (pounds)	Net yield per feddan (pounds)
2005	164	2.93	481	1000	1747	2933	1186
2006	165	2.81	464	1120	1900	3150	1250
2007	162	2.77	449	1133	2063	3141	1078
2008	171	2.78	475	1293	2297	3593	1296
2009	169	2.89	489	1540	2773	4456	1683
2010	164	2.38	390	1900	3118	4518	1400
2011	166	2.90	481	2400	3951	6954	3003
2012	191	2.82	538	2533	4113	7136	3023
2013	204	2.89	589	2667	4478	7699	3221
2014	220	2.74	603	2800	5179	7675	2496
2015	225	2.80	629	3247	5627	9076	3449
2016	230	2.72	625	3413	6460	9275	2815
2017	211	2.98	629	3767	8255	11229	2974
2018	222	2.61	579	4000	8373	10432	2059
2019	229	2.89	662	4500	10095	13009	2914
2020	241	2.91	701	4667	10442	13574	3132
2021	233	3.21	749	4833	12085	15537	3452
2022	230	3.01	692	5900	14225	17751	3526
2023	167	2.86	478	8000	18240	22898	4658
minimum	162	2.38	390	1000	1747	2933	1078
maximum	241	3.21	749	8000	18240	22898	4658
Average	198	2.84	563	3195	6601	9160	2559

Source: Compiled and calculated from data:

1- Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics Bulletin, Cost and Net Return Statistics Bulletin, various issues.

2- Directorate of Agriculture, Assiut Governorate, Statistics Department records, unpublished data.

By estimating the equation of the general time trend of the cultivated area of wheat crop in Assiut Governorate, it is clear from Table (2) that there is a statistically significant annual increase of about 3.91 thousand feddans, representing about 1.97% of the annual average of about 198 thousand feddans. The coefficient of determination (R^2), estimated at about 0.53, indicates that about 53% of the changes occurring in the cultivated area of wheat crop in Assiut Governorate are due to the influence of factors reflected by the time element.

2- Development of average productivity per feddan:

By studying the development of the average productivity per feddan of wheat crops in Assiut Governorate during the period (2005-2023), it was shown from the data in Table (1) that it fluctuated between a decrease and an increase

during the study period between a minimum of about 2.38 tons per feddan in 2010, and a maximum of about 3.21 tons per feddan in 2021, i.e. an increase rate of about 34.87% over the minimum, and about 29.23% over the general average of the average productivity per feddan of wheat crops in Assiut Governorate, which is estimated at about 2.84 tons per feddan.

By estimating the general time trend equation for the average productivity of the feddan of wheat crop in Assiut Governorate, it is clear from Table (2) that it increased by an annual amount that was not statistically significant.

3- Total production development:

By studying the development of total wheat production in Assiut Governorate during the period (2005-2023), it was shown from the data in Table (1) that it fluctuated between a minimum of about 390 thousand tons in 2010 and a maximum of about 749 thousand tons in 2021, i.e. an increase rate of about 92.05% over the minimum, and about 63.77% over the average total wheat production in Assiut Governorate, which is estimated at about 563 thousand tons.

By estimating the equation of the general time trend of the total production of wheat crop in Assiut Governorate, it is clear from Table (2) that there is a statistically significant annual increase of about 13.21 thousand tons, representing about 2.35% of the annual average of about 563 thousand tons. The coefficient of determination (R^2), estimated at about 0.55, indicates that about 55% of the changes occurring in the total production of wheat crop in Assiut Governorate are due to the influence of factors reflected by the time element.

Table (2): The general time trend of some productive and economic indicators of wheat crops in Assiut Governorate during the period (2005-2023).

Y	Cultivated area (thousand feddans	Feddan productivity (tons)	Total production (thousand tons)	Farm price (pounds per ton)	Cost of production per feddan (pounds)	Total revenue per feddan (pounds)	Net yield per feddan (pounds)
C	158.98	2.74	431.18	89.72	-1161.11	-104.28	1056.83
B	3.91	0.01	13.21	310.57	776.22	926.41	150.19
t	4.40**	1.46	4.52**	12.57**	11.35**	12.49**	6.38**
R^2	0.53	0.11	0.55	0.90	0.88	0.90	0.71
F	19.38**	2.14	20.41**	157.91**	128.77**	155.96**	40.72**
Average	198	2.84	563	3195	6601	9160	2559
Rate of change (%)	1.97	-	2.35	9.72	11.76	10.11	5.87

Where: Y = refers to the estimated value of the phenomenon, C = constant of the equation.
B = time coefficient, where time = 1, 2, 3, ..., 19., t = significance of the regression coefficient.
R^2 = coefficient of determination, F = significance of the model.
**Significant at a significance level of 0.01.
Source: Collected and calculated from data in Table (1).

B - Development of some economic indicators of the wheat crop in Assiut Governorate:

1- Development of the farm price:

By studying the development of the farm price per ton of wheat crop in Assiut Governorate during the period (2005-2023), it was shown from the data in Table (1) that it increased during the study period, from about 1000 pounds per ton in 2005, to about 8000 pounds per ton in 2023, i.e. an increase rate of about 700.00% over the minimum, and about 219.09% over the average farm price of wheat crop in Assiut Governorate, which is estimated at about 3195 pounds per ton.

By estimating the general time trend equation for the farm price per ton of wheat crop in Assiut Governorate, Table (2) shows a statistically significant annual increase of about 310.57 pounds per ton, representing about 9.72% of the annual average of about 3195 pounds per ton. The coefficient of determination (R^2), estimated at about 0.90, indicates that about 90% of the changes occurring in the farm price per ton of wheat crop in Assiut Governorate are due to the influence of factors reflected by the time element.

2- Development of the costs of production per feddan:

By studying the development of the costs of producing an feddan of wheat crops in Assiut Governorate during the period (2005-2023), it was shown from the data in Table (1) that they increased during the study period, from about 1747 pounds per feddan in 2005, to about 18240 pounds per feddan in 2023, i.e. an increase rate of about 944.08%

over the minimum, and about 249.86% over the average costs of producing an feddan of wheat crops in Assiut Governorate, which is estimated at about 6601 pounds per feddan.

By estimating the equation of the general time trend of the costs of producing an feddan of wheat crop in Assiut Governorate, it is clear from Table (2) that there is a statistically significant annual increase of about 776.22 pounds per feddan, representing about 11.76% of the annual average of about 6601 pounds per feddan. The coefficient of determination (R^2), estimated at about 0.88, indicates that about 88% of the changes occurring in the costs of producing an feddan of wheat crop in Assiut Governorate are due to the influence of factors reflected by the time element.

3- Development of total revenue per feddan:

By studying the development of the total revenue per feddan from wheat crops in Assiut Governorate during the period (2005-2023), it was shown from the data in Table (1) that it fluctuated up and down during the study period, between a minimum of about 2933 pounds per feddan in 2005, and a maximum of about 22898 pounds per feddan in 2023, i.e. an increase rate of about 680.70% over the minimum, and about 217.96% over the average total revenue per feddan from wheat crops in Assiut Governorate, which is estimated at about 9160 pounds per feddan.

By estimating the general time trend equation for the total revenue per feddan of wheat crop in Assiut Governorate, Table (2) shows a statistically significant annual increase of about 926.41 pounds per feddan, representing about 10.11% of the annual average of about 9160 pounds per feddan. The coefficient of determination (R^2), estimated at about 0.90, indicates that about 90% of the changes occurring in the total revenue per feddan of wheat crop in Assiut Governorate are due to the influence of factors reflected by the time element.

4- Development of net yield per feddan:

By studying the development of the net yield per feddan of wheat crops in Assiut Governorate during the period (2005-2023), it was shown from the data in Table (1) that it fluctuated up and down during the study period between a minimum of about 1078 pounds per feddan in 2007, and a maximum of about 4658 pounds per feddan in 2023, i.e. an increase rate of about 332.10% over the minimum, and about 139.90% over the average net yield per feddan of wheat crops in Assiut Governorate, which is estimated at about 2559 pounds per feddan.

By estimating the general time trend equation for the net yield per feddan of wheat crop in Assiut Governorate, Table (2) shows a statistically significant annual increase of about 150.19 pounds per feddan, representing about 5.87% of the annual average of about 2559 pounds per feddan. The coefficient of determination (R^2), estimated at about 0.70, indicates that about 70% of the changes occurring in the net yield per feddan of wheat crop in Assiut Governorate are due to the influence of factors reflected by the time element.

Second: The relative importance of the area, production and productivity of the wheat crop in the centers of Assiut Governorate for the average period (2021-2023).

Table (3) shows the relative importance of the area, production and productivity of the wheat crop in the centers of Assiut Governorate for the average period (2021-2023), as it was shown that Assiut Center ranked first in the area planted with wheat with an area of about 31.41 thousand feddans, representing about 15.09% of the total area planted with wheat, amounting to about 208.14 thousand feddans, while Sahel Selim Center ranked last in the area planted with wheat with an area of about 6.12 thousand feddans, representing about 2.94% of the total area planted with wheat. The same table also showed that Assiut Center ranked first in the total production of wheat with a production of about 92.66 thousand tons, representing about 15.13% of the total production of wheat, amounting to about 612.62 thousand tons, while El-Ghanaim Center ranked last in the total production of wheat with a production of Its capacity is about 19.86 thousand tons, representing about 3.24% of the total wheat production. The same table also shows that Sahel Selim Center ranked first in the average productivity per feddan of wheat with a production of about 3.32 tons per feddan, while Manfalout Center ranked last in the average productivity per feddan of wheat with a production of about 2.63 tons per feddan.

Table (3): The relative importance of the area, production and productivity of wheat crops in the centers of Assiut Governorate for the average period (2021-2023).

The Center	Cultivated area in thousand feddans	Relative importance of cultivated area(%)	Arrangement	Total production in thousand tons	Relative importance of total production (%)	Arrangement	Average productivity per feddan in tons	Arrangement
Dayrout	28.19	13.54	3	80.99	13.22	3	2.87	8
El-Quseya	26.41	12.69	4	82.85	13.52	2	3.14	3
Manfalout	29.82	14.33	2	78.49	12.81	4	2.63	11
Assiut	31.41	15.09	1	92.66	15.13	1	2.95	7
Abou Tig	19.31	9.28	6	60.97	9.95	5	3.16	2

Sadfa	13.45	6.46	8	41.28	6.74	8	3.07	4
El-Ghanaim	6.93	3.33	10	19.86	3.24	11	2.87	9
Abnoub	21.59	10.37	5	60.51	9.88	6	2.80	10
El-Fatah	17.28	8.30	7	52.00	8.49	7	3.01	5
Sahel Selim	6.12	2.94	11	20.34	3.32	10	3.32	1
El-Badari	7.63	3.67	9	22.68	3.70	9	2.97	6
Total	208.14	100.00	-	612.62	100.00	-	-	-

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Third: Analysis of the variance between the productivity of the feddan of wheat crop in the centers of Assiut Governorate.

Analysis of variance was used to measure the extent of the existence of significant differences or not between the productivity of the feddan of wheat crop in the centers of Assiut Governorate during the period (2021-2023), as it was shown from Table (4), the existence of significant differences that were inferred from the significance of the calculated (F) value.

The existence of this variance requires knowing whether this variance is due to inefficiency or due to random error, and to know this, random frontier analysis was used (Ali et al., 2016).

Table (4): Test of analysis of variance between the productivity of the feddan of wheat crop in the centers of Assiut Governorate during the period (2021-2023).

Source of difference	sum of squares	degrees of freedom	mean sum of squares	Value (f)
Between centers	1.069	10	0.107	3.34**
Inside the centers	0.707	22	0.032	
Total	1.776	32		

**Significant at 1% level.

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Fourth: Using random frontier analysis to measure the efficiency of using economic resources in wheat production in the centers of Assiut Governorate:

The efficiency estimate is greatly affected by measurement errors. The danger lies in the lack of accuracy when estimating efficiency due to the variation in measurement errors between each production unit and another. This may lead to misleading the researcher into interpreting it as a variation between the efficiency of the production units (Kassem and El-Shaer, 2012).

One of the most important requirements for accurate measurement of the level of technical efficiency is the ability to distinguish between the part related to random error and the part related to the regular deviation from the optimal level of inputs required for the production process, which causes a decline in technical efficiency. Random error can be distinguished from regular deviation by using specific functions for the part related to the regular deviation. In order to ensure the accuracy of the study results, and taking into account the latest available measurement methods, random frontier analysis will be used. This analysis is based on the hypothesis that the visible production possibilities frontier function for a single unit deviates from the optimal production possibilities frontier function for a single unit by a part that represents random noise, and another that reflects technical inefficiency and its value is positive or equal to zero (El-Ubaidan, 2006).

Since the measurement of production efficiency is done by estimating the random error, the expected value of which is not equal to zero, and therefore the ordinary least squares method cannot be used, the efficiency was measured using random frontier analysis (Amer, 2017).

Random frontier analysis is characterized by its ability to overcome the shortcomings of nonparametric models that do not take into account random errors, as this analysis allows the separation of the random variable into two parts, the first of which is the symmetric random part, which represents random disturbances such as random errors, collection and measurement errors, etc., and these disturbances cannot be controlled by the production unit, and this part has an independent and symmetric distribution with an expectation of zero, and the second is the asymmetric part, which is a random variable greater than or equal to zero and represents technical inefficiency or the gap between the actual output and the possible output, and this part represents the elements that the production unit can control, and

technical efficiency represents the ratio of actual output to the maximum possible output, and when the actual output is less than the maximum possible output, the unit is in a state of inefficiency, and the part related to inefficiency is assumed to have a semi-normal distribution (El-Rawashdeh and Saleh, 2015).

The random frontier analysis method is characterized by its suitability for studies related to the agricultural sector due to its ability to deal with random errors that govern the data of this sector, and it also excludes the hypotheses of traditional tests (El-Naimi and Abd, 2013).

The random boundary analysis model is formulated as shown in Table (5):

A- Estimating the random boundary production function for wheat crop in Assiut Governorate:

The random frontier production function is used to determine the factors affecting the technical efficiency of wheat production. To estimate the random frontier production function for wheat crop in Assiut Governorate for the average period (2021-2023), the double logarithmic production function (Cobb-Douglas) was used, so that the dependent variable was the quantity of wheat crop production in tons, while the independent variables were the quantity of seeds in kilograms, the quantity of organic fertilizer in cubic meters, the quantity of nitrogen fertilizer in kilograms of nitrogen units, the quantity of phosphate fertilizer in kilograms of phosphate units, the quantity of pesticides in liters, the number of workers, and the number of automated working hours.

The results shown in Table (6) showed the statistical significance of some variables of the random frontier production function, as it was shown that despite reducing the amount of nitrogen fertilizer, pesticides, and the number of mechanical working hours by 1%, the previous increase over the stagnant amount of these resources led to an increase in wheat crop production by 0.82%, 0.23%, and 0.39% respectively. This may be due to the existence of waste or surplus in the use of these resources, and that these resources used are more than what the land needs to grow wheat, which means that the use of these resources falls in the third production stage, which is an irrational production stage, which means that there is waste in the use of these production resources and the quantities used must be reduced. Meanwhile, the results showed that increasing the number of workers by 1% leads to an increase in wheat crop production by 0.51%, which is a value less than one and greater than zero, which means that the use of this resource falls in the second production stage, which is an irrational production stage.

Table (5): Random Frontier Analysis Model.

Random Frontier Analysis Model	Definition of stochastic frontier analysis model
$y_i = F(X_i, B) + E_i$ $E_i = V_i - u_i$ $X_i = F(X_i, B) + V_i - u_i$ $u_i = X_i B - u_i$ $TE_i = y_i / y_i^*$ $y_i = F(X_i, B) \exp(V_i - u_i)$ $y_i^* = F(X_i, B) \exp(V_i)$ $TE = \frac{F(Xi,B)\exp(Vi-ui)}{F(Xi,B)\exp(Vi)}$ $TE = \exp(-u)$ $T_i = 1 - TE$ $\text{Ln } y_i = \text{Ln } X_i B + (V_i - u_i)$ $y_i = \exp(B_0 + B_1 \text{Ln}X_i + (V_i - u_i))$	Whereas: i = 1,2,…….n $_i$y = Output quantity per unit. iX = Amount of input used in unit i B = Parameters of the production function to be estimated. $_i$E = Binomial error element. V_i = Random error is an expression of errors. Other random errors are assumed to be independent of each other and have an independent and identical distribution with a zero mean and a constant variance independent of the random variable. u_i = The non-negative error component associated with the technical inefficiency of the farm, independently and identically distributed and semi-normal or exponentially distributed.

Source: El-Wardi, Hawraa Mohamed (2014). Economic analysis of the economic efficiency of honey beekeepers using stochastic frontier analysis, PhD thesis, Department of Agricultural Economics, College of Agriculture, University of Baghdad: pp. 44-47.

Table (6): Estimation of the random boundary production function for wheat crop in Assiut Governorate for the average period (2021-2023).

Variables	Parameters	coefficient	standard-error	t-ratio
Intercept	B0	7.00	1.85	3.78**
Ln(S)	B1	-0.34	0.68	-0.50
Ln(Z)	B2	-0.34	0.16	-2.07
Ln(F)	B3	-0.82	0.28	-2.90*
Ln(P)	B4	-0.01	0.41	-0.02
Ln(D)	B5	-0.23	0.09	-2.43*
Ln(K)	B6	0.51	0.22	2.36*

Ln(W)	B7	-0.39	0.17	-2.29*
sigma-squared		0.002	0.001	2.56*
gamma		0.94	0.47	2.01
log likelihood function		22.25		
LR test of the one-sided error		0.10		
number of iterations		38		
maximum number of iterations set		100		

Where: Ln = natural logarithm, S = quantity of seeds in kilograms, Z = quantity of organic fertilizer in cubic meters, F = quantity of nitrogen fertilizer in kilograms of nitrogen units, P = quantity of phosphate fertilizer in kilograms of phosphate units, D = quantity of pesticides in liters, K = number of workers, W = number of hours of automated work, ** = significant at the 0.01 level, * = significant at the 0.05 level.

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

The value of gamma was estimated through the random frontier production function, where this value ranges between zero and one. The closer this value is to zero, the more it indicates that the deviations are due in their entirety to measurement errors, i.e. the effect of random error. The closer this value is to one, the more it indicates that the deviations are due in their entirety to the effect of inefficiency (Nader and Wannous, 2014).

It is clear from the data in Table (6) that the value of gamma reached approximately 0.94, and this value is closer to one than to zero, which means that 94% of the deviations are due to the effect of inefficiency and not to random error.

It is also shown from the data of the same previous table that the log likelihood function reached about 22.25, which is greater than the tabular value of the chi-square at a significance level of 0.05, which is estimated at about 18.31, which means the feasibility of using the random frontier production function to measure efficiency, as this indicates that there are technical changes that positively affect the production efficiency of the wheat crop in Assiut Governorate.

It is also clear from the data of the same previous table that the LR test of the one-sided error statistic reached about 0.10, which is less than the critical value at a significance level of 0.05, which is estimated at about 12.59, which means accepting the null hypothesis that the error element related to inefficiency is distributed according to the half-normal distribution, and this means that the model expresses the efficiency measure well.

B- Estimating the technical efficiency of wheat production in the centers of Assiut Governorate using random frontier analysis:

Table (7) shows the technical efficiency of wheat production in the centers of Assiut Governorate using random frontier analysis for the average period (2021-2023), where the average technical efficiency reached about 0.96, indicating that there is a deviation rate in actual production from the optimal production of about 0.04%, and wheat producers in the centers of Assiut Governorate can achieve it if they use the available economic resources optimally, which leads to a decrease in production costs by 4%. The results of the table also showed that wheat production in Abou Tig Center achieved the highest level of efficiency, reaching 0.99, while wheat production in El-Fateh Center achieved the lowest level of efficiency, reaching 0.90.

Table (7): Estimation of the technical efficiency of wheat production in the centers of Assiut Governorate according to the random frontier analysis method for the average period (2021-2023).

The Center	Technical efficiency	Arrangement
Dayrout	0.952	9
El-Quseya	0.993	2
Manfalout	0.960	7
Assiut	0.955	8
Abou Tig	0.994	1
Sadfa	0.983	5
El-Ghanaim	0.965	6
Abnoub	0.922	10
El-Fatah	0.909	11
Sahel Selim	0.984	4
El-Badari	0.985	3
Average	0.964	

maximum	0.994	
minimum	0.909	

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

The results showed that wheat production in the centers of Assiut Governorate did not achieve full economic efficiency (100%), and therefore all the centers of Assiut Governorate did not produce on the production potential curve and deviated from it by different percentages. This gives these centers the opportunity to reduce the quantities of economic resources used and thus the production costs to obtain the same production level or use the quantities of resources actually used to obtain a higher production level and thus increase revenue.

After verifying through the use of the random frontier production function that the changes are due to inefficiency and not to random error, the data envelope is used. Although it cannot distinguish between inefficiency and random error, it provides more details, as the random frontier production function cannot determine the sources of inefficiency as well as the amount of inefficiency, and therefore does not provide detailed data that helps in taking corrective measures for units that suffer from inefficiency.

Fifth: Using the data envelope method to measure the efficiency of using economic resources in producing wheat crops in the centers of Assiut Governorate for the average period (2021-2023):

The Data Envelopment Analysis Program (DEAP) is a linear programming method used to estimate the degree of efficiency of economic resource use (El-Gendy and Dos, 2020).

Farrell is considered the first to establish the methodology for analyzing and calculating efficiencies. Farrell's approach is based on the fact that each unit can be represented by a point on the isoquant curve (Ahmed, 2022).

The reason for calling this method Data Envelopment Analysis is that the efficient units envelop the inefficient units, as this curve envelops all the observations under study.

According to the data envelopment method (DEAP), the efficiency of any unit consists of two main components: the first is technical efficiency: it means achieving the maximum amount of production from the same amount of available resources and is called output-oriented technical efficiency, or achieving the same level of production with the least amount of available resources and is called input-oriented technical efficiency, and its value ranges between zero and one (Atwa et al., 2017). The second is allocative efficiency, which means the ability of the production unit to use the optimal combination of resources to obtain the same level of production at the lowest possible cost through the use of resource prices, and its value ranges between zero and one (Kassem et al., 2017).

By multiplying technical efficiency by distributive efficiency, economic efficiency can be obtained: It means the ability of the production unit to obtain the maximum possible production with the same amount of costs, or to obtain the same amount of production with less costs, and its value ranges between zero and one (Kassem et al., 2017).

The efficiency scores range from zero to one, with zero indicating that the production unit is located as far away as possible from the efficiency frontier, and one indicating that the production unit is located on the efficiency frontier. The data envelopment method is used according to two concepts: the first is the constant return to capacity, which means that the change in the quantity of inputs used by the production unit has a constant effect on the quantity of outputs, and the second is the variable return to capacity, which means that the change in the quantity of inputs used by the production unit has a variable effect on the quantity of outputs (El-Wardi, 2014).

The data envelopment method is characterized by measuring the efficiency of each production unit separately, unlike the production and cost functions, which measure all production units collectively in one function.

For the successful use of the data envelopment method, the number of centers must be greater than the product of the number of inputs and the number of outputs, otherwise the model will lose its discriminating power between efficient and inefficient units. This is the rule used in the usual method, or the number of centers must be greater than the product of the number of inputs and the number of outputs, which is three. This is the rule used in the Malmquist method (El-Zawawi and El-Sariti, 2017).

The input-oriented data envelopment analysis model is formulated in the cases of constant and changing returns to scale, as shown in Table (8):

Table (8): Data Envelopment Analysis Model with Input Orientation in the Case of Constant and Variable Returns to Scale.

Input-oriented data envelopment analysis model	
In the case of constant returns to scale (CRS)	Assuming variable returns to scale (VRS)
Min $_{\theta,} \boldsymbol{\lambda^{\theta CRS}}$ Subject to :	Min $_{\theta,} \lambda\, \theta^{\,VRS}$ Subject to :

-Yi + Y λ ≥ 0 ***θ*** Xi – X λ ≥ 0 λ ≥ 0	$-Y_i + Y \lambda \geq 0$ $\boldsymbol{\theta} X_i - X \lambda \geq 0$ λ ≥ 0
Where: λ = vector representing standard weights, θ = vector of the technical efficiency index of the production unit i and takes values 1 ≥ 0, as the value one means that the production unit's performance point falls on the maximum curve and thus indicates the technical efficiency of the production unit, while if the value of the index is less than one, it indicates that the production unit's performance falls below the limit curve and is technically inefficient, Xi = vector of inputs, Yi = vector of outputs, i = unit of output, X = input matrix, Y = output matrix.	

Source: El-Wardi, Hawraa Mohamed. (2014). Economic analysis of the economic efficiency of honey beekeepers using stochastic frontier analysis, PhD thesis, Department of Agricultural Economics, College of Agriculture, University of Baghdad: pp. 56, 58.

A- Estimating the technical efficiency of wheat production in the centers of Assiut Governorate according to the data envelope method:

The technical efficiency of wheat production in Assiut Governorate centers was estimated according to the data envelope analysis method for the average period (2021-2023), through the concepts of stability of return on capacity, and change in return on capacity, in addition to the capacity efficiency index, as it is clear from the data in Table (9), that the number of centers in Assiut Governorate reached 11 centers, and according to the concept of stability of return on capacity, which assumes that the change in the resources used in wheat production in the inefficient centers of Assiut Governorate has a constant effect on the quantity of wheat production when it moves towards the efficiency curve, 4 centers achieved the maximum efficiency in wheat production, representing about 36.36% of the total number of centers, while the remaining centers, 7 centers representing about 63.64%, achieved lower degrees of efficiency in wheat production, and the technical efficiency in wheat production in Assiut Governorate centers ranged between 83.30% and 100%, with an average of about 94.70%, meaning that the same level of Production using only about 94.70% of the actual combination of resources used, i.e. about 5.30% of the resources used can be saved without affecting the level of wheat crop production in the centers of Assiut Governorate.

Table (9): Technical efficiency in the cases of stability and change in the return on capacity and capacity efficiency for wheat production in the centers of Assiut Governorate according to the data envelope analysis method for the average period (2021-2023).

The Center	Technical efficiency		Capacity efficiency	Return on Capacity
	Return on Capacity Stability	Return on Capacity Change		
Dayrout	0.890	0.985	0.903	increase
El-Quseya	1.000	1.000	1.000	-
Manfalout	0.833	0.984	0.846	increase
Assiut	0.939	1.000	0.939	increase
Abou Tig	1.000	1.000	1.000	-
Sadfa	1.000	1.000	1.000	-
El-Ghanaim	0.912	0.988	0.923	increase
Abnoub	0.922	1.000	0.922	increase
El-Fatah	0.982	1.000	0.982	increase
Sahel Selim	1.000	1.000	1.000	-
El-Badari	0.943	0.990	0.953	increase
Number of centers that have reached optimal efficiency	4	7	4	-
Percentage of centers that reached optimal efficiency(%)	36.36	63.64	36.36	-
Number of centers that did not reach optimal efficiency	7	4	7	-
Percentage of centers that did not reach optimal efficiency(%)	63.64	36.36	63.64	-
Minimum efficiency	0.833	0.984	0.846	-
maximum efficiency	1.000	1.000	1.000	-

Overall average efficiency	0.947	0.995	0.952	-

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

According to the concept of change in return on capacity, which assumes that the change in the resources used in wheat production in the inefficient centers of Assiut Governorate has a variable effect on the quantity of wheat production when moving towards the efficiency curve, 7 centers achieved the maximum efficiency in wheat production, representing about 63.64% of the total number of centers, while the remaining 4 centers, representing about 36.36%, achieved efficiency levels less than 100%, as the technical efficiency in wheat production in the centers of Assiut Governorate ranged between 98.40% and 100%, with an average of about 99.50%, meaning that about 0.50% of the production resources used can be saved without affecting the current production level.

As is clear from the same previous table, according to the capacity efficiency index, 4 centers achieved full efficiency, i.e. the correct one, which means that the actual combination of resources used is the same as the optimal combination, which necessitates that these centers continue at their current production level, while the remaining 7 centers were characterized by an increasing return on capacity, such that increasing their efficiency level requires increasing the amount of resources used by intensifying the production elements in them, which leads to obtaining a greater amount of production.

Determining the reference centers for the inefficient centers of Assiut Governorate in wheat production according to the technical efficiency index in the cases of stability and change in the return on capacity in Assiut Governorate for the average period (2021-2023).

One of the most prominent features of data envelopment analysis is that it identifies efficient units as reference units for inefficient units to follow the same method as efficient units in their input combination, and this feature is not carried by any of the other methods for measuring efficiency (Atwa et al., 2017).

Table (10) shows that the most reference centers for inefficient centers according to the technical efficiency index in the case of a stable return on capacity in wheat production in Assiut Governorate for the average period (2021-2023) are Sahel Selim and El-Quseya centers, where they were repeated seven times, followed by Abou Tig center, where they were repeated four times, and finally Sadfa center, where they were repeated twice. As for the most reference centers for inefficient centers according to the technical efficiency index in the case of a change in the return on capacity, it is El-Fatah center, where it was repeated four times, followed by El-Quseya center, where it was repeated three times, followed by Abnoub and Sadfa centers, where they were repeated twice, and finally Sahel Selim center, which was mentioned once.

Table (10): The inefficient center and its reference centers according to the technical efficiency index in the cases of stability and change in the return on capacity in wheat crop production in Assiut Governorate for the average period (2021-2023).

Inefficient center according to the technical efficiency index in case of constant return on capacity	Its reference centers according to the technical efficiency index in the case of a constant return on capacity	Inefficient center according to technical efficiency index in case of change in return on capacity	Reference centers for it according to the technical efficiency index in the event of a change in the return on capacity
Dayrout	Sahel Selim – Abou Tig - El-Quseya	Dayrout	Abnoub – El-Quseya – El-Fatah - Sahel Selim
Manfalout	El-Quseya – Abou Tig - Sahel Selim	Manfalout	El-Fatah – El-Quseya - Abnoub
Assiut	Sahel Selim - El-Quseya	El-Ghanaim	El-Fatah – El-Quseya - Sadfa
El-Ghanaim	Sahel Selim – Sadfa - El-Quseya	El-Badari	El-Fatah - Sadfa
Abnoub	El-Quseya – Abou Tig - Sahel Selim	-	-
El-Fatah	El-Quseya – Abou Tig - Sahel Selim	-	-
El-Badari	Sadfa – El-Quseya - Sahel Selim	-	-

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

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B- Estimating the distributional and economic efficiency of wheat production in the centers of Assiut Governorate according to the data envelope method:

The distributional efficiency of wheat production in the centers of Assiut Governorate was estimated according to the data envelope analysis method for the average period (2021-2023), as it is clear from the data in Table (11) that only one center achieved the maximum efficiency in wheat production, representing about 9.09% of the total number of centers, while the remaining centers, 10 centers representing about 90.91%, achieved lower degrees of efficiency. The distributional efficiency of wheat production in the centers of Assiut Governorate ranged between 92.40% and 100%, with an average of about 96.70%, meaning that the same level of production can be achieved in light of the distributional efficiency by using only about 96.70% of the actual combination of resources used, meaning that about 3.30% of the resources used can be redistributed to reach the optimal distributional efficiency for wheat production in the centers of Assiut Governorate.

The economic efficiency of wheat production in Assiut Governorate centers was also estimated according to the data envelope analysis method for the average period (2021-2023), as it is clear from the data in Table (11) that only one center achieved the maximum efficiency in wheat production, representing about 9.09% of the total number of centers, while the remaining centers, 10 centers representing about 90.91%, achieved lower degrees of efficiency. The economic efficiency of wheat production in Assiut Governorate centers ranged between 76.90% and 100%, with an average of about 91.70%, meaning that the same level of production can be achieved in light of economic efficiency by using only about 91.70% of the actual combination of resources used, meaning that about 8.30% of the resources used can be saved to reach the optimal economic efficiency for wheat production in Assiut Governorate centers.

C- Estimating the optimal quantities of resources to achieve economic efficiency in wheat production in the centers of Assiut Governorate according to the data envelope analysis method:

To estimate the optimal quantities of resources to achieve economic efficiency in wheat production in the centers of Assiut Governorate according to the data envelope analysis method for the average period (2021-2023), the resources used in wheat production in each center of Assiut Governorate will be used as a concept for production inputs. These resources are: the quantity of seeds in kilograms, the quantity of organic fertilizer in cubic meters, the quantity of nitrogen fertilizer in kilograms of nitrogen units, the quantity of phosphate fertilizer in kilograms of phosphate units, the quantity of pesticides in liters, the number of workers, and the number of automated work hours. The quantity of wheat production in tons for each center of Assiut Governorate will also be used as a concept for production outputs.

One of the advantages of the data envelopment analysis method is that it provides a set of useful information about the sources of inefficiency in production inputs, the quantities of inefficiency, and the quantities proposed for each production unit in order to achieve efficiency (El-Shaibi, 2004).

Table (11): Distributional and economic efficiency of wheat production in the centers of Assiut Governorate according to the data envelope analysis method for the average period (2021-2023).

The Center	allocative efficiency	Economic efficiency
Dayrout	0.992	0.883
El-Quseya	1.000	1.000
Manfalout	0.924	0.769
Assiut	0.957	0.899
Abou Tig	0.988	0.988
Sadfa	0.941	0.941
El-Ghanaim	0.966	0.881
Abnoub	0.933	0.860
El-Fatah	0.983	0.966
Sahel Selim	0.992	0.992
El-Badari	0.962	0.907
Number of centers that have reached optimal efficiency	1	1
Percentage of centers that reached optimal efficiency(%)	9.09	9.09
Number of centers that did not reach optimal efficiency	10	10

Percentage of centers that did not reach optimal efficiency(%)	90.91	90.91
Minimum efficiency	0.924	0.769
maximum efficiency	1.000	1.000
Overall average efficiency	0.967	0.917

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Economic efficiency is achieved when the isocost line touches the isoquant production curve, and thus the point that achieves the efficient use of economic materials is determined (El-Gendy, 2020).

By using this point, the optimal quantities of resources used in wheat production in the centers of Assiut Governorate can be estimated, and compared with the actual quantities of the same resources used in these centers, so that the increase or decrease in the actual quantities from the optimal quantities can be identified to achieve the economic efficiency of the resources used in wheat production for each center of Assiut Governorate, as follows:

Table (12) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in Dayrout Center, Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, the number of workers, and the number of automated working hours must be reduced from about 57.67 kg, 14.33 cubic meters, 113.67 kg of nitrogen units, 39.00 kg of phosphate units, 29.33 workers, 15.67 hours to about 50.27 kg, 11.58 cubic meters, 101.76 kg of nitrogen units, 32.90 kg of phosphate units, 25.29 workers, 13.71 hours, which means that the reduction required to achieve the optimal economic efficiency amounted to about 7.40 kg, 2.75 cubic meters, 11.91 kg nitrogen unit, 6.10 kg phosphate unit, 4.04 workers, 1.96 hours, representing about 12.83%, 19.19%, 10.48%, 15.64%, 13.77%, 12.51% of the actual quantities of the above-mentioned resources, respectively, while to achieve the optimum economic efficiency, the quantity of pesticides must be increased from about 4.67 liters to about 4.87 liters, meaning that the increase that must be added to achieve the optimum economic efficiency amounted to about 0.20 liters, representing about 4.28% of the actual quantity previously mentioned.

Table (13) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in El-Quseya Center in Assiut Governorate for the average period (2021-2023), as it was shown that wheat production in El-Quseya Center is at the optimal economic efficiency, as there is no increase or decrease in the use of resources, as it is considered a reference for the rest of the centers producing wheat crops in Assiut Governorate, as through comparison with it, the weaknesses in other centers that operate in the same competitive conditions and were unable to achieve relative efficiency are identified, as El-Quseya Center is considered a good model for guidance.

Table (14) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in Manfalout Center, Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, the quantity of pesticides, the number of workers, and the number of automated working hours must be reduced from about 58.00 kg, 14.33 cubic meters, 123.67 kg nitrogen unit, 39.33 kg phosphate unit, 4.67 liters, 28.33 workers, 16.00 hours to about 46.07 kg, 10.61 cubic meters, 93.25 kg nitrogen unit, 30.15 kg phosphate unit, 4.46 liters, 23.18 workers, 12.56 hours, which means that the reduction required to achieve the optimal economic efficiency It amounted to about 11.93 kg, 3.72 m3, 30.42 kg nitrogen unit, 9.18 kg phosphate unit, 0.21 litre, 5.15 workers, 3.44 hours, representing about 20.57%, 25.96%, 24.60%, 23.34%, 4.50%, 18.18%, 21.50% of the actual quantities of the above-mentioned resources, respectively.

Table (12): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in Dayrout Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	57.67	50.27	-7.40	-12.83
Amount of organic fertilizer in cubic meters	14.33	11.58	-2.75	-19.19
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	113.67	101.76	-11.91	-10.48

Phosphate fertilizer quantity in kilograms Phosphate unit	39.00	32.90	-6.10	-15.64
Pesticide amount in liters	4.67	4.87	0.20	4.28
Number of workers	29.33	25.29	-4.04	-13.77
Number of automated working hours	15.67	13.71	-1.96	-12.51

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (13): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in El-Quseya Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	55.00	55.00	0.00	0.00
Amount of organic fertilizer in cubic meters	12.67	12.67	0.00	0.00
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	111.33	111.33	0.00	0.00
Phosphate fertilizer quantity in kilograms Phosphate unit	36.00	36.00	0.00	0.00
Pesticide amount in liters	5.33	5.33	0.00	0.00
Number of workers	27.67	27.67	0.00	0.00
Number of automated working hours	15.00	15.00	0.00	0.00

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (15) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in Assiut Center, Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, the quantity of pesticides, the number of workers, and the number of automated working hours must be reduced from about 60.67 kg, 12.33 cubic meters, 112.33 kg nitrogen unit, 41.33 kg phosphate unit, 5.33 liters, 29.00 workers, 15.00 hours to about 51.67 kg, 11.90 cubic meters, 104.59 kg nitrogen unit, 33.82 kg phosphate unit, 5.01 liters, 26.00 workers, 14.09 hours, which means that the reduction required to achieve efficiency The optimal economic value was about 9.00 kg, 0.43 m3, 7.74 kg N2O, 7.51 kg P2O, 0.32 L, 3.00 workers, 0.91 hours, representing about 14.83%, 3.49%, 6.89%, 18.17%, 6.00%, 10.34%, 6.07% of the actual quantities of the above mentioned resources respectively.

Table (16) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in Abou Tig Center, Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of phosphate fertilizer, the number of workers, and the number of automated working hours must be reduced from about 58.67 kg, 15.00 cubic meters, 43.33 kg phosphate unit, 28.67 workers, 16.00 hours to about 55.35 kg, 12.75 cubic meters, 36.23 kg phosphate unit, 27.85 workers, 15.10 hours, which means that the reduction required to achieve the optimal economic efficiency amounted to about 3.32 kg, 2.25 cubic meters, 7.10 kg phosphate unit, 0.82 workers, 0.90 hours, representing about 5.66%. 15.00%, 16.39%, 2.86%, 5.63% of the actual quantities of the above-mentioned resources, respectively, while to achieve the optimum economic efficiency, the quantity of nitrogen fertilizer and the quantity of pesticides must be increased from about 108.00 kg nitrogen unit, 4.00 liters to about 112.04 kg nitrogen unit, 5.36 liters, which means that the increase that must be added to achieve the optimum economic efficiency amounted to about 4.04 kg nitrogen unit, 1.36 liters, representing about 3.74%, 34.00% of the actual quantity previously mentioned, respectively.

Table (14): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in Manfalout Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	58.00	46.07	-11.93	-20.57
Amount of organic fertilizer in cubic meters	14.33	10.61	-3.72	-25.96
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	123.67	93.25	-30.42	-24.60
Phosphate fertilizer quantity in kilograms Phosphate unit	39.33	30.15	-9.18	-23.34
Pesticide amount in liters	4.67	4.46	-0.21	-4.50
Number of workers	28.33	23.18	-5.15	-18.18
Number of automated working hours	16.00	12.56	-3.44	-21.50

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (15): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in Assiut Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	60.67	51.67	-9.00	-14.83
Amount of organic fertilizer in cubic meters	12.33	11.90	-0.43	-3.49
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	112.33	104.59	-7.74	-6.89
Phosphate fertilizer quantity in kilograms Phosphate unit	41.33	33.82	-7.51	-18.17
Pesticide amount in liters	5.33	5.01	-0.32	-6.00
Number of workers	29.00	26.00	-3.00	-10.34
Number of automated working hours	15.00	14.09	-0.91	-6.07

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (17) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in Sadfa Center, Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, and the number of workers must be reduced from about 57.00 kg, 117.33 kg of nitrogen units, 37.00 kg of phosphate units, 27.33 workers to about 53.77 kg, 108.85 kg of nitrogen units, 35.20 kg of phosphate units, 27.05 workers, which means that the reduction required to achieve the optimal economic efficiency amounted to about 3.23 kg, 8.48 kg of nitrogen units, 1.80 kg of phosphate units, 0.28 workers, representing about 5.67%, 7.23%, 4.86%, 1.02% of the actual quantities of the above-mentioned resources, respectively, while to achieve the optimal economic efficiency, the quantity of municipal fertilizer, the quantity of pesticides, and the number of mechanical working hours must be increased from approximately 12.33 cubic meters, 5.00 liters, 13.67 hours to approximately 12.39 cubic meters, 5.21 liters, 14.67 hours, meaning that the increase that must be added to achieve the optimal economic efficiency amounted to approximately 0.06 cubic meters, 0.21 liters, 1.00 hours, representing approximately 0.49%, 4.20%, 7.32% of the actual quantity previously mentioned, respectively.

Table (16): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in Abou Tig Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	58.67	55.35	-3.32	-5.66
Amount of organic fertilizer in cubic meters	15.00	12.75	-2.25	-15.00
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	108.00	112.04	4.04	3.74
Phosphate fertilizer quantity in kilograms Phosphate unit	43.33	36.23	-7.10	-16.39
Pesticide amount in liters	4.00	5.36	1.36	34.00
Number of workers	28.67	27.85	-0.82	-2.86
Number of automated working hours	16.00	15.10	-0.90	-5.63

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (17): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in Sadfa Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	57.00	53.77	-3.23	-5.67
Amount of organic fertilizer in cubic meters	12.33	12.39	0.06	0.49
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	117.33	108.85	-8.48	-7.23
Phosphate fertilizer quantity in kilograms Phosphate unit	37.00	35.20	-1.80	-4.86
Pesticide amount in liters	5.00	5.21	0.21	4.20
Number of workers	27.33	27.05	-0.28	-1.02
Number of automated working hours	13.67	14.67	1.00	7.32

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (18) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in El-Ghanaim Center in Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, the quantity of pesticides, the number of workers, and the number of automated working hours must be reduced from about 56.33 kilograms, 15.67 cubic meters, 114.67 kilograms of nitrogen units, 38.67 kilograms of phosphate units, 5.33 liters, 30.33 workers, 14.67 hours to about 50.27 kilograms, 11.58 cubic meters, 101.76 kilograms of nitrogen units, 32.90 kilograms of phosphate units, 4.87 liters, 25.29 workers, 13.71 hours, which means that the reduction required to achieve efficiency The optimal economic value was about 6.06 kg, 4.09 m3, 12.91 kg N2O, 5.77 kg P2O, 0.46 L, 5.04 workers, 0.96 hours, representing about 10.76%, 26.10%, 11.26%, 14.92%, 8.63%, 16.62%, 6.54% of the actual quantities of the above-mentioned resources, respectively.

Table (19) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in Abnoub Center, Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, the number of workers, and the number of automated working hours must be reduced from about 59.33 kg, 14.33 cubic meters, 113.00 kg nitrogen unit, 39.67 kg phosphate unit, 27.67 workers, 15.33 hours to about 49.05 kg, 11.30 cubic meters, 99.28 kg nitrogen unit, 32.10 kg phosphate unit, 24.67 workers,

13.38 hours, which means that the reduction required to achieve the optimal economic efficiency amounted to about 10.28 kg, 3.03 cubic meters, 13.72 kg nitrogen unit, 7.57 kg phosphate unit, 3.00 workers, 1.95 hours, representing about 17.33%, 21.14%, 12.14%, 19.08%, 10.84%, 12.72% of the actual quantities of the above-mentioned resources, respectively, while to achieve the optimum economic efficiency, the quantity of pesticides must be increased from about 4.00 liters to about 4.75 liters, meaning that the increase that must be added to achieve the optimum economic efficiency amounted to about 0.75 liters, representing about 18.75% of the actual quantity previously mentioned.

Table (18): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in El-Ghanaim Center in Assiut Governorate for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	56.33	50.27	-6.06	-10.76
Amount of organic fertilizer in cubic meters	15.67	11.58	-4.09	-26.10
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	114.67	101.76	-12.91	-11.26
Phosphate fertilizer quantity in kilograms Phosphate unit	38.67	32.90	-5.77	-14.92
Pesticide amount in liters	5.33	4.87	-0.46	-8.63
Number of workers	30.33	25.29	-5.04	-16.62
Number of automated working hours	14.67	13.71	-0.96	-6.54

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (19): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in Abnoub Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	59.33	49.05	-10.28	-17.33
Amount of organic fertilizer in cubic meters	14.33	11.30	-3.03	-21.14
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	113.00	99.28	-13.72	-12.14
Phosphate fertilizer quantity in kilograms Phosphate unit	39.67	32.10	-7.57	-19.08
Pesticide amount in liters	4.00	4.75	0.75	18.75
Number of workers	27.67	24.67	-3.00	-10.84
Number of automated working hours	15.33	13.38	-1.95	-12.72

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (20) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in El-Fatah Center in Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, the number of workers, and the number of automated working hours must be reduced from about 54.67 kg, 13.67 cubic meters, 107.67 kg of nitrogen units, 40.33 kg of phosphate units, 29.33 workers, 15.00 hours to about 52.72 kg, 12.15 cubic meters, 106.72 kg of nitrogen units, 34.51 kg of phosphate units, 26.52 workers, 14.38 hours, which means that the reduction required to achieve the optimal economic efficiency amounted to about 1.95 kg, 1.52 cubic meters, 0.95 kg nitrogen unit, 5.82 kg phosphate unit, 2.81 workers, 0.62 hours, representing about 3.57%, 11.12%, 0.88%, 14.43%, 9.58%, 4.13% of the actual quantities of the above-mentioned

resources, respectively, while to achieve the optimum economic efficiency, the quantity of pesticides must be increased from about 4.67 liters to about 5.11 liters, meaning that the increase that must be added to achieve the optimum economic efficiency amounted to about 0.44 liters, representing about 9.42% of the actual quantity previously mentioned.

Table (20): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in El-Fatah Center in Assiut Governorate for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	54.67	52.72	-1.95	-3.57
Amount of organic fertilizer in cubic meters	13.67	12.15	-1.52	-11.12
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	107.67	106.72	-0.95	-0.88
Phosphate fertilizer quantity in kilograms Phosphate unit	40.33	34.51	-5.82	-14.43
Pesticide amount in liters	4.67	5.11	0.44	9.42
Number of workers	29.33	26.52	-2.81	-9.58
Number of automated working hours	15.00	14.38	-0.62	-4.13

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (21) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in Sahel Selim Center in Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of phosphate fertilizer, and the number of workers must be reduced from about 60.00 kg, 39.67 kg phosphate unit, 32.00 workers to about 58.15 kg, 38.06 kg phosphate unit, 29.26 workers, which means that the reduction required to achieve the optimal economic efficiency amounted to about 1.85 kg, 1.61 kg phosphate unit, 2.74 workers, representing about 3.08%, 4.06%, 8.56% of the actual quantities of the aforementioned resources, respectively, while to achieve the optimal economic efficiency, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of pesticides, and the number of automated working hours must be increased from about 12.67 m3, 117.67 kg N2O, 3.67 L, 15.33 h to about 13.40 m3, 117.71 kg N2O, 5.64 L, 15.86 h, which means that the increase that must be added to achieve the optimum economic efficiency amounted to about 0.73 m3, 0.04 kg N2O, 1.97 L, 0.53 h, representing about 5.76%, 0.03%, 53.68%, 3.46% of the actual quantity previously mentioned, respectively.

Table (22) shows the actual and optimal resources to achieve the economic efficiency of the resources used in wheat production in El-Badari Center, Assiut Governorate for the average period (2021-2023), where to achieve the optimal economic efficiency, the quantity of seeds, the quantity of organic fertilizer, the quantity of nitrogen fertilizer, the quantity of phosphate fertilizer, the number of workers, and the number of automated working hours must be reduced from about 59.00 kg, 15.00 cubic meters, 112.33 kg of nitrogen units, 42.33 kg of phosphate units, 29.33 workers, 14.67 hours to about 52.02 kg, 11.98 cubic meters, 105.30 kg of nitrogen units, 34.05 kg of phosphate units, 26.17 workers, 14.19 hours, which means that the reduction required to achieve the optimal economic efficiency amounted to about 6.98 kg, 3.02 cubic meters, 7.03 kg nitrogen unit, 8.28 kg phosphate unit, 3.16 workers, 0.48 hours, representing about 11.83%, 20.13%, 6.26%, 19.56%, 10.77%, 3.27% of the actual quantities of the above-mentioned resources, respectively, while to achieve the optimum economic efficiency, the quantity of pesticides must be increased from about 5.00 liters to about 5.04 liters, meaning that the increase that must be added to achieve the optimum economic efficiency amounted to about 0.04 liters, representing about 0.80% of the actual quantity previously mentioned.

Table (21): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in Sahel Selim Center in Assiut Governorate for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	60.00	58.15	-1.85	-3.08
Amount of organic fertilizer in cubic meters	12.67	13.40	0.73	5.76
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	117.67	117.71	0.04	0.03
Phosphate fertilizer quantity in kilograms Phosphate unit	39.67	38.06	-1.61	-4.06
Pesticide amount in liters	3.67	5.64	1.97	53.68
Number of workers	32.00	29.26	-2.74	-8.56
Number of automated working hours	15.33	15.86	0.53	3.46

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Table (22): The actual and optimal amount of resources to achieve the economic efficiency of the resources used in wheat production in El-Badari Center, Assiut Governorate, for the average period (2021-2023).

Resources	Actual	The ideal	Excess (+) or deficiency (-) of actual resources	Percentage of increase (+) or decrease (-) from actual resources(%)
Amount of seeds in kilograms	59.00	52.02	-6.98	-11.83
Amount of organic fertilizer in cubic meters	15.00	11.98	-3.02	-20.13
The amount of nitrogen fertilizer in kilograms is one unit of nitrogen.	112.33	105.30	-7.03	-6.26
Phosphate fertilizer quantity in kilograms Phosphate unit	42.33	34.05	-8.28	-19.56
Pesticide amount in liters	5.00	5.04	0.04	0.80
Number of workers	29.33	26.17	-3.16	-10.77
Number of automated working hours	14.67	14.19	-0.48	-3.27

Source: Collected and calculated from the Directorate of Agriculture in Assiut Governorate, Agricultural Administration in the centers, Statistics Department records, unpublished data.

Conclusion:

Wheat is considered the most important winter crop in Assiut Governorate, as the cultivated area amounts to about 208.14 thousand feddans, representing about 67.28% of the total area of winter crops, which amounts to about 309.36 thousand feddans for the average period (2021-2023).

Wheat production is affected by the level of economic resource utilization and the level of its production efficiency. Wheat production efficiency includes technical, distributional and economic efficiency. Estimating wheat production efficiency is an important issue in increasing crop production, because it will be able to show the possibility of increasing production by improving the efficiency of resource utilization.

The research problem is that wheat producers in the centers of Assiut Governorate are trying to increase their production by raising the efficiency of crop production, and in their attempt to do so, a deviation from the level of optimal use of resources may occur, and thus a waste of resources occurs.

The research aims to estimate the technical efficiency of wheat production in the centers of Assiut Governorate using the methods of random frontier analysis and data envelope analysis and estimating the optimal quantities of resources to achieve economic efficiency in wheat production in the centers of Assiut Governorate.

The research relied mainly on the use of stochastic frontier analysis to estimate the wheat production function using Frontier 4.1c program, and data envelope analysis to measure the technical, distributional and economic efficiency of wheat production in the centers of Assiut Governorate using DEAP ver.2.1 program.

The research results showed that the cultivated area, total production, farm price, production costs per feddan, total revenue per feddan, and net return per feddan for wheat crops in Assiut Governorate during the period (2005-2023) had a statistically significant annual increase estimated at about 3.91 thousand feddans, 13.21 thousand tons, 310.57 pounds per ton, 776.22, 926.41, 150.19 pounds, equivalent to about 1.97%, 2.35%, 9.72%, 11.76%, 10.11%, 5.87% of the annual average estimated at about 198 thousand feddans, 563 thousand tons, 3195 pounds per ton, 6601, 9160, 2559 pounds respectively, while the significant increase in productivity per feddan was not proven.

Through the relative importance of the wheat crop area in the centers of Assiut Governorate for the average period (2021-2023), it became clear that Assiut Center ranked first in the area planted with wheat crops with an area of about 31.41 thousand feddans, representing about 15.09% of the total area planted with wheat crops, amounting to about 208.14 thousand feddans, while Sahel Selim Center ranked last in the area planted with wheat crops with an area of about 6.12 thousand feddans, representing about 2.94% of the total area planted with wheat crops.

Through variance analysis, it was found that there were significant differences between the productivity of the feddan of wheat crop in the centers of Assiut Governorate during the period (2021-2023), and the existence of this variance requires knowing whether this variance is due to inefficiency or due to random error, and to find out this, random bounds analysis was used.

To estimate the random boundary production function for wheat crop in Assiut Governorate for the average period (2021-2023), the double logarithmic production function (Cobb-Douglas) was used. The results showed that despite reducing the amount of nitrogen fertilizer, pesticides, and the number of automated working hours by 1%, the previous increase over the stagnant amount of these resources led to an increase in wheat crop production by 0.82%, 0.23%, and 0.39%, respectively. This may be due to the existence of waste or surplus in the use of these resources, and that these resources used are more than what the land needs to grow wheat crops, which means that the use of these resources falls in the third production stage, which is an irrational production stage, which means that there is waste in the use of these production resources and the quantities used must be reduced. Meanwhile, the results showed that increasing the number of workers by 1% leads to an increase in wheat crop production by 0.51%, which is a value less than one and greater than zero, which means that the use of this resource occurs in the second production stage, which is a rational production stage.

It was also shown that the gamma value was about 0.94, and this value is closer to one than to zero, which means that 94% of the deviations are due to the effect of inefficiency and not to random error.

The log likelihood function was about 22.25, which is greater than the tabular value of the chi-square at a significance level of 0.05, which is estimated at about 18.31, which means the feasibility of using the random model to measure efficiency, as this indicates that there are technical changes that positively affect the production efficiency of the wheat crop in Assiut Governorate.

By calculating the LR test of the one-sided error statistic, it was found that it is about 0.10, which is less than the critical value at a significance level of 0.05, which is estimated at about 12.59, which means accepting the null hypothesis that the error element related to inefficiency is distributed according to the half-normal distribution, and this means that the model expresses the efficiency measure well.

By estimating the technical efficiency of wheat production in the centers of Assiut Governorate using random frontier analysis for the average period (2021-2023), it was found that the average technical efficiency was about 0.96, which indicates that there is a deviation in actual production from the optimal production of about 0.04%, and wheat producers in the centers of Assiut Governorate can achieve it if they use the available economic resources optimally, which leads to a decrease in production costs by 4%. The results of the table also showed that wheat production in Abou Tig Center achieved the highest level of efficiency, reaching 0.99, while wheat production in El-Fatah Center achieved the lowest level of efficiency, reaching 0.90.

After verifying through the use of the random frontier production function that the changes are due to inefficiency and not to random error, the data envelope is used. Although it cannot distinguish between inefficiency and random error, it provides more details, as the random frontier production function cannot determine the sources of inefficiency as well as the amount of inefficiency, and therefore does not provide detailed data that helps in taking corrective measures for units that suffer from inefficiency.

By estimating the technical efficiency of wheat production in Assiut Governorate centers according to the data envelope analysis method for the average period (2021-2023), and through the concept of constant return on capacity, 4 centers achieved the maximum efficiency in wheat production, representing about 36.36% of the total number of centers. As for the concept of changing return on capacity, 7 centers achieved the maximum efficiency in wheat production, representing about 63.64% of the total number of centers. It was also shown through the capacity

efficiency index that 4 centers achieved full efficiency, i.e. the correct one, which means that the actual combination of resources used is the same as the optimal combination.

It was also found that the most reference centers for inefficient centers according to the technical efficiency index in the case of a stable return on capacity in wheat production in Assiut Governorate for the average period (2021-2023) are Sahel Selim and El-Quseya centers, which were repeated seven times, while the most reference center for inefficient centers according to the technical efficiency index in the case of a change in the return on capacity is El-Fatah Center, which was repeated four times.

By estimating the indicators of the distributional efficiency of wheat production in the centers of Assiut Governorate according to the data envelope analysis method for the average period (2021-2023), it was found that only one center achieved the maximum efficiency in wheat production, representing about 9.09% of the total number of centers. The economic efficiency of wheat production in the centers of Assiut Governorate was also estimated according to the data envelope analysis method. It was found that the economic efficiency of wheat production in the centers of Assiut Governorate ranged between 76.90% and 100%, with an average of about 91.70%, meaning that the same level of production can be achieved in light of economic efficiency by using only about 91.70% of the actual combination of resources used, meaning that about 8.30% of the resources used can be saved to reach the optimal economic efficiency for wheat production in the centers of Assiut Governorate.

It was also shown that the largest percentage of increase in the wheat crop production requirement to achieve optimal economic efficiency was in the amount of pesticides, with an increase of about 53.68%, in Sahel Selim Center, which also had the lowest percentage of increase in the wheat crop production requirement to achieve optimal economic efficiency, which was in the amount of nitrogen fertilizer, with an increase of about 0.03%. It was also shown that the largest percentage of decrease in the wheat crop production requirement to achieve optimal economic efficiency was in the amount of organic fertilizer, with a decrease of about 25.96%, and it was in Manfalout Center, while the lowest percentage of decrease in the wheat crop production requirement to achieve optimal economic efficiency was in the amount of nitrogen fertilizer, with a decrease of about 0.88%, and it was in El-Fatah Center.

In light of the results reached, the research recommends the following:

1- Working to reduce the amount of nitrogen fertilizer, pesticides, and the number of automated working hours, and increase the number of workers in order to achieve technical efficiency in wheat production in Assiut Governorate.
2- Taking El-Quseya Center as a reference and a good model to be used as a guide for the rest of the inefficient centers in achieving economic efficiency in wheat production in Assiut Governorate.
3- Working to reduce the amount of pesticides in most of the centers of Assiut Governorate, especially in Sahel Selim Center, as it represents the largest percentage of increase over the need for wheat production to achieve optimal economic efficiency, while being guided by the percentages of increase and decrease in the resources used in wheat production in each center of Assiut Governorate.
4- Working to provide the resources used in wheat production at the appropriate time and price, especially resources that are in short supply, such as seeds and fertilizers, which some centers suffer from, which makes the farmer reduce their quantity, which affects the efficiency of crop production.

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