Journal of American Science
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Multidisciplinary Academic Journal Publisher

The effect of agricultural labor and technology used in rice production in Dakahlia Governorate

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Abstract: Dakahlia Governorate is considered one of the governorates suitable for the cultivation of the rice crop in terms of the farmers' long experience, which makes the governorate have a comparative advantage in the production of the rice crop. 18.5%, as well as the Dakahlia Governorate, which decreased from about 438 thousand feddan in 2005 to about 325 thousand feddan in 2020, at a rate of 25.8%, despite the fact that the governorate has new reclaimed areas. It requires measuring the efficiency of production resources used in the production of a crop to technological levels. The research aims to study the possibility of achieving the technical and economic efficiency of the various agricultural resources used for the rice crop to achieve the maximum return in a way that supports the expansion of the generalization of the cultivation of the Sakha 101 variety, in an attempt to raise the efficiency of the use of available economic resources, i.e. reducing costs to the lowest level to achieve the maximum possible profit, and to achieve this goal the study was used Data Envelope Analysis (DEA) method for directing the resources used to cultivate Sakha 101 of rice in Dakahlia Governorate in order to achieve economic and distributional efficiency, which works to expand the cultivation of this variety. The Sakha 101 variety was chosen because it is the largest area of the cultivated varieties in Dakahlia Governorate, which amounts to about 83.4 thousand feddan, representing about 25.6% of the total area of the governorate, which amounts to 325 thousand feddan for the year 2020. The aim of choosing this variety is to compare production efficiency through a sample of six technological levels to reach the optimal farm size for each level. The research reached a number of results, the most important of which is the superiority of technical efficiency indicators in constant and variable return of scale, while the average scale efficiency of the second technological level in constant return was about 0.961%, where the average scale efficiency of the first technological level was about 0.984% in variable return. It was also found that the allocative efficiency of the resources used for agricultural labor for the fifth technological level has outperformed the rest of the technological levels in constant and variable return to scale estimated at 0.960% and 0.971%, respectively, while it was found that the economic efficiency of the resources used for the fifth technological level has outperformed. Also on the rest of the technological levels in both the constant and variable return to scale, it was estimated at 0.912% and 0.941%, respectively. This indicates that the closer the actual cultivated area is to the optimum area, the more efficient the use of the resources used in production. The results also showed that the economic efficiency of the second and fifth technological levels is the highest in the efficiency ratio achieved over the other levels in constant return to scale, as for variable return to scale, it may exceed the second and fifth levels to achieve higher economic efficiency at the other levels, which indicates that the greater the area cultivated whenever the efficient use of the resources used for agricultural labor is achieved, from which it is possible to estimate the optimal volume of resources in the production of this variety Sakha 101 and compare it with the actual volume of all technological levels. When comparing the actual and optimal size of the resources used to produce the Sakha 101 variety for all technological levels, it becomes clear the importance of reducing the average actual area according to the concept of constant return to scale, where the surplus amounted to about 7.18%. It also requires reducing the actual quantities used in terms of the number of hours of automated labor, human labor per man/day, the amount of seeds per kilogram, the amount of chemical fertilizer a unit of nitrogen, and the amount of pesticides per kilogram by about 29.1%, 45.3%, 5.6%, 10.4%, 54.7%, respectively, in order to be achieved economic efficiency of the first technological level, In variable return on scale, it becomes clear when comparing the average actual and optimal area that the average actual area can be reduced by about 4.7%, and it also requires reducing the actual quantities used from the number of automated labor hours, human labor per man/day, the quantity of seeds per kilogram, the quantity of chemical fertilizer and the nitrogen unit The quantity of pesticides per kilogram is about 9%, 24.9%, 3.9%, 5.3%, and 30.1%, respectively, in order to achieve the economic efficiency of the first level. With regard to comparing the actual and optimal size of the resources used to produce Sakha 101 for all technological levels, it becomes clear the importance of reducing the average actual area according to the concept of constant return to

scale, as the amount of surplus amounted to about 5.2%, and it also requires reducing the actual quantities used in terms of the number of hours of automated labor, human labor per man/day, the amount of seeds per kilogram, the amount of chemical fertilizer a unit of nitrogen, and the amount of pesticides per kilogram by about 3.7%, 17.5%, 4.9%, 9%, 39.6%, respectively, in order to the economic efficiency of the second technological level is achieved. As for the variable return to scale, when comparing the average actual and optimal area, it becomes clear that the average actual area can be reduced by about 18.3%. It also requires reducing the actual quantities used in terms of the number of hours of automated labor, human labor per man/day, the amount of seed per kilogram, and the amount of chemical fertilizer one unit of nitrogen, and the quantity of pesticides per kilogram is about 4.2%, 9.7%, 3.5%, 7.7%, and 34.8%, respectively, until the economic efficiency of the second level is achieved. The agricultural labor was estimated for the amount of resources that could be saved from the fifth level, which achieved the highest allocative efficiency according to the variable return, as it was possible to save for the average variety Sakha 101 for the cultivated area 2.16 carats and from the number of automated labor hours 2 hours, with a value of about 283 pounds, and the amount of saving for labor is about 8.6 men/day, with a value estimated at about 554 pounds, while the amount of savings for seeds was about 2.6 kilograms, with a value of about 29 pounds, while the amount of saving for each of the nitrogen fertilizers was about 1.8 units of nitrogen, with a value of about 24 pounds, while the amount of savings for each amount of pesticides was 0.67 kg, at a value of 88 pounds. **The research recommends:** The state, represented by the Agricultural Research Center, should increase the improved seeds of the rice crop, especially for the Sakha 101 variety, to increase its use by farmers to increase productivity per unit area. Activating the role of automated farming stations located in the governorates to increase the necessary equipment and machines that help producers and farm owners to do laser leveling, automatic seeding and combined harvesting, while reducing the hourly wage for these equipments so that all farmers can use them, with the aim of raising the technical and economic efficiency of the crop.

[Nivine Todary Guirguis Bebawy, Rania Rashad Abd El Naby Yousef, Mohamed Moneir Fadel Elmaadawy. **The effect of agricultural labor and technology used in rice production in Dakahlia Governorate.** *J Am Sci* 2022;18(12):65-85]. ISSN 1545-1003 (print); ISSN 2375-7264 (online). http://www.jofamericanscience.org. 09. doi:10.7537/marsjas181222.09.

Keywords: Farm' labor, variety, Scale Efficiency, allocative efficiency, constant return to scale, variable return to scale.

Introduction:

The rice crop is considered one of the important strategic crops, whether in Egypt or the countries of the world, because it represents a major source of food, as humans consume it in different ways in food. It is also a good source of energy and occupies the second place in food components for the Egyptian people, and it is the only grain crop that achieves self-sufficiency and leaves a surplus for export, which makes it a significant contribution to the formation of Egyptian agricultural output, as well as a source of foreign exchange. It is known that the cultivation of the rice crop has been completely liberated since 1993, and since then the cultivated area has ranged between increase and decrease during the study period, reaching about 1.188 million feddan in 2020; This resulted in achieving high levels of total production, as barley rice reached about 4.441 million tons [(7)], and white rice about 3.109 million tons in 2020.

The varieties of the rice crop allowed to be cultivated in the Dakahlia Governorate were determined, and they are 8 varieties of rice, which included Sakha 101, Sakha 104, Sakha 106, Sakha 107, Sakha 108, Giza 178, and Giza 177, given their ability to tolerate salinity and lack of water. Drought and disease resistance.

Research problem:

It is noted that the area planted with the rice crop decreased at the level of the Republic from about 1459 thousand feddan in 2005 to about 1188 thousand feddan in 2020, or about 18.6%, Although Dakahlia Governorate is one of the governorates where rice cultivation is good in terms of farmers' long experience, which makes it the first governorate that has a comparative advantage in rice production, the area planted with the crop in Dakahlia Governorate decreased from about 437.5 thousand feddan in 2005 to about 325.2 thousand feddan [(7)] in 2020, or about 25.6%, despite the fact that the governorate has areas of reclaimed lands, and therefore it is necessary to know the impact of agricultural labor and the technological level used in the production of the new variety Sakha 101 for the rice crop in Dakahlia Governorate.

Research goal:

The research aims to study the possibility of achieving the technical, allocative, and economic efficiency of the technological levels used in the production of the Sakha 101 variety of rice to achieve

the maximum return by supporting the expansion of its cultivation in Dakahlia Governorate as the main objective, through a set of sub-objectives limited to:

First: Analyzing the productive situation of the rice crop at the level of the Republic and Dakahlia Governorate.

Second: Estimating the technical, allocative, and economic efficiency of agricultural labor for the resources used in the research sample

Third: Estimating the optimal use of farm labor for the resources used in the production farms of Sakha 101, with the study sample.

Fourth: Estimating the quantity and value of the saving in the resources used in the production of the rice crop in the study sample.

This is for:-

1- The first technological level is laser leveling.

2- The second technological level: Harvesting in a combination.

3- The third technological level: laser leveling and combined harvesting

4-The fourth technological level: automatic seeding and harvesting in combination.

5-The fifth technological level: is laser leveling, automatic seeding, and combined harvesting.

6- Sixth level traditional agriculture.

Research method and data sources:

To achieve the goal of the research, descriptive and quantitative statistical analysis methods were applied as simple statistical methods such as percentages and arithmetic averages, in addition to using the simple linear model to estimate annual growth rates for economic variables, also, the Data Envelopment Analysis Program (DEAP) was used to estimate Technical Efficiency (TE), Economic Efficiency (EE), and to determine the amount of resources achieved for economic efficiency, and thus estimate the surplus or deficit in the economic resources used in cultivating this crop. [(3)], and the study of the difference between the actual average quantities of the resources used, and the optimal quantities achieved for economic efficiency. In addition to comparing the cultivated cultivar Sakha 101 to rice farmers in the governorate to determine the efficient technological level in the use of farm labor.

The research relied on published and unpublished data available in economic and statistical bulletins issued by the Ministry of Agriculture and Land Reclamation, as well as the Directorate of Agriculture in Dakahlia Governorate. In achieving its objectives, the research also relied on field data that was provided using a questionnaire during the 2021 agricultural season for a random sample of 150 farmers representing the Sakha 101 rice crop in Dakahlia Governorate, It was provided using the questionnaire during the agricultural season of 2021 for a random sample of 150 farmers representing farmers of the Sakha 101 variety of rice in Dakahlia Governorate, where the area planted with the crop (Collected and calculated from the Ministry of Agriculture and Land Reclamation, Directorate of Agriculture in Dakahlia, Agricultural Affairs Department, Statistics Department, unpublished data) reached about 325.2 thousand feddan, representing about 27.4% of the Republic's area. Therefore, two districts were chosen at the governorate level according to their relative importance to the cultivated area of the total area of the governorate, namely Al-Sinbilaween, and Al-Mansoura, about 34.5 and 42.4 thousand feddan, representing about 10.61%, 13.04% of the total area of rice in the governorate for the year 2020, respectively, as it was found that the area of the variety amounted to about 83.4 thousand feddan in the governorate. The area of the two districts reached 14.2 and 16.9 thousand feddan, representing about 17%, 20.3% of the total area of the variety planted in the governorate for the year 2020, respectively. Taking into account the time, costs and surrounding circumstances in collecting the data, and for comparison, the research sample was divided into six technological levels for the cultivated variety Sakha 101.

Theoretical framework:

Efficiency refers to the optimal use of available economic resources to obtain maximum production at the lowest cost. The study relies on estimating the efficiency of productive resources on the Data Envelopment Analysis Program (DEAP), which is one of the non-parametric analysis methods using linear programming to determine the optimal combination of inputs and outputs for similar production units in the production process, based on performance Actual of these units (sample farms). The data envelope analysis method depends on the concept of efficiency, which is determined by the following equation:

$$E = \frac{\sum_{r=1}^{t} \left(u_r y_{rj} \right)}{\sum_{i=1}^{m} \left(v_i x_{ij} \right)}$$

r= 1, 2, 3… t i= 1, 2, 3… m

Whereas:

E: Efficiency

m: the number of inputs t: the number of outputs

Xij: the input quantity i from the unit J

yrj: output quantity r from the unit J

vi: weight assigned to entry I

ur: the weight assigned to the output r

Whereas, the DEAP program provides an arithmetic measure of the relative efficiency of each productive unit (farm), so the units produced with complete relative efficiency (Scale Efficiency) get a scale equal to one (1), while the units produced with incomplete relative efficiency (Scale inefficiency) get On a scale less than one (1), then the relative efficiency is limited between (0, 1).

That is:

$$\text{Scale Efficiency} = \frac{\text{Technical efficiency under constant return to Scale}}{\text{Technical Efficiency Under Variable return to Scale}}$$

This scale deals with two basic models:

1- Constant return to Scale Model (CRS)

2- Variable return to Scale Model (VRS)

In the Constant Return to Scale model, the efficiency of the production unit is calculated using rates and ratios models [(10)], each production unit whose efficiency is to be measured is done by calculating the ratios of all outputs to all inputs, and according to this relationship the scale allows direct comparison of all production units under study.

Since the assumption of CRS is applied only when production units operate at their optimum sizes, while in reality there are many obstacles that prevent production units from achieving these sizes, such as imperfect competition, financing restrictions, etc., that is, the rate of increase in inputs is not necessarily accompanied by the same rate of increase in outputs. Therefore, the Variable return to Scale (VRS) model has been developed which is used when production units are not operating at optimal levels of production (A level less than the maximum energy), where it is allowed to measure the Scale Efficiency, and since the degrees of technical efficiency or productivity (Technical Efficiency) calculated according to the Constant Return to Scale consists of two parts, the first is due to the inefficiency of the scale of the production unit, the second is due to the net technological inefficiency, which is what the program calculates according to the two models CRS & VRS in sample data.

Economic efficiency is achieved through the combination of resources used to obtain the maximum production at the least cost or the least amount of resources used [(11)]. This economic efficiency is divided into two parts: Technical Efficiency, which means the facility's ability to obtain the maximum possible output from a set of available Inputs, which is measured in terms of the iso-quant output curve of the unit, and the efficiency of resource allocation and directing (Allocative Efficiency), which refers to the ability of the facility (farm) to use the optimum combination of inputs (resources), which can be used to produce a certain amount of output at the lowest possible cost, taking into account the prices of the inputs. This is measured in terms of the iso-cost curve.

The Economic Efficiency (EE) of the farm in this case is estimated from the product of the Technical Efficiency (TE) and the Allocative Efficiency (AE).

That is:

$$EE = TE \times AE$$

It expresses the total reduction in costs without affecting the level of production, and the relationship between the quantity of production (Y), which includes the production of the crop and the resources used in its production, can be formulated as follows:

$$Y_i = f(X_1, X_2, X_3, X_4, X_5, X_6)$$

Where: X_1 the cultivated area in feddan, X_2 the automated labor hour/farm, X_3 the human labor per man/day, X_4 the quantity of seeds kg/farm, X_5 the amount of chemical fertilizers as nitrogen unit/farm, X_6 the quantity of pesticides kg/farm.

Discuss the Results

First: Analyzing the productive situation of the rice crop at the level of the Republic and Dakahlia Governorate.

1- The relative importance of the productive status of the rice crop in the Arab Republic of Egypt:

By extrapolating the data of Table No. (1) to the development of the relative importance of the production status of the rice crop in the Republic during the average period (2017-2020), as it was found that most of the rice areas are concentrated in Dakahlia, Kafr El-Sheikh, Sharkia, Beheira, Gharbia, Damietta, Ismailia, and Port Said. By arranging the governorates of the Republic according to their relative and absolute contribution to the total area planted with the rice crop during the studied period, it was found that the Dakahlia Governorate occupies the first place with its contribution of about 329 thousand feddan, or about 28.22% of the annual average of the total area cultivated in the Republic, the Sharkia Governorate occupies the second place, as it contributes about 244 thousand feddan, or 20.97% of the annual average of the total cultivated area in the Republic. Beheira and Al Gharbia, for their contribution of about 165, 92 thousand feddan, representing about 14.15%, 7.90% of the annual

average of the total area planted with rice during the studied period. Then the governorates of Damietta, Port Said and Ismailia came in the sixth, seventh and last place, with an average area of about 51, 22, 5 thousand feddan, representing about 4.39%, 1.90%, 0.44%, respectively, for the study period. Thus, about 98.81% of the area cultivated with the rice crop they are concentrated in eight governorates, as shown in the same table.

Table (1): The relative importance of the area and production of the rice crop for the most important governorates in Egypt during the period (2017-2020)

Years / Governorate	Cultivated area in thousand feddan						Total production in thousand tons					
	2017	2018	2019	2020	Mean	Relative importance	2017	2018	2019	2020	Mean	Relative importance
Dakahlia	392	229	369	325	329	28.22	1631	833	1401	1304	1292	29.85
Kafr El-Sheikh	258	191	266	256	243	20.84	1026	760	1060	1023	967	22.34
Sharkia	277	187	278	235	244	20.97	903	633	964	774	818	18.9
Beheira	164	116	192	187	165	14.15	626	420	690	665	600	13.86
Gharbia	120	60	99	89	92	7.9	452	223	348	343	341	7.89
Damietta	57	47	53	48	51	4.39	195	162	177	166	175	4.04
Ismailia	5	5	6	5	5	0.44	15	16	21	16	17	0.39
Port Said	20	18	23	28	22	1.9	61	55	74	95	71	1.65
The total of the republic	**1307**	**859**	**1304**	**1189**	**1165**	**100**	**4958**	**3122**	**4798**	**4441**	**4330**	**100**

Source: Compiled and calculated from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration of Agricultural Economy, published by Agricultural Economics, various issues.

The feddan's productivity of the rice crop is affected by many factors, the most important of which are the agricultural technological and labor used, soil quality, planting date, fertilization, irrigation, and pest resistance. It was found from the same table No. (1) that the total production of the rice crop in the Arab Republic of Egypt amounted to about 4330 thousand tons as an average for the period (2017-2020), and in the order of the governorates of the Republic, it was found that the Dakahlia Governorate occupies the first place with its contribution of about 1292 thousand tons, or about 29.85 % of the annual average of the total production of the Republic, Kafr El-Sheikh governorate comes in second place, as it contributes about 967 thousand tons, or 22.34% of the annual average of the total production of the Republic during the aforementioned period, Al Sharkia governorate occupies the third place with an average total production of about 818 thousand tons, at a rate of 18.90%, followed in the fourth and fifth place by the Beheira and Gharbia governorates, with their contribution of about 600, 341 thousand tons, equivalent to about 13.86%, and 7.89%, respectively, of the annual average of the total production in the Republic. While the governorates of Damietta, Port Said and Ismailia came in the sixth, seventh and last place with an average production of about 175, 71, 17 thousand tons, representing about 4.04%, 1.65%, 0.39%, respectively, for the study period, and it is noted that the production of approximately 98.91% of the rice crop It is concentrated in eight rice-producing governorates, as shown in the same table.

2- Production development of the rice crop at the level of the Republic and Dakahlia Governorate:

This part deals with the study of the production development of the rice crop at the level of the Republic and Dakahlia Governorate, with the aim of identifying the most important variables that occurred in the feddan area and productivity, and then the change in production.

a) Rice production in Egypt:

By extrapolating the data of Table No. (2) as well as the statistical analysis of the previous variables in Table No. (3) during the study period (2005-2020), it was found that the cultivated area of the rice crop in the Arab Republic of Egypt fluctuated between rise and fall during the aforementioned period, ranging between A maximum of about 1,770 thousand feddan in 2008, at a rate of about 129.62% of the annual average area of about 1,365,000 feddan, and a minimum of about 859 thousand feddan in 2018, a rate of about 62.88% of the annual average for the study period, then it tended to increase until it reached about 1,189 thousand feddan year 2020.

From equation No. (1) In Table (3), it became clear that the area took a general decreasing trend, estimated at about 30.3 thousand feddan annually, with a change rate of about 2.22%, and this decrease was statistically significant.

As for the average feddan productivity during the study period, it was found that the highest rate was about 4,234 tons/feddan in 2006, equivalent to about 106.81% of the annual average productivity per feddan during the study period, and the lowest rate was about 3,640 tons/feddan in 2018, or the equivalent of about 91.82 % of the average feddan productivity of the rice crop, which is about 3.964 tons/feddan, and from equation No. (2) In Table (3) it became clear that the feddan productivity of rice at the level of the Republic has taken a general decreasing trend of about 0.033 tons/feddan, equivalent to about 0.83% of the average feddan productivity during the study period, this increase was statistically significant, while the rate of change was about 0.83%.

Table (2): The development of some productive variables for the rice crop at the level of the Republic and Dakahlia Governorate during the period (2005-2020)

Years	Republic						Dakahlia					
	area		Productivity		Production		area		Productivity		Production	
	thousand feddan	%	feddan / ton	%	thousand tons	%	thousand feddan	%	feddan / ton	%	thousand tons	%
2005	1459	106.84	4.2	105.89	6128	112.68	438	111.31	4.328	102.06	1894	112.86
2006	1593	116.66	4.23	106.72	6744	124.01	458	116.39	4.493	105.95	2060	122.76
2007	1673	122.51	4.11	103.69	6876	126.44	445	113.09	4.3	101.4	1915	114.12
2008	1770	129.62	4.1	103.44	7240	133.13	489	124.27	4.399	103.73	2153	128.3
2009	1369	100.25	4.03	101.67	5512	101.36	360	91.49	4.365	102.93	1570	93.56
2010	1093	80.04	3.96	99.91	4325	79.53	287	72.94	4.373	103.12	1257	74.91
2011	1409	103.18	4.02	101.42	5667	104.21	422	107.24	4.387	103.45	1850	110.24
2012	1472	107.79	4.01	101.17	5896	108.42	455	115.63	4.338	102.29	1973	117.57
2013	1419	103.91	4.03	101.67	5717	105.13	423	107.5	4.3	101.4	1818	108.34
2014	1364	99.89	4	100.92	5461	100.42	409	103.94	4.331	102.13	1771	105.53
2015	1216	89.05	3.96	99.98	4818	88.6	381	96.82	4.43	104.46	1686	100.47
2016	1353	99.08	3.92	98.9	5308	97.61	414	105.21	4.209	99.25	1734	103.33
2017	1307	95.71	3.79	95.62	4958	91.17	392	99.62	4.201	99.06	1631	97.19
2018	859	62.9	3.64	91.84	3122	57.41	229	58.2	3.64	85.83	833	49.64
2019	1304	95.49	3.68	92.87	4798	88.23	369	93.77	3.749	88.4	1401	83.49
2020	1189	87.07	3.74	94.28	4441	81.66	325	82.59	4.009	94.54	1304	77.71
Average	**1365.56**	**100**	**3.96**	**100**	**5438.19**	**100**	**393.5**	**100**	**4.24**	**100**	**1678.13**	**100**

Source: Compiled and calculated from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration of Agricultural Economy, published by Agricultural Economics, various issues.

Table (3): Equations of the general time trend of the development of some productive variables for the rice crop at the level of the Republic and Dakahlia Governorate during the period (2000-2020)

Equation number	Statement		a	b	R^2	F	Rate of change (%)
1	Republic	**area** thousand feddan	**1623.36**	**-30.338 (-3.25)****	**0.43**	**(10.5)****	**-2.22**
2		**Productivity** feddan / ton	**4.248**	**-0.033 (-9.93)****	**0.85**	**(79.8)****	**-0.83**
3		**Production** thousand feddan	**6840.62**	**-164.99 (-4.23) ****	**0.56**	**(17.9)****	**-3.03**
4	Dakahlia	**area** thousand feddan	**460.065**	**7.841- (-2.46)***	**0.30**	**(6.01)***	**-1.99**
5		**Productivity** feddan / ton	**4.547**	**- 0.036 (-3.8)****	**0.51**	**(14.4)****	**-0.85**
6		**Production** thousand feddan	**2066.86**	**- 45.75 (3.11)****	**0.41**	**(9.6)****	**-2.72**

Where:
a = constant term b = regression coefficient R^2= coefficient of determination F = computed (F) value
The numbers below the regression coefficients indicate the value (t) calculated
Rate of change = annual change / average period x100
* Refers to statistical significance at a statistical level of 0.05
** Refers to a statistical significance at a statistical level of 0.01
Source: Calculated from Table No. (2).

As for the total production of rice, it ranged between a maximum of 7240 thousand tons in 2008, equivalent to about 133.13% of the average total production of about 5,438 thousand tons, and a minimum of about 3122 thousand tons in 2018, equivalent to about 57.41% of the annual average of total production. From equation No. (3) In Table No. (3), it was found that the total production took a general decreasing trend, amounting to about 165 thousand tons annually, and the rate of change was estimated at 3.03%, and its significance was statistically significant at all statistical levels.

b) Rice production in Dakahlia Governorate:

From the data of Table No. (2), (3) during the study period, it was found that the area planted with rice in Dakahlia Governorate fluctuated between a maximum of about 489 thousand feddan in 2008, representing about 124.27% of the annual average of the area of about 393.5 thousand feddan, and a maximum of about 489 thousand feddan in 2008. The lowest amounted to about 229 thousand feddan in 2018, representing about 58.20% of the annual average for the study period.

From equation No. (4) In Table (3), it was found that the area took a general decreasing trend, estimated at about 7.8 thousand feddan annually, with an annual change rate of about 1.99%, and its morale was statistically significant.

As for the average feddan productivity during the study period, it was found that its maximum rate was 4.493 tons/feddan in 2006, equivalent to about 105.94% of the annual average feddan productivity of about 4.241 tons/feddan, and a minimum of about 3,640 tons/feddan in 2018, or about 85.83% From the average feddan productivity of the rice crop, and from equation No. (5) In Table (3), it became clear that the feddan productivity of rice in Dakahlia Governorate took a general trend towards decreasing by about 0.036 tons/feddan, equivalent to about 0.85% of the average feddan productivity during the study period, and it proved to be significant this decrease is statistically significant.

As for the total production of rice, it ranged between a maximum of about 2,153 thousand tons in 2008, equivalent to about 128.30% of the average total production of about 1,678 thousand tons, and a minimum of about 833 thousand tons in 2018, equivalent to about 49.64% of the annual average of total production. From equation (6) in Table (3), it was found that the total production has taken a general decreasing trend, estimated at about 45.7 thousand tons annually, with a rate of change of

about 2.72%, and the statistical significance of the function has been proven at all probability levels.

3- The relative importance of the production of the long-stayed Sakha 101 variety in the governorates of Egypt in the year 2020

Sakha 101 is a short-grained Egyptian variety (Short Broad), short-stemmed, with a plant height of 90 cm and a growth period of 145 days from planting to harvest, excellent cooking qualities, moderate tolerance to salinity, sensitive to blight and in case of infection with this disease it is necessary to control the disease one of the recommended pesticides as soon as the infection is discovered.

As it became clear from table (4) that it is mainly cultivated in seven governorates, respectively (Dakahlia, Sharkia, Beheira, Kafr El-Sheikh, Gharbia, Damietta, Ismailia), where the cultivated area in each of them reached about 86.3, 80.9, 50.5, 32.1, 27.5, 9.2, 2.2 thousand feddan at a rate of about 29.41%, 27.57%, 17.21%, 10.94%, 9.37%, 3.14%, 0.75%, respectively, of the total cultivated area (in Sakha 101) at the level of the Republic.

The production rate in the aforementioned governorates amounted to 32.31%, 25.22%, 16.69%, 11.77%, 8.91%, 2.98% and 0.68%, respectively, of the total rice production (Sakha 101) at the level of the Republic.

Table (4): The relative importance of producing the most important long-staying rice varieties in the governorates of Egypt in 2020

Governorates	The variety Sakha 101 is long-staying in the soil per thousand feddan in the most important productive governorates			
Dakahlia	86.3	29.41	348	32.31
Kafr El-Sheikh	32.1	10.94	126.8	11.77
Sharkia	80.9	27.57	271.7	25.22
Beheira	50.5	17.21	179.8	16.69
Gharbia	27.5	9.37	96	8.91
Damietta	9.2	3.14	32.1	2.98
Ismailia	2.2	0.75	7.3	0.68
Total	293.4	100	1077.2	100

Source: Compiled and calculated from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration of Agricultural Economy, published by Agricultural Economics, 2020.

4- The relative importance of Sakha 101 in Dakahlia Governorate.

Table (5) shows that the area of the Sakha 101 variety planted in Dakahlia Governorate represents about 26.39% of the average area at the level of the Republic of about 307 thousand feddan, and the production represents about 28.29% of the average production at the national level of about 1,133 thousand feddan. It represents about 106.21% of the average productivity of the Republic of about 3.69 tons / feddan during the period (2017/2020).

Second: Estimating the technical, allocative and economic efficiency of agricultural labor for the resources used in the research sample:

A. Estimation of Technical Efficiency of Rice Crop:

In the following, each technological level of the Sakha 101 class of the research sample will be dealt with in detail in order to compare the technical efficiency.

1. First technological level (laser leveling):

As shown by the data of Table No. (6), this level includes 25 farms where laser leveling is carried out. According to the concept of constant return to scale, the technical efficiency ranged between 0.86% as a minimum and the maximum reached 100% with an average of about 96%, meaning that the same level of production can be achieved using 96% of the actual combination of the resources used, meaning that 4% of the resources can be saved. Without affecting the level of production. According to the concept of variable return to scale, it was found from the same table No. (6) that the technical efficiency index ranged between 92% and the maximum technical efficiency 100%, and the average of this indicator was 98%, meaning that 2% of the resources could be saved without affecting the level of production, and the scale efficiency ranged for this category, between 91% as a minimum and 100% as a maximum, and the average of this indicator is 97%, meaning that 3% of the resources can be saved without affecting the level of production. This indicates that Sakha 101 farmers lose some economic resources used in rice production, which leads to an increase in production costs by 3%.

Table (5): The relative importance of Sakha 101 cultivated in Dakahlia Governorate for the Republic during the period 2017-2020.

years	Republic			Dakahlia Governorate			The relative importance of the variety Sakha 101		
	area	productivity	production	area	productivity	production	area	productivity	production
2017	350	3.747	1312	97	4.132	402	27.77	110.27	30.62
2018	209	3.675	768	45	3.688	168	21.48	100.35	21.85
2019	375	3.669	1377	95	3.827	365	25.44	104.31	26.51
2020	293	3.671	1077	86	4.031	348	29.45	109.81	32.31
average	**307**	**3.691**	**1133**	**81**	**3.92**	**321**	**26.39**	**106.21**	**28.29**

Source: Compiled and calculated from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration of Agricultural Economy, published by Agricultural Economics, various issues.

The results of the analysis of the first technological level of farmers using laser leveling according to the scale efficiency index indicate that return to scale is decreasing (Drs) in about 12% of the farmers of this variety, where the average constant return to scale index in those farms is about 96%, and the average variable return to scale index about 98% and the average scale efficiency index is about 97%, which requires reducing the amount of resources used in those farms to achieve full technical efficiency. It was also found that about 60% of the farms of this variety have increased returns to scale (Irs), which requires increasing the resources used in those farms to achieve full technical efficiency. The results also indicate that about 28% of the farms of this category have achieved full technical efficiency and scale efficiency reached one correct.

Table (6): The average standards of technical efficiency and return to scale for the variety Sakha 101 for the rice crop in Dakahlia Governorate according to the research sample for each technological level, season 2021.

technological levels	Efficient with constant return	Efficient with variable return	scale efficiency	Return to scale	number of farms
First level					25
	0.961	0.984	0.976	decreasing	3
				increasing	15
				efficient	7
Second Level					25
	0.965	0.974	0.99	decreasing	1
				increasing	16
				efficient	8
The third level					25
	0.961	0.981	0.97	decreasing	1
				increasing	15
				efficient	9
fourth level					25
	0.951	0.981	978	decreasing	3
				increasing	14
				efficient	8
Fifth level					25
	0.95	0.969	0.98	decreasing	3
				increasing	15
				efficient	7
Sixth level					25
	0.914	0.965	0.947	decreasing	3
				increasing	19
				efficient	3

Source: collected and calculated from the preliminary data of the questionnaire form 2021 season.

2. **The second technological level (combine harvesting):**

This level includes 25 farms and harvesting is done in combination, where the technical efficiency ranged according to the concept of constant return to scale between 91% as a minimum and 100% as a maximum with an average of 96%, which means that it is possible to save 4% of the resources used without affecting the production level of the crop rice for this variety. According to the concept of variable return to scale, it became clear from the data of Table No. (6) that the growers of this variety reached a minimum of 94% and a maximum of 100%, with an average of 97%, and this confirms that the amount of resources used does not represent the optimal amount of production, as scale efficiency of this variety between 93% as a minimum and 100% as a maximum, and the average for this indicator was 99%, meaning that 1% of resources can be saved without affecting the level of production. This indicates that the farmers of this variety lose some of the economic resources used in the production of the rice crop, which leads to an increase in production costs by 1%.

It is clear from the results of the analysis of the second technological level of harvesting in combination according to scale efficiency index that the return to scale is decreasing (Drs) in about 4% of the farmers of this variety, and it was found that about 64% of the farms of this variety have an increasing return to scale (Irs), Which requires increasing the resources used in those farms to achieve full technical efficiency. The results also indicate that about 32% of farms in this category have achieved total technical efficiency and scale efficiency reached one correct.

3. **The third technological level (laser leveling and combine harvesting):**

This level includes 25 farms, and laser leveling and combined harvesting take place, according to the concept of constant return to scale, where technical efficiency reached between 89% as a minimum and 100% as a maximum, with an average of about 96%, meaning that 4% of the resources used can be saved without the level of production is affected by those farms for this level. According to the concept of variable return to scale, the technical efficiency ranged between 89% as a minimum and 100% as a maximum, with an average of about 98%, which means that the same level of production can be achieved by using only 98% of the actual combination of resources used. To increase the technical efficiency of this level, a level reduction is required. Production in one farm, amounting to 4% of the farms of this level, increased production in 15 farms, amounting to 60%, and about 36% of the farms of this level achieved full technical efficiency and reached the correct scale efficiency, as the average scale efficiency reached 97%, which requires to reduce the resources used in those farms to achieve full technical efficiency, meaning that 3% of the resources can be saved without affecting the level of production.

4. **The fourth technological level (automatic seeding and combined harvesting):**

This level includes 25 farms, in which automatic seedlings and harvesting are done in combination, and according to the concept of constant return to scale, the technical efficiency ranged between 0.83% as a minimum and the maximum reached 100%, with an average of about 95%, meaning that it can be achieved the same level of production by using 95% of the actual combination of the resources used, meaning that 5% of the resources can be provided without affecting the level of production. According to the concept of variable return to scale, it was shown from the same table No. (6) that the technical efficiency index ranged between 85% and the maximum technical efficiency 100%, and the average of this indicator was 97%, meaning that 3% of the resources could be provided without affecting the level of production, and the scale efficiency ranged of this level ranges between 88% as a minimum and 100% as a maximum, and the average for this indicator is 97%, meaning that 3% of resources can be saved without affecting the level of production. This indicates that Sakha 101 growers lose some of the economic resources used in rice production, which leads to an increase in production costs by 3%.

The results of the analysis of the fourth technological level, according to the scale efficiency index, indicate that the return to scale is decreasing (Drs) in about 12% of the farmers of this level, as the average of the constant return to scale index in those farms is about 95%, and the average of the variable return to scale is about 97% and the average the scale efficiency index is about 97%, which requires reducing the amount of resources used in those farms to achieve full technical efficiency. It was also found that about 56% of farms of this type have an increased return on scale (Irs), which requires an increase in the resources used in those farms to achieve full technical efficiency. The results also indicate that there are about 32% of the farms of this category that have achieved full technical efficiency and scale efficiency reached one correct.

5. The fifth technological level (laser leveling, automatic seedling, and combined harvesting):

This level includes 25 farms and laser leveling, automatic seedling and combined harvesting, where technical efficiency ranged according to the concept of constant return between 83% as a minimum and 100% as a maximum with an average of 95%, which means that it is possible to save 5% of the resources used without being affected the level of production of rice crop for this level. According to the concept of variable return to scale, it became clear from the data of Table No. (6) that growers of this level reached a minimum of 85% and a maximum of 100%, with an average of 97%, and this confirms that the amount of resources used does not represent the optimal amount of production, as the scale efficiency of this variety between 88% as a minimum and 100% as a maximum, and the average for this indicator was 97%, meaning that 3% of resources can be saved without affecting the level of production. This indicates that the farmers of this variety lose some of the economic resources used in the production of the rice crop, which leads to an increase in production costs by 3%.

It is clear from the results of the analysis of the fifth technological level according to the scale efficiency index that the return to scale is decreasing (Drs) in about 12% of the farmers of this level, and it was found that about 60% of the farms of this level have an increasing return to scale (Irs), which requires increasing the resources used by those farms to achieve full technical efficiency. The results also indicate that there are about 28% of the farms of this category that have achieved full technical efficiency and scale efficiency reached one correct.

6. The sixth level (traditional agriculture):

This level includes 25 farms and traditional farming takes place, according to the concept of constant return to scale, where technical efficiency reached between 77% as a minimum and 100% as a maximum, with an average of about 91%, meaning that 9% of the resources used can be saved without affecting the level of production those farms to this level. According to the concept of variable return to scale, the technical efficiency ranged between 86% as a minimum and 100% as a maximum, with an average of about 96%, which means that the same level of production can be achieved by using only 96% of the actual combination of resources used, and to increase the technical efficiency of this level requires a decrease in the level Production in 3 farms, amounting to 12% of the farms of this level, increased production in 19 farms, amounting to 76%, and about 12% of the farms of this level achieved full technical efficiency, as the efficiency of the correct scale reached one, which necessitates the need for those farms to continue at the same amount of production is equal to the actual combination of farm labor resources used in the productive process.

From the foregoing, it is clear that the indicators of technical efficiency are superior in the constant and variable return of scale in the second and fifth technological levels, as the average for them reached 99% and 98%, respectively, while it was found that traditional agriculture was less technically efficient, amounting to about 94%, which necessitates the need to pay attention to extension and guidance programs to this level to raise their scale efficiency.

B. Estimating the allocative efficiency of rice crop in Dakahlia Governorate

It is clear from the results of Table No. (7) that the allocative efficiency of agricultural labor for the resources used in the production of the Sakha 101 rice crop was estimated using the (DEAP) model in the presence of the prices or costs of those resources.

In the following, the technological levels of the research sample will be dealt with in detail to compare the allocative efficiency at each level.

1- The first technological level (laser leveling):

It was found that the indicator of the allocative efficiency of farm labor for the resources used for this level, according to the constant return to scale, ranged between a minimum of about 51% and a maximum of about 100%, with an average estimated at about 78%, this means that about 22% of the farm labor cost used in the production of this level of rice crop for Sakha 101 can be saved without affecting the quantity produced. While in the variable return to scale, the average allocative efficiency reached about 91%, and this means that the redistribution of economic resources will save 9% of the cost of producing Sakha 101, and its minimum amounted to about 77% for this technological level. It was also found that the actual average area of this first technological level ranged between a minimum of about 0.42 feddan and a maximum of 6 feddan, with an average of about 1.66 feddan.

2- The second technological level (combine harvesting):

Table (7) indicates that the allocative efficiency of farm labor for the resources used for this level ranged between a minimum of 56% and a maximum of 1, with an average estimated at 87% under the constant return scale, this means that the redistribution of economic resources will save 13% of the cost of farm labor used in producing this level of rice crop for Sakha 101 without affecting the quantity produced. As for the variable return to scale, the value of the allocative efficiency index ranged between a minimum of 86% and a maximum of one correct, with an average estimated at 94%. This

means that the redistribution of economic resources will provide 6% of the production cost of this level for Sakha 101. While it was found that the actual average area of this second technological level ranged between a minimum of about 0.16 feddan and a maximum of 5 feddan, with an average of about 1.22 feddan.

3- The third technological level (laser leveling and combine harvesting):

It was found that the average allocative efficiency index of the resources used for farm labor for this level in relation to the constant return to scale was about 88%, and its minimum level was about 66 this means that the redistribution of economic resources will save 12% of the cost of farm labor used in the production of this level of rice crop for Sakha 101 without affecting the quantity produced. As for the variable return to scale, the value of the allocative efficiency index ranged between a minimum of 79%, with an average estimated at 93% this means that by redistributing economic resources, it will save 7% of the cost of producing this level of Sakha 101. It was also found that the actual average area of this third technological level ranged between a minimum of about 0.5 feddan and a maximum of 10 feddan, with an average of about 2.28 feddan.

Table (7): Estimating the allocative and economic efficiency of technological levels in the constant return and variable return to scale in Dakahlia Governorate according to the research sample, season 2021.

technological levels	number of farms	appreciation categories	The area in feddan	Allocative Efficiency or (Price) % AE		Economic Efficiency (Optimum) or (Cost Efficiency) CE	
				In the constant return to scale	In the variable return to scale	In the constant return to scale	In the variable return to scale
First level	25	average	1.66	0.786	0.914	0.756	0.901
		highest value	6	100	100	100	100
		lowest value	0.42	0.508	0.774	0.481	0.773
Second level	25	average	1.22	0.87	0.947	0.84	0.922
		highest value	5	100	100	100	100
		lowest value	0.16	0.565	0.864	0.656	0.833
The third level	25	average	2.28	0.887	0.931	0.855	0.914
		highest value	10	100	100	100	100
		lowest value	0.5	0.662	0.791	0.599	0.735
fourth level	25	average	1.78	0.914	0.928	0.869	0.902
		highest value	2.25	100	100	100	100
		lowest value	1	0.764	0.817	0.759	0.777
Fifth level	25	average	1.94	0.96	0.971	0.912	0.941
		highest value	3.5	100	100	100	100
		lowest value	1.25	0.903	0.915	0.806	0.824
Sixth level	25	average	1.58	0.902	0.931	0.825	0.897
		highest value	3.5	100	100	100	100
		lowest value	0.66	0.708	0.794	0.637	0.78

Source: collected and calculated from the preliminary data of the questionnaire form 2021 season.

4- The fourth technological level (automated seeding and combined harvesting):

It was found that the indicator of the allocative efficiency of agricultural labor for the resources used for this level, according to the constant return to scale, ranged between a minimum of about 76% and an upper limit of about 100%, with an average estimated at 91%, which means that it is possible to save about 9% of the cost of farm labor used in producing this level of rice yield of Sakha 101 variety without affecting the quantity produced. While in the variable return to scale, the average allocative efficiency reached about 92%, and this means that the redistribution of economic resources will provide 8% of the cost of producing Sakha 101, and its minimum amounted to about 81% for this technological level. It was also found that the average actual area for this fourth technological level it ranged between a minimum of about 1 feddan and a maximum of 2.25 feddan, with an average of about 1.78 feddan.

5- The fifth technological level (laser leveling, automated seedling and combined harvesting):

Refers to the allocative efficiency of farm labor for the resources used for this level. It ranged between a minimum of 90% and a maximum of 1, with an average estimated at 96% under the constant return to scale. This means that the redistribution of economic resources will provide 4% of the cost of farm labor used in this level produced the rice crop of Sakha 101 without affecting the quantity produced, while in the variable return to scale, the value of the allocative efficiency index ranged between a minimum of 91% and a maximum of the correct one, with an average estimated at 97%. This means that the redistribution of economic resources will save 3% of the production cost of this level for Sakha 101. While it was found that the actual average area of this fifth technological level ranged between a minimum of about 1.25 feddan and a maximum of 3.5 feddan, with an average of about 1.94 feddan.

6- The sixth level (traditional agriculture):

It was found that the average index of the allocative efficiency of farm labor for the resources used for this level in the constant return to scale was about 90% and its minimum level was about 70%. Sakha 101 without affecting the quantity produced. As for the variable return to scale, the value of the allocative efficiency index ranged between a minimum of 79%, with an average estimated at 93%. This means that by redistributing economic resources, it will save 7% of the production cost of this level for Sakha 101. It was also found that the average actual area of this sixth technological level ranged between a minimum of about 0.66 feddan and a maximum of 3.5 feddan, with an average of about 1.58 feddan.

C. Estimating the economic efficiency of rice cultivars in Dakahlia Governorate:

It was clear from the results of Table No. (7) that the economic efficiency of agricultural labor for the resources used in the production of the Sakha 101 rice crop was estimated using the (DEAP) model using the costs of those resources.

In the following, the technological levels of the research sample will be dealt with in detail to compare the economic efficiency at each level.

1- The first technological level (laser leveling):

It turned out that the average economic efficiency index for the production of this item for the first technological level amounted to about 75% in constant return to scale, and reached 90% according to variable return to scale, and this means that the same level of production can be achieved by reducing production costs by 25%, 10% for each Respectively. With a minimum of about 48% under the constant return to scale, 77% according to the variable return to scale.

2- The second technological level (combine harvesting):

The average economic efficiency index for this level was about 84% with a minimum of 65% in f constant return to scale, and this means that the same level of production can be achieved by reducing production costs by 35%. As for variable the return to scale, the average value of the economic efficiency index ranged by about 92%, with a minimum of 83%, which means that the same level of production can be achieved by reducing production costs by 17%.

3- The third technological level (laser leveling and combined harvesting):

It was found that the average economic efficiency index reached about 85%, with a minimum of about 59% for constant return to scale, which indicates that the same level of production can be achieved by reducing production costs by 15%. As for variable return to scale, the average economic efficiency index was about 91%, with a minimum of 73%, and this means that the same level of production can be achieved by reducing production costs by 9%.

4- The fourth technological level (automated seeding and combined harvesting):

It turned out that the average economic efficiency index for the production of this item for the fourth technological level was about 86% in relation to constant return to scale, and it reached

90% according to the variable return to scale, and this means that the same level of production can be achieved by reducing production costs by 14%, 10% for each of them. With a minimum of about 75% under the constant return to scale, 77% according to the variable return to scale.

5- The fifth technological level (laser leveling, automated seedling and combined harvesting):

The average economic efficiency index for this level was about 91%, with a minimum of 80% for constant return to scale, and this means that the same level of production can be achieved by reducing production costs by 9%. As for the variable return to scale, the average value of the economic efficiency index ranged at about 94 %, and its minimum level was 82%, which means that the same level of production can be achieved by reducing production costs by 6%.

6- The sixth level: (traditional agriculture):

It was found that the average economic efficiency index was about 82%, with a minimum of about 63% for constant return to scale, which indicates that the same level of production can be achieved by reducing production costs by 18%. As for the variable return to scale, the average economic efficiency index reached about 89%, with a minimum of 78%, and this means that the same level of production can be achieved by reducing production costs by 11%.

From the foregoing, it is clear from the results that the economic efficiency of the fifth technological level has outperformed all other levels in relation to both constant and variable return to scale, with an average efficiency of about 91% and 94%, respectively. This indicates that the greater the cultivated area, the more efficient use of economic resources will be achieved, from which it is possible to estimate the optimal size of the resources used for agricultural labor in the production of Sakha 101 and compare it with the actual size. This is consistent with the previously estimated allocative efficiency.

Third: Estimating the optimal use of agricultural labor for the resources used in farms producing Sakha 101.

A. The optimal size of the economic resources used in constant return to scale:

By reviewing the data of Table No. (8) To compare the technological levels used in agricultural labor to produce the Sakha 101 variety, it is clear that the average actual resources at the level of the study sample and their counterparts that achieve (optimal) economic efficiency according to constant return to scale.

1- The first technological level (laser leveling):

It is clear from the comparison of the average actual area cultivated with the crop at the first technological level and its counterpart that achieves economic efficiency (optimum) according to constant return to scale that the optimal area is less than the actual area by about 0.119 feddan, or 2.8 carat, equivalent to 7.18% of the actual area, so it is necessary to reduce the average area from 1.658 feddan to 1.539 feddan. It also requires reducing the actual quantities used from the number of automated labor hours 5.81 hours, human labor 45.31 workers, the amount of seeds 5.61 kilograms, the amount of nitrogen fertilizers 14.83 nitrogen units, and the amount of pesticides 1.76 kilograms, at rates estimated at 29.07%, 45.31%, 5.61%, and 10.36%. , 54.76%, respectively.

2- The second technological level (combine harvesting):

The data of the same table to compare the average actual area cultivated with Sakha 101 at the governorate level and its counterpart that achieves (optimal) economic efficiency according to the constant return to scale indicates that the optimal area is less than the actual area by about 0.063 feddan, or 1.5 carats, representing about 5.17% of the actual area, so it is necessary to reduce the average area from 1.218 feddan to 1.155 feddan. It also requires reducing the actual quantities used from the number of automated labor hours 0.71 hours, human labor 8.15 workers, the amount of seeds 5.24 kilograms, and the amount of nitrogen fertilizers 9.04 nitrogen units, with rates amounting to about 3.88%, 17.50%, 4.96%, 9.04%, 39.64%, respectively.

3- The third technological level (laser leveling and combine harvesting):

When comparing the average actual area cultivated with the crop at the level of the cultivar and its counterpart that achieves economic efficiency (optimal) according to constant return to scale, it turns out that the optimal area is less than the actual area by about 0.121 feddan, or 2.9 carats, equivalent to about 5.31% of the actual area, so it is necessary to reduce the average area from 2.28 feddan to 2.15 feddan. It also requires reducing the actual quantities used from the number of automated labor hours 3.51 hours, human labor 22.81 workers, the amount of seeds 9.29 kilograms, and the amount of pesticides 1 kilogram, at rates of about 9.72%, 25.54%, 4.78%, and 20.52%, respectively. While it is necessary to increase the amount of nitrogen fertilizers by about 7.91 nitrogen units, representing about 4.03%.

Table (8): Shows the difference between the actual and optimal quantities used in the production of rice for the variety Sakha 101 season 2021, according to constant return to scale

Statement		First level	Second level	third level	fourth level	Fifth level	Sixth level
The area (feddan)	Actual	1.658	1.218	2.279	1.789	1.943	1.588
	target	1.539	1.155	2.158	1.557	1.802	1.382
	the difference	0.119	0.063	0.121	0.232	0.141	0.206
	%	7.18	5.17	5.31	12.97	7.26	12.97
Automated labor (hours)	Actual	20	18.32	36.2	29.76	33.32	15.57
	target	14.19	17.61	32.68	24.91	29.74	13.13
	the difference	5.814	0.71	3.52	4.85	3.58	2.44
	%	29.07	3.88	9.72	16.3	10.74	15.67
Human labor (man/day)	Actual	69.92	46.56	89.31	64.08	64.08	83.12
	target	38.24	38.41	66.5	56.05	57.68	54.98
	the difference	31.68	8.15	22.81	8.03	6.4	28.14
	%	45.31	17.5	25.54	12.53	9.99	33.85
Amount of seeds (kg)	Actual	144.12	105.75	194.32	152	160.6	142.95
	target	136.03	100.51	185.03	130.79	162.23	124.44
	the difference	8.091	5.24	9.29	21.21	-1.63	18.51
	%	5.61	4.96	4.78	13.95	-1.01	12.95
Chemical Fertilizer (Azote Unit)	Actual	143.16	119.56	196.24	135.43	159.12	137.2
	target	128.3	108.8	204.2	114.6	146	122.4
	the difference	14.83	10.81	-7.91	20.83	13.11	14.83
	%	10.36	9.04	-4.03	15.38	8.24	10.81
Amount of pesticides (kg)	Actual	3.216	3.388	4.718	2.725	2.608	2.391
	target	1.455	2.045	3.75	3.973	1.036	1.472
	the difference	1.761	1.343	0.968	-1.248	1.572	0.919
	%	54.76	39.64	20.52	-45.8	60.28	38.44

Source: collected and calculated from the preliminary data of the questionnaire form 2021 season.

4- The fourth technological level (automated seeding and combined harvesting):

It is clear from the comparison of the average actual area cultivated with the crop at the fourth technological level and its counterpart that achieves economic efficiency (optimum) according to constant return to scale that the optimal area is less than the actual area by about 0.232 feddan, or 5.5 carats, equivalent to 12.97% of the actual area, so it is necessary to reduce the average area from 1.78 feddan to 1.55 feddan. It also requires reducing the actual quantities used from the number of automated labor hours 4.85 hours, human labor 8 workers, the amount of seeds 21.21 kilograms, and the amount of

nitrogen fertilizers 20.83 nitrogen units, at rates estimated at 16.30%, 12.53%, 13.95%, 15.38%, respectively, as shown. It is necessary to reduce the quantity of pesticides by 1.24 kilograms, by about 45.8%.

5- The fifth technological level (laser leveling, automated seedling and combined harvesting):

The same table indicates a comparison of the average actual area cultivated with Sakha 101 at the governorate level and its counterpart that achieves economic efficiency (optimum) according to constant return to scale. 1.94 feddan to 1.80 feddan. It also requires reducing the actual quantities used from the number of automated labor hours to 3.58 hours, human labor to 6.4 workers, the amount of nitrogen fertilizers to 13.11 nitrogen units, and the amount of pesticides to 1.57 kilograms, at rates amounting to about 10.74%, 9.99%, 8.24%, and 60.28%, respectively. It is also necessary to increase the quantity of seeds by 1.63 kilograms, at a rate of about 1.01%.

6- The sixth level: (traditional agriculture):

When comparing the average actual area cultivated with the crop at the level of the cultivar and its counterpart that achieves economic efficiency (optimal) according to constant return to scale, it turns out that the optimal area is less than the actual area by about 0.206 feddan, or 5 carats, equivalent to about 12.97% of the actual area, so it is necessary to reduce the average area from 1.59 feddan to 1.38 feddan. It also requires reducing the actual quantities used from the number of automated labor hours 2.44 hours, human labor 28.14 workers, the amount of seeds 18.51 kilograms, the amount of nitrogen fertilizers by about 14.83 nitrogen units, and the amount of pesticides 0.92 kilograms, with rates amounting to about 15.67%, 33.85%, 12.95%, 10.81 %, 38.44%, respectively.

B- The optimal size of the economic resources used in variable return to scale:

By reviewing the data of Table No. (9) To compare the technological levels used in agricultural labor to produce the Sakha 101 variety, it is clear that the average actual resources at the level of the study sample and its counterpart achieved economic efficiency (optimal) according to variable return to scale:

1- The first technological level (laser leveling):

It is clear from the comparison of the average actual area cultivated with the crop at the level of Sakha 101 variety and its counterpart that achieves economic efficiency (optimum) according to variable return to scale that the optimal area is less than the actual area by about 0.08 feddan, equivalent to 4.76% of the actual area, so it is necessary to reduce the average area from 1.66 feddan to 1.58 feddan, it is roughly equivalent to 2 carats. It also requires reducing the actual quantities used from the number of automated labor hours 1.8 hours, human labor 17.4 workers, the amount of seeds 5.69 kilograms, the amount of nitrogen fertilizers 7.61 nitrogen units, and the amount of pesticides 0.98 kilograms, at rates estimated at 9%, 24.9%, 3.95%, and 5.32%, 30.57%, respectively.

2- The second technological level (combine harvesting):

The data of the same table to compare the average actual area cultivated with the crop at the level of cultivar Sakha 101 and its counterpart achieving (optimal) economic efficiency according to the variable return to scale indicates that the optimal area is about 0.04 feddan more than the actual area, equivalent to 3.28% of the actual area, so it is necessary to reduce the average actual area from 1.22 feddan to 1.18 feddan, equivalent to approximately 0.96 carats. It also requires reducing the actual quantities used from the number of automated labor hours 0.76 hours, human labor 4.56 workers, the amount of seeds 3.71 kilograms, the amount of nitrogen fertilizers 9.21 nitrogen units, and the amount of pesticides to 1.18 kilograms, at rates of about 4.15%, 9.79%, 3.51%, and 7.70%, 34.86%, respectively.

3- The third technological level (laser leveling and combine harvesting):

When comparing the average actual area cultivated with the crop at the level of the variety and its counterpart that achieves economic efficiency (optimal) according to variable return to scale, it turns out that the optimal area is less than the actual area by about 0.09 feddan, equivalent to about 3.80% of the actual area. Therefore, it is necessary to reduce the average area from 2.289 feddan to 2.202 feddan that is equivalent to 2.16 carats. It also requires reducing the actual quantities used from the number of automated labor hours 1.98 hours, human labor 12.1 workers, the amount of seeds 4.82 kilograms, and the amount of pesticides 1.23 kilograms, at rates amounting to about 5.47%, 13.59%, 2.48%, and 26.11, respectively. While it was necessary to increase the amount of actual nitrogen fertilizers by about 7.8 units of nitrogen, at a rate of about 3.97%.

4- The fourth technological level (automated seeding and combined harvesting):

It is clear from the comparison of the average actual area cultivated with the crop at the fourth technological level and its counterpart that achieves (optimal) economic efficiency according to variable return to scale that the optimal area is less than the actual area by about 0.28 feddan, or 6.72 carats, equivalent to 15.43% of the actual area, so it is

necessary to reduce the average area from 1.78 feddan to 1.51 feddan. It also requires reducing the actual quantities used from the number of automated labor hours 3.28 hours, human labor 4.77 workers, the amount of seeds 15.4 kilograms, and the amount of nitrogen fertilizers 28.9 nitrogen units, at rates estimated at 11.02%, 7.44%, 10.13%, and 21.35%, respectively. It was also found that it is necessary to reduce the amount of pesticides by 0.5 kilograms, by about 17.61%.

Table (9): Shows the difference between the actual and optimal quantities used in the production of rice varieties for the 2021 season, according to the variable return to scale

Statement		First level	Second level	third level	fourth level	Fifth level	Sixth level
The area (feddan)	1.658	1.218	1.218	2.289	1.789	1.943	1.588
	1.579	1.178	1.178	2.202	1.513	1.854	1.455
	0.08	0.04	0.04	0.09	0.28	0.09	0.13
	4.76	3.28	3.28	3.8	15.43	4.58	8.38
Automated labor (hours)	20	18.32	18.32	36.2	29.76	33.32	15.37
	18.2	17.6	17.6	34.2	26.5	31.4	13.8
	1.8	0.76	0.76	1.98	3.28	1.9	1.56
	9	4.15	4.15	5.47	11.02	5.7	10.15
Human labor (man/day)	69.9	46.6	46.6	89.3	64.1	64.1	83.1
	52.5	42	42	77.2	59.3	55.4	72.8
	17.4	4.56	4.56	12.1	4.77	8.66	10.3
	24.9	9.79	9.79	13.59	7.44	13.51	12.4
Amount of seeds (kg)	144.12	105.76	105.76	194.32	152	160.6	142.95
	138.43	102.05	102.05	189.5	136.6	157.92	130.95
	5.69	3.71	3.71	4.82	15.4	2.68	12
	3.95	3.51	3.51	2.48	10.13	1.67	8.39
Chemical Fertilizer (Azote Unit)	143.2	119.6	119.6	196.2	135.5	159.1	137.2
	136	110	110	204	107	157	133
	7.61	9.21	9.21	-7.8	28.9	1.8	4.65
	5.32	7.7	7.7	-3.97	21.35	1.13	3.39
Amount of pesticides (kg)	3.22	3.39	18.32	36.2	29.76	33.32	15.37
	2.23	2.21	17.6	34.2	26.5	31.4	13.8
	0.98	1.18	0.76	1.98	3.28	1.9	1.56
	30.57	34.86	4.15	5.47	11.02	5.7	10.15

Source: collected and calculated from the preliminary data of the questionnaire form 2021 season.

5- The fifth technological level (laser leveling, automated seedling and combined harvesting):

The data of the same table to compare the average actual area cultivated with Sakha 101 at the governorate level and its counterpart that achieves (optimal) economic efficiency according to the variable return to scale indicates that the optimal area is less than the actual area by about 0.09 feddan, or 2.16 carats, representing about 4.58% of the actual area, so it is necessary to reduce the average area from 1.94 feddan to 1.85 feddan. It also requires reducing the actual quantities used in terms of the number of automated labor hours 1.9 hours, human labor 8.66 workers, the amount of seeds 2.68 kilograms, the amount of nitrogen fertilizers 1.8 units of nitrogen, and the amount of pesticides 0.67 kilograms, at rates of about 5.70%, 13.51%, 1.67%, 1.13 %, and 25.77%, respectively.

6- The sixth level: (traditional agriculture):

When comparing the average actual area cultivated with the crop at the level of the cultivar and its counterpart that achieves economic efficiency (optimum) according to variable return to scale, it turns out that the optimal area is less than the actual area by about 0.13 feddan, or 3.12 carats, equivalent to about 8.38% of the actual area, so it is necessary to reduce the average area from 1.58 feddan to 1.45 feddan. It also requires reducing the actual quantities used in terms of the number of automated labor hours 1.56 hours, human labor 10.3 workers, the amount of seeds 12 kilograms, the amount of nitrogen fertilizers

4.65 units of nitrogen, and the amount of pesticides 0.65 kilograms, at rates of about 10.15%, 12.40%, 8.39%, 3.39%, and 27.19%, respectively.

Fourth: Estimating the quantity and value of the savings in the resources used in the production of the rice crop.

A. The amount and value of the savings in constant return of scale:

By reviewing the data of Table No. (10), it was found that there is an average saving for all technological levels of resources used for agricultural labor was about 0.119, 0.063, 0.121, 0.232, 0.141, 0.206 of the feddan, with a value of about 887, 344, 1210, 1802, 1208, 1460 pounds, this indicates that the actual area is greater than the optimal area, and therefore the actual resource quantity must be reduced.

Table (10): Comparing the amount and value of savings in the resources used to produce rice varieties season 2021, according to the constant return to scale in Dakahlia Governorate

Statement		According to fixed return					
technological levels		First level	Second level	third level	fourth level	Fifth level	Sixth level
Area	The amount of savings in the area	0.119	0.063	0.121	0.232	0.141	0.206
	Average rent value (in EGP)	7456	5464	10004	7769	8566	7088
	The value of the total savings (in EGP)	887	344	1210	1802	1208	1460
automated labor	he amount of savings in automated labor per hour	5.814	0.71	3.52	4.85	3.58	2.44
	The average hourly rate (in EGP)	148	147	146	146	149	147
	The value of the total savings (in EGP)	860	104	514	708	533	359
human labor	The amount of human labor (a man/day)	31.68	8.15	22.81	8.03	6.4	28.14
	The average wage of a laborer (in EGP)	57	65	65	67	64	62
	The value of the total savings (in EGP)	1806	530	1483	538	410	1745
seeds	The amount of savings for the quantity of seeds (in kilograms)	8.091	5.24	9.29	21.21	-1.63	18.51
	Average price per kilogram	11	11	11	12	11	10.4
	The value of the total savings (in EGP)	89	58	102	255	-18	193
chemical fertilizers	The amount of savings in chemical fertilizers (in EGP)	14.83	10.81	-7.91	20.83	13.11	14.83
	The average price of a nitrogen unit (in EGP)	13.5	13.7	13.61	13.29	13.44	13.6
	The value of the total savings (in EGP)	200	148	-108	277	176	202
pesticides	The amount of pesticides saved (in kilograms)	1.761	1.343	0.963	-1.248	1.572	0.919
	Average price per kilogram (in EGP)	138	127.6	131	131	132	135.6
	The value of the total savings (in EGP)	243	171	126	-163	208	125
Total resource savings (in EGP)		4086	1355	3328	3416	2517	4082
Total actual costs (in EGP)		18409	14449	26683	20227	22004	18236
The ratio of savings to total actual costs %		22.19	9.38	12.47	16.89	11.44	22.39
Total costs in savings (in EGP)		22495	15804	30011	23643	24521	22318
Total Actual Revenue(in EGP)		28067	21420	41015	31493	36330	23193
Actual net return (in EGP)		9658	6971	14332	11266	14326	4957
Net return saving (in EGP)		13744	8326	17660	14682	16843	9039
Average actual area of the farm		1.66	1.22	2.28	1.79	1.94	1.59
Average feddan return saving (in EGP)		8279	6825	7746	8202	8682	5685
Average production (per ton)		6.57	5	9.71	7.49	8.65	5.53
The ton's share of the actual net return (in EGP)		1470	1394	1476	1504	1656	896
The ton's share of the net return saving (in EGP)		2092	1665	1819	1960	1947	1635
Ton return per month for the actual net return		1932	1394	2866	2253	2865	991
Ton return per month for Saving net return		2749	1665	3532	2936	3369	1808

Source: collected and calculated from table (8), by research

As for the rest of the research technological levels, the amount of saving for the number of hours of automated labor was about 5.81, 0.71, 3.52, 4.85, 3.58, and 2.44 hours, respectively, with a saving value of 104, 860, 514, 708, 533, 359 pounds for the technological levels, respectively.

The amount of savings for human labor was about 31.7, 8.15, 22.81, 8.03, 6.4, 28.14 man/day, with a value of about 1806, 530, 1483, 538, 410, 1747 pounds for all technological levels, respectively.

While the amount of saving for the amount of seeds was about 8.09, 5.24, 9.29, 21.21, -1.63, 18.51 kilograms, with a value of about 89, 58, 102, 255, -18, 193 pounds for the technological levels, respectively. As for the amount of saving for chemical fertilizers, it was about 14.83, 10.81, -7.91, 20.83, 13.11, and 14.83 nitrogen units, with a value of about 200, 148, -108, 277, 176, and 202 pounds for the technological levels, respectively. While it was found that the amount of saving for the quantity of pesticides was about 1.76, 1.34, 0.96, -1.25, and 1.57, 0.92 kilograms, with a value of about 243, 171, 126, 163, 208, and 125 pounds for the technological levels, respectively.

It was clear from the same table that the percentage of saving to the total actual costs as an average for the technological levels of farm labor represented about 22.2%, 9.4%, 12.5%, 16.9%, 11.4% and 22.4%, respectively. While the average return for the technological levels of the farm in saving was about 13744, 8326, 17660, 14682, 16843, and 9039 pounds, respectively.

While the average actual production of the farm for the technological levels was estimated at about 6.57, 5, 9.71, 7.49, 8.65, and 5.53 tons of rice, respectively. While the feddan's productivity for each level of technology was estimated at about 3.958, 4.098, 4.258, 4.184, 4.458, 3.477 tons per feddan,

The net return per ton in month in savings was about 2749, 1665, 3532, 2936, 3369, and 1808 pounds, respectively.

Then it turns out that the fifth technological level, which used laser leveling, automated seedling, and combined harvesting to produce Sakha 101 (for the farm), achieves the highest net return per ton in month, after adding savings to the resources used in producing the rice crop in Dakahlia Governorate, and this is confirmed by the optimal cultivated area estimated at two feddan for this. The variety in the province under the constant return.

B. The quantity and value of the savings in variable return to scale.

By reviewing the data of Table (11), it was found that there is an average saving for all technological levels of resources used for agricultural labor. The amount of saving for the area was about 0.08, 0.04, 0.09, 0.28, 0.09, 0.13 of the feddan, with a value of about 596, 219, 900, 2175, 771, 921 pounds, this indicates that the actual area is greater than the optimal area, and therefore the amount of the actual resource must be reduced.

As for the rest of the research technological levels, the amount of saving for the number of hours of automated labor was about 1.8, 0.76, 1.98, 3.28, 1.9, and 1.56 hours, respectively, with a saving value of 266, 112, 289, 479, 283, 229 pounds, respectively, for the technological levels.

As for the amount of saving for human labor, it was about 17.4, 4.56, 12.1, 4.77, 8.66, 10.3 man/day, with a value of about 992, 296, 787, 320, 554, 639 pounds for all technological levels, respectively.

While the amount of seed saving was about 5.69, 3.71, 4.82, 15.4, 2.68, 12 kilograms, with a value of about 63, 41, 53, 185, 29, and 125 pounds for the technological levels, respectively. As for the amount of saving for chemical fertilizers, it was about 7.61, 9.21, -7.8, 28.9, 1.8, 4.65 nitrogen units, with a value of about 103, 126, -106, 384, 24, and 63 pounds for the technological levels, respectively. While it was found that the amount of saving for the quantity of pesticides was about 0.98, 1.18, 1.28, -0.5, 0.67, 0.65 kilograms, with a value of about 135, 151, 168, -66, 88, 88 pounds for the technological levels, respectively.

It was clear from the same table that the percentage of saving to the total actual cost as an average of the technological levels of farm labor represented about 11.7%, 6.5%, 7.8%, 17.2%, 7.9%, and 11.3%, respectively. While the average return for the technological levels of the farm in saving was about 11813, 7915, 16422, 14743, 16076, and 7023 pounds, respectively.

While the actual average production of the farm for the technological levels was estimated at about 6.57, 5, 9.71, 7.49, 8.65, and 5.53 tons of rice, respectively. While the feddan's productivity for each level of technology was estimated at about 3.958, 4.098, 4.258, 4.184, 4.458, 3.477 tons per feddan.

The net return per ton in month in saving was about 2363, 1583, 3284, 2949, 3215, and 1405 pounds, respectively.

Then it turns out that the third technological level that used laser leveling and combined harvesting to produce the Sakha 101 variety (for the farm) achieves the highest net return per ton in month, after adding saving to the resources used in the production of the rice crop in Dakahlia Governorate, and this is confirmed by the largest area

of the farm estimated at 2.28 feddan for this variety. In the province under the variable return.

Table (11): Comparison of the amount and value of savings in the resources used to produce rice varieties season 2021, according to the variable return to scale in Dakahlia Governorate

Statement		According to the variable return					
technological levels		First level	Second level	third level	fourth level	Fifth level	Sixth level
Area	The amount of savings in the area	0.08	0.04	0.09	0.28	0.09	0.13
	Average rent value (in EGP)	7456	5464	10004	7769	8566	7088
	The value of the total savings (in EGP)	596	219	900	2175	771	921
automated labor	he amount of savings in automated labor per hour	1.8	0.76	1.98	3.28	1.9	1.56
	The average hourly rate (in EGP)	148	147	146	146	149	147
	The value of the total savings (in EGP)	266	112	289	479	283	229
human labor	The amount of human labor (a man/day)	17.4	4.56	12.1	4.77	8.66	10.3
	The average wage of a laborer (in EGP)	57	65	65	67	64	62
	The value of the total savings (in EGP)	992	296	787	320	554	639
seeds	The amount of savings for the quantity of seeds (in kilograms)	5.69	3.71	4.82	15.4	2.68	12
	Average price per kilogram	11	11	11	12	11	10.4
	The value of the total savings (in EGP)	63	41	53	185	29	125
chemical fertilizers	The amount of savings in chemical fertilizers (in EGP)	7.61	9.21	-7.8	28.9	1.8	4.65
	The average price of a nitrogen unit (in EGP)	13.5	13.7	13.61	13.29	13.44	13.6
	The value of the total savings (in EGP)	103	126	-106	384	24	63
pesticides	The amount of pesticides saved (in kilograms)	0.98	1.18	1.28	-0.5	0.67	0.65
	Average price per kilogram (in EGP)	138	127.6	131	131	132	135.6
	The value of the total savings (in EGP)	135	151	168	-66	88	88
Total resource savings (in EGP)		2155	944	2090	3477	1750	2066
Total actual costs (in EGP)		18409	14449	26683	20227	22004	18236
The ratio of savings to total actual costs %		11.71	6.53	7.83	17.19	7.95	11.33
Total costs in savings (in EGP)		20564	15393	28773	23704	23754	20302
Total Actual Revenue(in EGP)		28067	21420	41015	31493	36330	23193
Actual net return (in EGP)		9658	6971	14332	11266	14326	4957
Net return saving (in EGP)		11813	7915	16422	14743	16076	7023
Average actual area of the farm		1.66	1.22	2.28	1.79	1.94	1.59
Average feddan return saving (in EGP)		7116	6488	7203	8236	8287	4417
Average production (per ton)		6.57	5	9.71	7.49	8.65	5.53
The ton's share of the actual net return (in EGP)		1470	1394	1476	1504	1656	896
The ton's share of the net return saving (in EGP)		1798	1583	1691	1968	1859	1270
Ton return per month for the actual net return		1932	1394	2866	2253	2865	991
Ton return per month for Saving net return		2363	1583	3284	2949	3215	1405

Source: collected and calculated from table (9), by research

References

[1]. Amal Kamel Eid, Rasha Mohamed Farag, Wael Ahmed Ezzat El-Abd, Estimating the Technical and Economic Efficiency of Sesame Crop Production in Fayoum Governorate, The Egyptian Journal of Agricultural Economics, Volume (26), Issue Two, June 2016.

[2]. Ahmed Mohammad al-Hindi, Mohammad Hamad al-Qunibit, Abdulaziz Mohammad al-Duwais (Doctors), Estimating the efficiency of date farms in the Qassim region using data envelope analysis, Journal of the Saudi Society for Agricultural Sciences, King Saud University, Volume (10), Issue (29), 2011.

[3]. Wael Ahmed Ezzat Al-Abd, Amal Kamel Eid, Mohamed Mounir Fadel (Doctors), Economic efficiency of producing the winter green bean crop in the new lands, Journal of Agricultural and Environmental Sciences, Damanhour University, Volume (18), First Issue, April 2019.

[4]. Mostafa Babiker (Doctor), Analysis of Efficiency Indicators, Development Bridge Journal, Issue (8), Fifth Year, Kuwait.

[5]. Wael Ahmed Ezzat Al-Abd, Amin Abdel-Raouf Al-Daqla, Hana Mohammad Shaddad (Doctors), Estimating the Technical and Economic Efficiency of Rice Production in Egypt, Journal of the Saudi Society for Agricultural Sciences, King Saud University, Volume Eleven, Issue (1), January 2012.

[6]. Wael Ahmed Ezzat Al-Abd, Alaa Al-Saeed Al-Shabrawi (MD), Estimating the Efficiency of Cotton Farms in Kafr El-Sheikh Governorate Using Data Envelope Analysis, Journal of the Saudi Agricultural Society, King Saud University, Volume (13), First Issue, January 2014.

[7]. Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Department of Agricultural Economy, Bulletin of Agricultural Economics, various issues.

[8]. Ministry of Agriculture and Land Reclamation, Directorate of Agriculture in Dakahlia, Department of Agricultural Affairs, Department of Statistics, unpublished data.

[9]. Afriat ،P (1972) Efficiency estimation of production function, International Economic Review 13: 568 – 598.

[10]. coelli, T.J. and Perelman, S. (1999) A comparison of parametric and non-parametric distance functions: With application to European railways, European Journal of Operational Research 117: 326 – 339.

[11]. Coelli, T.J. (1996) A Guide to DEAP Version 4.1: A Data Envelopment Analysis (Computer) Program. CEPA Working Paper 96/08, Department of Econometrics, University of New England, Armidale, Australia.

[12]. Seiford, L.M., Data Envelopment Analysis: The Evolution of the state of the Art (1978 – 1995), Journal of productivity Analysis 1996, 7:99-138.

1/2/2023