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Economic Efficiency of Corn Crop Cultivating (Al-Nahrain Hybrid) in Salahdin and Kirkuk Governorates in Agricultural Season 2023

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ABSTRACT

The objective of this research is to measure the efficiency of the performance of the cultivation of Corn crop of the two rivers variety using the DEAP program to measure technical and economic efficiency and measure total productivity based on the Malmquist index for a sample of 60 farmers in the governorates of Salahdin and Kirkuk for the year 2023. The average technical efficiency was 0.858 and the average cost efficiency was 0.604 When measuring the total production efficiency and using the Malmquist index, it was found that the average change in total productivity reached 1.264 The average change in technical efficiency was 1.015 and technical change was 1.237. It can be concluded through these results that the application of modern technologies and the use of improved seeds (the Mesopotamian variety) resulted in the use of productive resources efficiently and then helped farmers to obtain rewarding profits by reducing the costs of growing this variety due to government support for it, so we recommend By expanding the cultivation of this variety and continuing to support the producers of this variety to achieve the desired production levels of the Corn crop in the future.

Keywords: Agricultural technological advancement, data envelop analysis, Index ,productive efficiency.

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INTRODUCTION

The Corn crop is one of the most widespread crops in the world, and America is the original home of this crop, this led to its control over global production and its possession of high production levels relative to global production. Its grains are consumed directly or indirectly by humans. Corn seed flour is suitable for baking when mixed with spelt flour by 5-15%, as its seeds are used in the production of starch because it contains a percentage of 70-80% of carbohydrates, as well as the production of oils, as its seeds contain 4% of liquid oil, which is characterized by its good nutritional and health qualities, so it is not used within the basic inputs as poultry feed, and the use of crop stems and leaves as green or dry fodder The plant residues are used in the paper industry. The importance of the Corn crop globally is highlighted by the global trends in the extraction of biofuels from Corn grains. Ethanol or so-called biofuels are extracted. Corn is one of the important economic crops in Iraq, it comes fourth in the relative importance of the cultivated area after wheat, rice and barley, and second after rice in terms of productivity (Obaid, 2008) . The importance of this crop has increased in Iraq with the further expansion of livestock projects in general and poultry and fish in particular (Janabi, 2021). Corn constitutes a large proportion of the inputs and components of concentrated diets, which led to an increase in demand for it recently, increasing the demand for it. This demand was accompanied by a decrease in production represented by a decrease in productivity of this crop. To address this decline and decline in production, the search for means and methods through which to increase the production and productivity of this crop and increase the farm income of Corn farmers, through the use of technical innovation to produce and improve hybrid varieties with high productivity can through these techniques to improve the efficiency of use and then increase their productivity and move away from traditional methods in production By developing hybrid corn

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varieties, the added value of the yellow corn crop can be increased. This criterion is one of the most important economic criteria in evaluating projects, and has been used in many studies , as the production and productivity of this crop depends mainly on the type of seeds, their variety and their compatibility with the specific agricultural and climatic conditions governing the geographical area, and following the instructions and recommendations issued by scientific institutions to improve the farm reality of the Corn crop, so many research stations emerged and followed many ways to produce varieties and generations of Corn with high production efficiency per unit area and good quality within the water allocation Appropriate. This method is one of the scientific methods in promoting and achieving indicators of sustainable agricultural development in Iraq (AL-Zobaie, 2021). One of the priorities of economists in developing countries and Iraq, in particular, is their attention towards the efficiency of farmers because inefficient farms have low productivity and high costs (Khalis, 2010). The relative scarcity and optimal utilization of the limited available resources of any society have raised scientific minds in previous centuries to the need to deal with the ideal molecules required to achieve the optimal use of these resources (Qadri, 2002) and to reduce waste in productive resources (Tohamy, 2018). presented research on Corn because Corn is a large proportion of the components of concentrated diets, so attention must be paid to the use of modern technologies that will increase the productivity of this crop, farmers were interested in their reliance on the technique of using improved seed varieties and hybrids with production specifications and it was found that the hybrid variety is more efficient and specialized than the other variety, while the economic efficiency was 0.37 and 0.46 for the local and hybrid varieties in 2022. (Chaubey et al. (2022) studied research evaluating the agricultural performance of 31 samples in India using the DEA technique based on the Malmquist index and found that there is an increase in overall productivity change in Madhya Pradesh optimally. Some researchers believe that the application of modern technologies may help increase productivity without the need to increase the cultivated areas, i.e. there is an inverse proportion between productivity and unit area when applying certain levels of technology,. Al-Hashemi also presented research in 2010 to study the functions of the costs and economies of size of Corn in the province of Babylon, through which he explained the re Al-Qaddo ty of Corn production in Iraq in general and the province of Babylon in particular by addressing the economic and social characteristics and indicators (AL-Hashemi, 2010). Efficiency is defined as the rational criterion in the use of human and material resources, especially since the available resources are scarce, so this method must be adopted in directing towards achieving optimal performance in the use of available resources (AL-Sheikh,1995). The important goal in the development of agriculture is the efficiency of the farm and the method of measuring it (Parikh et al.,1995), and this is also agreed with by (AL-Quraishi, 2006, AL-Sheikh,1995, Khalis, 2010). The problem of the study revolves around the reality of the production and productivity of the Corn crop of various varieties in Iraq, as Corn is one of the crops with multiple uses, whether on the human or animal side. The demand for them increased compared to the decline in the productivity rates of some local varieties of Corn in light of the shrinking size of the cultivated areas due to the conditions of water scarcity and the increase in water requirements for the crop. This reflected negatively on the quantities of production achieved for farmers and then affected their revenues and profits, forcing them to refrain from growing this crop and resort to the state's alternative solution to provide import, which costs the state budget to spend hard currency On these basis, the problem lies in finding solutions and tools necessary to increase production rates and productivity of this crop per unit area. In addition, improving the productivity of new varieties of corn in Iraq.

MATERIALS AND METHODS

The primary cross-sectional data was obtained through the design of a questionnaire prepared for this purpose of the study by selecting a

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sample of farmers of the Nahrain variety in the governorates of Kirkuk and Salahdin, as the study sample was followed up and the required data were taken from them directly through a personal interview, and the sample included 60farmers to measure the efficiency of the performance of the Nahrain variety using the DEAP program to measure technical and economic efficiency. Measure total productivity based on the Malmquist index**.**

First: Corn production in Iraq and the provinces of Kirkuk and Salahdin

1-Areas : Figure (1). shows that the average area planted with Corn at the level of Iraq amounted to 42195 dunums, there were fluctuations in the area planted in it, as it reached its maximum in 2013 by 787752 dunums which can be observed through Figure(1). The lowest area in 2018 amounted to 46519 dunums, and the average area planted by Corn in Kirkuk governorate was 81224 dunums. If the governorate of Kirkuk contributed in 2018 with importance of 68% of the average area at the level of Iraq as a whole, in addition to the fact that the governorate of Kirkuk in 2022 reached the area planted with Corn 215286 dunums and constituted importance of 64% for the same year, while Salahdin governorate had an average area of 36525 dunums, and the highest percentage of importance in 2023 was 19%. While the largest area for planting the crop in this governorate was in 2013 with an area estimated at 78582 dunums and an importance of 9%, we see through the data of Table 1 that there are years in which the area planted with corn was 0 and that was in 2014 for Kirkuk and the period (2014-2017) for Salahdin due to the security situation. Hence, we see the great disparity in the cultivated areas during the study period and that these fluctuations as a result of productive economic conditions or security conditions led to such a dispersion of the Corn crop, and this is clear in figure (1). which illustrates this disparity

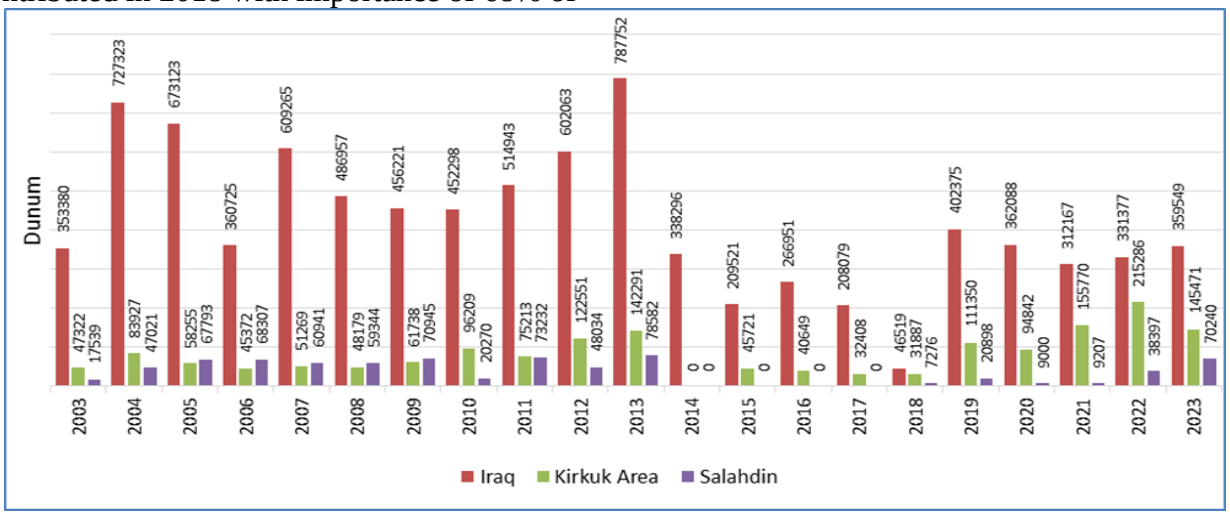

Figure 1. Cultivated areas of corn in Iraq, Kirkuk and Salahdin

Resource: Minis. of Agri./ Department of Agricultural Statistics

2- Productivity : Productivity plays the most important role in the development of the agricultural sector, as it shows the extent of the use of modern means and techniques in production that increased the percentage of productivity per unit area, whether these increases are through improved seeds or pesticides and fertilizers with high effectiveness since Iraq suffers from the crisis of water scarcity and high costs in the production of corn, so attention must be paid to the use of the most important modern means and techniques to increase productivity per unit area, This is what the Ministry of Agriculture sought in previous years through breed development programs for the four strategic crops, as these programs produced improved seeds with higher productivity, such as Tarkibi 5018, Almaha, Baghdad 63 and Alfajr. Figure 2. showed that the productivity per dunum at the level of Iraq reached an average quantity of 1191.6 kg/dunum for the period 2003-2023. Achieved in 2023 the maximum productivity reached 1515.1

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kg/dunum and productivity was at its lowest amount in 2004 if it reached 562 kg/dunum if it is noted from the general trend of these ratios, in general, there is a clear development in the productivity rates of the crop and this is noted that the average productivity of Kirkuk province if it reached 1072.6 kg/dunum, was the maximum productivity in 2013 by 1898 kg/dunum. Kirkuk governorate did not record any production quantity in 2014 due to the security situation of the governorate at that time, while Salahdin governorate had average productivity of 812.3 kg/dunum and in 2023 it had the highest share in productivity, reaching 1679.7 kg/dunum for Saladin, Through these ratios, we see that there is a development in the development and use of production elements to achieve continuity in raising the productivity levels of the Corn crop, especially when persevering in the implementation of development plans for agriculture in Iraq through commitment to the policies set by decision-makers.

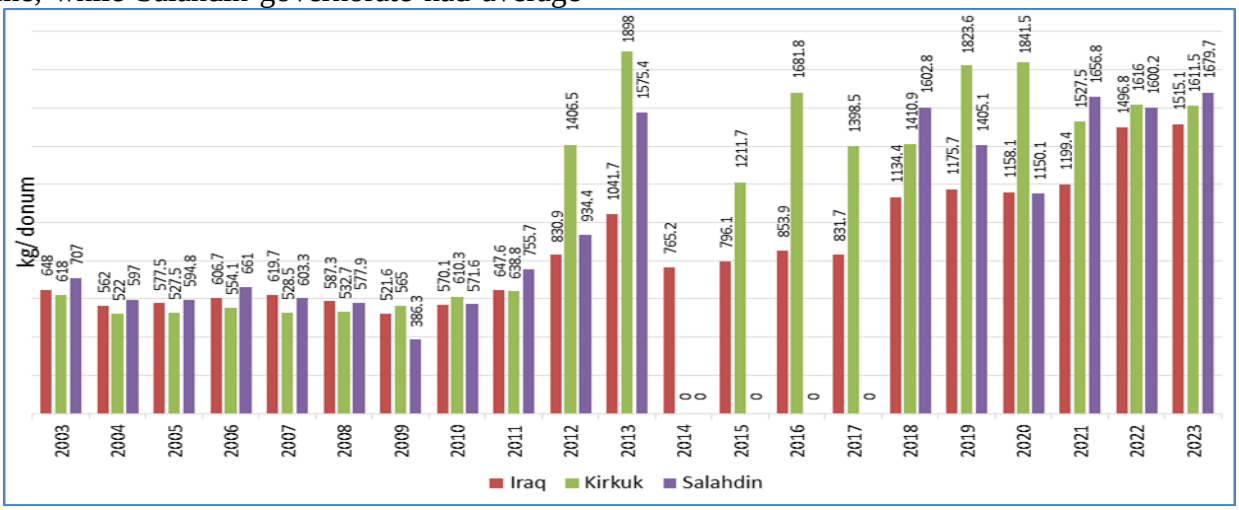

Figure 2. Corn productivity in Iraq and Kirkuk and Salahdin

Resource: Minis. of Agri./ Department of Agricultural Statistics

Second: Efficiency and overall productivity of resources: Economic efficiency and its components: The DEAP model was relied on the nonparametric mathematical data envelope method, which depends on linear programming methods, through which we obtain an objective evaluation of the facilities under study, and this study was based on the CRS assumption, which uses confusion between technical efficiency indicators and volume efficiency, and the property of the stability of the volume return of production was not adopted, i.e. increasing production by a fixed percentage at any change in the amount of production inputs that are used in the production process because it assumes the work of all the facilities under study in their optimal sizes, and this is unrealistic in agriculture, especially because it faces many difficulties such as incomplete competition, financing restrictions and other consequences, so it was based on CRS that depends on the volume return of production (constant, increasing, decreasing, meaning that any increase in production inputs may lead to an increase, decrease or stability in the volume of outputs from the production process, meaning that it works to separate both technical and volumetric efficiency, The selected combination of inputs and outputs is one of the pillars in the method of data envelope analysis (Toufik, 2023) due to the impact of these relationships on the results, so there was a difference between scientists in choosing the approach used when determining the inputs, whether controlled or non-controlled, due to the impact of inputs on outputs (Cubbin and Tzanidakis,1998) and some of them went to the need to divide the analysis of efficiency into two parts, the first for controlled inputs and the other for uncontrolled inputs as stipulated (Fried et al.,1993) and (Bowlin,1998) argue that the researcher should identify which inputs have the most impact on efficiency, taking into account the need for a positive relationship between inputs and

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outputs. The environmental conditions affect the nature of agricultural output significantly (Ail & Hamaza, 2018) compared to the outputs of the rest of the sectors, so economic efficiency is estimated by imposing restrictions on inputs to the production process, considering that production and its increase or decrease cannot be controlled due to the uncertainty conditions to which the agricultural sector is exposed (Ali, 2014). That is, the size of the combination of inputs can be controlled and increased or decreased according to prices and preferences to ensure that it obtains from controlling the cost of inputs compared to its inability to control the increase in production in one day, which is represented by the independent variables that affect the dependent factor represented by (production of the sample of farms and is based on this group of variables based on previous farm experience and the opinions of specialists in this field, and must take into account the number of farms under study and balanced with the total inputs and outputs of the model to be studied, as (Fitzsimmons,2004) believes that the number of establishments under comparison must equal or more than twice the total inputs and outputs of the model. A problem with the data envelope method was found that it does not give the results with the required accuracy if this condition is not met. To find the efficiency index of unit *i* Using the input map and assuming the constant returns of the volume and the availability of statistical data on K of inputs, M of outputs and N of time durations and the vector Xi represents a symbol for the input and the vector Yi is a symbol for the output, as i stands for the production unit and X The input matrix K*N and Y represent the output matrix M*N Using the duality method in linear programming and with the presence of the above assumptions, the efficiency index can be found by solving the following linear programming problem resources (Coelli et al.,2005):

$$Min_{\theta,\lambda}\theta$$

Subject to:

$$Yi + \dot{Y}\lambda \geq o$$

$$\theta xi - x\lambda \geq o$$

$$N\lambda, \lambda = 1$$

$$\lambda \geq 0$$

As TE is represented by the technical efficiency of the farm with an indicator and to measure or estimate the efficiency of the capacity θSE, the technical efficiency must be estimated under the stability and change of the capacity yield, either the estimate of technical efficiency and AE (distributional efficiency as well as cost efficiency) The input prices of the production elements PX are used to reduce costs assuming the change in volume returns, i.e. the technical efficiency is calculated in two stages, the first is measuring capacity efficiency and the second is the allocation efficiency (Vicente,2004) Economic efficiency is estimated from the product of allocation efficiency multiplied by technical efficiency and allocated efficiency is calculated through:

$$AE = \frac{EE}{TE}$$

RESULTS AND DISCUSSION

Assessment results and levels of efficiency by the DEA method: Considering that the farmer did not reach the optimal economic sizes, the description of the model under study was based on the variable size returns model with input guidance in measuring the efficiency of the farmer, and the description was at a certain level of inputs and the data envelope analysis relied on the second version DEAP ver2.1 Data Envelopment Analysis Program.

Capacity and technical efficiencies with fixed and change of the yield of capacity: Both the technical efficiency must be measured under the stability of the yield of capacity and the change of yield of capacity to measure the efficiency of the capacity SE of the farms of the research sample. As obtaining it requires dividing the technical efficiency in light of the stability of the return of capacity on the change of return to capacity (AL-Wardi,2014), and when reviewing the results in table 1. we find that the efficiency of the capacity fluctuates between 0.058-1 and an average of 0.337, meaning that the production of these farms can be increased by 67% In other words, it loses its economic resources involved in the production process and it has to increase productive resources by 63%, and this can be seen more clearly in Figure3, and as it was addressed in the theoretical framework of the data envelope analysis

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method, the efficient farm has an efficiency index of 100% and then the farms with an index of efficiency less than this percentage are inefficient, and according to Table 1 we see that there are 6 farms in the sample, which numbered 60 farms, achieved efficiency by 100%, as they constitute 10% of the total sample, which is considered the reference farms for the rest of the inefficient farms that these farms operate at their optimal sizes as shown by the volume returns index and can continue to work at the same level of mixing the same combination of production elements, but they do not achieve any economies of scale and that any increase in variable production elements leads to a steady increase in total production, either farms that operate at increasing returns have constituted 90% of the total sample, in addition to that there are no farms in this sample operating with decreasing returns (the law of decreasing ratios in production, which stipulates that any increase in outputs from agricultural production is less than any additional percentage of inputs from the elements of production. The technical efficiency in light of the stability of the return, which is the main pillar in calculating the efficiency of capacity, reached a varying ratio between 0.04-1 and an average of 0.33 That is, the production of these farms can be increased by 67% or maintain thesame level of production with less use of productive resources, while the technical efficiency in light of the change in the return of capacity has averaged about 0.85, varying between 0.498-1, as the output can be increased by 15% without any increase in the inputs of the production elements.

Table 1. Capacity and technical efficiencies with fixed and change of the yield of capacity in the sample

T	Technical efficiency under fixed yield Crest	Technical efficiency in light of variable return Vrste	Capacity Efficiency THE AVENUE	Yield volume	t	Technical efficiency under fixed yield Crest	Technical efficiency in light of variable return Vrste	Capacity Efficiency THE AVENUE	Yield volume
1	0.256	1.000	0.256	Irs	31	0.209	1.000	0.209	Irs
2	0.168	0.893	0.189	Irs	32	1.000	1.000	1.000	-
3	0.081	0.809	0.100	Irs	33	0.049	0.846	0.058	Irs
4	0.683	1.000	0.683	Irs	34	0.429	0.733	0.586	Irs
5	0.247	0.483	0.512	Irs	35	1.000	1.000	1.000	-
6	0.433	1.000	0.433	Irs	36	1.000	1.000	1.000	-
7	0.850	0.863	0.985	Irs	37	0.267	1.000	0.267	Irs
8	0.075	0.650	0.115	Irs	38	0.253	1.000	0.253	Irs
9	0.569	1.000	0.569	Irs	39	0.258	0.861	0.300	Irs
10	0.095	0.676	0.140	Irs	40	0.217	0.908	0.240	Irs
11	0.241	0.724	0.332	Irs	41	0.164	0.837	0.196	Irs
12	0.325	0.835	0.389	Irs	42	1.000	1.000	1.000	-
13	0.637	0.772	0.825	Irs	43	0.283	1.000	0.283	Irs
14	0.130	0.761	0.170	Irs	44	0.160	0.889	0.180	Irs
15	0.158	0.747	0.212	Irs	45	0.178	0.833	0.214	Irs
16	0.103	1.000	0.103	Irs	46	0.199	0.809	0.246	Irs
17	0.096	0.762	0.126	Irs	47	0.083	0.767	0.108	Irs
18	0.227	0.856	0.265	Irs	48	0.166	0.842	0.197	Irs
19	0.131	0.941	0.139	Irs	49	0.173	0.889	0.195	Irs
20	1.000	1.000	1.000	-	50	0.288	0.824	0.350	Irs
21	0.519	1.000	0.519	Irs	51	0.050	0.667	0.075	Irs
22	0.188	0.601	0.314	Irs	52	1.000	1.000	1.000	-
23	0.098	0.846	0.116	Irs	53	0.236	0.868	0.271	Irs
24	0.050	0.498	0.101	Irs	54	0.385	1.000	0.385	Irs
25	0.096	0.545	0.176	Irs	55	0.521	1.000	0.521	Irs
26	0.070	0.846	0.083	Irs	56	0.086	0.585	0.147	Irs
27	0.239	1.000	0.239	Irs	57	0.296	0.714	0.414	Irs
28	0.684	0.846	0.809	Irs	58	0.308	1.000	0.308	Irs
29	0.082	0.856	0.095	Irs	59	0.327	1.000	0.327	Irs
30	0.688	0.705	0.976	Irs	60	0.409	1.000	0.409	Irs
-			Crest			vrste		THE AVENUE	
Average			0.33			0.86		0.37	
Upper limit			1			1		1	
The bare minimum			0.049			0.483		0.058	

Source: The work of the researcher based on the results of the analysis of the data envelope

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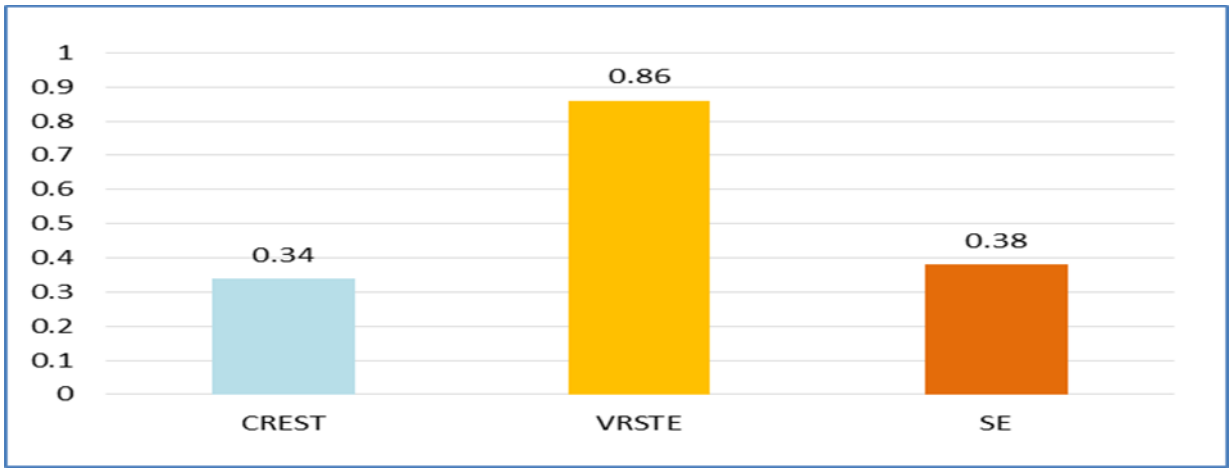

Figure 3. Averages of technical efficiency under fixed and change returns and capacity efficiency
Resource: By author's work based on Table 1.

Technical, distributional and cost efficiency

We can see in Table 5. and Figure 5. that three efficiency criteria were evaluated: technical efficiency, distributional efficiency and economic efficiency (cost efficiency, cost efficiency is estimated through production costs based on production element price levels, and the average technical efficiency was 0.85, which corresponds to the estimated technical efficiency rate under the variable return of capacity when calculating capacity efficiency, which shows that these farms can avoid wasting productive resources by 15% if it is efficient, that is, the cost has increased by 15% when estimating cost efficiency. The distributional efficiency was estimated between 0.40-1 and averaged about 0.705 for sample This result is good, but there is a possibility to increase production by distributing economic resources optimally through the use of technological techniques in allocating these resources correctly, as approximately 30% of the production cost of these farms can be saved at the same current production level, as this amount moves us at the point of contact between the equal output curve and the budget line to reach the optimal production point (Ali,2014). We believe that this percentage of waste in costs is somewhat acceptable due to the agricultural reality and that these results reached by farmers have been obtained as a result of government support for the Corn crop in general and the Nahrain variety in particular, given that it is a strategic crop that has a special program in the Ministry of Agriculture to develop varieties and obtain the highest possible productivity, as well as that most of the other productive resources involved in the production process of these farms for the sample are obtained for The way of government support for them The waste of production elements in these farms may be attributed to the lack of experience to deal with this new variety, which is grown for the first time. The number of farms that achieved 100% distribution efficiency was only two farms (Tohamy, 2018), i.e. 3.3% of the sample, and these farms do not have any surplus of production elements in order to consume them all in an optimal productive manner, i.e. there are no savings from these inputs, and we note that most of the farms that achieved optimal technical efficiency did not achieve distributional efficiency, because the costs of inputs to the production process of these farms were high, so they could not achieve distributional efficiency at the optimal level, i.e. production was done at an efficient technical level and an inefficient distribution level, as the farm is at an efficient level when the cost line drops to the level that makes it in contact with the equal output curve, and this can only be done when production costs are reduced (AL-Zobaie & Zanzal, 2022) As for the economic efficiency (cost efficiency), it averaged 60%, which is a good level, and ranged between 0.250-1 This average cost efficiency means that these farms can reduce their production costs by 40% at the same level of production, i.e. they can produce the same amount of output using 60% of the

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inputs. As Figure 4 shows, these farms operate at the boundaries of the equal output curve because they have reached the best output at a specific level of production elements and must continue to operate at the same level of mixing production elements. The number of farms achieved technical efficiency was 22 farms. In comparison, only two farms were specialized efficient, which indicates that most farms operate at a high production cost level, which leads to a higher cost line than the boundary efficiency curve. The result of the level of economic efficiency reached by the sample farmer is a good level in general due to the productive reality of the Corn crop, whichis one of the crops with high production costs, as helped at this level is the presence of government support in terms of providing production requirements of improved seeds, fertilizers and pesticides for this variety The waste of resources that was reached in the research sample has resulted from the lack of farmers to follow modern techniques in irrigation and the lack of sprayers for most Farmers and the dependence of most of them on family labour led to waste and that the work on technical development in the means of production significantly reduces the loss of production elements and the high production costs of these elements.

Table 2. Cost efficiency, technical efficiency and allocative efficiency

T	Technical proficiency TE	Distributive efficiency AE	Cost Efficiency CE	t	Technical Proficiency TE	Allocative efficiency AE	Cost Efficiency CE
1	1.000	0.748	0.748	31	1.000	0.563	0.563
2	0.893	0.428	0.382	32	1.000	1.000	1.000
3	0.809	0.571	0.462	33	0.846	0.629	0.532
4	1.000	0.558	0.558	34	0.733	0.681	0.499
5	0.483	0.735	0.355	35	1.000	1.000	1.000
6	1.000	0.726	0.726	36	1.000	0.669	0.669
7	0.863	0.600	0.518	37	1.000	0.819	0.819
8	0.650	0.668	0.434	38	1.000	0.425	0.425
9	1.000	0.974	0.974	39	0.861	0.668	0.575
10	0.676	0.572	0.387	40	0.908	0.853	0.774
11	0.724	0.780	0.564	41	0.837	0.611	0.511
12	0.835	0.865	0.723	42	1.000	0.402	0.402
13	0.772	0.744	0.575	43	1.000	0.964	0.964
14	0.761	0.615	0.468	44	0.889	0.583	0.518
15	0.747	0.735	0.548	45	0.833	0.556	0.463
16	1.000	0.665	0.665	46	0.809	0.768	0.621
17	0.762	0.719	0.547	47	0.767	0.785	0.602
18	0.856	0.892	0.764	48	0.842	0.665	0.560
19	0.941	0.849	0.799	49	0.889	0.585	0.520
20	1.000	0.842	0.842	50	0.824	0.826	0.680
21	1.000	0.854	0.854	51	0.667	0.986	0.657
22	0.601	0.888	0.534	52	1.000	0.674	0.674
23	0.846	0.641	0.542	53	0.936	0.817	0.765
24	0.498	0.679	0.338	54	1.000	0.748	0.748
25	0.545	0.507	0.276	55	1.000	0.250	0.250
26	0.846	0.704	0.596	56	0.585	0.640	0.375
27	1.000	0.624	0.624	57	0.714	0.744	0.531
28	0.846	0.736	0.623	58	1.000	0.496	0.496
29	0.856	0.893	0.765	59	1.000	0.719	0.719
30	0.705	0.613	0.432	60	1.000	0.718	0.718
-		Technical Proficiency TE		Allocative efficiency AE		Cost Efficiency CE	
Average		0.858		0.705		0.604	

Resource: Researcher's work based on data envelope analysis

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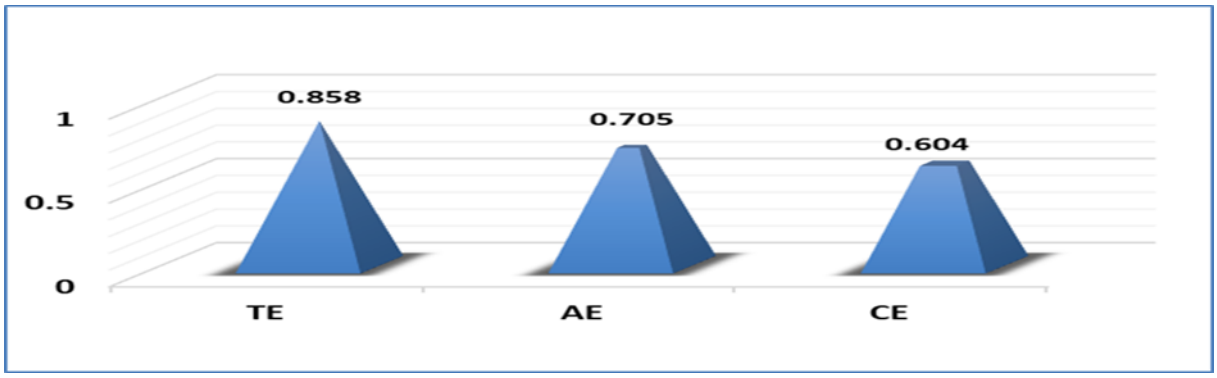

Figure 4. Averages of technical efficiency, allocative efficiency, and cost efficiency

Resource: By Author based on Table 2

Malmquist productivity index: The performance evaluation of economic units plays an important role in determining what can be produced what we aim to make available and the possibility of achieving the goals set or maintaining the current level (Coelli et al., 2005), so performance evaluation works to determine the relationship with which productive resources are linked to reaching economic efficiency, i.e. the desired goal and that (Ali, 2014). Between that there are three important elements to evaluate performance effectiveness, productivity and efficiency, each of these elements represents important economic criteria and from here we find the need to evaluate productivity and ways to mix productive elements to reduce waste in resources and improve the level of production, has been found that the partial relationships between production and production elements foggy because they stipulate a causal relationship between each element and the output (Debertin, 2012). It is not only a statistical technical relationship so it is preferable to use total productivity for partial productivity, especially in applied studies as well as the law of decreasing yield (decreasing productivity and its dependence on the amount used of each element whenever it increases led to decreasing productivity, meaning that productivity is affected by the intensity of the use of each element so he sees the importance of moving towards total productivity in measuring production efficiency. Meanwhile, (Fried et al., 1993) shows that There are many methods for analyzing productivity, but one of the most important of these methods is the Malmquist index, as it can link two close establishments by linking the production movement to them, and this indicator is used in non-parametric studies and in which differences compared to the boundary curve are given to efficiency values only (Ihsan,2002). This indicator measures the change in the total productivity of factors between two observations by the average distances between the boundary curve of production and each observation, which is a geometric mean of the ratio of two distance functions (Lyroudi and Angelidis,2006). The Malmquist index is calculated by the equation:

$$M_0\left(x^{t+1}, y^{t+1}, x^t, y^t\right) = \frac{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_0^t\left(x^t, y^t\right)} \left[\frac{D_0^t\left(x^{t+1}, y^{t+1}\right)}{D_0^{t+1}\left(x^{t+1}, y^{t+1}\right)} \frac{D_0^t\left(x^t, y^t\right)}{D_0^{t+1}\left(x^t, y^t\right)}\right]^{\frac{1}{2}}$$

It is the product of the change in technical efficiency the technical change, as the amount outside the arc represents the change in technical efficiency, which reflects the phenomenon of catching up (the catching-up effect), i.e. the movement of the facility for the better (the extent of proximity and distance from the best performance) The boundary curve is the best performance (Ihsan, 2002), while the average represents inside the arc, it measures technological transformations for two periods, the technological reference period *t* and technical change *t+1*. The model was estimated to access the sources of productivity change based on data envelope technology, as three indicators were estimated: Tfch total productivity, effect change in technical efficiency and tech technical change. Table 3

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shows the change in technical efficiency, which measures the distance of observations from the maximum efficiency by measuring relative efficiency for two close periods, as the average technical efficiency was 1.015. The number of farms that witnessed an improvement in efficiency amounted to 16.6% of the sample, meaning that these farms in the second phase were used. Fewer inputs to produce one unit of output, i.e. there is an improvement in the level of efficiency, while the percentage of farms that fell below the efficiency level was seen by 15%, while the rest of the farms in the sample did not witness any change in efficiency. As for tech, The technological change that shows if there is a change in the optimal limit of efficiency for the two periods, i.e. there is an improvement or decline in efficiency rates, it has an average of 1.237, i.e. there is technological progress and that this improvement may be the result of the use of seeds of the improved variety Al-Nahrain Some farms have seen a decline in technological levels, as the percentage of the sample is approximately 28.3%, As for total productivity, according to the Malmquist Index (TFPCH), its average was 1.264, ranging from a high of 4.369 to a minimum of 0 in some farms, this average of total productivity means progress and improvement in productivity, which is the result of the phenomenon of catching up

Table 3. Total productivity of resources and components by Malmquist index

F.	Effch Changing technical competence	Tech Technical change	Tfch Total productivity	F.	Effch Changing technical competence	Tech Technical change	Tfch Total productivity
1	1.000	4.369	4.369	31	1.000	1.443	1.443
2	1.000	1.437	1.437	32	1.000	1.143	1.143
3	1.000	2.516	2.516	33	0.682	0.671	0.458
4	1.000	1.389	1.389	34	1.000	1.294	1.294
5	1.346	1.885	2.538	35	0.938	1.069	1.002
6	1.000	0.982	0.982	36	1.000	1.083	1.083
7	1.000	1.500	1.500	37	1.000	0.000	0.000
8	1.000	1.197	1.197	38	1.466	1.184	1.736
9	1.000	1.369	1.369	39	1.000	1.662	1.662
10	1.000	1.342	1.342	40	1.067	1.282	1.367
11	1.000	1.333	1.333	41	1.000	1.026	1.026
12	1.000	2.037	2.037	42	1.000	0.802	0.802
13	0.833	1.893	1.578	43	1.000	1.118	1.118
14	1.000	1.886	1.886	44	1.000	0.952	0.952
15	1.000	1.461	1.461	45	1.000	1.218	1.218
16	1.000	1.976	1.976	46	0.899	0.911	0.818
17	0.835	0.940	0.785	47	1.000	1.065	1.065
18	1.200	1.062	1.275	48	1.000	1.251	1.251
19	0.833	0.972	0.810	49	1.000	1.476	1.476
20	0.769	1.298	0.998	50	1.000	0.000	0.000
21	1.000	0.945	0.945	51	0.710	0.981	0.697
22	0.998	1.198	1.196	52	1.000	0.736	0.736
23	1.000	1.250	1.250	53	0.667	1.011	0.674
24	1.200	1.451	1.741	54	1.000	0.562	0.562
25	1.300	1.245	1.619	55	1.000	0.787	0.787
26	1.000	1.570	1.570	56	1.566	0.518	0.811
27	1.200	1.692	2.031	57	1.000	0.959	0.959
28	1.000	1.288	1.288	58	1.419	0.619	0.878
29	1.000	1.050	1.050	59	1.000	0.916	0.916
30	1.000	1.304	1.304	60	1.000	0.685	0.685
	Average		Effects Technical Competence Change		Tech Change		Total Productivity TFPCH
	_		1.015		1.237		1.264

Resource: Researcher's work based on data envelope analysis.

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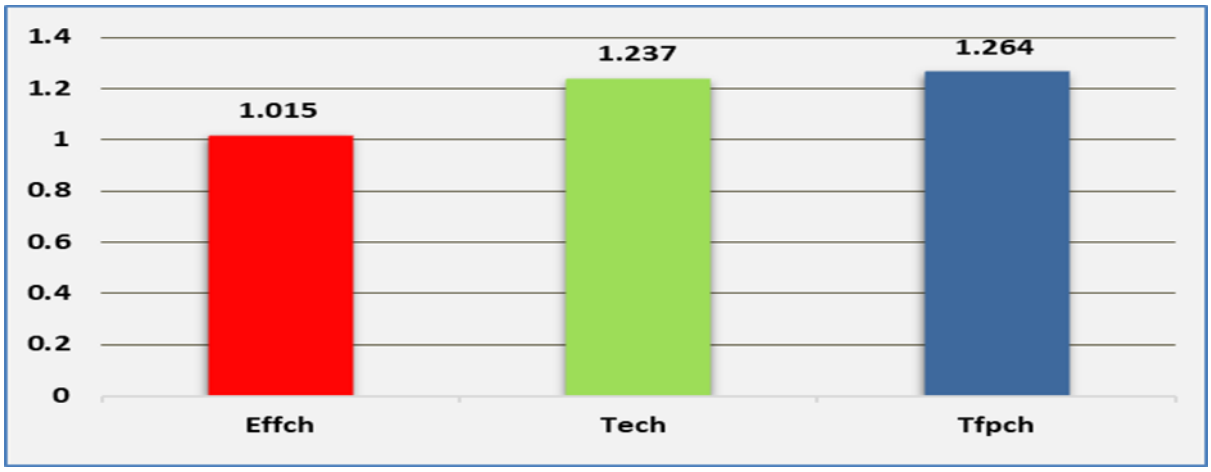

Figure 6. Averages of technical efficiency change, technical change and total productivity

Resource: By Author based on Table 6

CONCLUSION

The research has found that the Corn crop is one of the strategic crops that are characterized by high costs of production locally, so many farmers have refrained from cultivating it, and therefore it is necessary to support farmers by supporting production requirements and providing production requirements to support local producers, and that technological change and the adoption of modern means in agriculture such as improved seeds or the use of modern mechanization works to achieve the goals of the agricultural development process, whether by reducing production costs by providing production requirements at prices Subsidized or increase productivity per unit area if the cost efficiency of the sample is approximately 0.61, which is an acceptable ratio to the agricultural reality of the Corn crop It was found that some farms were technically efficient but not allocate efficient, and the total production efficiency improved as it averaged approximately 1.27 Therefore, we recommend the importance of supporting technological progress by supporting research and development centers and producing productive requirements that suit the agricultural reality in Iraq and the need to support farmers by providing supplies Production or subsidizing their prices to reduce their production costs to ensure that they continue to grow strategic crops and achieve self-sufficiency in them and thus reduce imports of these crops and achieve an acceptable level of food security.

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الكفاءة الاقتصادية في زراعة محصول الذرة الصفراء (لهجين النهرين) في محافظتي صلاح الدين وكركوك للموسم الزراعي 2023

لبوه عبد المحسن كردي ، سعد جعفر الفلوجي
قسم الاقتصاد الزراعي / كلية علوم الهندسة الزراعية/ جامعة بغداد

المستخلص

هدف البحث الى قياس كفاءة أداء صنف النهرين من محصول الذرة الصفراء باستخدام برنامج DEAP لقياس الكفاءة الفنية والاقتصادية وقياس الإنتاجية الكلية بالاعتماد على مؤشر Malmquist لعينة متكونة من 60 مزارعا لمحافظتي صلاح الدين وكركوك للموسم الزراعي 2023 وقد بلغ متوسط الكفاءة التقنية 0.858 اما متوسط كفاءة الكلفة فقد بلغ 0.604 وعند قياس الكفاءة الإنتاجية الكلية وباستخدام مؤشر مالمكويست تبين ان متوسط تغير الإنتاجية الكلية بلغ 1.264 اما متوسط التغير في الكفاءة التقنية فقد بلغ 1.015 وكان متوسط التغير التقني 1.237، ويمكن الاستنتاج من خلال هذه النتائج بان تطبيق التقنيات الحديثة واستخدام البذور المحسنة (صنف النهرين) نتج عنه استخدام الموارد الإنتاجية بكفاءة ومن ثم مساعدة المزارعين في الحصول على أرباح مجزية من خلال تقليل التكاليف المترتبة على زراعة هذا الصنف بسبب الدعم الحكومي له لذلك نوصي بالتوسع بزراعة هذا الصنف والاستمرار بدعم منتجي هذا الصنف لتحقيق المستويات الإنتاجية المرجوة من محصول الذرة الصفراء في المستقبل.

الكلمات المفتاحية: التقدم التكنولوجي الزراعي، تحليل مغلف البيانات، مؤشر، الكفاءة الإنتاجية.

* جزء من رسالة ماجستير للباحث الأول..