An economic study to estimate the levels of technical and specialized efficiency of the watermelon crop using the data envelopment analysis (DEA) method in the .Al-Ishaqi region as an applied model

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Abstract
Using the data envelopment analysis (DEA) method, the study sought to quantify the technical, specialized, and economic efficiency of the pruning crop in Salah al-Din Governorate - Al-Ishaqi District. The data was collected by creating a questionnaire and selecting farms at random from the field. The percentage of the farms in the sample was used to determine the pruning crop's sample size. The (Deap) program was utilized in the community of (60) farms to analyze efficiency using the data encapsulation method. In order to test the study hypotheses and accomplish its goals through the application of the technique, the study relied on descriptive and quantitative analysis that is based on the foundations, principles, and concepts of economic theory as well as mathematical, statistical, and analogous analysis methodologies. Data envelopment analysis. The data envelopment of production and cost functions with stability and change in capacity returns led to the efficiency analysis's conclusions. Based on variables, the analysis's findings were displayed. The production function, as represented by the average technical efficiency percentage attained (82%). Regarding technical efficiency, the average percentage obtained (89%), taking into account the shift in return to capacity. The number of farms that achieved pricing efficiency (AE) at a level of 100% was three, and the average rate of economic efficiency (EE) was 48%, depending on the factors of the cost function, according to the data. The study found that crop producers who use drip irrigation to cultivate their crops do not. And work to support agricultural production requirements, including providing good seeds and pesticides at reasonable prices, in addition to using modern mechanization in agricultural operations that increase economic efficiency.

Keywords: data envelope, watermelon crop, and economic efficiency

introduction

One of the most significant fruit-bearing vegetable crops, Watermelon is cultivated over vast tracts of land for both domestic and international markets. The fruits of the raqi crop suffer both quantitative and qualitative losses in transit from the farm to the customer. 20% of the harvest is thought to have been lost, which represents a significant loss of national income. One of the principal summer crops in Iraq, the raqi crop is farmed in every governorate in the country. Iraq is taken into Due to its huge tracts of fertile land, it is one of the agricultural countries of the Arab world and the world at large, where numerous varieties can be farmed.. This is a significant vegetable that is high in carbohydrates, sugars, proteins, and salts. It is also high in vitamins, particularly C and A. However, the employment of conventional agricultural

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practices has resulted in high production costs and a fall in net returns realized, which has led to the decline in crop productivity. Every year, some 117,000 watermelon plants are produced worldwide. 204,081 lbs. Watermelon production in China is regarded as the highest in the world, with an annual production of about 792,442.71 tons. Turkey is the second-largest producer of watermelons, producing about 392,889.2 tons of the fruit annually. Egypt is the ninth-largest watermelon producer in the world and one of the Arab nations with the highest annual production, with 168,099.4 tons produced. Saddest among the Arab nations is Iraq.

research importance

Given the importance of the crop in increasing demand for it, this research is important because it is one of the important economic studies in the agricultural field in order to improve economic efficiency and separate its components into each of: (technical and specialization efficiency), which contributes to providing students and researchers with a large amount of necessary information about the extent of the contribution of economic resources used in agricultural production.

Research problem

The low productivity of the crop under study, the high costs of its production, the inability to reach production sizes close to the optimal sizes through which the farms of the research sample can achieve the lowest production costs and maximum profits - and the low economic efficiency in the farms producing this crop in the research sample - are the main problems of the study.

research aims

The research aims to estimate the economic efficiency of watermelon farmers - Al-Ishaqi District as an applied model by estimating the technical and specialized efficiency as well as the economic efficiency of the variety crop among farmers in the research sample using the data envelopment analysis (DEA) method, in addition to using the data envelopment analysis (DEA) method to estimate the economic, technical and specialized efficiency of the variety crop among farmers in the research sample.

Theoretical framework

Utilizing wealth resources in a way that allows for higher production at the same cost as before or lower production costs at the same level of production is known as economic efficiency. It can also mean being economically efficient and getting the maximum return at the same cost or the same return at a lesser cost. A concept that ensures optimal use of limited resources while including technical and distribution efficiency, making it a useful instrument that helps achieve resource sustainability [1[

Efficiency Implication Economic

According to Farrell (1957; 253), allocative and technical efficiency are components of economic efficiency. The following is a definition of these elements:

Technical Efficiency (TE:(

One component of overall economic efficiency is technical efficiency. However, a farm needs to be technically efficient in order to be profitable. The ability to employ fewer material inputs to produce a given level of output is known as input-oriented technical efficiency [2[

Allocative Efficiency (AE :(

Specialized efficiency measures the farm's capacity to use pickles in the best possible ratios based on pickle prices and technology. The efficiency of distribution of production is taken into consideration in addition to the efficiency of resource utilization. When

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resources are distributed and the ideal size is reached in order to reach the well-being of society, specialized efficiency is achieved[3[

Measurment Economic Efficienc:

The concept of economic efficiency is credited to Farrell (1957; 263). It is a composite measure of technical efficiency and allocative efficiency. Thus, there are two ways to calculate economic efficiency. It is measured with an orientation towards the use of inputs, or from the input side, in the first method (called input-oriented measures), and economic efficiency is measured with an external orientation, or from the output side, in the second method (called output-oriented measures) [4[

Methods to Estimate - Economic Efficiency

Both classic and current approaches can be used to evaluate economic efficiency. The most significant traditional method is the defined statistical marginal method (OLS), whilst standard parametric methods are used in modern methods. The parametric method, also known as the stochastic boundary analysis method, and the non-parametric method, also known as data envelopment analysis (DEA), are the two most popular approaches for calculating economic efficiency and its constituent parts. Economic efficiency will be calculated in this study using both data envelopment analysis (DEA) and cost functions, as is customary:

Data envelopment analysis (DEA) method:

It is thought of as a non-parametric way to perform data envelopment analysis. The scientist Edwardo Rhodeso was given credit for creating the (DEA) system in 1978. He did this by utilizing it to create a system that could provide many inputs and outputs. By means of extreme observations, the location of the frontier efficiency curve is established. (Ali and Farhan, 2015) Exterme. The 1975 paper by Farell served as the foundation for the idea of (DEA). This idea is based on the straightforward idea that an efficient facility is one that utilizes fewer inputs than others to achieve the same level of output[5]. The idea of the frontier efficiency curve (DEA It is formed by finding a hypothetical production unit that expresses the best combination of observations for the ratio of outputs to inputs. This curve encloses or covers all the observations under study, as in Figure(1) [6.[

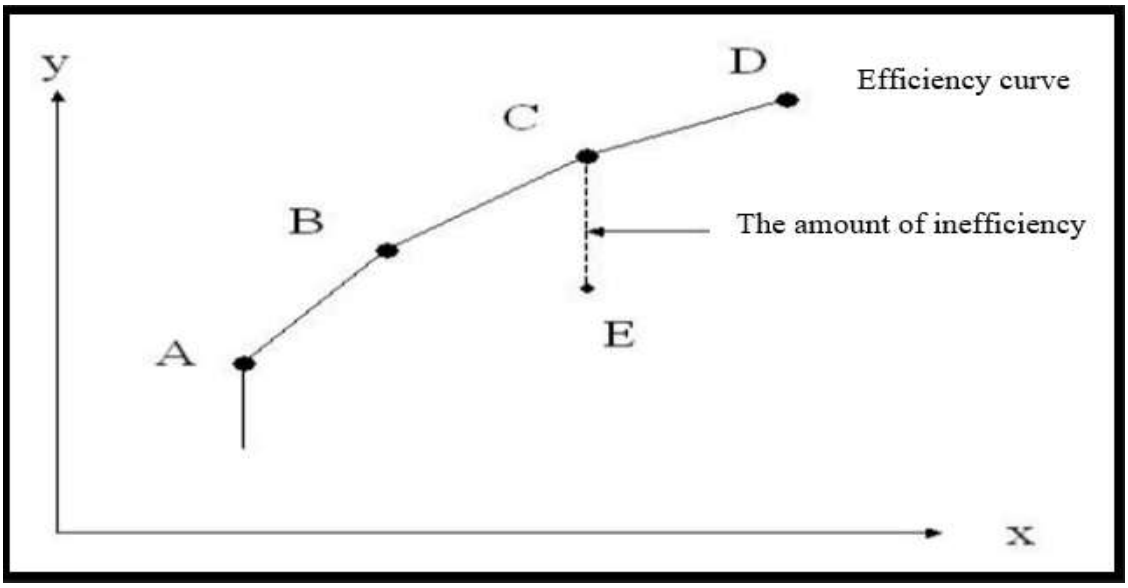

Figure (1) Efficiency curve according to the data envelopment concept
Source: (Huguenin, 2012: 12(

Materials and working methods

Standard description of the model used to measure economic efficiency and its components according to the variables of the production function.

Since the farm's surroundings force the farmer to control his inputs more than his outputs (production), it is necessary to estimate the technical efficiency on the input side of the study sample crops. Stated differently, input costs can be decreased, and if field statistical data is available, they can be decreased more reliably than by raising output. The dependent factor (M), which is the total production of the sample farms (N), is represented by (K) of inputs, which included (amount of seeds/seed), (amount of fertilizers/kg), (amount of pesticides/liter), (mechanical work/hour), and (manual work/worker). These explanatory variables affected the data envelopment analysis (DEA) model, which was used to estimate the technical efficiency.

Minɵ,λθ

yi +yλ ≥ 0-

θxi – X λ ≥ 0

Ni λ= 1

λ ≥ 0

Since:

Xi: input vector.

Yi: output vector.

λ: resultant vector.

Ni: Expresses the constants and weights associated with efficient farms.

θ: represents the value of the farmer’s technical efficiency index and falls between (0-1.(

It requires measuring the capacity efficiency (SE) of the farmer in light of the stability and change of capacity returns.

Standard explanation of the model based on cost function variables that is used to quantify economic efficiency and its constituent parts

To reduce costs for the sample farms, which are represented by the following (seed costs, tillage costs, irrigation costs, fertilizer costs, pesticide costs, mechanical labor costs), the technical efficiency (TE), the specialized efficiency (AE), and the cost efficiency (CE)

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will be estimated based on the cost function, using the prices of production inputs. Human labor) and presuming a variation in returns to scale, the linear programming model takes on the following form:

Min λ , Xi*wiXi

Subject to:

$-y_i + y\lambda \geq 0$

$\theta X_i^* - X\lambda \geq 0$

$\lambda \geq 0$

Since:

Xi = vector to minimize the cost of unit production i

Wi = vector of input prices.

yi = output vector for production unit i.

Economic efficiency (EE), which is determined by the ratio of the minimum cost to the actual cost, is calculated through the following equation:

EE= 〖W_i X_i〗^*/(W_i X_i(

In addition, the specialized efficiency (AE=EE/TE) can be computed by dividing the economic efficiency by the technical efficiency. What level of economic effectiveness exists? It is computed as follows: EE = TE*AE, where specialized efficiency and technical efficiency are multiplied.

Results and discussion

Outcomes of utilizing the data envelopment analysis (DEA) program to measure economic efficiency and its constituents based on production function variables

Because an efficient and inefficient farm is directly determined by economies of scale, and because the efficiency of scale is measured by dividing the technical efficiency in light of the return being constant by its counterpart in light of changing the return, it is possible to ascertain the nature of the return on capacity for any farm by measuring the efficiency of capacity. Table ( ) provides information on the capacity efficiency and technical efficiency for producers of agricultural crops on (60) farms for the agricultural season (2023) in relation to capacity returns that are stable and changing. The average capacity efficiency attained (0.92), according to the results of assessing technical efficiency and capacity efficiency in light of steady and fluctuating returns, and thus. There existed an upper limit and a lower limit to the capacity efficiency. The lowest value was between 1 and 0.35. The table indicates that there were twenty-four farms that attained 100% efficiency. These farms may be regarded as exemplars of the sample farms' vetch that did not attain maximum productivity, and they may persist based on the mix employed. The returns to scale index demonstrates that the elements function at the ideal size even in the absence of economies of scale. This indicates that an increase in the same variable production parameters results in an increase in overall production. The rate of increase in total production is stable in this instance, indicating a set proportion of production elements. utilized during the manufacturing process. There were 36 farms left in the sample that were not operating at maximum efficiency. Technical efficiency served as the foundation for determining capacity efficiency. The table reveals that, when considering constant returns, technical efficiency ranged from the highest and lowest efficiency (1 - 0.31), with an average of (0.82), while when considering changing returns, the highest and lowest technical efficiency reached (1 - 0.32), with an average of (0.89). Additionally, the number of farms that reached 100% efficiency in light of the yield change was 36, while the number of farms that did not reach 100% efficiency in light of the yield change was 24. The explanation behind

Table (1) Capacity efficiency and technical efficiency in light of stability and change in yield to capacity for the meadow crop

Sequence	Technical efficiency CRS	Technical efficiency VRS	Capacity efficiency SE	Volume yield	Sequence	Technical efficiency CRS	Technical efficiency VRS	Capacity efficiency SE	Volume yield
1	0.98	1	0.98	drs	41	0.726	1	0.726	irs
2	0.926	1	0.926	irs	42	0.718	1	0.718	irs
3	0.779	0.829	0.94	drs	43	0.681	1	0.681	irs
4	0.971	0.971	1		44	0.333	0.339	0.982	irs
5	0.685	0.768	0.891	irs	45	1	1	1	
6	1	1	1		46	0.876	1	0.876	irs
7	0.985	0.986	0.999	drs	47	0.669	0.844	0.793	irs
8	1	1	1		48	0.395	0.411	0.96	irs
9	0.878	1	0.878	irs	49	1	1	1	
10	1	1	1		50	0.311	0.323	0.963	drs
11	0.812	0.833	0.975	drs	51	1	1	1	
12	0.756	1	0.756	irs	52	0.861	1	0.861	irs
13	0.917	0.917	1		53	0.352	1	0.352	irs
14	0.754	0.825	0.915	drs	54	0.657	0.746	0.88	irs
15	1	1	1		55	0.917	0.958	0.957	irs
16	1	1	1		56	0.721	0.785	0.919	irs
17	0.801	1	0.801	irs	57	0.623	0.626	0.996	irs
18	0.667	0.667	1		58	0.694	1	0.694	irs
19	1	1	1		59	0.322	0.323	0.998	drs
20	1	1	1		60	1	1	1	
21	0.988	0.988	1		المتوسط	0.824	0.896	0.924	
22	0.656	0.656	1		أعلى	1	1	1	
23	1	1	1		أدنى	0.311	0.323	0.352	
24	0.727	0.727	1						
25	0.732	0.825	0.887	drs					
26	0.902	1	0.902	irs					
27	1	1	1						
28	1	1	1						
29	1	1	1						
30	1	1	1						
31	0.929	1	0.929	irs					
32	1	1	1						
33	0.939	1	0.939	irs					
34	1	1	1						
35	0.662	1	0.662	irs					
36	0.99	1	0.99	drs					
37	0.933	1	0.933	irs					

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38	**0.604**	**0.611**	**0.988**	**irs**					
39	**0.67**	**0.807**	**0.831**	**irs**					
40	**0.929**	**0.987**	**0.941**	**irs**					

Source: Prepared by the researcher according to the Deap program, based on the data of the questionnaire form

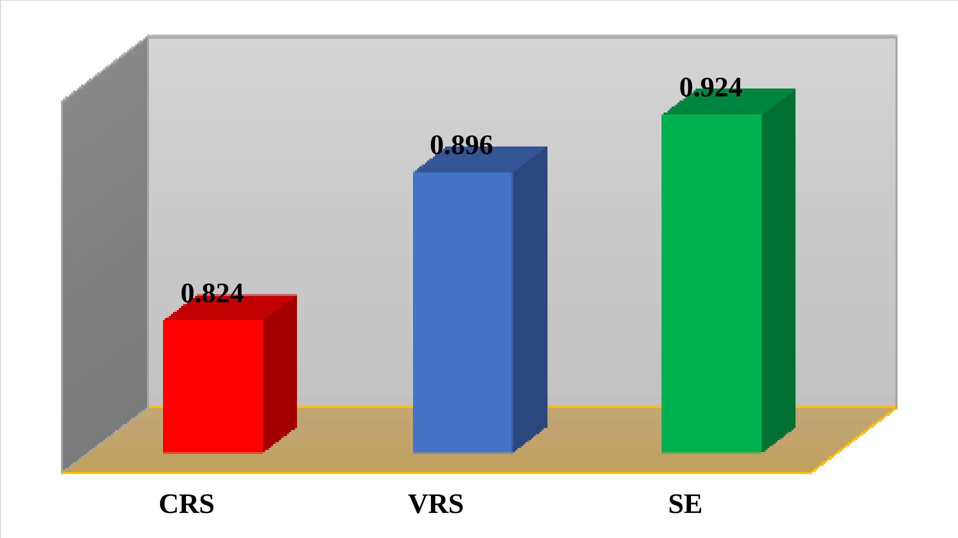

Figure (2) Average capacity efficiency and technical efficiency under constant and changing returns.
Source: Prepared by the researcher based on table data (1) using Excel.

Estimating the economic efficiency and its components (technical and allocative) of the meadow crop according to cost function variables.

Technical efficiency, allocative efficiency, and economic efficiency (cost efficiency) can all be obtained by using the quantities and costs of resources used in the production process, as Table (2) makes clear. This is assuming a change in the return on capacity for the pruning crop for (60) farms for the agricultural season (2022). These farms can increase their production by 4% with the resources they use, as evidenced by the average technical efficiency of 0.96, which is close to the result obtained when calculating capacity efficiency in light of changing yield. It also demonstrates that these farms allow the loss of some resources due to inefficiency, which results in. Regarding the allocative efficiency, the table indicates that, at the sample level, it varied from the maximum efficiency, which amounts to the proper one, to the lowest efficiency, which amounts to (0.055). The average, however, amounts to (0.51), which is obviously quite low. This suggests that productivity might be increased by implementing contemporary technology, which would enable the use of optimal resources by 49%. Thus, while keeping the same level of production, the transfer of economic resources will save (49%) of the costs associated with them. As a result, these farms are able to approach the tangency of the cost line to the isotropic output curve, or the ideal production point. Furthermore, it transpires that the aggregate count of farms that attained. Furthermore, it appears that a few farms attained perfect technical efficiency but fell short of perfect allocative efficiency. This is because, at the level when allocative efficiency decreased below the optimal level, the costs of the resources used in production were considerable. This suggests that

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production has reached the stage where it is neither allocatively nor technically efficient. The findings of assessing the meadow crop's economic efficiency are likewise displayed in the table, with an average economic efficiency of 0.48. This level is regarded as low and results from multiplying the allocative and technical efficiency. It indicates that these farms may cut costs by 52% and

The plan followed by the agriculture industry to protect the local product and close the border crossings during the production period of the melon crop had a positive impact on the farmers of the sample, as despite the high costs used in the production process, the selling price of the crop was feasible during the production period, which led to an economic return. Additionally, the reason for the low economic efficiency that was estimated is due to the agricultural reality that the Iraqi farmer is experiencing in light of the lack of government support and the high prices of production requirements, especially seeds, fertilizer, pesticides, and fuel. All of this costs the farmer a lot of money

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Table (2) Economic efficiency, technical efficiency and allocative efficiency of the upbringing crop

Sequence	Technical competence TE	Allocative efficiency AE	Economic efficiency EE	Sequence	Technical competence TE	Allocative efficiency AE	Economic efficiency EE
1	1	0.256	0.256	41	1	0.933	0.933
2	1	0.346	0.346	42	1	0.565	0.565
3	0.899	0.055	0.049	43	1	0.889	0.889
4	0.998	0.102	0.102	44	0.827	0.917	0.759
5	0.972	0.353	0.344	45	1	0.687	0.687
6	1	0.207	0.207	46	1	0.542	0.542
7	0.992	0.228	0.227	47	0.976	0.591	0.577
8	1	0.243	0.243	48	0.952	0.607	0.578
9	1	0.355	0.355	49	1	1	1
10	1	0.246	0.246	50	0.738	0.688	0.508
11	0.865	0.287	0.248	51	1	1	1
12	1	0.303	0.303	52	1	0.874	0.874
13	0.996	0.382	0.38	53	1	1	1
14	0.8	0.311	0.249	54	0.838	0.586	0.491
15	1	0.438	0.438	55	0.973	0.567	0.551
16	1	0.255	0.255	56	0.928	0.623	0.578
17	1	0.376	0.376	57	0.785	0.782	0.614
18	0.846	0.291	0.246	58	1	0.77	0.77
19	1	0.102	0.102	59	0.771	0.67	0.516
20	1	0.249	0.249	60	1	0.901	0.901
21	0.996	0.205	0.205	المتوسط	0.961	0.51	0.488
22	1	0.223	0.223	أعلى	1	1	1
23	1	0.252	0.252	أدنى	0.738	0.055	0.049
24	0.945	0.376	0.355				
25	0.858	0.283	0.243				

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26	1	0.245	0.245				
27	1	0.31	0.31				
28	1	0.378	0.378				
29	1	0.248	0.248				
30	1	0.442	0.442				
31	1	0.59	0.59				
32	1	0.606	0.606				
33	1	0.807	0.807				
34	1	0.535	0.535				
35	1	0.9	0.9				
36	1	0.929	0.929				
37	1	0.639	0.639				
38	0.834	0.838	0.699				
39	0.898	0.608	0.546				
40	0.992	0.601	0.596				

Source: Prepared by the researcher according to the Deap program, based on the data of the questionnaire form

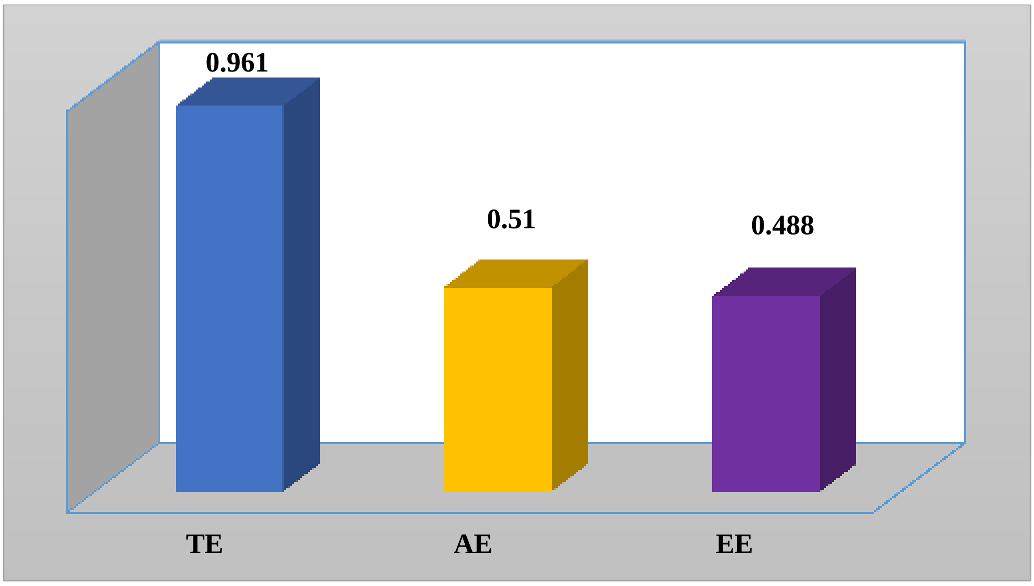

Figure (3) Average technical efficiency, allocative efficiency, and economic efficiency of the cultivar crop.

Source: Prepared by the researcher based on table data (2) using Excel.

Conclusions and recommendations

Conclusions:

.1

The results of the study showed that the average economic efficiency of the cultivated crop was 48%, which is considered low and indicates that these farms are able to reduce costs by 52%, which is a result of doubling technical efficiency and allocative efficiency and reaching the same level of production. We conclude that the reason for the low economic efficiency that was estimated is attributed to the agricultural reality that the Iraqi farmer lives in in the absence of government support and the high prices of production requirements, especially seeds, fertilizers, pesticides and fuel, and all of this costs the

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farmer a lot of money, which led to low levels of economic efficiency in the study area.

.2Based on the cost function variables and the data envelopment analysis method (DEA) for assessing technical efficiency, three farms met the criteria for pricing efficiency (AE) at 100% for the grain crop, accounting for 5% of the total. of the entire sample under investigation.

.3The average percentage of technical efficiency obtained (82%) for the cultivar crop was determined by estimating the technical efficiency based on the production function's factors. Regarding technical efficiency in relation to the shift in capacity yield, the average percentage of technical efficiency was 89%. It was also evident that there were 24 farms that reached the maximum technical efficiency of 100%, or 40% of the total number of farms in the sample under study

Recommendations:

.1Agricultural crop farms that did not reach a 100% efficiency index will benefit from the efficiency indicators derived by the data envelopment model for production functions with constant and fluctuating returns to scale.

.2Taking up the efficient farm owners' knowledge and profiting from them by applying their experience to unproductive farms in order to achieve maximum efficiency.

.3The data envelopment analysis method (DEA), which provides detailed results for each farm and resource used in the production process, is advised for use in future research and studies by the study because it helps identify issues and challenges that farmers face when producing vegetable crops and other agricultural crops and how to successfully address them.

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