Estimating the technical and economic efficiency of tomato crop farms in Samarra district for the production season 2022

Manar Saleh Hamad[1]
manar-saleh@tu.edu.iq
[1]Associate Professor Department of The agricultural economy, College of Agriculture, Tikrit University, Tikrit , Iraq

Abstract

The aim of the research is to estimate the technical, specialized and economic efficiency of the tomato crop in Salah al-Din Governorate according to the data envelope analysis (DEA) method. (100) farms using modern irrigation techniques (drip), the program (Deap) to analyze efficiency according to the method of the data envelope, and the study relied on the descriptive and quantitative analysis that is based on the foundations, principles and concepts of economic theory in achieving the objectives of the research through the application of the data envelope analysis method DEA And in two ways, according to the concept of stability and change of return to capacity, which allows estimating technical efficiency and capacity efficiency, and using the same method, specialized efficiency and economic efficiency were extracted, and the results of the efficiency analysis were reached according to the data envelope of the production and cost functions with the stability and change of capacity returns. The percentage of the average technical efficiency was (77%). As for the technical efficiency in light of the change in the return on capacity, the percentage of the average technical efficiency was (93%). Depending on the cost function variables, the results showed that the number of farms that achieved price efficiency (AE) at the level of (100%) are (4) farmers, and the average rate of economic efficiency (EE) was ((69%). The study concluded that the tomato growers by drip irrigation method do not achieve reaching the optimal size of production, and this means that there is a deviation from the optimal size of the crops of the study sample, and in the light of The results that were reached, the study recommended to take advantage of the efficiency indicators obtained through the data envelope model.

Introduction

Agricultural crops, despite the abundance of arable land, labor force, and capital needed to cover the needs of local agricultural activities and operations. [1] Since the prevailing pattern in agriculture is the family farm, Iraq suffers from misuse of available resources, and this leads to low economic efficiency. For farms, as agricultural production decreases with increased costs in the event that farmers are inefficient in their management and practice of agricultural lands.[2]

Research problem :

The primary challenge in this study is the lack of knowledge among tomato crop farmers in the study area regarding the ideal farm sizes and levels of efficiency, as well as their ignorance regarding the amount of resource waste at both the farm and individual resource levels and the low yield of this crop. due to the use of manufactured components Given that Iraq is one of the developing nations that experiences numerous production limits and does not rely on economic norms, which results in low production, importing them from abroad or paying exorbitant rates for economic resource components like seeds, fertilizer, control materials, and pesticides, which necessitates making the best use of these resources. Additionally, work to boost productivity by boosting the level of efficiency that in some way aids in regulating the productivity of the tomato crop.

Research Aims:

ISSN 2072-3857

Based on the research problem, this research will aim to:

1- Estimating the technical efficiency of the tomato crop in Samarra district

2- Estimating the specialized efficiency of the tomato crop in Samarra district

3- Estimating the economic efficiency of the tomato crop in Samarra district according to the data envelope analysis (DEA) method.

research importance:

The significance of the study is derived from the significance of the tomato crop, which is a significant crop for the Iraqi consumer and has made inroads into various food industries. As a result, in order to achieve economic efficiency and optimal resource utilization, an increase in the quantities produced from this crop is necessary. This can be done by researching the sources of production growth and the key variables influencing it, as well as by working to increase the yield of the crop.

Data sources:

Data were obtained by designing a questionnaire using the random sampling method for farmers in the field, and the size of the sample was determined according to its percentage in the community, as (30) questionnaires were collected and all of them were entered into the study plan and were represented by (7%) of the study population using the (Deap) program to analyze Efficiency under the data envelope method.

search style:

The research will depend on the descriptive and quantitative analysis that is based on the foundations, principles and concepts of economic theory through the application of the data envelope analysis method (DEA) in two directions according to the concept of constant return of scale (CRS) and the change of return of capacity (VRS) (Variable Return of Scale), which allows the assessment of efficiency Technical Efficiency (TE) and Scale Efficiency (SE), and using the same method, the Allocative Efficiency (AE) and Economical Efficiency (EE) can be extracted.

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

In order to estimate the technical efficiency of the inputs of the tomato crop in the Samarra district, since the environmental conditions surrounding the farm make the more tightly regulate the production's inputs than its outcomes over his outputs (production), In other words, decreasing input costs is a more secure strategy than increasing output, and with the presence of data Field statistics represented by (K) of the inputs, which included (amount of seeds/g), (amount of fertilizers/kg), (amount of pesticides/liter), (mechanical work/hour) and (manual work/worker), which are explanatory variables. Influencing the dependent factor (M) represented by the total production of sample farms (N), and by using the Duality theory in linear programming, the Data Envelope Analysis (DEA) model used to estimate technical efficiency on the part of the inputs in light of the change in capacity returns (VRS) becomes as follows:[3]

$$\text{Min}_{\ddot{o}, \lambda} \theta$$

$$yi + y\lambda \geq 0 -$$

$$\theta xi - X\lambda \geq 0$$

$$Ni\ \lambda = 1$$

$$\lambda \geq 0$$

Since:

Xi: input vector.

Yi: output vector.

λ: resultant vector.

ISSN 2072-3857

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

θ: represents the value of the farmer's technical efficiency index and is located between (0-1).

It requires measuring the efficiency of the SE capacity of the farms in light of the stability and variability of the return on capacity.

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

Technical efficiency TE, specialized efficiency AE, and cost efficiency CE will be estimated based on the cost function, using the prices of production inputs for the purpose of reducing costs for the sample farms, represented by the following (seed costs - tillage costs - watering costs - fertilizer costs - pesticide costs - mechanical work costs - costs Manual work) and assuming a change in returns to scale, the linear programming model becomes as follows: [4]

Min λ , Xi*wiXi

Subject to:

$-yi + y\lambda \geq 0$

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

$\lambda \geq 0$

Since:

Xi = vector of declining unit cost i

Wi = input price vector.

yi = output vector per unit of output i.

The economic efficiency (EE) is calculated and determined by the ratio of the minimum cost to the actual cost and through the following equation:-[5]

EE= (W_i X_i) ^*/(W_i X_i)

As well as calculating the specialized competence by dividing the economic efficiency by the technical competence AE=EE/TE, what is the economic efficiency calculated by multiplying the technical competence by the specialized competence EE = TE*AE.[6]

Results and discussion

The results of measuring economic efficiency and its components using the Data Envelope Analysis (DEA) method, according to the variables of the production function

The results obtained by estimating and presenting each of the degrees of technical efficiency, volume yield and capacity efficiency according to the variables of the production function of the tomato crop were analyzed and interpreted in Table (1). productive season (2022) of the study sample in light of the stability of the return to capacity, ranged between a minimum of (35%) for farm No. (24), and a maximum of (100%) for farm No (7) farms, which constituted a percentage of (%) 41), while the average percentage of technical efficiency was (73%), and therefore these farms can increase their production by (27%) for the tomato crop or achieve the same level of current production by reducing the cost by (27%). The return on capacity ranged between a minimum of (74%) for farm No. (14), and a maximum of (100%) for farm no (14) farms for the tomato crop, which constituted a percentage of (46%), while the average percentage of Technical efficiency (93%), and this indicates the possibility of increasing production according to this concept by (7%) without increasing the amount of resources used.

ISSN 2072-3857

It should be noted here that the farms that achieved full technical efficiency by (100%), which numbered (7) farms, constituted a percentage of (23%) of the total number of farms in the studied sample, which are the farms that were working on the curve of production possibilities and can be counted as farms A reference for the rest of the inefficient farms, which are among the farms whose production diverges from the production possibilities curve in different proportions, and this means that technically efficient farms can reduce the quantities of inputs used to obtain the same level of production, or use the same quantities of inputs to obtain a higher level of production, either By reviewing the results of capacity efficiency, we find that they were also varied, as they ranged between (1- 0.406) with an average rate of (77%), meaning that these farms can increase their production by (23%) or lose some of their economic resources used in production. It entails reducing the cost by (23%). As for the number of farms that were operating with increasing returns, they are (23) farms, which represented a percentage of (76%) of the total sample studied and according to the drip irrigation method. No farm operating with diminishing capacity returns was recorded within the sample. Study, and this indicates that the rate of increase in the volume of production is greater than the rate of increase in the elements of production actually used in the production process.

Table (1) Technical efficiency and capacity efficiency under the constant and variable returns to capacity.

Yields volume	Scale efficiency	Technical Proficiency with variable returns (vrste)	Technical Efficiency with Constant Returns (crste)	Farm sequence
Irs	0.932	1.000	0.932	1
-	1.000	1.000	1.000	2
Irs	0.747	0.832	0.622	3
Irs	0.596	1.000	0.596	4
-	1.000	1.000	1.000	5
Irs	0.698	0.826	0.577	6
-	1.000	1.000	1.000	7
Irs	0.587	0.911	0.535	8
-	1.000	1.000	1.000	9
Irs	0.925	0.942	0.871	10
-	1.000	1.000	1.000	11
Irs	0.675	0.910	0.615	12
Irs	0.877	1.000	0.877	13
Irs	0.717	0.747	0.536	14
-	1.000	1.000	1.000	15
Irs	0.559	0.962	0.538	16
Irs	0.609	1.000	0.609	17
Irs	0.981	0.998	0.979	18
Irs	0.744	0.857	0.638	19
Irs	0.429	1.000	0.429	20

ISSN 2072-3857

Irs	0.715	0.868	0.621	21
Irs	0.585	0.748	0.437	22
Irs	0.792	0.904	0.716	23
Irs	0.406	0.858	0.348	24
Irs	0.695	0.794	0.552	25
Irs	0.771	1.000	0.771	26
Irs	0.542	0.805	0.437	27
Irs	0.908	1.000	0.908	28
Irs	0.687	0.990	0.680	29
-	1.000	1.000	1.000	30
Average	**0.773**	**0.932**	**0.727**	
The lowest value	**0.406**	**0.747**	**0.348**	
highest value	**1**	**1**	**1**	

Source: Based on the data of the questionnaire according to the Deap data envelope analysis program

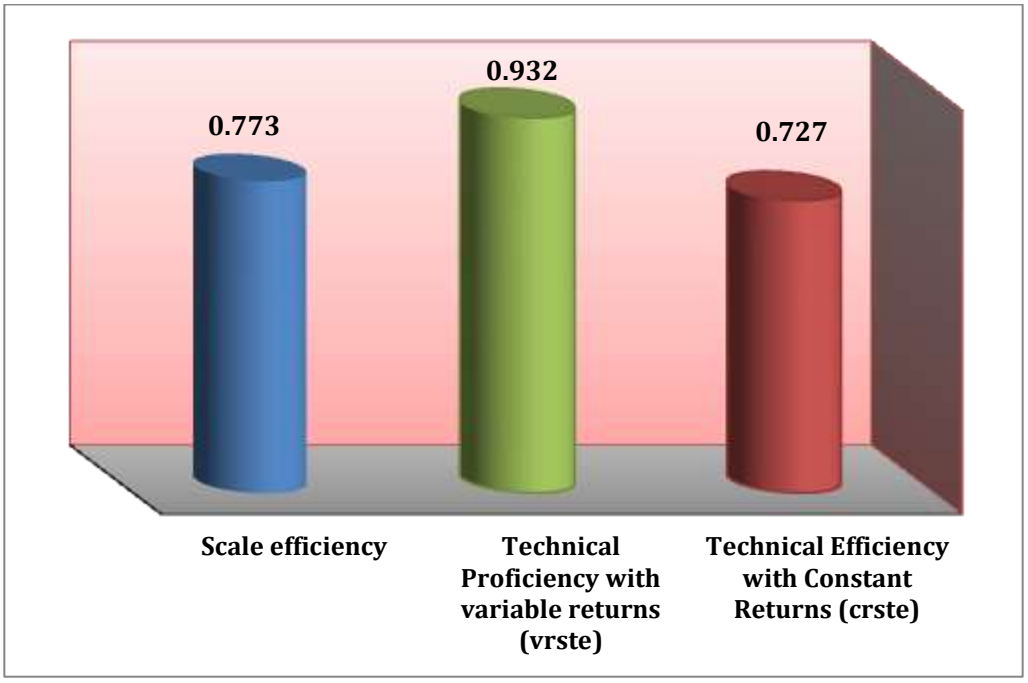

Figure 1: Average technical efficiency and capacity efficiency with constant and variable capacity returns

Source: prepared by the researcher based on the data of Table (1).

The results of measuring economic efficiency with its components (technical efficiency and allocative efficiency) according to the variables of the cost function.

The total economic efficiency (EE) was estimated with its components Technical Efficiency (TE) and Allocative Efficiency (AE) for tomato farms in Samarra district for the productive season (2022 AD) using the data envelope analysis (DEA) method. According to the variables of the cost function, using the quantities and prices of resources, and assuming a change in capacity

returns, the results of the levels of estimating economic efficiency (EE), technical efficiency (TE) and allocative efficiency (AE) were presented in Table (2). Through the results that were reached and presented in the aforementioned table, it became clear that the levels of technical efficiency in light of the change in the yield of capacity for the study sample ranged between (1 - 0.714) with an average of (93%). As for the levels of allocative efficiency (AE) for crop growers Tomato by drip irrigation method, it turned out that it ranged between a minimum of (0.285%) for farm No. (4) and a maximum of (100%) for a number of farms, which amounted to (4) farms for the tomato crop, and the average percentage was (74%). This indicates that the redistribution of economic resources used in the cultivation of the tomato crop in Hawija district can reduce the level of costs without reducing the level of production, or produce a higher amount of current output at the current costs used, and thus these farms will be able to reach the optimum production point, which is the point of contact of the cost line with the isoquant curve, as output maximization is achieved when the slope of the isoquant curve (marginal rate of substitution) and the slope of the cost line (allocation ratio) are equal. This means that these farms do not have the ability to choose the optimal resource combination, especially in the absence of governmental support for it, as most of the production resources are purchased from the market at high prices, especially at the beginning of the production season, which is reflected in its impact on the allocative efficiency, which predicted the existence of a waste of resources and an excess in preparing the variables used in the production process, and that the number of farms that achieved price efficiency (AE) at the level of (100%) they are (4) farms for the tomato crop, and a percentage of (13%) constituted the total sample studied, and in such a case, these farms do not have any surplus inputs because they consume all inputs sufficiently or optimally to reach the necessary production. We also note by referring to the results of Table (2) that the number of farms that achieved optimal technical efficiency (complete) were not all able at the same time to achieve price efficiency at the optimal level, and this is due to the high costs of production factors to the extent that led to a decrease in efficiency This means that the production is marketed at the point where it is technically efficient and price inefficient. As for the economic efficiency (EE), it ranged in levels between a minimum value of (0.285) for farm No. (4) and a maximum value of 100% for a number of farms amounted to (4) farms, which was represented by a percentage of (13%), while the average percentage was (69%). experienced by the agricultural sector in Iraq in general and in the Samarra district in particular, especially in light of the absence of government support and the high costs of production requirements. Low allocative efficiency, which caused a decrease in the level of economic

ISSN 2072-3857

Table (2) Technical, specialized and economic efficiency in light of the change in the return on capacity.

economic efficiency (EE)	allocative efficiency AE)(	Technical efficiency)TE(	Farm sequence
0.625	0.625	1.000	**1**
0.801	0.801	1.000	**2**
1.000	1.000	1.000	**3**
0.285	0.285	1.000	**4**
0.758	0.758	1.000	**5**
0.526	0.709	0.743	**6**
0.570	0.669	0.852	**7**
0.661	0.753	0.877	**8**
1.000	1.000	1.000	**9**
0.599	0.665	0.901	**10**
0.579	0.579	1.000	**11**
0.748	0.768	0.973	**12**
0.918	0.918	1.000	**13**
0.625	0.796	0.785	**14**
1.000	1.000	1.000	**15**
0.605	0.605	1.000	**16**
0.526	0.709	0.743	**17**
0.937	0.937	1.000	**18**
0.291	0.291	1.000	**19**
0.728	0.728	1.000	**20**
0.537	0.645	0.832	**21**
0.551	0.692	0.797	**22**
0.648	0.908	0.714	**23**
1.000	1.000	1.000	**24**
0.591	0.656	0.901	**25**
0.596	0.596	1.000	**26**
0.735	0.755	0.974	**27**
1.000	1.000	1.000	**28**
0.638	0.638	1.000	**29**
0.789	0.789	1.000	**30**
0.696	**0.743**	**0.936**	**Average**
0.285	**0.285**	**0.714**	**The lowest value**
1	**1**	**1**	**highest value**

Source: Based on the data of the questionnaire according to the Deap data envelope program.

ISSN 2072-3857

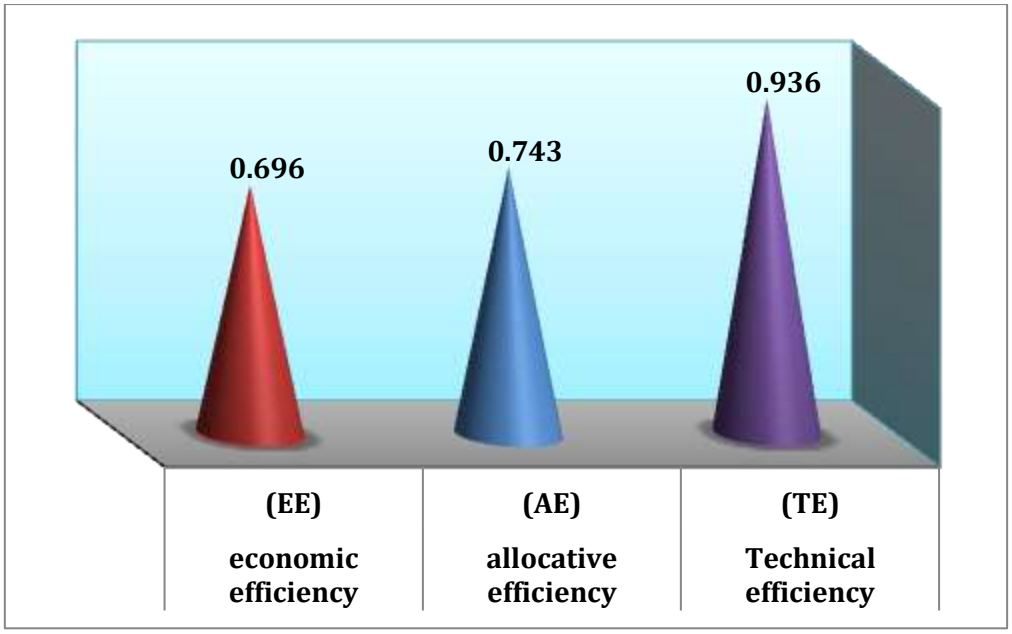

Figure (2): Average technical, specialized and economic efficiency according to the change in capacity returns
Source: prepared by the researcher based on the data of Table (2).

Conclusions and recommendations

Conclusions:

1- By estimating the technical efficiency based on the variables of the production function using the drip irrigation method, the average technical efficiency rate was (72%) for the tomato crop in the Samarra district. There is a (7) farms achieving optimum technical efficiency (100), as they constituted a percentage of (23%) of the total number of farms in the studied sample.

2- By estimating the technical efficiency according to the method of data envelope analysis (DEA) and depending on the variables of the cost function, the number of farms that achieved price efficiency (AE) at the level of (100%) are ((4 farms for the tomato crop, and it constituted a percentage of (13%) of the total sample studied.

3- The study's findings revealed that the average economic efficiency (EE) for the tomato crop was 69%, which is quite low given the conditions that the country's agricultural sector, in general, and the Samarra district in particular.

Recommendations:

1- Adopting the expertise of the owners of efficient farms and benefiting from them in employing their expertise in the inefficient farms in order to bring them to full levels of efficiency.

2- Benefiting from the efficiency indicators obtained through the data envelope model for production functions with constant and variable volume returns for tomato farms that did not achieve 100% efficiency index.

3- The research recommends using the DEA data envelope analysis method in future research and studies because it provides detailed results on each farm and each resource used in the production process to know the problems and obstacles facing farmers in the production of tomato crops and other agricultural crops and how to reach successful solutions to them.

4- Adopting effective price policies by the state to support farmers by providing production elements with good quality and reasonable prices, maintaining the stability of the output price to serve the producer and

ISSN 2072-3857

consumer, limiting the imported quantities of vegetable crops and imposing customs duties on the borders in order to encourage local production of vegetable crops.

References:

1. Al-Aqabi, Mahdi Alwan Rahima. (2020). The reality of government support for the agricultural sector in Iraq for the period (2004-2016). Journal of Wassit for human sciences, volume 15, p:683-724.
2. Henriques, I.C., Sobreiro, V.A.,Kimura, H.,& Mariano, E.B.(2020). Two-stage DEA in banks: Terminological controversies and future directions. Expert Systems with Applications, 161, https://doi.org/10.1016/j.eswa.2020.11363
3. Huguenin, Jean-Marc. (2012). Data Envelopment Analysis (DEA) A pedagogical guide for decision makers in the public sector. Institut de hautes etudes en administration puplique swiss Graduate School of Public Administration Quartier UNL - Lausanne.
4. Muhammad Badawi Hussein, Kamel Kazem Bashir Al-Kinani, & Rasoul Hadi Hassoun. (2020). The reality of agricultural policies and their effectiveness in achieving sustainable agricultural development in Iraq. Journal of Economics and Administrative Sciences, 26 (117), 327-346
5. Rostamzadeh, R., Akbarian, O., Banaitis, A., & Soltani, Z. (2021). Application of DEA in benchmarking: a systematic literature review from 2003–2020. Technological and Economic Development of Economy, 27(1), 175-222
6. Zhong, K., Wang, Y., Pei, J., Tang, S., & Han, Z. (2021). Super efficiency SBM-DEA and neural network for performance evaluation. Information Processing & Management, 58(6), 102728

ISSN 2072-3857