

Estimation of the Overall Economic Efficiency of Pepper Farms Cultivated in Greenhouses for the 2024 Summer Production Season in Salah Al-Din Governorate – Al-Ishaqi Subdistrict (A Field Study)

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Abstract

The research aims at assessing and measuring the economic efficiency of pepper farms under greenhouse cultivation in the Ishaqi sub-district of Salah al-Din Governorate during the production season of 2024/2025 with the aim of measuring the efficiency of the production factors deployed, and the presence of inefficiencies and inadequacies in the performance of the farms. The study was composed of 75 random selected farms, whereby data were collected with the help of specially developed questionnaire and assessed with the help Utilization of the Data Envelope Analysis (DEA) methodology to ascertain technical, allocative, and economic efficiency. The results showed that the average technical efficiency was 0.89 which implied that there could be a 11 percent production gain even when there would not increase any more inputs and the average allocative efficiency was 0.85 implying that there was a 15 percent wastage of resources because of the reduced utilization of production factors or high costs. The macroeconomic efficiency was on average 0.76 which means that farmers can reduce the production costs by a quarter and maintain the current production level.

The results revealed that only six farms have achieved full allocative efficiency, which means that resources used are productive and are utilized at the optimal level. The study revealed that the government policy of protection of local produce and curbing border crossings during pepper production season positively impacted on increasing the price and improving the profitability, but at high costs. The research suggests that there is a necessity to enhance the agricultural extension programs, to motivate the farmers in utilizing modern technologies in the irrigation and fertilization methods, as well as the cost of basic production requirements should be reduced with the help of efficient support policies, in such a manner that this will help to increase the economic efficiency and realize the sustainability of agricultural production in the region.

Keywords: Overall Economic Efficiency, technical efficiency, allocative efficiency, protected agriculture, data envelope analysis (DEA), pepper crop.

Introduction:

Protected cultivation is regarded as one of the most effective mechanisms of producing vegetables that are out of their natural growing season or those situations where the crops are affected adversely by environmental factors such as temperature, humidity and light intensity. Such a combination of the cultivation method, with modern technical processes in the irrigation, fertilization and pest inhibition of crops enables the farmers to produce the maximum per hectare of quality crops even though the establishment and maintenance costs of the greenhouse production are relatively high. Furthermore, the under protection cultivation area is an efficient strategy to expand the productive cultivation area since it encourages the growth of the vegetable crop production. This, in its turn, allows open-field lands being employed to cultivate strategic staple crop [2].

The most significant issue of Iraq now, and even in the predictable future, is the adequate food supply, and the need to make the gap between the fact that the production of vegetables and their consumption is ranked second only to grains among the main food components. Iraqi vegetable crops are likely to have high and high frequency change of products prices and competing products prices that are directly related to the producers and consumers.

Pepper (*Capsicum* spp.) is one of the vegetable crops of great importance in Iraq. It can be consumed fresh, dry or ground and used as a spice in addition to being a primary ingredient in most types of foods especially in hot and tropical regions. Pepper plant was native to South America where it grew in different forms in the wild before transportation to India, and later to the tropical and subtropical

parts of all the continents, East Indian, Chinese, Spanish, Greek and African islands.

Pepper requires a warm and long growing period without frost. The seed germination is optimal at a temperature between 20 °C and 30 °C, and at this temperature, it takes the seed about ten days to germinate [3] [4]. However, the crop is highly sensitive to low temperatures during the vegetation stage of growth and moderately to high temperatures and drought. This is because the ideal fruit setting temperature ranges between 30 °C and 35 °C [1].

Given these climatic conditions, pepper growing is a good step in the optimization of the output of the vegetable crops in Iraq. It also contributes to improving the quality of the crops and it also counteracts these adverse effects of climatic variability. Therefore, there is the need to investigate the economic effectiveness of pepper production under greenhouse to calculate the efficiency of operation of the resources, maximize the input to productivity, and make the farmers more profitable.

Research Problem:

Although the growth of the agrarian sector of the Salahuddin Governorate was marked by the spread of controlled agriculture, there is still a considerable difference in the level of productivity of pepper plantations and the consumption of production factors. This dispersion implies that, there exists both technical and allocative inefficiency among the farmers that might lead to misallocation of resources in the economy and low returns to the economy. Thus, this makes it necessary to determine what extent productive resources is being actively applied in guarded pepper farms in the Ishaqi sub-district, and what factors are the

key ones affecting the level of productive effectiveness in these farms.

Objectives of the Research:

The objectives of this research are to examine and quantify the economic efficiency of pepper crop farms planted under the system of protected agriculture located in the Ishaqi sub-district of Salah Al-Din Governorate to fulfill the following objectives:

- 1- Determining the technical efficiency, Allocative and economic efficiency of pepper cultivation in a greenhouse using Data Envelopment Analysis (DEA).
- 2- The examination of the reasons behind the level of production efficiency and what level of production efficiency can be attributed to each of the different factors of production (labor, land, fertilizers, seeds, water, and energy).
- 3- Detect productivity weaknesses and waste among farmers in the utilization of agricultural resources, and in the diagnosis of the efficiency weaknesses in certain farms.
- 4- Recognizing the possibility to enhance economic efficiency by means of optimal redistribution of resources to ensure maximum productivity and minimal cost.
- 5- Giving proper quantitative indicators that help in formation of the policies related to the agricultural resources management and guide the technical and financial assistance to the agricultural production increase and attainment of sustainable agricultural development in the area.

Significance of the study:

The research is very important because it offers accurate quantitative measures used in determining the economic efficiency of the secured pepper farms at the Ishaqi sub-district. In this way, it helps get a better insight into the differences in the productive resources used in various farms and allows conducting an analysis of the correlation between production inputs and results scientifically rigorously. The results of this study will be used in the formulation of efficient agricultural resource management strategies towards greenhouse systems and provide viable advice to the farmers on the best utilization of seeds, fertilizers, water, and labor. These enlightenments are meant to add values in terms of productivity, minimizing the wastage of resources, maximizing profitability, and minimizing operation costs.

Moreover, the research is important to any sustainable rural development by increasing the income of farmers, increasing employment in rural regions, bridging the economic disparity between smallholders and large-scale farmers, and giving policy-makers a credible, evidence-based source in useful allocation of technical and financial assistance. The outcomes will also contribute to the development of strategic plans on how to develop the protected agriculture, which will increase the food security in the region, and will decrease the reliance on the imports, especially under the conditions of the climate change and the increase of inputs prices.

Moreover, the research work can be used by other scientists in future as a source of scientific data when they may plan to research other crops or other fields. It prepares a basis of implementing the

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sophisticated approaches toward economic efficiency analysis, thus adding to the level of scientific knowledge and strengthening the ability to make quality economic and agricultural choices grounded on reliable data and thorough analysis.

Researcher's Hypothesis:

- 1- The research is based on the hypothesis that there are statistically significant differences in production efficiency levels.
- 2- The lack of farmers to select the best resource combination of production elements so as to use inherited habits and skills in the agricultural industry and to not keep up with scientific advances by which production elements can be mixed in a manner that is the one that maximizes profits and minimal cost resulting in economic efficiency.

The research community: The research was based on the use of a questionnaire form to sample out 75 farmers in the productive season 2025, having a random sample of the farmers based on the Salah al-Din Governorate - Ishaqi sub-district. Data analysis was done using DAE data envelope analysis program.

Theoretical paradigm

Economic efficiency:

Economic efficiency is the ability to produce more at a lower cost by utilizing sources of wealth in a manner that maximizes return at the same or reduced cost [9]

- 1- **Technical Efficiency:** Technical efficiency is the capacity of a production unit to give the maximum output possible using a given amount of available resources [6]. It is one of the most critical components of the overall economic effectiveness. An facet

of technical efficiency is the ability of a farm to maintain output at the same level while utilizing the least quantity of inputs in production. [10]. Therefore, technically efficient farm is located where production frontier is being run at the production frontier, where no more output can be achieved without an increase in the input use.

- 2- **Allocative (Distributive or Price)-Efficiency:** Allocative efficiency or distributive efficiency or price efficiency: this term describes the efficiency of a production unit to choose the best combination of inputs to incur the lowest total cost of producing a given quantity of output at the current prices of inputs and available technology. It indicates that the farm is well able to utilize its resources in a proportion that would equate the marginal value product of every input to the marginal cost, which would guarantee that the resources are utilized in the most economically rational way. [7]. One of the types of economic efficiency is the specialization efficiency besides the technical efficiency of the capacity of the farm to acquire the best allocation of economical resources considering its prices on economic options available. [11]

Economic efficiency:

- 1- **1- Economic efficiency with a focus on input:** The input-oriented economic efficiency is the level at which the amount of inputs can be minimized without causing any reduction in the output levels. That is to say that it evaluates the possibility to reduce the input consumption and achieve

the same output level [8]. This strategy is input-oriented, and it is especially applied when the main priority is a reduction of resources or a decrease in costs.

- 1- **Output-oriented economic efficiency:** Output-oriented economic efficiency in its turn is the measure of the ability to raise the levels of output in a proportionate manner without the need to raise the level of inputs [5]. This is the view where maximizing the production efficiency is the primary consideration and can be used in situations where one wants to maximize the productivity given a given fixed resources.

Assessing the economic efficiency of pepper cultivation and its components (technical and allocative) via the analysis of cost function variables.

The quantities and costs of resources used in the production process can be used to compute the technical efficiency, allocative efficiency, and economic efficiency (cost efficiency) as is shown in Table (1). The assumption is that the output of pepper crop will vary depending upon the time of the year (2024). Table (1) points out that the average technical efficiency was (0.89). This observation is quite close to the calculation of capacity efficiency with respect to changes in yields which points to the fact that such farms can increase their output by 11 percent using their resources. It is also indicating that resource wastage can occur due to inefficiency which will increase the costs by 11 percent.

It can be observed that the allocative efficiency varied between the highest level of the right and the lowest level of 0.249 at the sample level with the mean being 0.85. It means that there is an opportunity to enhance output through the application of the modern technologies and optimality in the use of resources by 15%. As a result, the economic resources transfer will lead to

the reduction of the expenses by 15 percent without the decrease of the same level of output. As a result, such farms attain the optimum output, the costs are equated to an equal output curve, as they are the sum total of all the farms which have attained 100 percent allocative efficiency, which are termed as model farms. The surplus inputs on these farms are zero in this case, as all inputs are utilized in their optimum levels to give maximum output, therefore, the stationary values are zero. Other farms which have reached full technical efficiency have not managed to reach full allocative efficiency since the cost of other resources employed in the production process is high. This leads to inefficient allocation efficiency compared to the optimum level meaning that the only solution of efficient production is at the level of complete technical competence and definite incompetence. But as the cost of the farm declines to the point of the cost line touching the equal output curve the farm will obtain both the private and economic efficiency since the technical efficiency will just cross the boundary to obtain an increment of economical efficiency, so that the rate of change of the technical efficiency will maintain the same rate till it reaches the maximum capacity. The table illustrates the findings of estimating the economic efficiency of pepper crops, and the overall economic efficiency is 76; this is an average result of the product of technical efficiency and allocative efficiency. This means that these farms will be able to cut down the cost by 24 percent whilst still delivering the same amount of output. The 24 percentage point growth can be achieved in such farms without improving the economic efficiency of the production resources. The plan implemented by the Ministry of Agriculture to protect local products and ensure crossing points at the borders during the production of the 2024 pepper crop had a considerable influence on the sampled producers. The high cost of production and the selling price of the crop during the production period was

viable and it provided the farm with an economic payoff that made the farmer be

able to cover the cost of farming and make a financial gain. Figure 1 illustrates this.

Table (1) The pepper crop's technological, financial, and distributive efficiency.

Economic Efficiency	Technical Efficiency	Price Efficiency	T	Economic Efficiency	Technical Efficiency	Price Efficiency	T
0.657	0.84	0.781	40	0.249	0.249	1	1
0.916	0.916	1	41	1	1	1	2
0.900	0.963	0.935	42	0.485	0.705	0.688	3
0.769	0.941	0.817	43	0.542	0.542	1	4
0.756	0.917	0.824	44	0.590	0.650	0.907	5
0.789	0.947	0.833	45	0.832	0.923	0.902	6
0.801	0.951	0.842	46	0.759	0.759	1	7
1	1	1	47	1	1	1	8
0.908	0.908	1	48	0.704	0.704	1	9
0.751	0.917	0.818	49	0.897	0.897	1	10
0.784	0.943	0.832	50	0.596	0.596	1	11
0.776	0.944	0.822	51	1	1	1	12
0.738	0.835	0.884	52	0.794	0.949	0.837	13
0.902	0.902	1	53	0.751	0.917	0.818	14
0.843	0.953	0.885	54	0.671	0.821	0.817	15
0.761	0.931	0.817	55	0.86	0.919	0.936	16
0.743	0.908	0.818	56	0.931	0.968	0.961	17
0.756	0.925	0.818	57	0.743	0.9	0.825	18
0.850	0.965	0.881	58	0.801	0.951	0.842	19
0.861	0.956	0.901	59	0.769	0.941	0.817	20
0.891	0.974	0.914	60	0.682	0.770	0.886	21
0.819	0.955	0.857	61	0.758	0.928	0.817	22
0.756	0.917	0.824	62	0.749	0.911	0.822	23
0.941	0.941	1	63	0.95	0.962	0.988	24
0.784	0.943	0.832	64	0.915	0.915	1	25
0.749	0.911	0.822	65	1	1	1	26
0.767	0.931	0.824	66	0.837	0.933	0.898	27
0.62	0.62	1	67	0.993	0.998	0.996	28
0.690	0.896	0.771	68	0.361	0.405	0.890	29
0.713	0.798	0.893	69	0.827	0.827	1	30
0.737	0.91	0.81	70	0.865	0.909	0.951	31
0.704	0.916	0.768	71	0.351	0.409	0.858	32
0.723	0.766	0.944	72	0.337	0.383	0.879	33
0.728	0.872	0.835	73	1	1	1	34
0.729	0.917	0.795	74	0.311	0.402	0.773	35
0.648	0.907	0.714	75	0.276	0.347	0.796	36
0.761	0.854	0.890	Average	0.817	0.93	0.879	37
1	1	1	Highest	0.939	0.962	0.976	38
0.249	0.249	0.688	Lowest	0.914	0.961	0.951	39

The source :prepared by the researcher based on the results of the Data Envelopment Analysis method.

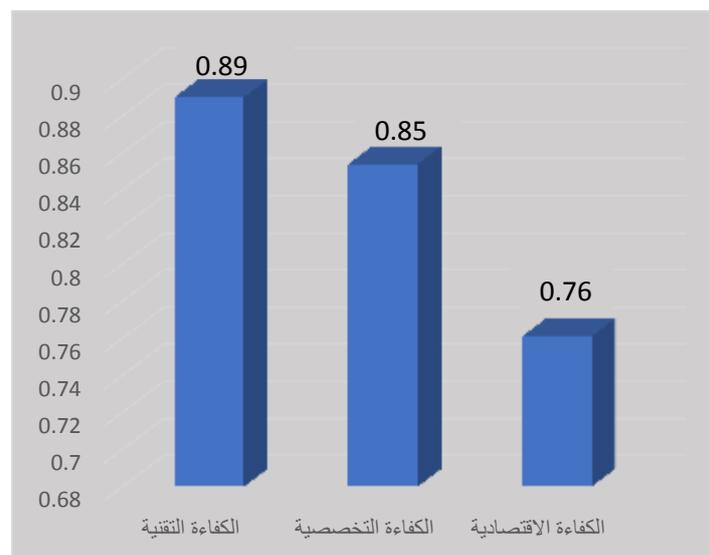


Figure (1) Economic, allocative, and technological efficiency of the pepper crop on average.

Source: created by the researcher using Excel and based on the information in Table (1).

Findings:

- 1- The study results revealed that the mean technical efficiency of pepper farms was (0.89), which indicates that the production can be increased by (11%) without the necessity to increase the present inputs of production.
- 2- The average efficiency of the allocation was (0.85) that indicates the waste in the consumption of the resources by approximately (15) percent due to the absence of optimal consumption of the factors of production or its high price.
- 3- The mean macroeconomic efficiency measures (0.76), this means that the farms will be able to cut down their production expenditure by (24) and at the same level of the current production.
- 4- It was also observed that not all the farms that were highly technologically efficient were similarly allocatively efficient because the cost of the productive resources, in particular, fertilizers and energy, was high, and they were not able to achieve the most efficient combination of inputs.
- 5- It was established that the full allocative efficiency (100) of the number of farms was attained at only (6) farms which are the farms that could utilize the resources at its optimal size with a maximum production being attained.
- 6- The results of the analysis revealed that government policy of protecting the local product and closing the border crossings at the season of pepper production showed the farmers in a good light as it positively influenced the rise in prices and the economic yield despite the high cost of production.
- 7- The findings suggest that macroeconomic efficiency can be increased to levels above (85%), through better agricultural management and modern technologies in the production of the agricultural

sector to improve the sustainability and profitability of agricultural production.

Recommendations:

- 1- The necessity to enhance the agricultural extension programs to increase the awareness of farmers about the significance of efficient various productive resources utilization and promote the entry of modern scientific farming methods.
- 2- promote the use of modern techniques in agriculture use of irrigation, fertilization and pest management in order to increase technical efficiency and productivity of the unit of area.
- 3- Striving to mobilize agricultural support policies to minimize the price of basic productions needs particularly fertilizers and energy in such a manner that helps increase the allocative efficiency of farmers.
- 4- Facilitating the creation of the correct marketing data bases so that farmers have access to the market information on a regular basis so as to assist farmers make more efficient and profitable production and marketing choices.
- 5- The outcomes of the analysis of economic efficiency that the local and regional agricultural policy formulates by channeling resources towards agricultural activities that are more efficient and economically viable.
- 6- The need to extend the area of further research to cover other vegetable produce under the protection agriculture system in order to have a comprehensive research on the effectiveness of agricultural production in Iraq.
- 7- Promoting practical research that has an association between economic effectiveness and environmental aspects, particularly on the realms of rationalizing water and energy

utilization, to realize long-term agricultural sustainability.

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