Measuring the Technical and Economic Efficiencies of Citrus Productionin Latakia, Syria

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Abstract

The study was conducted to evaluate the technical and economic efficiencies of citrus production in Latakia Governorateby using Data Envelopment Analysis through a personal interview with 381 farmers forthe growing season 2017-2018.It included a number of variables such as organic, nitrogenous and phosphate fertilizers, irrigation water, and labor. Theoutputs were production and application of anoutput-oriented linear programming model that assumes the variable return to scalefor estimating the economic efficiency of production and costs function. It was found that the average technical efficiency at constantreturn to scale was 65.5% vs. 80.2%forvariablereturn to scale and 83.6% for scale efficiency. The results showed that the average allocative and economic efficiencies for citrus growerswere 37.6% and 30.4%, respectively. Farmers in the second landholding category (1-2ha) were the highestin achieving scale and technical efficienciesby using the optimal combination of inputs, but they were less interested in the purchase price of inputs and thus increased the waste of money, resulting in lower economic efficiency. Therefore, the study recommends intensified training courses for farmers on using optimal quantities of production inputs to achieve the best technical efficiency, as well as combining smallholdings of the first category and reducing the cultivated area in the third category to achieve the efficiency of the optimal scale of farm, as well as the need to increase farmers' interest in inputs price for reducingmoney waste, coinciding with government agencies' study of the reasons for rising prices of inputs and thus to ensure the creation of appropriate solutions to reduce or subsidize prices.

Keywords: *Citrus, Technical and Economic Efficiency, Data Envelope, Syria.*

I.INTRODUCTION

In recent decades, citrus production has been growing at a global level due to an increase in citrus growing area and changes in consumer preferences towards more healthy and appropriate food consumption as a result of higher incomes (Lawal, 2007).

During 1996-2005, citrus production reached about 20% of the world's fruit production (Ali, 2008). In 2016, the world production reached 165,259 thousand tons, of whichoranges production was: 49.5%, lemon 11.9%, mandarin 30.3% and grapefruit 8.3%. The area reached 10,461 thousand hectares, of which the area of orange was 42.7%, the area was 11.3% forlemon, 41.5% formandarin, and 4.5% for grapefruit. According to the Food and Agriculture Organization (FAO) data for the year 2016, the most important citrus producing countries are distributed to more than 104 countries, including Brazil, China, India, the United States of America, Mexico, Spain, Egypt, Indonesia, South Africa and Turkey (FAO, 2016).

Syria occupied the third place in the Arab world with a production of 1173 thousand tons, an area of 44.1 thousand hectares after Egypt and Morocco, the seventh place atthe Mediterraneanlevel, and 24th rank at the world level (Syrian Annual Agricultural Statistic Abstract, 2016).

Technical efficiency is one of the main productivity components used in measuring farm performance. It is used to measure the farm's ability to maximize production using a given set of inputs. Therefore, the technically efficient farm operates within production limits, while the technically inefficient farm working under production limits can be effective by increasing its output at the same level of input or using fewer inputs to produce the same level of production. As such, the closer the farm is to the border, the more technically efficient it becomes (Ogunyinka&Ajibefun, 2003) .As the availability of production inputs and their use management have had a significant impact on the success of the citrus growing sector, the importance of measuring technical and economic efficiency should be given due consideration in proportion to the urgent need to find appropriate solutions during the current economic crisis in Syria.

II. RESEARCH PROBLEM

The problem of the research mainly lies in the negative economic impact of the Syrian crisis on the citrus growing sector in Syria, i.e. an increase in production costs due to higher prices of production inputs such as mineral and organic fertilizers, control materials and others. This resulted in high costs of agricultural practices such as harvesting and pruning, and lack of trained labor and high wages, and thus low economic efficiency of citrus production in Latakia, so the farmers started uprooting trees and searching for alternative crops, prone this sector to threat.

III. RESEARCH IMPORTANCE AND OBJECTIVES

This research is important because it studies a high economic crop and anincome source for many farming households in the coastal region in general and in Latakia in particular, as well as measuring the possibility of increasing production in light of current crisis, which requires increased utilization of inputs and in line with savings of scale to achieve the highest productive efficiency. The research aims at:

1. Measuring the technical efficiency in light of the constant and variable return to scale based on production function.
2. Estimating the economic and allocative efficiencies of citrus production based on cost function.

IV. MATERIALS AND METHODS

A. Study Region

The research was carried out in the coastal area which is suitable for citrus growing and the most important citrus growing area in the Syrian Arab Republic. Latakiaoccupies the first place in terms of citrus production which is estimated at 903 thousand tons and 77% of the total citrus production in Syria. In terms of cultivated area, it was 33.4 thousand hectares and 75.7% of the total area according to 2016 statistics. The region is characterized by moderate climate throughout the year, as well as the importance of citrus as a source of income for more than 50 thousand farming households and availability of agricultural information and technical expertise for farmers.

B. Methodology

Data sources: Two types of data were relied upon:

❖ Secondary data: data collected from the Ministry of Agriculture and Agrarian Reform, the annual agricultural statistical abstract, the Agriculture Directorate in Latakia, and the Food and Agriculture Organization (FAO).

❖ Preliminary data:data collected forthe growing season 2017/2018 through a questionnaire prepared for the purpose ofpersonal interview with a simple random sample of citrus growers in Latakia. This sample included 381 farmers. A number of variables such as organic,nitrogenous and phosphate fertilizers, and irrigation water amountand labor were used. Outputs were represented by production for the purpose of estimating the technical efficiency of the outputs, called measures output oriented, assuming variablereturn to scale (VRS), and constantreturn to Scale (CRS) for citrus farmbased on the Data Envelope Analysis model (DEA). This model is based on two aspects: the first by searching for quantitative items to measure the inputs and outputs of each unit of study, and then comparing the activity of each of these units with the activity of a typical virtual unit that works with the lowest possible inputs to produce the best possible outputs, and thus to differ from traditional comparisons based on the general (modified) line of inputs and outputs of these units. The second is through linear programming to construct actual performance based on N independent variables affecting production (Joe, 2003). a non-parameter approach that does not take into account the random error of estimation (Herrero& Sean, 2002). The name of this approach is due to that the administrative efficiency units are at the forefront and inefficient administrative units are enveloped, and thus the data enveloped by the introduction are analyzed(Charnes et al, 1982).

The most important characteristic of the data envelope analysis technique is the lack of the need to develop hypotheses (mathematical formula of the function) linking the independent and dependent variables, as the data expresses aboutitself rather than expresses about the framework of the formula of a function imposed on it as in the production function of the "Cobb-Douglas"(Charnes et al, 1982). The overall objective of the method is to maximize the amount of outputs or to reduce the amount of inputs. This method is used to find economic efficiency and its components (Technical efficiency and allocative efficiency) and estimate scale efficiency,where input-oriented technical efficiency refers to the ability to reduce the use of inputs to a given level of output, i.e. the possible reduction of inputs to a given quantity of output, as well as the possible increase in production by using a specific set of inputs (Osborne &Trueblood, 2006).However, the allocative efficiency refers to produce a certain amount of outputs at the lowest possible cost of production inputs(Yot, 2011).Allocative efficiency determines the return to scale of any production unit by measuring scale efficiency. The main reason for this method is that economies of scale can directly determine the efficient and non-inefficient production units. Scale efficiency is measured by avariable Return to Scale (VRS) and Constant Return to Scale (CRS) by using DEA method. Thus, the degree of technical efficiency obtained through CRS and VRS is divided into two parts,the first is for non-efficiency of scale and other for technical non-efficiency. The differences between the technical efficiency obtained from CRS and VRS for the production unit mean that the production unit suffers from non-efficiency of scale, which is equivalent to the difference between technical efficiency in CRS and VRS. The scale efficiency for production unit is calculated by dividing the technical efficiency index of the unit underconstancy of return to scale to thetechnical efficiency index undervariable return to scale for the same production unit as follows:

$$Sei = TEi^{crs} / TEi^{vrs}$$

If Sei = 1 means that there is scale efficiency, whereas Sei<1 means no scale efficiency (Qurmla, 2008).

V. RESULTS AND DISCUSSION

A. *Estimating the Efficiency of Citrus Farms Based on Production Function:*

1. *Technical Efficiency of Citrus Farms with Constancy of Return to Scale (CRSTE)*

The results of the sample analysis for citrus farms in Latakia Governorate for the growing season 2017/2018 showed that the average technical efficiency based on the production function in light of the constancy of return to scale reached 65.5%. This means that farmers can increase their production by 34.5% without using additional resources. The efficiency ranged between a minimum of 25.4% and a maximum of 100%. The following table shows the level of technical efficiency of citrus farms underconstancy of return to scale based on the production function.

Table (1).The Level of Technical Efficiency of Citrus Farms underConstancyof Return to Scale

Level of CRSTE	Farms	%
%40 >	13	3.4
%50 – 40	64	16.8
%60 – 50	96	25.2
%70 – 60	73	19.2
%80 – 70	46	12.1
%90 – 80	39	10.2
%100 – 90	22	5.8
%100	28	7.3
Total	381	100

Source: the researcher based on the research sample 2018, and DEAP analysis

2. *Technical Efficiency of Citrus Farms with Variable Return to Scale (VRSTE):*

The average technical efficiency of citrus growers was 80.2%. This means that farmers can increase their production by 19.8% without additional resources. Efficiency ranged between 31.0% and 100%. The following table shows the level of technical efficiency for citrus farms with variable return to scale based on production function.

Table (2). The Level of Technical Efficiency of Citrus Farms with Variable Return to Scale

Level of VRSTE	Farms	%
%40 >	5	1.3
%50 – 40	22	5.8
%60 – 50	66	17.3
%70 – 60	47	12.3
%80 – 70	30	7.9
%90 – 80	33	8.7
%100 – 90	45	11.8
%100	133	34.9

Total	381	100

Source: the researcher based on the research sample 2018, and DEAP analysis

3. Scale efficiency of citrus farms:

The scale efficiency of the farm is expressed by the ratio between technical efficiency with constant return to scaleand the technical efficiency with variable return to scale (CRS/VRS). By analyzing the study sample using DEA method, the scale efficiency ranged between a minimum of 25.4% and a maximum of 100%, andon an average of 83.6%. The following table shows the level of scale efficiency of citrus farms based on production function:

Table (3). The Level of Scale Efficiency of Citrus Farms

Level of SCALE	Farms	%
%40 >	5	1.3
%50 – 40	9	2.4
%60 – 50	18	4.7
%70 – 60	52	13.7
%80 – 70	51	13.4
%90 – 80	71	18.6
%100 – 90	146	38.3
%100	29	7.6
Total	381	100

Source: the researcher based on the research sample 2018, and DEAP analysis

B. Estimating the Efficiency of Citrus Farms Based on the Cost Function:

1. Allocative Efficiency of Citrus Farms (AE):

The results showed that the levels of Allocative Efficiency(AE) of the citrus farms in the study sample ranged between a minimum of 9% and a maximum of 100%, and on an average of 37.6%. This means that there is a waste of resource prices of 62.4%.The following table shows the level of allocative efficiencyof citrus farms based on cost function:

Table (4). The Level of Allocative Efficiency of Citrus Farms

Level of AE	Farms	%
%40 >	258	67.7
%50 – 40	53	13.9
%60 – 50	29	7.6
%70 – 60	10	2.6
%80 – 70	9	2.4
%90 – 80	7	1.8
%100 – 90	6	1.6
%100	9	2.4
Total	381	100

Source: the researcher based on the research sample 2018, and DEAP analysis

2. Economic Efficiency of Citrus Farms (CE):

The average economic efficiency of citrus farms in the study sample was 30.4%, ranging between a minimum of 9% and a maximum of 100%. The following table shows the level of economic efficiency of citrus farms based on cost function:

Table (5). The Level of Economic Efficiency of Citrus Farms

Level of CE	Farms	%
%40 >	299	78.5
%50 – 40	32	8.4
%60 – 50	20	5.2
%70 – 60	8	2.1
%80 – 70	4	1.0
%90 – 80	3	0.8
%100 – 90	6	1.6
%100	9	2.4
Total	381	100

Source: the researcher based on the research sample 2018, and DEAP analysis

C. Estimatingthe Technical, Scale, Allocative and Economic Efficienciesof Citrus Farms bylandholding Category:

The area cultivated with citrus was divided into three categories to measure the technical efficiency of each category. The first one is smaller than 10 dunums, the second is between 10 and 20 dunums, and the third is larger than 20 dunums. The minimum efficiency under constancy of return to scale was 25.4% and 35% and 30.2%, respectively,while the minimum efficiency under variable return to scale was 44.1%, 36.6% and 31%, respectively. Scale efficiency reached a minimum of 25.4%, 35.2% and 54%, respectively. The allocative and economic efficiencies for the three landholding categories were calculated in light of variable return to scale based on cost function, and the minimum allocative efficiency for categories was 12.9%, 9%, 9.4%, respectively,while the minimum economic efficiency reached 9.1%, 9%, 9%, respectively. The following table shows the average technical, scale, allocative and economic efficiencies of citrus farms by landholding category.

Table (6).Technical Efficiency, Scale, Allocative and Economics of Citrus Farms by landholdingCategory

Landholding category (ha)	CRSTE	VRSTE	SCALE	AE	CE	farms	%
<1	65.6	80.7	83.3	45.1	37.1	141	37.0
1 – 2	69.5	81.2	87.5	31.4	25.1	121	31.8
>2	61.5	78.6	80.1	35.1	28.1	119	31.2
Total	–	–	–	–	–	381	%100

Source: the researcher based on the research sample 2018, and DEAP analysis.

Through the average technical efficiency underconstancy of return to scale for the first threelandholding categories, farmers would able to increase production by 34.4%, 30.5%, and 38.5%, respectively, if the farmers optimally used the same amount of inputs, and the actual production was less than optimal achievable production, resulting in anincrease in the cost per ton with the same percentage. However, they can increase production with the same amount of inputs in light of variable return to scale by 19.3%, 18.8%, and 21.4%. For scale efficiency, scale savings for landholding categories were 16.7%, 12.5%, 19.9% respectively. Based onthe above, it was clear that the growers of the second category (1-2 ha) were the most technically efficient in using available resources atconstancy of return to scale and variable return to scale. It also achieved the highest efficiency in exploiting the area to achieve optimal production, but they were less interestedin the price of inputs and ability to obtain inputs at competitive price comparing with other categories.There was a waste of input price of 54.9% for the first category and 68.6% for the second and 64.9% for the third.However, growers in all categories were far from achieving economic efficiency because they did not achieve price efficiency, but it was the best for the owners of the first landholding category with 37.1% and higher than the other two categories, 28.1% for the third and 25.1% for the second.

D. Estimating the Technical, Scale, Allocative and Economic Efficienciesof Citrus Farms by variety:

In order to estimate the efficiency of citrus varieties, the sample was divided into its main groups represented by orange, lemon, mandarin and grapefruit. The minimum technical efficiency underconstancy of return to scale was 41.8%, 53.6%, 45.5% and 47.1%, respectively versus 41.9%, 67.8%, 64.1% and 53.9%, respectively variable return to scale. Therefore the scale efficiency was at a minimum of 45%, 58%, 47.7% and 47.1%.The allocative efficiency for citrus group was at a minimum 9.4%, 12.8%, 15.9%, and 26.8% respectively, and the economic efficiencywas at a minimum 9.3%, 12.6%, 15.9%, and 26.8% respectively.The following table shows the technical, scale, allocative and economic efficiencies of citrus farms by variety:

Table (7).Technical Efficiency, Scale, Allocative and Economic Efficienciesof Citrus Farms by Variety

Variety	CRSTE	VRSTE	SCALE	AE	CE	Farms	%
Oranges	75.6	83.9	90.1	38.8	33.1	352	92.4
Lemons	83.0	91.5	90.7	49.9	46.1	247	64.8
Mandarin	78.1	90.3	86.7	50.9	46.4	285	74.8
Grapefruit	79.4	91.5	87.2	68.7	63.7	119	31.2

Source: the researcher based on the research sample 2018, and DEAP analysis.

The table shows the average technical efficiency of oranges, lemons, mandarin and grapefruit farms.The farmers were able to increase their production by 24.4%, 17%, 21.9%, and 20.6% respectively, using the same amount of input. It also shows an increase in production using these inputs under variable return to scale by 16.1%, 8.5%, 9.7%, and 8.5% respectively. The savings of scale were 9.4%, 9.6% 13.3%, and 12.8% respectively. For allocative efficiency, there was a waste in the price of inputs by 61.2%, 50.1%, 49.1%, and 31.3%respectively. The highest economic efficiency was for grapefruit growers, followed by growers of mandarin, lemons farms, and oranges.

VI. CONCLUSIONS

The results show that the technical and scale efficiencies for citrus farmers can achieve a higher production level using the same amountof inputs, and the farmers in landholding category (1- 2ha) were the best in achieving scale efficiency and the best in using the optimal combination of inputs. In terms of variety, the technical efficiency was the highest for lemons and grapefruit farms followed by mandarin and oranges.The scale efficiency was higher for lemon farms, oranges, grapefruit and mandarin, respectively. The resultsof allocative and economic efficiencies, based on cost function, showed that smallholders less than 1haare highly interested in inputs price, thus achieving higher allocative efficiency which positively improved economic efficiency compared with the second category which is less interested in the purchase price of inputs, resulting in low economic efficiency despite of achieving high technical efficiency in light of using the amount of inputs.

In general, citrus growers are far from economic efficiency due to the lack of allocative efficiency resulting from the high costs of agricultural practices of harvesting and transport. There is also a waste in inputs price from mineral and organic fertilizers, control materials, etc. due to variant prices during close intervals, and between traders of the same region, because of the Syrian crisis, which had had consequences represented by instable and significantly variant costs of agricultural practices and production inputs.

Therefore, the study recommends intensifying extension and training courses via agricultural extension bodies to educate farmers on the need to use the optimal quantities of production inputs to achieve the best technical efficiency, as well as collection of smallholdings for the first category and reduce the cultivated area for the third category to achieve the optimal efficiency of the farm, and increase farmer interest in inputs prices to reduce the waste of money, in conjunction with a study by government agencies for the reasons of rising inputs prices to ensure the creation of appropriate solutions to reduce or subsidize prices.

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