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Efficiency Analysis in the Agricultural Sector in Iran: The Case of West Azerbaijan Sunflower Producers

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Abstract

The main purpose of this study is to analyze the efficiency of sunflower production in the West Azerbaijan province of Iran. In many previous studies conducted in Iran, efficiency analyzes of agricultural producers were examined with parametric methods in general. However, in this study, performance analysis of sunflower production by using Tobit model with Data Envelopment Analysis (DEA), which is known as nonparametric method, is discussed. The technical inefficiency and scale inefficiencies of sunflower producers in the West Azerbaijan province of Iran were 26.2% and 7.5%, respectively and the ineffective production results revealed. The performance of the producers varied between 12.1% and 100%, indicating a large difference in performance. In addition, some social and economic factors have significant effects on technical inefficiency of sunflower production in West Azerbaijan province of Iran.

Keywords: Technical Efficiency, Scale Efficiency, Data Envelopment Analysis, Sunflower, Iran.

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Introduction

Sunflower is one of the most important industrial and food products in terms of production and trade in the world. This product ranks fourth among the annual plants, after soy, rape and peanuts. The importance of sunflower is remarkable in many ways. These include quick adaptation to different climatic conditions, mechanization of all agricultural processes, and consumption of both food and fat. (Hajihassaniasl, 2003)

The land statistics of this product sown in Iran show that after 1967, cultivation fluctuated and not more than 105 acre. However, the planted history of this product, cultivated on 30-35 thousand acres in West Azerbaijan, shows that the province is more suitable for the production of this crop. Recently, the decrease in the demand for the oil type of this product and the increase in the price of nut type compared to the oil type, the production of this nut type is increasing not only in West Azerbaijan, but also in many provinces in Iran (such as Isfahan and Khorasan) (Ghaffari, 2006). For this reason, in West Azerbaijan and similar provinces, production of this product will be important in the agricultural economy in terms of employment creation and income generation, as well as providing the opportunity to export to neighboring countries, thus providing a part of the foreign exchange required by the country and it also helps to improve income distribution in rural areas and to reduce poverty. Accordingly, the support for the production of these and similar products will lead to high economic growth, poverty reduction and a more equitable distribution of income. However, as in other manufacturing sectors of the country, there is an extreme difference between the actual and potential production capacities in the agricultural sector. In other words, production resources are not used efficiently in this sector and there are clear differences between the performances of the producers. Therefore, many of the deficiencies in meeting domestic demand depend on the gap between actual (current) and potential production. According to this, the optimum use of production factors and existing facilities can be considered a reliable method to increase production and increase the welfare of the society and thus, the aim of increasing the performance of the producers is the first step in determining the deficiencies in the current situation.

In this study, the measurement of technical and scale efficiency of the sunflower producers in the West Azerbaijan province of Iran was discussed. Accordingly, the fact that this product has a comparative advantage as well as the possibility of being a monopolist, and that the amount of cultivated land is high and that the economic work in this field is not high, further increases the importance of this study. In the case of the objectives of the study are realized, it may also constitute a basis for the analysis of the performance efficiency of other agricultural producers in the province at different time intervals.

In the study, the following two questions are sought:

a. What are the technical and scale efficiency of the sunflower producers in of West Azerbaijan province?

b. What are the variables affecting the inefficiency of producers?

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Theoretical Framework

Mankind has always sought to reach maximum results from the lowest opportunities available. These efforts can be described as achieving high efficiency. However, while the meaning of the efficiency is very wide, it is generally addressed in the fields of engineering, economics and management. Therefore, different definitions were made from the efficiency. According to Farrell (1957), efficiency consists of technical efficiency and allocative efficiency components. The economic efficiency is obtained by multiplying these components. Maximum production or production frontier is used to measure efficiency scores. The model proposed by Farrell (1957) was a nonparametric model because a specific production function was not addressed. According to the definition of Farrell (1957), technical efficiency is the ability of a firm to reach maximum production with its current production factors. The allocation efficiency of the same firm is the optimum allocation of resources among various products according to the marginal production value and the prices of the products.

The frontier function proposed by Farrell (1957) was then re-considered by some economists. Charnes, Cooper and Rhodes (1978), who proposed the concept of Data Envelopment Analysis (DEA), developed Farrell's method and used it in many studies. In Farrell's method and in the model proposed by Charnes, Cooper and Rhodes, the constant return scale (CRS) assumption was used. Later, however, Banker, Charnes and Cooper (1984) developed a new method called BCC model. In this model, the assumption of variable return to scale (VRS) was taken into account. If the BCC model is defined; assuming that N is a manufacturer and each of these manufacturers produces r output using m input, in this case, the technical efficiency of the unit manufacturer is obtained as follows (Coelli, 1996):

$$\min \theta \qquad (1)$$

$$\text{S.T} \quad -y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0,$$

$$\lambda > 0$$

This model is a mathematical programming model that arranged under the assumption of constant return to scale and with input oriented. Here, θ shows the manufacturer's technical effectiveness. The fact that θ is equal to 1 indicates that the respective manufacturer is above the isoquant frontier curve (efficient production frontier) and is 100 percent efficient according to Farrell. The fact that θ is less than 1 indicates that the relevant producer is inefficient and the technical efficiency number will be between zero and 1. The model must be solved separately each time for each of the producers for N times. Thus, the technical efficiency of each manufacturer is calculated separately.

The technical efficiency, which is calculated under the assumption of variable return to scale, is the most appropriate assumption to examine the efficiency of agricultural producers according to many economists. In order to calculate the technical efficiency

under this assumption, a constraint such as $\lambda = 1$ should be added instead of $\lambda \geq 0$ and the model must be solved again. When the efficacy scores obtained under the CRS value are divided by the scores obtained with the VRS variance, the scale efficiency of each producer will be obtained.

In addition to nonparametric methods, there are also parametric methods to measure efficiency. In these methods, a specific form of production functions (Cobb-Douglas, CES, Translog, etc.) is primarily considered and then model parameters can be estimated by using one of the methods of function determination in econometrics and statistics. Some of these methods are:

a. Deterministic Frontier Production Function Method

b. Deterministic Stochastical Frontier Production Function Method

c. Stochastical Frontier Production Function Method

d. Profit Function Method

Literature Review

Considering the efficiency analysis studies of agricultural producers in Iran and all over the World, it is seen that both parametric and non-parametric methods are used. Measuring the efficiency of wheat producers in Iran's Fars province by Najafi and Zibaee (1994), measuring the efficiency of rice producers in Isfahan province by Riahi, Taheri and Nohammadi (2015), measuring the efficiency of potato producers in Zanjan Province by Khajeh Hassani, Saboohi Sabooni and Jaafari (2012), measuring the total factor productivity of rice in Iran by Tahami, Saleh and Nemati (2013), examining the impact of technology development on productivity in the Iranian agricultural sector by Salarieh, MohammadiNejad and Moghaddasi (2016), studying the technical efficiency of the Iran's agricultural sub-sectors by Sepehr Doost and Hamze Ali (2013), measuring the efficency of dairy cattle in the Fars province by Zibaee (1996), measuring the efficiency of clover producers in Gom province by Fetros and Selgi (2002) and measuring the efficiency of fig producers in the Fars province by Hossein Pour and Torkamani (2000) are examples of some studies on Iran agriculture and animal husbandry.

Measuring rice efficiency in the Philippines by Kali Rajan and Phlin (1988), analyzing the technical efficiency in the agricultural sector in Southeast China by Liu et al (2015), which examining the efficiency and productivity of the agricultural sector in Africa by Opanda Majiwa (2017), measuring the efficiency of agricultural farms in India by Batis and Tisma (1993), measuring the efficiency of Thai rice producers by Krasachat (2003), measuring livestock efficiency in New Zealand by Jafarollah and Whiteman (1999), measuring the efficiency of coffee producers in Vietnam by Rios and Shirli (2005) and measuring the efficiency of rice producers in Bangladesh by Vadud (2002) are some of the studies conducted in the world about agricultural efficiency.

Research Methodology

This research is a quantitative study type in which the linear programming as well as econometric model has been used for determining the producer's efficiency and variables affecting efficiency.

Research Variables and Study Sample

The statistical sample of this study consists of the North districts of the West Azerbaijan province of Iran. In these districts, the type of nuts of sunflower is generally planted. According to the statistics, approximately 15000 acres of sunflower seeds are planted in the fields of Khoy, Salmas and northern districts (Maku and Gharaziaddin). Accordingly, 52 people were selected randomly from these districts and the required data were collected by using questionnaires in 2017 and used for analysis.

This study is discussed in two stages. First, using Data Envelopment Analysis (DEA) to obtain technical efficacy scores, both under the assumption of constant return to scale and variable return to scale, taking advantage of linear programming, technical and scale efficiencies of sunflower producers were calculated by DEAP[2] package program. In the model, planted land (acres), employee labor power (Person / Day), used pesticide (liters), used fertilizer (Kilograms) and Preparation costs (such as irrigation, riding) as input variables and the Sunflower harvest amount (kilogram) as output variable has been used. After calculating the technical and scale efficiencies of each manufacturer, the technical inefficiency of each producer shall be calculated according to the following equation and shall be used as the dependent variable in the model discussed in the next stage:

Technical inefficiency of the i producer = 1 - Technical efficiency of I producer under the assumption of VRS (2)

After this stage, econometric models can be used to examine the variables affecting the technical inefficiency of the producers. However, since the technical efficacy scores obtained in the first stage with the DEA method are between zero and 1, the inefficiencies of the efficient producers will be equal to zero. Therefore, it cannot be expected that technical inefficiencies, which are dependent variables, have a normal distribution. Thus, the use of the Ordinary least Squares method (OLS) cannot be very appropriate (Long 1997 and Kraschat 2003). Accordingly, the required estimates will be made using the Tobit model. The technical inefficiency score of each producer will be estimated according to the independent variables such as age, number of planted lands, educational level, number of participants in training courses, distance of producers to agricultural services center and the amount of bank credit they use. General form of this model is as below:

$$y_i = x_i\beta + \delta\varepsilon \qquad \text{If } y_i > 0 \qquad (3)$$
$$y_i = 0 \qquad \text{if } y_i \leq 0$$
$$i = 1,2,3 \ldots, N$$

[2] - This program is one of the most important programs used to measure technical efficiency and efficiency with the DEA method. Some other programs on this subject are Banxia, WarwickDEA, EMS, Omforent and Frontier.

Research Findings

Based on the previous studies in this field, the results obtained by using the models are shown in Table 1.

Table 1. Technical and Scale efficiency Statistics of Sunflower Producers

	Technical Efficiency under the assumption of CRS		Technical Efficiency under the assumption of VRS		Scale Efficiency	
	Number of Producer	%	Number of Producer	%	Number of Producer	%
$TE \geq \%90$	12	23.07	19	36.53	29	55.76
$\%90 > TE \geq \%80$	10	19.23	6	11.53	15	28.84
$\%80 > TE \geq \%70$	8	15.38	6	11.53	4	7.69
$\%70 > TE \geq \%60$	6	11.53	5	9.61	2	3.84
$\%60 > TE \geq \%50$	4	7.69	3	5.76	2	3.84
$\%50 > TE \geq \%40$	3	5.76	5	9.61	-	
$\%40 > TE \geq \%30$	4	7.69	4	7.69	-	
$\%30 > TE \geq \%20$	2	3.84	2	3.84	-	
$\%20 > TE \geq \%10$	3	5.76	2	3.84	-	
$\%10 > TE$	-		-		-	
Total	52		52		52	
Maximum of TE	100		100		100	
Minimum of TE	11.9		12.1		55.4	
TE Average	68.4		73.8		92.5	

Producers have less than 90% technical efficiency. Generally, the CRS assumption is only applicable if all economic units operate at the optimum scale. However, as it is known, due to management deficiencies and some random variables, producers cannot operate at optimum scale. Therefore, technical efficiency obtained under the assumption of variable return to scale can better show the behaviors of producers. In this case, under the assumption of VRS, the lowest technical efficiency was 12.1% and the highest efficiency was 100% and the average technical efficiency was 73.8%. Thus, in this case, 36.5% of the producers (19 people) have more than 90% efficiency. For this reason, it is seen that, under both assumptions, most of the producers produce below 100% efficiency

and therefore not use the existing production factors and technology effectively. The difference between them indicates scale efficiency. In fact, the scale efficiency is the ratio of the technical efficiency obtained under the assumption of CRS to the technical efficiency obtained under the assumption of VRS. According to the table values, the lowest, the highest and the average of the scale efficiency are 55.4%, 100% and 92.5%, respectively. Considering Table 1, it is understood that approximately 44% of producers have scale inefficiency. This indicates that the problem of technical inefficiency is more severe than the scale inefficiency problem. According to the technical efficiency results obtained under the assumption of variable return to scale, the sunflower producers can maximize their production by 73.8% with current technical level and inputs.

The difference between the best producer and the average of the sample is 26.2%. Among sunflower producers, using existing technology, there is a clear gap of 26.2% in the province studied accordingly. If this gap falls to zero with the increase in the average technical efficiency of the producers, using existing technology, the production level in the region can be increased by 26.2%. This indicates that, in the current situation in the West Azerbaijan province, with the improvement of technical efficiency, there is a high potential for Sunflower production increment.

The results of the analysis of the variables affecting the technical inefficiency of sunflower producers in the West Azerbaijan province are presented in Table 2. Examining the results, it is clear that age and education level variables are significant at 5% confidence level and they have negative relationship with technical inefficiency. In other words, the producer's age is large and has much experience, and also when the level of education is high, the technical ineffectiveness decreases. Similarly, the use of bank credits was significant at 5% confidence level and it was observed that it had a negative relationship with technical inefficiency.

The number of planted land was significant at 10% confidence level and it was found to have a positive relationship with technical inefficiency. In other words, as the number of cultivated land increases, the relative technical inefficiencies of the producers also increase due to the increase in the use of production factors (preparation costs, irrigation, labor power etc.).

No significant relationship was found between the producers' distance to agricultural service centers, participation in training courses, and having their own agricultural production factors and the technical inefficiency variable. Accordingly, these variables do not have any effect on the Sunflower production process and therefore they are not effective in increasing or decreasing the inefficiencies of producers.

Table 2. Tobit model results examining the variables affecting the efficacy of sunflower Producers

Generally, according to the results of the level of significance of the coefficients, the variables of age, educational status and number of planted lands have the greatest impact on the technical inefficiency of the producers, respectively. For this reason, increasing the age of the producers and obtaining the necessary technical and practical experience, as well as the increase in education levels and the combination of the cultivated land can

	Coefficient	P-Value	Maximum	Minimum	Average	Standard Error
Constant	0.6301	0.0003	-	-	-	-
Age	-0.0817	0.0016	71	20	48.64	12.36
Education level	-0.0629	0.0207	15	0	4.589	0.4849
Number of Planted Lands	0.0512	0.0976	5	1	2.51	0.712
Producers' Distance to Agricultural Service Centers	0.1123	0.3297	41	3	22.18	17.12
Number of Participants in Training Courses	0.0328	0.0217	5	0	0.761	1.566
Using Bank Credits	-0.0379	0.0413	1	0	0.413	0.120
Owning the Factors of Production	0.2139	0.4351	1	0	0.71	0.493
Log Likelihood	20.3042					

be considered as the most important factors that improve the technical efficiency (reducing the technical inefficiency).

Conclusion and Discussion

In this study, technical and scale efficiencies of sunflower producers in West Azerbaijan province of Iran were obtained using data envelopment analysis method. In addition, the variables affecting the technical inefficiencies of the producers were examined using the Tobit model. Many variables such as climatic conditions, biological variables, etc. can be effective on the efficiency of agricultural producers. However, taking into account the variables and information that can be collected in this study, the results show that there is a remarkable gap between the performances of the producers; the difference between the best producer and the average of the sample was 26.2%. This difference points to the high potential in the increase of the production of sunflower by improving the efficiency in the province of West Azerbaijan. On the other hand, the results showed that the problem of technical inefficiency was more severe than the scale inefficiency problem. Therefore, improvement policies should focus on improving technical inefficiency as a priority. Because after the improvement in technical efficiency, the efficiency of scale will also improve.

Due to the inverse relationship between age, level of education and the number of planted lands and technical inefficiency, consolidation of land, as well as increasing manufacturers' educational levels and providing financial and insurance support, increase in producers' efficiency and reducing in their performance gaps can occur. Accordingly, the government should take into account macroeconomic issues in the country's agricultural policies as the sole decision-maker and technical and scale efficiency, as well as other efficiency issues, such as cost and allocative efficiency, should be included in their programs and policies. Because, if the technical, scale and even the cost efficiency

is low, it means that the country's valuable resources like water, soil, seed etc has been wasted. In addition, since Iran is considered to be a geographically dry and semi-dry climate, and in these climates water resources and the increase of cultivated land is very limited, these resources should be used in the best way. As can be seen in the results of the study, without technological development, at the micro level, production performance can be increased to an acceptable level with improvements in efficiency and productivity.

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