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DETERMINATION OF GREENHOUSES PERFORMANCE USING DATA ENVELOPMENT ANALYSIS

SUMMARY

The landraces of common bean are cultivated all over Kosovo, along with Reviews of the performance of agricultural products are an important factor and effective in increased production. The purpose of this study was to measure the technical efficiency of greenhouse owners based on a Data Envelopment Analysis (DEA) model and to determine the factors affecting their performance. The statistical population of this study included 125 greenhouse owners of Somesara Township. Due to the limitation of respondents, 83 questionnaires were collected. The questionnaire included performance and the greenhouses and greenhouse factors affecting it as well as the personal and professional characteristics of the greenhouse owners. The results showed that the mean of technical greenhouse owners was 51%, and most greenhouses (65.1%) were in the group of less than 50 in terms of efficiency. By comparing total amounts of each auxiliary input, it was determined that the greatest weakness related to personnel costs or work force, and thereafter to the cost of pesticides. Lowest weakness was attributed to the cost of fertilizer. Therefore, based on our results, we can say that the implementation of appropriate programs to increase the efficiency of greenhouse owners and the appropriate use of production inputs can increase production and decrease costs.

Key words: DEA, Greenhouse, Performance, Somesara Township, Technical efficiency.

INTRODUCTION

The trend of increasing population increases the need for food security, and producing enough food is essential for feeding the future world population. Agriculture is one of the most important sources of the food supply (Ranamukharachi et al., 2008). Due to weather conditions and water restrictions, Iran is among the world’s countries that need a basic reconsideration of the structure of their cultural system. In this regard, the development of greenhouse planting can be considered a suitable method. Moreover, due to the use of specific seeds and the ease of controlling annoying factors, greenhouse products

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have higher quality and better marketable properties (Lall and Piesse, 1999). Water preservation through the use of pressured irrigation systems is another advantage of greenhouse production. By using greenhouse production, the amount of human resources required to produce about 20 tons of product decreases to a third of the labor required for production in outdoor areas. Due to the closed environment, the factors of weather, disease, and pests are easy and inexpensive to control (Engindeniz, 2000). Therefore, under present conditions, due to the limitations of soil and water, control of climatic factors, and biological open space, the development of greenhouse planting is one of the best proposed strategies for food production because of its effective use of resources and energy (Roosta et al., 2011).

Performance is a concept that has a long history in science including agricultural economics (Witzel, 2002). Increased performance in a firm is a secure way to increase competitiveness, strength, and most profits. Performance evaluation between firms and between times will help identify a firm's inefficiencies (Akbari and Dinmohammadi, 2009). There are several methods for measuring manufacturing functionality. In this study, the Data Envelopment Analysis (DEA) method was used. DEA is a nonparametric technique of frontier estimation which has been used and continues to be used extensively in many settings for measuring the efficiency and benchmarking of Decsion Making Units (DMUs) (Adler et al., 2002). Many authors have applied DEA in agricultural researches. AjabShirchi Oskoiee et al. (2011), evaluated the energy performance in dry land wheat using the Data Envelopment Analysis (DEA) technique and found that the mean energy performance of triple cropping is 82%, 78%, and 68%, respectively. Due to its higher output, the first level is more efficient than the other two levels which have more energy use of inputs. It was also determined that the highest vicious energy consumption and the highest share of total energy storage of the three levels were related to the inputs of fertilizer, seeds, and chemical pesticides followed by fuel consumption. Alrovis and Francis (2003), used the DEA technique to determine the technical performance of a broiler chicken production unit. They found that most of the studied units were active at less than full capacity. Their results also showed that the mean efficiency of small units was 83% and the mean efficiency of large units was 88%. Dounga et al. (2004), examined the technical inefficiency of rice fields in Nepal using the DEA method and an assumption of variable returns to scale estimate. In this model, inputs included seed, labor, fertilizer, machinery, and land. The result showed that economic inefficiency, allocation, technical, and scale were 34%, 13%, 24%, 18% and 7% respectively. Yousef and Malomo (2007), examined the technical efficiency of egg production units in Niger using DEA. In this study, factors affecting the performance of these units and the role of factors such as experience and training-provided in performance using ordinary least squares regression were investigated. Results showed that there was a significant relationship between capacity and the measure of unit performance. Yalmaz et al. (2009) examined the efficiency of the water basin

Mandras of Turkey using DEA. In this study, the efficiency of decision making units according to weight restrictions based on specified value judgments were evaluated. Farija et al., (2009) used the DEA method to examine water use efficiency and its effective factors in greenhouses in Tunisia. Their results showed that the mean of water efficiency in fixed and variable yield conditions to scale were 42% and 52% respectively. Invest in irrigation technologies used has a positive effect and land size has a negative effect on water performance. Banaeian et al. (2011) applied the DEA technique to evaluate efficiency of strawberry commercial greenhouse in Tehran province of Iran. This technique was used based on the amount of four important inputs include labour, fertilizers, capital and other expenses. Also, gross margin per hacter considered as output. Results showed that geometic mean of technical efficiency for understudy samples was 0.73, indicating that there is ample potential for more efficient and sustainable input utilization in production and 27% of overall resources could be saved.

The main purpose of this study was the determination of greenhouse performance in Somesara Township using DEA nonparametric approach. For this purpose, the following specific objectives were considered: calculation of greenhouses technical efficiency; determination of most important effective factors on greenhouse performance; appropriate strategy presentation for efficiency increase of Somesara Township's greenhouse performance.

MATERIALS AND METHODS

DEA models are linear programming methods that calculate the frontier production function of a set of decision-making units (DMUs) and evaluate the relative technical efficiency of each unit, thereby allowing a distinction to be made between efficient and inefficient DMUs. Those identified as "best practice units" (i.e., those determining the frontier) are given a rating of one, whereas the degree of technical inefficiency of the rest is calculated on the basis of the Euclidian distance of their in-put–output ratio from the frontier (Coelli et al., 1998).

DEA has two models including CCR and BCC models. The CCR DEA model assumes constant return to scale. It measures the technical efficiency by which the DMUs are evaluated for their performance relative to other DMUs in a sample (Cooper et al., 2007). The BCC DEA model assumes variable return to scale conditions. Therefore this model calculates the technical efficiencies of DMUs under variable return to scale conditions. It decomposes the technical efficincy into pure technical effeceency for management factors and scale efficiency for scale factors (Mousavi-Avval et al., 2011).

According to Farrell (1957), technical efficiency (TE) represents the ability of a DMU to produce maximum output given a set of inputs and technology (output-oriented) or, alternatively, to achieve maximum feasible reductions in input quantities given input prices and output (input-oriented). The choice between input- and out-put-oriented measures is a matter of concern, and selection may vary according to the unique characteristics of the set of DMUs under study. In this study, input-oriented DEA seems more appropriate, given that it is more reasonable to argue that in the agricultural sector a farmer has more control over inputs rather than output levels, which may often be exogenously bounded.

The present study was performed in greenhouses of Somesara Township as an applied, non-experimental and field study. The statistical population of this study included greenhouse owners of Somesara Township (N=125). An insufficient number of DMUs for a DEA model would tend to rate all DMUs 100% efficient, because of an inadequate number of degrees of freedom. A proper DMU number is required for identifying a true performance frontier (Zhang and Bartels, 1998). As regard in DEA model the proportion between the number of input and output parameters and the number of DMUs are very important for presentation the valid results, it is necessary that the number of DMUs be almost three times bigger than the total number of input and output parameters (Cooper et al., 2007). According to the limitation of respondents' number, 95 questionnaires were collected, and after omitting the incomplete questionnaires, 83 questionnaires were analyzed. In this study, the greenhouse performance of the study area was calculated using the DEA method. In a DEA method, there are normally some inputs and outputs related to all decision-making units. Let x_{ij} be the inputs for one of decision-making unit with i =1,…,m and y_{rj} be the outputs of the same units with r =1,…, s and j =1,…,n and suppose u_i and v_j are the dual variables associated with x_i and y_j, respectively. Inputs related to performance compute included production labor costs, fertilizer expense, fuel costs, the cost of electricity, costs of agricultural pesticides used in production, cost of seeds or seedlings, and machinary costs, all expended over a one-year period of 2011. Also, the income of greenhouse owners in the study area was considered as output.

RESULTS AND DISCUSSION

The result of this research showed that the mean of production labor costs over a one-year period was 2045 $. Minimum and maximum expenditures were 187.5 and 5000 $, respectively. The labor cost of maximum respondents (42.2%) was between 1875 and 2500 $. Research results showed that the mean of the fertilizer cost used in the one-year period was 240 $ with minimum and maximum amounts being 31.25 and 625 $, respectively. The cost of fertilizer of maximum respondents (30.1%) was between 62 and 125 $. The result of this research showed that the mean of fuel costs used in the one-year period was 1825 $; minimum and maximum expenditures were 62 and 5000 $, respectively. Maximum frequency (41%) was related to 1562 and 1875 $. Research results showed that the mean of electricity cost used in the one-year period was 526 $ with minimum and maximum costs equaling 125 and 1875 $, respectively. The cost of electricity used by maximum respondents (69.9%) was between 312 and 625 $.

Table 1. Descriptive analysis of input variables in DEA

Variables	Frequency	Percent	Cumulative Percent	Mean	SD	Min	Max
Labor cost ($)							
Less than 625	11	13.3	13.3	2045	1054	187.5	5000
625 to 1250	1	1.2	14.5				
1250 to 1875	14	16.9	31.3				
1875 to 2500	35	42.2	73.5				
2500 to 3125	15	18.1	91.6				
More than 3125	7	8.4	100				
Fertilizers cost ($)							
Less than 62	9	10.8	10.8	240	168	31.25	625
62 to 125	25	30.1	41				
125 to 187	11	13.3	54.2				
187 to 250	12	14.5	68.7				
250 to 312	9	10.8	79.5				
More than 312	17	20.5	100				
Fuel cost ($)							
Less than 312	14	16.9	16.9	1825	1190	62	5000
312 to 625	1	1.2	18.1				
625 to 937	4	4.8	22.9				
937 to 1250	3	3.6	26.5				
1250 to 1562	5	6	32.5				
1562 to 1875	34	41	73.5				
More than 1875	22	26.5	100				
The cost of electricity ($)							
Less than 312	20	24.1	24.1	526	297	125	1875
312 to 625	58	69.9	94				
625 to 937	1	1.2	95.2				
937 to 1250	1	1.2	96.4				
1250 to 1562	1	1.2	97.6				
More than 1562	2	2.4	100				
Pesticides cost ($)							
Less than 312	66	79.5	79.5	244	223	37.5	1437.5
312 to 625	16	19.3	98.8				
More than 625	1	1.2	100				
The cost of seeds or seedlings ($)							
Less than 625	72	87.7	86.7	670	597	250	3125
625 to 1250	5	6	92.8				
1250 to 1875	2	2.4	95.2				
1875 to 2500	1	1.2	96.4				
More than 2500	3	3.6	100				
The cost of Machinery ($)							
Less than 312	47	56.6	56.6	381	456	62.5	3125
312 to 625	34	41	97.6				
More than 625	2	2.4	100				
Greenhouse units income ($)							
Less than 3125	4	4.8	4.8	9104	103	1250	62500
3125 to 6250	28	33.7	38.6				
6250 to 9375	41	49.4	88				
9375 to 12500	4	4.8	92.8				
More than 12500	6	7.2	100				

The result of this research showed that the mean of agricultural pesticides cost used in production over the one-year period was 244 $, with minimum and maximum were 37.5 and 1437.5 $, respectively. The cost of agricultural pesticide used by maximum respondents (79.5%) was less than 312 $.As evident in Table 1, the mean of seeds or seedlings cost in the one-year period was about 670 $; minimum and maximum were 250 and 3125 $, respectively. Maximum frequency (87.7%) was related to less than 625 $. The result of this research showed that the mean of machinary costs in the one-year period was 381 $; minimum and maximum were 62.5 and 3125 $, respectively. The machine cost of maximum respondents (56.6%) was less than 312 $.

Research results showed that the mean of income from greenhouse production during the one-year production period was 9104 $; minimum and maximum were 1250 and 62500 $, respectively. Maximum frequency (49.4%) was related to 6250 to 9375 $ (Table 1).

Totally, labor, fertilizers, fuel, electricity, pesticides, seeds or seedlings and machinery had 34, 4, 31, 9, 4, 11 and 6 percents of total greenhouse production cost shares. In the present study, the CCR model was used to calculate the greenhouse performance. Labor costs, fertilizers, energy, pesticides, seeds and seedlings, and machines were analyzed as inputs. Study showed that the mean of technical performance of greenhouses was about 51%. These findings also showed that minimum performance was 11% and maximum was 100%; nine greenhouses had 100% performance.

Table 2, Grouping of greenhouses based on technical efficiency (TE)

Variable	Level (%)	Frequency	Percent	Cumulative Percent
Technical efficiency	Less than 50	54	65.1	65.1
	50 to 70	10	12	77.1
	70 to 90	5	6	83.1
	More than 90	14	16.9	100
Sum		83	100	
Mean: 51.3	SD = 0.25	Minimum:11		Maximum:100

CONCLUSION

This study applied a CCR DEA method to analyze the efficiency of greenhouse producers in Somesara Township of Iran in year 2011. Results revealed that nine greenhouses were efficient and the average value of TE were found to be 51.3%. The results of performance measurement suggested the following:

1- For increased performance, inputs such as labor costs, cost of pesticides should be better used.

2- The relatively low performance level in these units shows that managers of these units lack the necessary managerial capabilities. So, greenhouse owners' knowledge and skills should be increased through training courses, conferences, and workshops.

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UTVRĐIVANJE UČINKA PLASTENIKA KORISTEĆI ANALIZU OMEĐENIH PODATAKA

SAŽETAK

Kontrola učinka poljoprivrednih proizvoda je važan faktor u povećanju proizvodnje. Svrha ovog istraživanja bila je da izmjeri tehničku efikasnost vlasnika plastenika na osnovu modela analize omeđenih podataka (Data Envelopment Analysis - DEA) i da utvrdi faktore koji utiču na njihov učinak. Statistička populacija ovog istraćivanja obuhvatila je 125 vlasnika plastenika u gradskom području Somesare. Zbog ograničenja ispitanika, prikupljena su 83 upitnika. Upitnikom je obuhvaćen učinak plastenka i faktori koji utiču na njega, kao i lične i stručne karakteristike vlasnika plastenika. Rezultati su pokazali da je aritmetička sredina tehniče efikasnosti vlasnika plastenika bila 51%, a da je većina plastenika (65,1%) bila u grupi od manje od 50 u smislu efikasnosti. Upoređivanjem ukupnih iznosa za svaki pomoćni input,utvrđeno je da se najveća slabost odnosi na osoblje, odnosno, troškove radne snage, a nakon toga, troškove pesticida. Najmanja slabost se odnosila na troškove vještačkog đubriva. Stoga, na osnovu naših rezultata, možemo reći da sprovođenje odgovarajućih programa za povećanje efikasnosti vlasnika plastenika i odgovarajuća upotreba inputa u proizvodnji može povećati proizvodnju i smanjiti troškove.

Ključne riječi: DEA, platenik, učinak, Somesara, tehnička efikasnost.