The efficiency analysis of organic and conventional olive farms: Case of Turkey

Analýza efektivnosti ekologických a konvenčních farem specializovaných na produkci oliv: Případová studie Turecka

M. Metin ARTUKOGLU, Akin OLGUN, Hakan ADANACIOGLU

Department of Agricultural Economics, Ege University, Faculty of Agriculture, Bornova-Izmir, Turkey

Abstract: This paper investigates technical and economically efficiency of 62 organic and 62 conventional olive producing farms in Turkey. According to the study results; by using the CRS model which is input and output-oriented, the average technical efficiency of organic olive farms is 67.68%, the average technical efficiency of conventional olive farms is 47.93%. The technical efficiency of the output-oriented VRS model is 74.78%, and the technical efficiency of the input-oriented VRS model is 93.46%. Also, considering the same model, the average efficiency of the conventional olive farms in the input and output are 59.58% and 94.97%, respectively. Therefore, according to the Data Envelopment Analysis, the technical efficiency in conventional olive farms is less than in the organic ones. When the farms have been evaluated one by one in the light of the total potential improvement values, inputs and outputs, improvement is needed in all values.

Key words: olive, efficiency analysis, farm efficiency, data envelopment analysis

Abstrakt: Práce se zabývá výzkumem technické a ekonomické efektivnosti 62 ekologických a 62 konvenčních farem zaměřených na pěstování oliv v Turecku. Podle výsledků studie na základě využití modelu CRS orientovaného na input-output je průměrná technická efektivnost konvenčních farem 6,68 % a průměrná technická efektivnost ekologických farem 47,93 %. Output-orientovaný VRS model technické efektivnosti vykazuje hodnotu 74,78 % a input-orientovaný VRS model 93,46 %. Uvažujeme-li tentýž typ modelu, je průměrná technická efektivnost konvenčních farem v input-orientovaném modelu 59,58 % a v output-orientovaném modelu 9,97 %. Z analýzy dat pak vyplývá, že technická efektivnost konvenčních farem je nižší, než u farem ekologických. Když pak byly farmy analyzovány jednotlivě z hlediska celkových hodnot potenciálního zlepšení efektivnosti, bylo zjištěno, že zlepšení je žádoucí ve všech zkoumaných hodnotách.

Klíčová slova: olivy, analýza efektivnosti, efektivita farmy, analýza dat

Olive is usually cultivated in the Mediterranean Region. It is cultivated totally in 7 379 090 ha area in all Mediterranean countries and the organic olive is cultivated on 4.91% of this area. Most of the organic olive cultivation is carried out in 80 016 ha area in Tunisia, Syria follows this country with 5 000 ha and Turkey with 3 776 ha (Santucci 2007; TURKSTAT 2007).

Olive and olive oil production is an important industry of the agricultural sector in Turkey. Organic production is significantly subsidized via low interest credits and higher direct income supports rather than other products. Furthermore; a rise is seen in the consumers' demand of a healthier food. By this way, the organic olive production has been increasing in recent years. During the period 2003–2006, the number of organic olive producer raised from 469 to 1 183, the production area from 1 534 to 5 716 ha and the organic olive production is increased from 6 456 to 13 116 tones in Turkey (MARA 2007).

In the world, limited studies were made on economic efficiency in organic agricultural products (Lansink et. al., 2002; Lachael et.al, 2005; Lohr and Park 2007). However, there are a few studies which investigate the technical efficiency of organic and conventional products comparatively (Tzouvelekas et al. 2001). For this reason, there is a strong demand for such studies which search the technical efficiency comparing the conventional and organic production in different products. In this study, the subject is examined on the case study from Turkey.

MATERIALS AND METHODS

The organic olive production in the Aegean Region; Aydın, Çanakkale and İzmir provinces is very intensive, in terms of the number of producers and the production area and also in the production quantity. These three provinces include 93.12% of all organic olive oil producers, 86.49% of the total production area, and 90.14% of the production quantity in Turkey. In this area, 609 organic olive farms have been determined. The sample size is determined by using the proportional sampling method (Newbold 1995).

$$n = \frac{Np(1-p)}{(N-1)\sigma_{px}^2 + p(1-p)}$$

where:
n = number of samples
N = number of farms (609 farms)
p = ratio of organic olive oil producer (it shows the ratio of farms in the total farms which have the desired characteristics. to reach the maximum number of the sample size, p is accepted as 0.5)
$1 - p$ = the ratio of producers who do not produce organic olive oil
Confidence interval = 90%
Standard error = 10%
$\sigma^2_{p_x}$ = variance of the ratio = 90% confidence interval, for 0.10 standard error
$Z_{\alpha/2} = r \quad 1.645\ \sigma_p = 0.10 \Rightarrow \sigma_p = 0.06079$
n = number of samples

$$n = \frac{609 \times (0.5) \times (0.5)}{608 \times (0.06079)^2 + (0.5) \times (0.5)} \cong 61$$

Calculating the number of sample is not used for the conventional olive oil farms; its capacity is determined 62 as in the organic farming. In order to compare the efficiency accurately, a different area is not considered for the conventional olive oil producers, the cities and villages where the organic olive oil producers are interviewed are considered.

The Data Envelopment Analysis (DEA) Method is utilized in this study which is frequently used for measuring the efficiency in farms where the organic and conventional olive is produced. It is seen that the DEA is used in many researches aimed at the technical efficiency of using inputs in agricultural farms (Fousekis et al. 2001; Günden and Miran 2001; Abay et al. 2004; Candemir and Koyubenbe 2006; Lilienfield and Asmild 2007; Davidova and Latruffe 2007; Haji 2007; Bojnec and Latruffe 2008).

The DEA involves the use of linear programming methods to construct a non-parametric piece-wise surface (or frontier) over the data. Efficiency measures are then calculated relative to this surface (Coelli et al. 2002).

$$\begin{aligned} &\min_{\theta\lambda} \theta, \\ &\text{st} \quad -y_i + Y\lambda \geq 0 \\ &\qquad \theta x_i - X\lambda \geq 0 \\ &\qquad \lambda \geq 0 \end{aligned} \qquad (1)$$

where θ is a scalar and λ is a $NX1$ vector of constants. This envelopment form involves fewer constraints than the multiplier form ($K + M < N + 1$), and hence is generally the preferred form to solve. The value of θ obtained will be the efficiency score for the i-th firm. It is satisfied that $\theta < 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient firm, according to the Farrell (1957) definition.

Charnes et al. (1978) proposed a model which had an input orientation and assumed constant returns to scale (CRS). The subsequent papers have considered alternative sets of assumptions, such as Banker et al. (1984), in which a variable returns to scale (VRS) model is proposed.

Table 1. The input and output variables of data envelopment analysis

Organic olive farms
Output
Organic olive gross production value
Inputs
Land (ha)
Fertilizer costs (YTL)
Organic control costs for disease and pests (YTL)
Fuel oil costs (YTL)
Labour costs (YTL)
Other costs (YTL)
Conventional olive farms
Output
Conventional olive gross production value
Inputs
Land (ha)
Fertilizer costs (YTL)
Pesticide costs for disease and pests (YTL)
Fuel oil costs (YTL)
Labour costs (YTL)
Other costs (YTL)

The CRS linear programming problem can be easily modified to account for the VRS by adding the convexity constraint: to the equation (1) to provide:

$$\begin{aligned} &\min_{\theta\lambda} \theta, \\ \text{st} \quad & -y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & N1'\lambda = 1 \\ & \Lambda \geq 0 \end{aligned}$$

Producers and firms are analyzed under the assumption of not being always at a full efficiency level. For carrying out the method; input and output variables have to be indicated. For that purpose; input and output variables are indicated for the analysis for organic and conventional olive farmers (Table 1).

Data are analyzed by using the DEA according to the CRS (Constant Returns to Scale) and the VRS (Variable Returns to Scale). Estimations are made for both models.

Constant returns scale estimation in the CRS model; both input and output-oriented technical efficiency results are obtained. In the input- oriented model approach; the target output is obtained by the minimum input utilization. For this reason, there is a saving tendency in the input utilization. Via the VRS model; variable returns to the scale hypothesis are taken over for both input-oriented and output-oriented analyses. The aim of the output-oriented analysis is to gain the maximum output by a certain input.

Potential improving analyses are done through the model estimation. In this analysis, the output values are determined to improve the ineffective farmers to the effective farmers' level in the group. According to these values, the potential improving ratios are assigned.

The Frontier Analyst Package Software is utilized for efficiency measurement in the Data Envelopment Analysis.

RESULTS

Socio-economic characteristics of the olive oil farms

The average cultivated area is 6.75 ha and the ratio of the olive orchard land in the total farm area is 68.31% in the organic farms. The average cultivated area is 5.26 ha, and the ratio of the olive orchard land in the total farm area is 71.93% in the conventional farms.

The household size of the organic and conventional farms is approximately 4 people. The average age is 55 years and the average education level is 6 years for the farmers in organic farms. The average age is 58 years and the average education level is 6.2 years for the farmers in conventional farms (Table 2). 95% of the organic farmers and 65% of the conventional farmers are the shareholders of the cooperatives. 83.40% of the cooperatives shareholders of organic farmers and the 32.50% of cooperatives shareholders of conventional farmers are partners of the Olive and Olive Oil Agricultural Wholesale Cooperative (TARIS).

Most of the olive orchards both in the organic and conventional farms are real estates. The average age of the olive orchards is 92 (Table 3).

In the studied area, 50% of olive orchards, which is an important ratio, are in the low-sloped ground (Table 4).

Table 2. Age of farmers, education status and agricultural experience (year)

	Olive farms	
	organic	conventional
Age	54.92	57.6
Education period	6.0	6.2
Farming experience	36.90	34.5
Organic farming experience	5.48	–
Olive farming experience	36.31	32.3
Organic olive farming experience	4.61	–

Table 3. Selected data related to the olive orchards

	Olive farms	
	organic	conventional
Average plot number	7.15	5.40
Real estate olive land (ha)	4.27	3.47
Total number of olive tree (number/farm)	744.58	116.10
Total olive land (ha)	4.61	3.81
Average age of olive orchards (year)	91.73	69.54

Table 4. Olive orchards' slope status (farm %)

Slope status	Olive farms	
	organic	conventional
Highly	19.6	24.5
Low sloped	49.2	40.5
Plane land	31.2	35.0

Olive and olive oil production in the farms

Organic farms generally have both organic and conventional olive orchards. Therefore, they produce mostly organic and a little conventional olive and olive oil (Table 5). The important part of the organic olive production is used for the olive oil processing (Table 6). Also it can be seen that the conventional olive farmers produce olives for the olive oil process as well (Table 7).

Production costs and farm income

A summary of the cost and revenue information obtained from the farms is presented in Table 8. The most important costs are the labour costs.

According to the model of CRS which is directed by the input and output variables, the organic olive farms' average technical efficiency is 67.68% and in the conventional olive farms' technical efficiency is 47.93%. The technical efficiency of the organic farms output-oriented in the VRS model is 74.84%, and the input-oriented efficiency in the VRS is 93.46%. Also, considering the same model average efficiency of the conventional olive farms, the input and output are 59.58% and 94.97%, respectively (Table 9). Consequently, in respect to the data envelopment analysis, the conventional olive farms' technical efficiency is lower than that of the organic farms.

In Greece, the average output-oriented technical efficiency score is 69.13% for the organic olive farms and 58.72% for the conventional olive farms. On the other hand, the input-oriented technical efficiency score is 73.12 for the organic olive farms and 54.30% for the conventional olive farms (Tzouvelekas et al. 2001). In Tunisia, the average technical efficiency score is 82% for olive farms (Lachael et al. 2005).

Referring to the distribution of the technical efficiency score of the organic olive farms' in CRS model,

Table 5. Olive usage in organic olive farms

	Olive production (kg/farm)	Olive usage (%)		
		sold	table olive for self consumption	olives for olive oil process
Organic	1 5751.13	5.77	3.99	90.24
Organic production transition period	177.90	4.53	0.28	95.19
Conventional	1 516.13	–	5.69	94.31
General	17 445.16	5.26	4.10	90.64

Table 6. Olive oil usage in organic olive farms

	Olive oil production (kg/farm)	Olive oil usage (%)		
		sold	self consumption	stock
Organic	3 328.02	84.03	6.75	9.22
Organic production transition period	40.32	64.00	36.00	–
Conventional	235.08	87.31	2.74	9.95
General	3 603.42	84.02	6.82	9.16

Table 7. Olive and olive oil usage in conventional olive farms

Olive production (kg/farm)		12 382.10
Olive usage (%)	sold	8.73
	home consumption	0.98
	olives for olive oil process	90.29
Olive oil production (kg/farm)		2 442.29
Olive oil usage (%)	sold	45.66
	home consumption	10.47
	stock	43.87

for 27 of 62 (43.55%) studied farms, the technical efficiency score is between 91–100%. 13 of these farms have the full technical efficiency score (100%). As a conclusion, it can be stated that the conventional olive farms are less efficient than the organic olive farms according to the model.

In the output-oriented VRS model, the technical efficiency is 91–100 in 35 organic farms. 30 of these farms are in the category of fully efficient (100%) farms. According to this model, among the conventional farms, the number of farms which have the efficiency rate of 91–100 is 23, and 21 of these have the fully efficient (100%) score. In the input-oriented VRS model, 55 (88.71%) of the organic farms, and 58 (93.54%) of the conventional farms have the full efficiency score (100%).

When the farms have been evaluated one by one in the light of the total potential improvement values, inputs and outputs, improvement is needed in all values. The organic olive farms should raise the organic olive production which is stated as an output in the rate of 55.35% to increase the efficiency.

Table 8. Some economic data of the farms*

	Organic farm	Conventional farm
Labor costs (YTL/ha)	5 371.7	2 491.0
Fuel costs (YTL/ha)	1 600.8	718.3
Fertilizer costs (YTL/ha)	762.1	486.5
Combat material (YTL/ha)	119.5	221.4
Other costs (fixed and variable) (YTL/ha)	10 114.9	8 985.1
Total costs (fixed and variable) (YTL/ha)	17 969.0	12 902.3
Olive production amount (average of 2005/2006 years) (kg/ha)	4 773.9	3 552.5
Unit price (YTL/Kg)	1.69	1.32
Gross olive production value (YTL/ha)	8 067.9	4 689.3

*The exchange rate is (Jan. 2008): 1US $= 1.42 YTL (Turkish Liras)

Table 9. Frequency of distribution of output-oriented and input-oriented technical efficiency for organic and conventional olive-growing farms

Efficiency	Organic farms				Conventional farms			
	CRS		VRS		CRS		VRS	
	TEo	TEi	TEo	TEi	TEo	TEi	TEo	TEi
< 20	5	5	4	1	19	19	11	2
21–30	6	6	4	2	4	4	7	–
31–40	8	8	9	1	10	10	7	1
41–50	5	5	3	2	6	6	4	–
51–60	3	3	1	–	3	3	3	–
61–70	3	3	2	–	3	3	4	–
71–80	1	1	1	–	3	3	3	–
81–90	4	4	3	1	1	1	–	1
91–100	27	27	35	55	13	13	23	58
Mean	67.68	67.68	74.84	93.46	47.93	47.93	59.58	94.97
Minimum	7.55	7.55	9.28	18.70	1.82	1.82	1.83	16.61
Maximum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Standard deviation	33.07	33.07	32.13	19.78	32.72	32.72	34.90	18.35

CRS = Constant returns to scale; VRS = Variable returns to scale; TEo = Output oriented technical efficiency; TEi = Input oriented technical efficiency

The proposal of improvement of the data is on the way of a decrease in the whole variable and it is not a serious decrease. Due to this; 8.08% of the farms, 11.21% of the fertilizer costs, 7.38% of the pesticide costs of organic process, 2.26% of the fuel, 7.90% of the labour and 2.57% of other costs were seen as suitable to decrease (Table 10). As it is seen here, the organic olive farmers could reach the full technical efficiency if they increase their production values seriously and decrease their inputs by a small amount.

According to the results of the potential output improvement analysis, 39 firms (62.90%) out of 62 examined organic olive producer firms need a potential improvement (Figure 1). If 28 firms (71.79%) increase their olive production value by 10%, they will be able to become completely effective, also 3 of these firms can be effective if they increase their production value by 10–11%. On the other hand, there have been 6 firms (15.38%) who needed an improvement by 51% and more to reach the effective level.

When the conventional olive oil farms' total potential improvement values were evaluated separately considering the inputs and outputs, it has been seen that all variables needed improvement. The conventional olive oil farms should increase their production value by 66.21% (and 55.35% for organic) in order to raise their efficiency. Consequently, the conventional farms ought to improve their olive production value more than the organic firms.

All variables must be cut down to improve the inputs, however, there is no need of a serious decrease like in the organic farms. When it is viewed from this aspect, the production area should decrease by 3.13% (8.08 for organic), fertilizer costs by 7.86% (11.21% for organic), pesticide costs by 1.91% (7.38% for organic), fuel costs by 3.93% (2.26% for organic), labour cost by 7.17% (7.90% for organic), and other expenditures

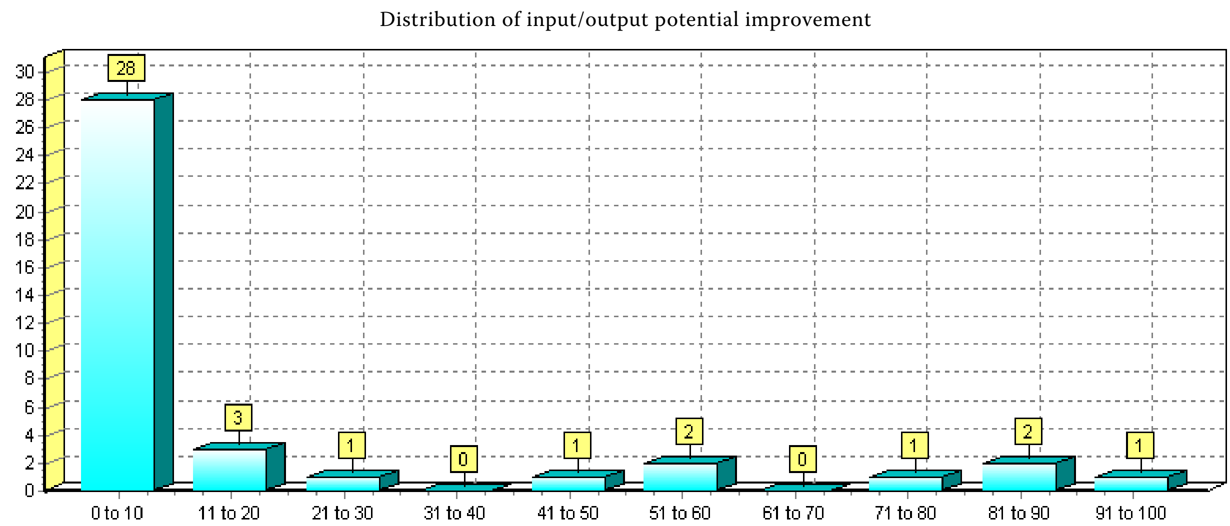

Figure 1. Distribution of farms which are subject to the potential improvement in the organic olive production value

Table 10. Potential ratio of the improvement in organic olive farms

Variable	Ratio (%)
Olive production value	+55.35
Area (ha)	–8.08
Fertilizer costs	–11.21
Pesticide costs	–7.38
Fuel costs	–2.26
Labour costs	–7.90
Other costs	–2.57

Table 11. Improvement proportions for the studied conventional olive oil farms

Variable	Rate (%)
Olive production value	+ 66.21
Area (ha)	–3.13
Fertilizer costs	–7.86
Pesticide costs	–1.91
Fuel costs	–3.93
Labour costs	–7.17
Other expenditures	–6.45

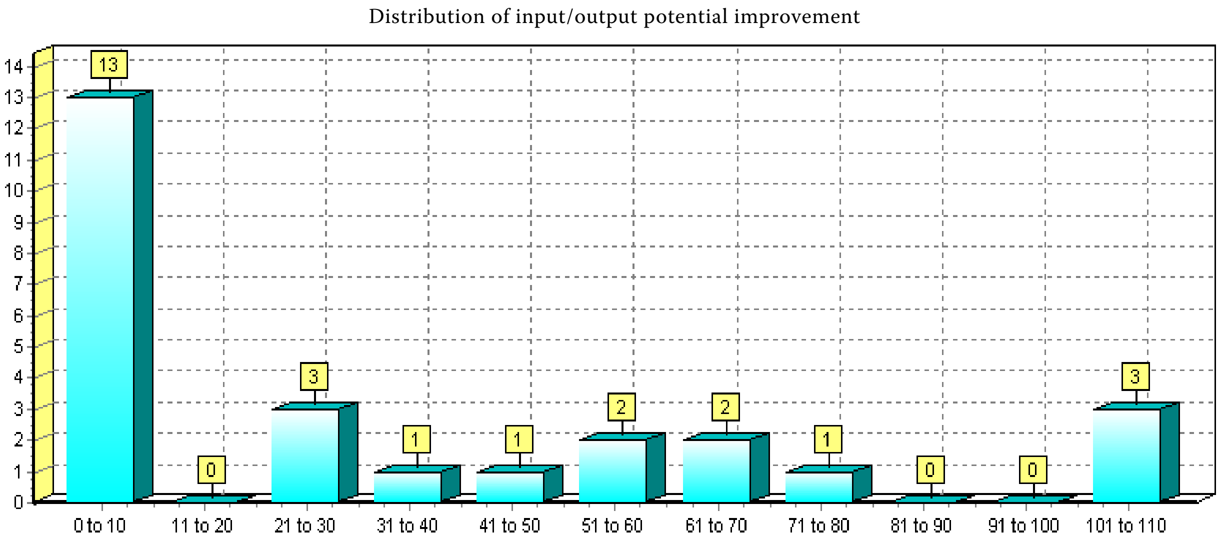

Figure 2. Distribution of farms which are subject to potential improvement in the conventional olive production value

by 6.45% (2.57% for organic) (Table 11). According to these results, it can be said that the conventional farms need less cutting down than the organic farms in order to improve inputs.

According to the results of the potential output improvement analysis, 26 (41.94% of total farms) farms from the studied 62 conventional olive oil farms need a potential improvement (Figure 2). These results showed that 13 items (50%) of these 26 farms will be able to be fully effective if they increase their olive production value by 10%. Also 3 farms (11.54%) would have needed to increase their production value by 21–30% providing the full efficiency. Furthermore, in the technical efficiency level of 51% or more degrees, 8 farms (30.77%) are needed to be improved. This result shows that the mentioned farms need to improve their olive production value at least by 51% or more to reach full technical efficiency.

CONCLUSION

It has been determined that, the technical efficiency of conventional olive oil farms is lower than that of organic farms. When we evaluate the total potential improvement considering the inputs and outputs, we can see that all variables need to be improved. Therefore, the conventional olive oil farms should increase their olive production value by 66.21% (55.35% for organic) in order to increase their technical efficiency and to be fully effective. Both input and output oriented approaches show that the inefficiency has taken root from the fact that the farms do not implement the production using minimum input or cannot derive the maximum output from the existing inputs.

REFERENCES

Abay C., Miran B., Günden C. (2004): An analysis of input use efficiency in tobacco production with respect to sustainability: The case study of Turkey. Journal of Sustainable Agrıculture, *24*: 123–143.

Banker R.D., Charnes A., Cooper W.W. (1984): Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science, *30*: 1078–1092.

Bojnec S., Latruffe L. (2008): Measures of farm business efficiency. Industrial Management & Data Systems, *108*: 258–270.

Candemir M., Koyubenbe N. (2006): Effeciency analysis of dairy farms in the province of Izmir (Turkey): Data envelopment analysis (DEA). Journal of Applied Animal Research, *29*: 61–64.

Charnes A., Cooper W.W., Rhodes E. (1978): Measuring the efficiency of decision making units. European Journal of Operational Research, *2*: 429–444.

Coelli T., Prasada Rao D.S., Battese G.E. (2002): An Introduction to Efficiency and Productivity Analysis. Kluwer Academic Publishers, USA.

Davidova S., Latruffe L. (2007): Relationships between technical efficiency and financial management for Czech Republic farms. Journal of Agrıcultural Economıcs, *58*: 269–288.

Farrel M.J. (1957): The measurement of productive efficiency. Journal of the Royal Statistical Society, series A, CXX, Part 3: 253–290.

Fousekis P., Spathis P., Tsimboukas K., Tsoukala S. (2001): Technical and scale efficiency in cotton production: DEA evidence for Greece. Agricoltura Mediterranea, *131*: 9–17.

Gunden C., Miran B. (2001): Technical Efficiency in Cotton Production: A Case Study. Turkish Agricultural Chambers, Ankara.

Haji J. (2007): Production efficiency of smallholders' vegetable-dominated mixed farming system in eastern Ethiopia: A non-parametric approach. Journal of Afrıcan Economies, *16*: 1–27.

Lachaal L., Karray B., Dhehibi B., Chebil A. (2005): Technical efficiency measures and its determinants for olive producing farms in Tunisia: A stochastic frontier analysis. African Development Review/Revue africaine de développement (Oxford), *17*: 580–591.

Lansink A.O., Pietola K., Backman S. (2002): Efficiency and productivity of conventional and organic farms in Finland 1994–1997. European Review of Agricultural Economics, *29*: 51–65.

Lilienfeld A., Asmild M. (2007): Estimation of excess water use in irrigated agriculture: A data envelopment analysis approach. Agrıcultural Water Management, *94*: 73–82.

Lohr L., Park T.A. (2007): Efficiency analysis for organic agricultural producers: The role of soil-improving inputs. Journal of Environmental Management, *83*: 25–33.

MARA (Ministry of Agriculture and Rural Affairs) (2007): Documents of Organic Products.

Newbold P. (1995): Statistics for Business and Economics. Prentice-Hall, New Jersey.

Santucci F.M. (2007): Organic Olive Oil. DSEEA UniPG, Washington DC, November.

TURKSTAT (Turkish Statistical Institute) (2007): Agricultural Situation (Production, Price, Value). Ankara.

Tzouvelekas V., Pantzios C. J., Fotopoulos C. (2001): Technical efficiency of alternative farming systems: The case of Greek organic and conventional olive-growing farms. Food Policy, *26*: 549–569.

Arrived on 15th September 2009

Contact address:

M. Metin Artukoglu, University of Ege, Faculty of Agriculture, Department of Agricultural Economics, 35100 Izmir, Turkey
e-mail: metin.artukoglu@ege.edu.tr