Pak. J. Agri. Sci., Vol. 49(4), 577-582; 2012
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
http://www.pakjas.com.pk

PRODUCTIVITY ANALYSIS OF SUNFLOWER PRODUCTION IN TURKEY

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In Turkey, which ranks the 10th country worldwide in the sunflower (*Helianthus annuus L.*) production, 55% of the production is carried out in Thrace Region. Therefore, agricultural enterprises in Thrace Region, situated in the European part of Turkey have specialized in producing sunflower, and have become the centre of vegetable oil industry in the region in terms of produced raw material. This research was conducted in 182 agricultural enterprises in 3 provinces of Thrace Region in Turkey and its objective was to determine input/output relations in sunflower production. The study indicates that the determination coefficient (r^2) derived from Cobb-Douglas production function was significant at 0.01 level and the elasticity coefficients of the variables (except chemical fertilizer) were found (β_i) positive in derived equation. It was determined that the variable of herbicide cost had the highest value of the marginal effectiveness coefficients and none of the variables was used at economically optimal level in the study area. When the Marginal Technical Substitution and the Price Rates were taken into consideration, it was noted that only the seed cost/hoeing cost was closest to economically optimum level (1.10). According to stepwise analysis the Land Renting Value was determined as the most important variable in sunflower production.

Keywords: Sunflower, productivity, Cobb-Douglas, econometric analysis, oilseed

INTRODUCTION

In the world, numbers of the oilseed crops are grown like soybean, groundnuts, sunflower seed, rapeseed, maize, olive, sesame seed, palm kernel, cotton seed, linseed, safflower, copra and castor seed. Soybean has the largest cultivated area, followed by cotton seed, groundnuts, rape seed, sunflower seed and sesame seed. Sunflower is ranked third in the production of oilseeds throughout the world and the most important oilseed in Turkey (Kolsarici *et al.*, 2005).

Turkish vegetable oil consumption is getting higher but the adequate increase in oilseeds production is not enough (VOFIAT, 2002). Oil seeds and vegetable oils are one of the most important groups of products which are deficient in Turkey and can only be met by means of import (Semerci *et al.,* 2011a). Turkey's foreign trade in agricultural products was 24.5 billion US$ in 2008. The amount of export on the total scale of foreign trade was 11.5 billion US$ whereas the amount of import was 13 billion US$. The import value of vegetable and animal oil, which increased two fold in 2008 compared to 2007, was 1.7 billion US$ total, of which 1.5 billion US$ was vegetable oils import. When oilseeds are added to this number, the import of this group reached 23% of total agricultural products with 3 billion US$ (MFAL, 2009).

Sunflower is oil-bearing and used as raw material in vegetable oil production. Due to its larger adaptation capability and higher oil quality, sunflower (*Helianthus annuus L.*) has been grown almost in all the regions of the world with high seed yield and oil content (Sencar *et al.,* 1991). Turkey is among the top ten countries in sunflower production with 1320,000 tons in 2010 (FAO, 2012). In Turkey, sunflower is mainly produced in Thrace Region. Thrace Region have a share of 51.36% with a cultivated area of 641343 ha and a share of 55.44% with a production of 1320,000 tons in Turkey (TURKSTAT, 2012). The agricultural enterprises in Thrace Region are specialized in terms of intensive sunflower production, and this region is the main area of country's vegetable oil industry (Semerci *et al*., 2011b). Since Thrace Region has an important position in vegetable oil production, input usage and productivities of the enterprises in sunflower production were examined in this study.

Providing efficiency in resource usage and creating extra-value addition from limited resources are foremost goals and principles of the economy. Therefore, in all production activities, it is required to expose resource productivity and resource usage situation as well as to provide the available usages in accordance with economical conditions (Acil and Rehber, 1979).

Being commonly located in the Thrace Region, which is the European part of Turkey, the sunflower has yield values per unit area which are over the average values throughout Turkey. In yield differentiations, the input usage amount per area and especially the convenience of precipitation regimes with sunflower requirements have played very important roles during recent years.

There are few studies in economic analysis of sunflower production in Turkey and they are mainly related to determination of sunflower production cost and input use in sunflower. However, the number of studies on econometric analysis of sunflower production in Turkey is not sufficient.
The first economic study in sunflower in Thrace Region was performed in 1973 by Pirinccioglu. The sunflower land rent (0.377) and the fertilizer (0.48) were found the main inputs in this study (r^2 = 0.92, $\sum\beta_i$ = 0.906). In another study conducted in the region on 100 farms in 1997, r^2 value was 0.936 and total elasticity coefficient ($\sum\beta_i$) was 0.1025, and also the seed and the chemical fertilizer were determined as the main inputs in the sunflower production equation (Semerci, 1998).
Another research based on the econometric analysis was conducted in 44 agricultural enterprises producing sunflower in Kirikkale, Central Anatolia of Turkey. Six variables were used in their equations and while the production areas of sunflower and seed cost were found at lower level, the soil preparation cost was found to be at higher level (Oguz and Altintas, 2002).
Multivariate Cobb-Douglas type function coefficients may be estimated by least squares method, using logarithmic values of observed values of variables after the logarithmic conversion of the function. Upon the assumption of classical multiple regression, classic statistical tests may be applied to coefficients of the function, multiple determination coefficient and variance analysis of the whole equation. With this aspect, the model has the qualifications to be used in practical production researches (Zoral, 1975).
The determination of the productivity levels of the inputs in sunflower production constitutes the fundamental point of this study. The measurement of the productivity degree of the production factors (added to the production in a certain period) displays the effectiveness of the applied factors and methods, showing that how it is so beneficial (Ergun, 1990). The calculated productivity of the inputs (land, capital, seed, fertilizer, herbicide etc.) concerning productivity analysis was called as productivity of the relevant inputs (Tuna, 1993).
One of the most important studies in sunflower production is cost calculation study. A production cost research was performed in 2008 mentioned that gross production value was 1178 US\$ ha^{-1}, the variable cost was 734 US\$ ha^{-1} and the constant cost was 404.29 US\$ ha^{-1}. In other words, the gross profit was 444.0 US\$ ha^{-1}, and net profit was 39.00 US\$ ha^{-1} (Semerci and Kaya, 2010). Low profits obtained in sunflower production indicated that sunflower producers did not receive enough income from sunflower in the region. The only vital component to continue sunflower production of farmers was the fact that they use their own lands and labor sources.
Using a different approach from other studies conducted in this area could be said to be the most important point of this study. This research was conducted by applying econometrical approach to sunflower which is grown in Edirne, Kirklareli and Tekirdag provinces in Thrace Region and by setting up an equation only related to sunflower production via factor analysis.

MATERIALS AND METHODS

The data used in the survey were obtained through questionnaires from 182 enterprises, engaged in sunflower production in Thrace Region during 2005. Neyman Method was used, as the stratified random sampling method, in order to adapt the data to normal distribution in similar studies as well as to determine the enterprises where the figures in the research would be obtained for further studies. The formula of Stratified Random Sampling Method used in the research is given below (Yemane, 1967).

$$n = \frac{\Sigma(N_h(S_h)^2}{N^2D^2 + \Sigma N_h(S_h)^2}$$

In formula,
n: sample volume
N_h: the number of units in the layer (frequency)
S_h**:** standard deviation of layer h
N**:** total unit number
D**:** d/z
d**:** average of a certain percentage deviation (1% – 5% – 10%, etc.)
z**:** degrees of freedom in t-distribution scale (N-1) and expresses ‘t value’ belongs to a certain confidence limit (90% - 95% - 99% etc.)
In data analysis, Cobb-Douglas type production function was used because for this mathematical model, β_i values show the elasticity of Y over X and β_i’s total is used to determine the return to scale (Ertek, 1996; Heady and Dillon, 1966). Therefore, Cobb-Douglas function becomes appropriate to the figures (obtained from agricultural enterprises), provides calculation facility and adequate degree of freedom in the research.
In the Cobb-Douglas type production function, the Gross Production Value (GPV) of sunflower production was taken up as a dependent variable and Land Renting Value, Seed Cost, Chemical Fertilizer Cost, Herbicide Cost and Hoeing Cost were considered as independent variables.
The variables formed in the equation were as follows:
Dependent Variable:
Y: Gross Production Value (GPV); obtained by multiplying the output and sales price (market price) of sunflower crop (€ $farm^{-1}$)
Independent Variables:
X_1: Land Renting Value (€ $farm^{-1}$)
X_2: Seed Cost (€ $farm^{-1}$)
X_3: Chemical Fertilizer Cost (€ $farm^{-1}$)
X_4: Herbicide Cost (€ $farm^{-1}$)

X_5: Hoeing Cost (€ farm^{-1})

To get the function and to determine statistical parameters in this study, similar to other studies (Green *et al*., 2000) SPSS software was utilized. Marginal yield values (MYV), marginal efficiency coefficients (MEC), production elasticity (PE), marginal rates of technical substitution (MRTS), and price ratio (PR) were determined utilizing the function similar to Johnston study (1963). The levels of statistical significance of production elasticity for the equation were determined and the Marginal Production Value (MPV), MEC, MRTS and PR of the inputs as well as MEC of factor compositions were calculated like in other studies (Karagolge, 1973; Kip and Isyar, 1976).

The number of the coefficient (β_i) for the production factors showed whether the relevant factor was used less or more viz-a-viz to other factors. However, "Efficiency Coefficient" is the factor which expresses the situation more clearly and openly. Since the marginal revenue of one factor would be equal to its price in economic optimum, then MEC, obtained by dividing the marginal revenues to the factor prices, must also be also equal to 1.

RESULTS AND DISCUSSION

In this study, the following function was obtained.

$$Y = 0.648\, X_1^{\,0.806}\, X_2^{\,0.136}\, X_3^{\,-0.015}\, X_4^{\,0.037}\, X_5^{\,0.025}$$

The determination coefficient (r^2) refers to explainable part of the changes in dependent variable through the equation of multivariable regression (Kilicbay, 1986). In this study, the determination (multiple determination) coefficient (r^2) of the function was 0.918 (F=394.39) and was statistically significant (P>0.01) (Table 1).

The multiple determination coefficients of the obtained function shows that about 92% of the changes for the sunflower gross production value might be explainable via the considered variables in the equation. The calculated correlation coefficients amidst were shown in Table 2.

In sunflower gross production value function, correlation values amidst were found statistically significant (P>0.05). In the examination of the correlation values of the variables, an important relationship was also observed between the land renting value (X_1) and the seed cost (X_2) variable. For the application of the least squares method, a very important condition was the lack of a complete direct connection between the explanatory variables by themselves. In the existence of a multiple connections, some problems for the estimation of the structural parameters, such as incomplete determination, might appear. However, if the aim of the study was to estimate only the values of the dependent variable, then multiple correlation problems would not trouble the analysis as long as the relationship between the relevant dependent variable would be kept by good estimation in the future (Ozcelik, 1994).

In the determination of autocorrelation existence of the function aside from the tests like 'β Density Function', Tchil Nagor Table' and 'Von Neumann Rate', one of the most widespread tests was 'Durbin Watson (DW) D Statistic' (Gurler, 1996). In this research 'Durbin Watson D Statistic' was used for the examination of autocorrelation. With $DW_{calculation}$ 1.66 > $DW_{table\ upper\ limit}$ 1.65 was obtained for the function and we came to the conclusion that the internal correlation does not exist for the equation, obtained at 1% significance level.

The examination of the production elasticity's of the independent variables (Table 3), it was seen that the elasticity coefficient of the chemical fertilizer cost (X_3) factor got negative value. Since the production elasticity of chemical fertilizer factor (X_3) was negative, any increase in this factor would cause reduction in the gross production value of sunflower.

Although negative production elasticity of chemical fertilizer (X_3) clearly showed excessive usage of chemical input, it definitely would not be correct to make a statement like that owing to the statistical insignificance of production elasticity (Heady and Dillon, 1966). Therefore, it would be more appropriate to express that the fertilizer would not be used timely technique-compliant (Acil and Rehber, 1979). Within the independent variables in the equation, only the elasticity coefficient of the land renting value (X_1) factor was found significant (P>0.01).

As other inputs were fixed, the reduced yield was valid only for the chemical fertilizer cost (X_3). Provided that input compositions are fixed, an increase of 10% in the land renting value (X_1), the seed cost (X_2), the herbicide cost (X_4) and the hoeing cost (X_5) factors separately might result in an increase of 8.06%, 1.36%, 0.37% and 0.25% increase in the gross production value, respectively.

While the sum of the elasticity coefficients of the production factors ($\Sigma\beta_i$) was 0.989, there was almost a constant proximity return to scale. In other words, an increase of 10% in all inputs might provide nearly 10% increase in the gross production value, evaluated as dependent variable.

The production elasticity of the land renting value in the function was found statistically significant at 1% level of significance. This shows that handling the land prices (able to reflect productivity factor) would be more suitable than the physical scale in the land factor expression. Each of the independent variables; the geometrical averages of GPV and MPV as well as the MEC was presented in Table 4. Since the elasticity coefficient of the chemical fertilizer cost (X_3) was negative, MEC of the relevant factor was not calculated.

In the equation obtained, the herbicide cost (X_4) had the biggest marginal efficiency coefficient. Moreover, the marginal production value of this factor was higher than the other inputs. However, no efficient factor, close to economic optimum was found among the inputs.

Table 1. Parameters of function of sunflower gross production value

Dependent Variable (Y)	Regression coefficients (β_i)					Statistical parameters		
	X_1	X_2	X_3	X_4	X_5	r^2	F	DW
Log Y	0.806	0.136	- 0.015	0.037	0.025	0.918	394.39	1.66

Table 2. Interfunction correlation matrix

	X_1	X_2	X_3	X_4
X_2	0.946*			
X_3	0.521*	0.495*		
X_4	0.370*	0.456*	0.246*	
X_5	0.605*	0.600*	0.351*	0.164**

*,**: *Significant at P=0.01 and P=0.05, respectively*

Table 3. Production elasticity and importance levels of functions

	X_1	X_2	X_3	X_4	X_5
Production Elasticity (β_i)	0.806*	0.136**	- 0.015	0.037	0.025
Standard Error (S_{bi})	0.070	0.072	0.250	0.025	0.027
t_{bi}	11.534	1.897	- 0.598	1.476	0.918

*,**: *Significant at P=0.01 and P=0.10, respectively*

Table 4. Gross production value, geometrical averages of production factors, marginal product, values of factors, factor prices and marginal efficiency coefficients

	X_1 (€ $farm^{-1}$)	X_2 (€ $farm^{-1}$)	X_3 (€ $farm^{-1}$)	X_4 (€ $farm^{-1}$)	X_5 (€ $farm^{-1}$)	Y (€ $farm^{-1}$)
Geometrical average	1101.48	245.79	211.00	30.85	138.90	3276.25
Marginal product value (€)	1.52	1.15	-	2.47	0.37	-
Factor price (€)	22.05	12.60	-	4.41	3.78	-
Marginal efficiency coefficient	0.069	0.091	-	0.561	0.098	-

MRTS and PR which show the usage situation together with the comparative rate of each are given in Table 5. To make the composition between two factors (where scale factor compositions were close to the optimum level) economical and to understand which factors should be reduced or increased, factor prices should also be taken into account together with MRTS. The values, which are aimed to be obtained by dividing MRTS to PR among factors which were equal to 1, higher than 1 or less than 1, exhibit in which direction factor compositions should be changed.

Table 5. Marginal Technical Substitution and Price Rates among factors

		X_2		X_4		X_5	
X_1	MRTS	0.75	1.32	1.64	8.20	0.25	1.47
	PR	0.57		0.20		0.17	
X_2	MRTS			2.17	6.20	0.33	1.10
	PR			0.35		0.30	
X_4	MRTS					0.15	0.17
	PR					0.86	

Since the production elasticity of the fertilizer cost (X_3) was negative, it's MRTS and PR with other factors was not calculated.

According to the coefficients of MRTS/ PR of the factors, it was shown that the land renting value (X_1) was used more than the seed cost (X_2), the herbicide cost (X_4) and the hoeing cost (X_5), while the seed cost (X_2) was used more than the herbicide cost (X_4) and the hoeing cost (X_5). According to the MRTS and PR among factors, the Herbicide Cost (X_4) factor was used less than the Hoeing Cost (X_5) factor. The usage level of the seed cost (X_2) factor to the hoeing cost (X_5) factor was slightly over the optimal point.

Stepwise process was one of the methods in the researches to get multiple determination coefficient, which expresses the relationship between dependent and independent variables in the best manner (Duzgunes *et al*., 1987). In the new equation, it was determined that the land renting value (X_1) and the seed cost (X_2) were the variables which had the largest effect on the sunflower gross production value.

The new function, obtained by stepwise process was constituted as follows:

$$Y = 0.645\, X_1^{\,0.785}\, X_2^{\,0.180}$$

In the new equation r^2 value was 0.916 (F: 984; S_{bi}: 0.1029) which was found significant (P>0.01). The sum of the elasticity coefficients of the new function was 0.965, and it indicates almost constant proximity return of scale.

In the agricultural enterprises which were situated in the research area, average sunflower sowing area was found as 4.86 hectare. The calculated result was higher than those of Semerci (1998) (3.67 hectare) and Safak (1981) (4.21 hectare), but lower than Oguz and Altintas's (2002) (5.59 hectare) and Pirinccioglu's (1973) (70.5 decare) studies. On the other hand, the determination coefficient of the equation (r^2) is 0.918, and lower than the values of other researches carried on sunflower production by Semerci (1998) (0.936), Pirinccioglu (1973) (0.92) and, Oguz and Altintas (2002) (0.88).

The sum of the coefficients of the production elasticity belonged to the equation is ($\Sigma\beta_{i}$ = 0.989), and it implies that there is approximately constant return to scale. Basically, if the independent variables increase expenses value at 10%, this causes a rise of 9.89% in gross production values. The sum of the coefficients of the production elasticity concerning the sunflower production was calculated as 0.906 (Pirinccioglu, 1973), 1.025 (Semerci, 1998) and 1.148 (Oguz and Altintas, 2002).

The F value of the equation was calculated as 394.39 and it was determined that there was no correlation (DW: 1.66) in the equation. This research displayed that the fertilizer cost had influenced the sunflower's gross domestic values negatively (β_i: -0.015). The main reason of this could be explained as the chemical fertilizers could be used, but a long period was required for the plant to get benefit from these because the melting and spreading in the soil was very weak. On the other hand, the type of the fertilizer, the application time and its quantity could also have influenced on the quantity of the sunflower production.

Attained in the function land renting value was significant ($P>0.01$), and so was the seed cost at level 6%. In Oguz and Altintas (2002) study, land renting value variable was found significant ($P>0.01$). Naturally, it was expected that the size of the production and its quality affect the sunflower production quantity and its gross production value.

When the efficiency coefficient of the variables was considered, it was concluded that there was no variable used at economically optimum level, as reported by Oguz and Altintas (2002) and Semerci's (1998). It was basically understood from this study that the land renting and the seed cost variables were used less than expected, and it was recommended to increase these inputs. Oguz and Altintas (2002) reported the low level of sunflower production and the seed cost while the preparation of the soil cost was found at a higher level.

Another important point of the study is that, it was observed that land renting value (X_1) and herbicide cost (X_4) were used more than other factors when compared to the MRTS/PR coefficients ratio. It could be inferred that ration of seed cost and hoeing cost was the only factors which were used at the economically optimum level.

After stepwise process, it was concluded that land renting value was the most important factor affecting sunflower production in the new equation, while it was the size of production area in Oguz and Altintas (2002) study. Size and type of the soil were naturally very important factors for sunflower growing due to their effect on the quantity and revenue of sunflower.

***Conclusions*:** This research was conducted in Thrace Region, which is in European part of Turkey and holds 55% of sunflower production in Turkey. In the study the multiple determination of the equation, which was obtained by using Cobb-Douglas type function, was found to be over 0.90 and was significantly based on 1% probability. The total coefficient of production elasticity was close to 1 (0.989) and these results meant that a non profitable sunflower production had been continuing in the region. Another important result of the study was that chemical fertilizer used in sunflower exhibited a negative effect. This result implied that fertilizers were being used without considering technical advises on proposed application times and amounts or not using soil analysis. The relationships among the components of inputs were examined but only the seed cost/hoeing cost value demonstrated the closest rate to optimum level in the research. On the other hand, the most effective variable on sunflower production was found land renting value depending on applied stepwise process.

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