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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Science 8 (11): 1533-1540, 2005
ISSN 1028-8880

Technical Efficiency and Productivity of Apple Farming in Antalya Province of Turkey

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Abstract: This study analyzes social-economic characteristics of apple farms in Antalya province and reveals economic structure of apple farming. Technical efficiency of apple farming was also analyzed. Data were collected through personal interview from 60 agricultural enterprises during 2001 production year. Average size of the apple orchards in the study area is 12.46 da. Share of the total apple land in total farm land is 28.47%. Annual average gross margin of apple production consists of 67.91% of total gross margin of the farms surveyed. Traditional farming technique is prevailing in the region and farmers interviewed are growing traditional apple varieties. Unit cost of apple produced on the farms surveyed was calculated to be 161.269 TL kg^{-1}. On the other hand, apple is sold at a price of 280.581 TL kg^{-1}. Accordingly, profit margin was calculated to be 119.312 TL kg^{-1}. Technical efficiencies of apple production were estimated with Data Envelopment Analysis (DEA) and found to be 0.69 and 0.92 for constant and variable returns to scale assumptions, respectively. The greatest input slacks were in fertilizer use (K, N and P respectively). Therefore, to achieve a technically efficient apple production, appropriate soil tests should be conducted to determine fertilizer requirements of the soils.

Key words: Apple, production economics, profitability, data envelopment analysis

INTRODUCTION

Agriculture is an important sector in Turkish economy and horticulture is a crucial component. Horticulture and apple production acquired a high priority during the period between 1960 and 2001.

Apple farming is practiced in several locations in Turkey. Apple growing areas were classified and divided into four groups by Özbek[1], based on ecological conditions and cultural practices required for apple farming. Study area is located in the third apple farming region of Turkey, according to this classification. This is a region characterized by naturally unfavorable conditions for apple farming. However, apple can be grown under special climatic conditions of some river valleys and lake basins under suitable cultural practices such as soil tillage and adequate irrigation.

Apple planted areas cover approximately 7% of total fruit planted area in Turkey. Apple orchards rank third after grape and hazelnut areas. Apple is regarded as the second most valuable fruit crop in Turkey following grapes (19% in total fruit production). It is mostly consumed as a fresh fruit (about 90% of the total supply).

Isparta, Karaman, Niğde, Antalya, Denizli and Konya provinces are the most important apple producers in Turkey. Approximately, 200.000 t apple is produced in Antalya province. (31.5 and 8.5% of the total fruit production of Antalya and Turkey, respectively).

Apple plays a key role in the rural economy of Antalya. Improving production is quite important, but marketing is also equally important for a commercial crop like apple, which is purely produced to sell in the market. Although there are multi-dimensional efforts to increase the production of apple in Antalya province, marketing has not received proper attention. Apple market is not regulated in Antalya province.

In Antalya, agricultural land is 414.572 ha; 44.290 ha of agricultural lands is allocated to fruit growing (10.7% of total area) in this province. Share of apple in total fruit production is about 31.5%. Elmalı and Korkuteli districts are important apple producers in Antalya. 54.4% of the total apple lands of the province are located within (6.562 ha) Elmalı and 31.5% (3.807 ha) in Korkuteli district. These two districts comprise 87.9% of total apple production in Antalya province.

There are not sufficient economic researches carried out on apple farming in Turkey. So with this study carried out, apple growing farmers' economic situation was explained and apple production was discussed from the standpoint of productivity and efficiency. It is hoped that the findings of this study may help and direct future studies.

Therefore, this study was carried out to investigate the productivity of apple farming ad technical efficiencies of individual apple orchards.

MATERIALS AND METHODS

Data were compiled from apple growing enterprises in Antalya province. The data, pertaining to the 2001 production period were collected through a questionnaire study and personal interview method.

The Elmalı and Korkuteli districts were intentionally selected for the study as their share is 85.9 and 87.9% of Antalya's total apple planted area and production, respectively. From these districts, 8 of the most important apple growing villages were selected employing Neyman method[2]. Eight villages (4 from each district) are chosen for the study. The apple farms in the sample were stratified into four apple planted area size groups, by using the Neyman method as given below:

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

Where, n is the required sample size, N is the number of holdings in target population, Nh is the number of the population in h th stratified layer, Sh^2 is the variance of h th stratified layer, d is the precision where (x - X), z is the reliability coefficient (1.96 which represents 95% reliability) and D^2 is the d^2/z^2.

The permissible error in sample population was defined to be 10% and the sample size was calculated to be 60 for 99% reliability.

Social and economic characteristics of the farms were also determined.

Production costs consist of both variable and fixed costs. These two types of costs were calculated separately. Cost of family labor was calculated by multiplying amount of family labor used with unit payment for hired labor. Variable costs are those that can be change based on the production size. In apple production, variable costs include fertilizer, chemicals, water, machinery hiring, hired labor, marketing, fuel oil and other expenses and interest on operating capital. Fixed costs cannot be altered during production period based on the production size. Fixed costs included rent, family labor and general farm overheads.

Interest on operating capital denotes opportunity cost. In this study it is assumed to be 5% as recommended by Açıl and Demirci[3]. Hired labor charge was the price for unpaid labor. General farm overhead is 3% of the total costs. This was specified considering both fixed and variable costs.

Investment costs to establish apple orchards are used to determine capital recovery expenses, depreciation and interest on investment, during the production years. The establishment cost is the sum of cash costs for land preparation, planting, trees, production expenses and cash overhead for growing apples less returns through the first year when fruit is harvested. We have interviewed ten newly establishment orchards in that region and calculated establishment costs and depreciation based on them. The orchard establishment cost is amortized over the remaining 49 years of the 55 year orchard life. Establishment period and orchard life in apple production was selected as proposed by Açıl[4].

Gross value of production is the value of apple production obtained by annual productive operations. Net farm income was calculated by subtracting production costs per unit area from unit gross value of production per unit area (decare). Relative income in apple production was obtained by comparing gross value of production per decare to production cost per decare. And the gross income was calculated by subtracting variable costs from gross value of production.

Another purpose of this study was to investigate technical efficiencies of apple orchard in Antalya province based on the primary data obtained from farmers in two districts of this province. For this reason a nonparametric method (data envelopment analysis) was used.

Data Envelopment Analysis (DEA) is a nonparametric method widely used in efficiency measurement studies. In this method, production units are given an efficiency score based on their distance to a production frontier. This production frontier is constructed by means of linear programming model. In DEA, no explicit functional form is assumed for the underlying production technology and it is an advantage of this method.

Mathematical development of DEA was first introduced by Charnes and Cooper[5]. These researchers established their basic CCR model based on the works of Farrell[6] and others.

An input oriented BCC model is given below for N Decision Making Units (DMU), each producing M outputs by using K different inputs[7]:

$$\begin{aligned} &\text{Min}_{\theta,\lambda} \quad \theta \\ &\text{Subject to} \\ &-y_i + Y\lambda \geq 0 \\ &\theta x_i - X\lambda \geq 0 \\ &N1'\lambda = 1 \\ &\lambda \geq 0 \end{aligned}$$

Where, θ is a scalar, N1' is convexity constraint and λ is N x 1 vector of constants. Y represents output matrix and X represents input matrix. The value of θ will be the efficiency score for the ith firm. This linear programming problem is solved for each firm in the sample. θ with a value of one indicates that the firm is technically Farrell[6] efficient. Since slacks are not handled in Farrell definition of efficiency, a more strict efficiency definition known as Koopmans[8] criteria was developed later. According to this more strict definition, a firm is only technically efficient when it operates on the frontier and where all associated slacks are zero.

In order to meet this more strict criteria, identify the nearest efficient points and make the models independent from measurement units, original DEA specification has been extended in several ways developed multi stage models. Coelli[9,10] developed such a multi stage methodology and a computer program which implements a robust multi-stage model.

Scale Efficiency (SE) is measured with a ratio between technical efficiency scores obtained under CRS and VRS assumptions. Scale efficiency can be interpreted as the ratio of average product of a firm operating at any point to the average product of another firm operating at a technically optimal scale. A SE value equal to one implies that the farm is scale efficient and a value less than one suggests the farm is scale inefficient. A farm operating under decreasing returns to scale conditions means that it is operating under super-optimal conditions. On the other hand a farm operating under increasing returns to scale is operating under sub-optimal conditions.

Since it is believed that farmers have more control on inputs then they have on outputs, an input oriented DEA model was employed in the study.

Eight inputs (N, P, K, number of trees, labor, machinery, irrigation, pesticides) and one output (apple gross production value) were used in the analyses. Fertilizing was represented with three inputs, nitrogen (kg da^{-1} N) and phosphorus (kg da^{-1} P_2O_5) and potassium applied. For this purpose, animal manure and different types and brands of commercial fertilizers were converted to pure nutritional elements. Labor input consists of both hired and unpaid family labor. Machinery input was represented by machinery working hours. Irrigation was represented as the number of irrigations since there are no volumetric measurements available. Pesticides and other chemicals are the only input group represented by monetary units (TL da^{-1}), since their conversion to standard physical units is difficult.

DEA analysis requires production units using similar inputs to obtain similar outputs, under similar climatic, social and economic conditions. All apple farms are located within the third ecological apple growing region, according to Özbek[1] classification. However it is still very difficult to satisfy some of the similarity conditions in farming perennial crops. In an apple orchard, trees of different varieties and ages exist. Replacement of old trees contributes to the complexity of this situation. In order to account for different ages and to create a data set covering farms working under similar conditions, orchards where the share of trees between ages of 11 and 30 was greater than 80% were selected for the analysis. On the other hand, in order to make a fair comparison and avoid biases, another variable is constructed to represent number of apple trees. This variable is called Total Weighted Trees (TWT).

TWT variable is defined as:

$$TWT_{ij} = \lambda_{0810}T_{0810(ij)} + \lambda_{1121}T_{1121(ij)} + \lambda_{2235}T_{2235(ij)}$$

Where, TWT represents the total number of weighted fruit bearing trees; T0810 represents the number of trees in 8-10 age group; T1121 represents the number of trees in 11-21 age group; T2235 represents the number of trees in 22-35 age group; and λ values are coefficients to calculate number of weighted trees. These coefficients were derived from the questionnaire data.

Apple yields obtained for different age groups during the questionnaire were used to obtain yield-age profile indices. Yield-age profile index of a mature tree was taken as unity and yield indices of other trees within different age groups were calculated based on the ratio constructed between their yields and those of mature trees.

To eliminate quality differences, gross value of apple product (per unit area) was used to represent output.

Large variations exist in physical input and output parameters (Table 3). The greatest variations are

Table 1: Apple production costs per decare* by farm size group

	1		2		3		4		Average	
Cost items	Million TL	%	Million TL	%	Million TL	%	Million TL	%	Million TL	%
Material	185,35	27,39	119,50	21,88	75,06	20,91	82,31	26,19	92,80	23,72
Machine hire	2,41	0,36	8,40	1,54	0,00	0,00	0,00	0,00	2,05	0,52
Fuel oil	42,71	6,31	35,69	6,53	26,31	7,33	18,09	5,76	24,97	6,38
Seasonal labor	67,65	10,00	44,62	8,17	47,04	13,10	58,01	18,46	52,63	13,45
Harvesting and marketing	124,48	18,39	105,65	19,35	77,14	21,49	55,34	17,61	74,56	19,06
Other variable expenses	11,17	1,65	7,92	1,45	7,43	2,07	5,21	1,66	6,57	1,68
Unpaid family labor	77,45	11,44	58,36	10,69	31,10	8,66	10,63	3,38	28,86	7,38
Overheads	12,96	1,91	9,59	1,76	6,89	1,92	6,53	2,08	7,55	1,93
Depreciation	114,09	16,86	95,26	17,44	46,06	12,83	39,71	12,63	56,72	14,50
Building repair	2,41	0,36	25,06	4,59	5,89	1,64	2,43	0,77	8,54	2,18
Investment interest	36,05	5,33	36,05	6,60	36,05	10,04	36,05	11,47	36,05	9,21
Total. production costs	676,77	100,00	546,11	100,00	358,99	100,00	314,31	100,00	391,31	100,00

* 1 da = 0.1 ha

observed in P, N and K fertilizers, when coefficients of variation are taken into consideration. Some farmers are not using all of these fertilizers (Table 5). These great variations in input use may be an indicator of mismanagement problems.

RESULTS AND DISCUSSION

Apple producing organizations surveyed for this study were classified according to the size of apple plantations:

- Group 1 Apple orchard size: 1.0-5.0 decare
- Group 2 Apple orchard size: 5.1-15.0 decare
- Group 3 Apple orchard size: 15.1-30.0 decare
- Group 4 Apple orchard size: 30.1 decare and more

Socioeconomic characteristics of the apple farms: In enterprises surveyed, average age of the apple growers was 48.62 years. There were no significant differences between farm groups with respect to growers' ages and education levels. Average family size in survey households was 4.2 people. This is lower than the general average (5.4 people) of rural areas of Turkey[11]. No significant differences were observed between farm groups with respect to demographic characteristics. Of the family, 52.4% were men and 47.6% were women. About 11.9% of the population was illiterate, 6.9% can read and write and 55.6% were graduate from primary school.

Land use and cropping pattern: In the research area, average farm size was found to be 64.73 da. 92.48% of the farms were owned and 7.52% was rented. In the surveyed enterprises average number of tractors was 0.88.

Fallow land consists 9.2% of the total farm size. Field crops comprises 64.22% of total farm size. The major crops grown in farms were wheat, apple, barley, sugar beet, peaches, chickpea and pear.

24.11% of the farm area is used for the production of fruit crops. There is a positive relationship between size of the apple planted area and total cultivated land (varying from 6.49% at Group 1 to 52.54% at Group 4 farms).

Annual economic analysis of farms: The estimated gross and net margins of the enterprises are presented for harvest year 2001. The figures are then disaggregated to provide more information on the distribution of the costs and returns of the agricultural production. The contribution of apple farming to the overall farm enterprises is then discussed.

Gross production value was 23.177.040.000 and 262.391.600 TL da^{-1}. Shares of field crops, other fruits, vegetables, animal production and apple production values in gross production value were 7.68, 13.98, 2.38, 7.72 and 68.24%, respectively. Gross profit was 166.191.300 TL da^{-1}. Shares of apple, field crops, other fruits, vegetables and animal production values in gross profit were 67.91, 13.24, 8.80, 3.01 and 7.05%, respectively. Gross profit varies depending on farm size groups.

In surveyed enterprises farm income was 140.749.000 TL da^{-1} and this income varies with farm size groups. In surveyed farms, total family income was calculated by summing farm income and non agricultural income. Shares of agricultural income and non agricultural income in total family income were 94.77 and 5.23%, respectively. In general, non agricultural income was very low in small apple planted groups.

Structural properties in apple farming: Most modern apple varieties were brought to Turkey after the 1960s through the FAO Yalova Project[12]. After the 1980s, new apple varieties were introduced through collective work of Çukurova University Pozantı Agricultural Research and Application Center (POZ-MER) and Agriculture Ministry. These were varieties such as Elite, Spur Early, Stripe, Ed Gould Golden, Golden Smothee, Gloster, Erwin Spur, Red Spur, Hi-Early etc.[12].

In Turkey, apple varieties grown are Starking Delicious, Golden Delicious, Amasya, Starkrimson Delicious and. Stark Spur Golden Delicious in general[13]. Besides these, in Turkey and research area, new apple varieties were being grown recently, especially after the 1990s.

The most widespread apple varieties grown in the survey area are Starking Delicious, Starkrimson Delicious, Golden Delicious, Stark Spur Golden Delicious, Granny Smith and Amasya. Average size of apple farms in the region is 12.46 da. All apple growing areas are owner operated lands and all of the farmers irrigate their apple orchards.

In investigated farm enterprises about 28.47% of the area was allocated to apple cultivation. Shares of the apple cultivation are 6.43% at Group 1, 26.80% at Group 2, 19.92% at Group 3 and 52.54% at Group 4.

31.59, 47.71, 58.02 and 89.63% of total gross margin is obtained with this crop in Group 1-4, respectively. Average farm apple production was observed to be as 15.27, 31.52, 54.57 and 170.84 t in Group 1-4, respectively. Production from one decare land varies from 2-3.6 t in the groups (Table 2).

Cultural practices and material inputs: It is assumed that orchards reach maturity in year 7 and maximum production

Table 2: Apple production cost, selling price, net and relative profit by farm size

Farm size	Yield (kg da^{-1})	No. of apple trees (da^{-1})	Production cost (TL kg^{-1})	Selling price (TL kg^{-1})	Net profit (TL da^{-1})	Net profit (TL kg^{-1})	Relative profit (%)
1	3580,80	23,08	189.000	245.889	203,71	56.889	130
2	2604,17	21,42	209.705	262.207	136,72	52.502	125
3	2007,37	21,72	178.835	250.016	142,89	71.182	140
4	2461,67	59,35	127.681	304.861	436,16	177.180	239
Average	2426,43	40,43	161.269	280.581	289,50	119.312	174

Table 3: Summary statistics for variables used in the efficiency analysis

Input/Output Variables	Min.	Max.	Mean	SD*
Output				
Apple gross value product (10^6 TL da^{-1})**	262,40	1917,58	684,15	346,63
Inputs				
Total weighted trees (trees da^{-1})	6,95	40,00	17,70	5,64
Fertilizer-N (kg N da^{-1})	0,20	109,71	35,71	26,79
Fertilizer-P (kg P_2O_5 da^{-1})	0,03	88,82	19,71	18,09
Fertilizer-K (kg K_2O da^{-1})	0,00	60,28	6,01	11,98
Labor (h da^{-1})	37,48	245,58	108,47	43,66
Machinery (h da^{-1})	2,13	27,03	6,21	3,93
Pesticide (1000 TL da^{-1})	11,37	248,89	64,10	44,58
Number of irrigations	2,00	16,00	5,20	1,90

*Standard deviation; ** 1 da = 0.1 ha

is obtained this year also. Orchard establishment cost was calculated and found to be 721 m TL da^{-1} in research area.

Generally, average number of land preparation operations is 2.6. These activities are performed mainly between March and October.

Pruning is very important for obtaining high yield. In research area apple pruning is done by hand during the winter months, January to April.

Fruit thinning is very important for quality fruit and is done by hand during June and July in the farms surveyed. In this research, farmers usually do not use chemical thinning. It is applied in greater apple orchards. There is a positive relationship between the size of apple orchard and number of thinning operations.

Both chemical fertilizers and farm yard manure are used in the farms surveyed. According to the findings of the study fertilizer is applied 2.7 times during the production period. 29.57 kg N da^{-1} fertilizer, 15.08 kg da^{-1} P fertilizer and 6.53 kg da^{-1} K fertilizer is applied in April, May, June and July. Fertilization is done by hand. Calculated fertilization cost was found to be 30.77 m TL da^{-1}.

Most apple orchards in the region are irrigated with water taken from irrigation channels, but some apple operator use pumps to bring water to their orchards. In surveyed area number of irrigations was 5.3 times in apple production. Water cost per decare varies among groups. In this study, water cost was calculated to be 12.11 m TL da^{-1}. Water is applied to the orchards from May through September.

While spraying is not a common practice, hoeing has a widespread use in weed control.

Apple is very unlikeness fruit compare other fruits about varmint and disease. After year 1997, an Integrated Pest Management program was introduced by Turkish Ministry of Agriculture for fruits especially for apple and citrus. It was observed that pesticide spraying was applied 7.3 times. Spraying cost per decare was 49.91 million TL.

In the sample farms, apple harvesting period varies based on apple varieties grown. In general, apple is harvested in September and October. In apple growing enterprises, harvesting period is between September 11 and October 10. According to the results of the survey, the most significant factor to determine harvesting date was found to be appearance of the fruit. The other significant factors were color, taste, dropping and date.

In sample farms, most important apple marketing channel is the dealer. Apple producers usually sell their products to the dealers (79.51% of the total apple sold). Other important apple marketing channels were fruit juice factories, middlemen and sellers in the market.

Average machinery use hours in apple farming were found to be 5.39 h in the survey area. Most of this time is spent in spraying (40.80% of total machinery use) and marketing (22.43% of total machinery use). This is a higher duration than those found in surveys carried out before[14-16].

In surveyed enterprises, 88.22 h labor is used per decare. Most of the labor work is was in harvesting (51.41% of total labor used), pruning, thinning, hoeing (27.28%) and irrigation (10.35%). In general, labor use per decare is higher in smaller apple orchards.

Fertilization amount required should be determined with soil and leave analyses. In general, farmers do not conduct soil or leaf analysis.

Apple production cost and profit: Production cost covers total cost of inputs used in production and other costs required to realize production operations. Therefore, the production cost consists of material, labor, fuel oil, machinery rented, harvesting-marketing, depreciation, building repair and interest on investment etc.

Average total production cost is 391.31 m TL da^{-1}. Average production costs according to farm sizes are as follows: 676.77 m TL da^{-1} in Group 1, 546.11 m TL da^{-1} in Group 2, 358.99 m TL da^{-1} in Group 3 and 314.31 m TL da^{-1} in Group 4. It is easily seen that as the area increases average total production costs decrease (Table 1).

The material cost covering fertilization, spraying and irrigation water costs accounts for 23.72% of the production costs. Harvesting and marketing cost is the second highest cost item (19.06% of the production costs). This is followed by depreciation, seasonal labor, interest on investment (Table 1).

Farmers reported an average yield of apple was 2426 kg da^{-1}. Farms in Group 1 produced the highest yield; those in Group 3 produced the lowest yield. In orchards surveyed, average density is 40.43 trees da^{-1} (Table 2).

Net profit is obtained by subtracting the production cost per decare from the gross value of production per decare. Net profit per decare was 289.50 million TL (Table 2).

Relative profit is obtained by comparing gross value of production to production cost. The average farm has a relative profit of 174%. Organizations in Group 4 had the highest relative profit (Table 2).

Group 4 had the highest selling price among all the other groups (Table 2).

Kilogram cost and margin of profit: In the surveyed enterprises, Cost of 1 kg apple was 161.269 Turkish Liras and profit margin was found to be 119.312 TL kg^{-1}. Group 4 produces apple with minimum cost and Group 4 with maximum (Table 2).

Technical efficiency of apple farming: DEA scores were estimated using the software DEAP version 2.1 developed by Coelli[9]. Efficiency scores of the farms were calculated under CRS and VRS assumptions (Table 4).

Of the 60 apple orchards studied, 14 farms under CRS and 30 farms under VRS are fully efficient. 19 farms under CRS showed a performance below 0.50. In DEA analysis, 1 farm became a peer more than 25 times for other farms. This farm is a robustly efficient farm since its production practice is frequently used to construct the efficient frontier for the other farms.

Slack variables were also analyzed in order to determine excess input use. A farm can reduce its expenditure on an input by the amount of slacks without reducing its output.

The greatest input excess is in potassium fertilizer (Table 5). According to the results of efficiency analysis, potassium fertilizers are used excessively in approximately one third of the apple orchards (23 out of the 60 apple farms, Table 5). Excesses in fertilizer use can be attributed to the habit of farmers, who do not make their fertilizing decisions conducting appropriate soil tests.

Table 4: Frequency distributions of technical efficiency scores obtained with DEA model

	DEA		
Efficiency scores	CRS	VRS	SE
1.00	14	30	14
0.90-1.00	3	8	5
0.80-0.90	5	14	9
0.70-0.80	9	4	9
0.60-0.70	4	4	5
0.50-0.60	6	0	3
0.40-0.50	10	0	11
<0.40	9	0	4
Mean	0.69	0.92	0.74
Minimum	0.33	0.64	0.37
Maximum	1.00	1.00	1.00
SD	0.24	0.10	0.22

Table 5: Input slacks and number of farms using excess inputs

Input	Number of farms	Mean slack	Mean input use	Excess input use (%)
TWFBT	13	1.14	23.75	6.45
Fertilizer-N	18	8.22	27.27	23.01
Fertilizer-P	16	2.94	19.72	14.91
Fertilizer-K	23	2.09	4.61	34.81
Labor	22	11.32	108.45	10.44
Machinery	17	0.94	4.79	15.15
Pesticide costs	20	8.98	44.59	14.02
Number of irrigations	16	0.39	5.22	7.54

TWT: Total Weighted Fruit Bearing Trees
Fertilizers in kg-nutrient da^{-1}. Labor and machinery in h da^{-1}
Pesticide costs in 10^6 TL da^{-1}. 1 da = 0.1 ha

It is well known that some nutritional elements such as phosphorus are combined with the soil by a process known as fixation. Therefore soil tests are important in determining actual fertilizer requirements of soils. Mixed fertilizer use may also be another cause of excess phosphorus use.

Relatively high efficiency scores and low input excesses may be attributed to apple's being a commercial crop. Commercial crops are grown by mostly specialized farmers and applications are almost standardized.

For the inefficient farms, the causes of inefficiency may be either inappropriate scale or misallocation of resources. Inappropriate scale suggests that the farm is not taking advantage of economies of scale, while misallocation of resources refers to inefficient input combinations. In this study, scale efficiencies are relatively high. Therefore, efficiencies are mainly due to improper input use.

Mean scale efficiency of the sample apple farms is 0.74. Of the 60 apple farms, 14 show constant returns to scale, 46 show increasing returns to scale. There are no farms practicing under decreasing returns to scale conditions. As it is seen from the Table 6, mean farm sizes are approximately the same for optimal and sub-optimal apple orchards. However, there are great differences between mean output and mean gross return per unit are.

Table 6: Characteristics of farms with respect to returns to scale

	Number of farms	Mean farm size	Mean output	Mean gross return
Sub-optimal	46	19.81	2538.04	609.94
Optimal	14	34.47	2849.86	928.01
Super-optimal	-	-	-	-

In order to get information on determinants of inefficiency, efficiency scores were regressed upon some environmental variables. After several trials, the most important environmental factors were found to be total land area and number of plots.

Signs of the parameters are as expected. Sign of the area parameter is positive. This indicates that the bigger farms are more efficient. Farms with higher plot sizes (greater land fragmentation) are less efficient. As it is well known, fragmented lands increases in labor and machinery use.

CONCLUSIONS AND RECOMMENDATIONS

In this study, social and economics structures of the apple growing enterprises were investigated. Production structure, production cost and productivity in apple farming were also discussed. Besides, efficiencies were calculated using DEA.

Apple crop has important social and economic effects in the survey area.

In the light of all these considerations some suggestions have been put forward to tackle the problems concerning the apple production.

Firstly, it is important to develop fruit quality and high yield in apple production. To do this, apple producers should be informed about new apple rootstock systems and varieties mostly demanded by consumers.

The problems are complex and range from agronomic aspects to pests and disease management, post-harvest handling, marketing and financing in research area. In surveyed enterprises, some apple producers have inefficient knowledge or are uninformed on technical operations (such as fertilization, thinning). So these problems could be improved through collective works of technical experts.

For marketing of the crop, there is a need for creation and strengthening of such agencies which would address these problems.

Extension services need to be streamlined in order to disseminate the technical know-how about the crop.

There is need for the provision of crop insurance in case of natural calamities like drought, etc.

The procedure of financing should be made easy and convenient for the farmers in order to make it popular among the apple growers.

DEA analysis results showed that high efficiency scores and number of efficient farms imply that apple farming is almost standardized among farmers. This is an expected result since apple is a commercial crop and requires special techniques and qualification. However study also reveals some important resource use inefficiencies in apple farming in selected regions and that technical efficiencies can be increased by 8% through better use of available resources under VRS assumption.

The greatest excesses were observed in fertilizer use. Appropriate soil tests should be conducted in order to determine fertilizer requirements of the soils in the region.

Input slacks associated with other input variables are also important although their extent is not as great as that of phosphorus. All these excesses adversely affect technical efficiencies of apple farms. Inefficiencies indicate a wrong input mix between these the inputs.

Finally, it should be kept in mind that inefficiency is not just a result of the amount of inputs used. Factors such as timing of irrigation and fertilization and environmental factors have also an effect on efficiency.

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