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Full Length Research Paper

An input-output energy analysis in pistachio nut production: A case study for Southeastern Anotolia region of Turkey

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This research examined the energy use pattern and energy input/output analysis of pistachio nut widely grown in the South-eastern Anatolia, Turkey. For this purpose, data from pistachio nut production were collected in 61 farms from ten villages by a questionnaire which was selected according to their regional properties. As a result, the total energy input used in various farm operations for cultivating the pistachio nut fruit was calculated to be 4286.8 MJ ha^{-1}. Out of all operations, tillage consumed maximum energy. This operation was followed by spraying, and then by harvesting, transportation, and fertilizer application. The total energy requirement consumed in various energy sources for the pistachio nut fruit was calculated as 12044.0 MJ ha^{-1}. The average fruit yield of the pistachio nut was determined as 1500 kg ha^{-1} and its output energy was calculated as 17 700 MJ ha^{-1}.

Key words: Energy use, input-output energy, pistachio nut, South-eastern Anatolia.

INTRODUCTION

Turkey is one of the main pistachio producing countries in the world and pistachio is an important product for Turkish agriculture. Turkey is the third biggest producer of pistachio nut in the world (FAO, 2004; Polat et al., 2005).

Although Turkish pistachio varieties are smaller in shell and kernel, these varieties are preferred in many European and USA markets because of their better taste and more uniformly green kernels (Ozeker et al., 2001, Woodroof, 1982). One of the origin places of pistachio nut is Anatolia; therefore, it is grown in all over Turkey, especially in Southeast Anatolia (Kaska, 1995). Turkey is the third pistachio producer after Iran and USA and has approximately 10.6% of the total production of the world (FAO, 2004).

Pistachio tree (*Pistacia vera* L.) recently expanded to the other regions and some warmer parts of Turkey. In the last 20 years, world pistachio production has increased 4 to 5 times; also the production of the nuts increased in Turkey in the same period. It was also expected that Turkey's upward trends of pistachio production will continue in the future due to increment in number of the tree and irrigation facilities which will be provided by GAP (South-eastern Anatolia Project) in South-eastern Anatolia. However, pistachio exports are not increased in parallel to production as expected in Turkey (Polat et al., 2007). The share of our pistachio export was about 20% of the total world export in 1980, after that it seriously declined in 1990 (Emeksiz and Songul, 1999). Pistachio production areas are 218 500 ha and average production is about 50 000 metric tons in Turkey (FAO, 2005; Acar, 2004).

Applications of agricultural mechanization are limited in pistachio cultivations in Turkey. This limitation decreases yields of the tree, and consequently decreases the pistachio nuts production, thereby increasing the cost (43.33%) of labour power of harvest and annual maintenance (41.51%) (Yildiz, 1998).

Pistachio nut is widespread produced in Şanliurfa and Gaziantep provinces, located in GAP region (Polat and Ulger, 2001). Approximately, 50% of the total production

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Table 1. Energy equivalences of inputs and outputs.

Energy source	Unit	MJ	Reference
Man	h	1.96	De et al., 2001; Singh, 2002
N	Kg	60.6	Shresta, 1998; De et al., 2001; Singh, 2002
P_2O_5	Kg	11.1	Shresta, 1998; De et al., 2001; Singh, 2002
K_2O	Kg	6.7	Shresta, 1998; De et al., 2001; Singh, 2002
Diesel fuel	L	47.8	Hetz, 1992; Hetz, 1998
Tractor	Kg	93.61	Hetz, 1992; Hetz, 1998
Agricultural machine	Kg	62.7	Singh, 2002; De et al., 2001
Chemicals	Kg	120	Singh, 2002
Output	Kg	11.8	Hatirli et al., 2004

MJ, mega joule.

of pistachio nut in Turkey is provided from these two locations (Anonymous, 2002). When the GAP project was finished completely, it was also expected that pistachio tree would be planted on most farm in this region.

Different studies have been conducted on the energy use patterns and energy input-output analysis in agricultural production processes. Among them, Heidari and Omid (2011) examined the energy use patterns and energy input-output analysis of major greenhouse vegetable productions, Zengeneh et al. (2010) determined the amount of input-output energy used in potato production and made an economic analysis of potato production and Yilmaz et al. (2005) determined the direct input energy and indirect energy per hectare in cotton production and compared it with input costs. On the other hand, Canakci and Akinci (2006) have investigated the energy use patterns in greenhouse vegetable production, to determine the energy output–input ratio and their relationships.

The aim of this research was to determine the energy equivalents of inputs and outputs in pistachio nut production in GAP region of Turkey.

MATERIALS AND METHODS

Data were obtained from 61 agricultural farms producing pistachio nut in Şanliurfa and Gaziantep Provinces from year 2006 to 2007 in Turkey. These farms have similar agricultural characteristics, that is, structure of agricultural machine, production techniques etc., which are representatives of the region. Pistachio producers have carried out agricultural production processes in 30 to 20 ha areas. The producers were asked a numbers of questions about the planting applications, plantation areas, using of agricultural machineries, labour and machinery hours used in farm production processes and total crop yields received from pistachio nut cultivation areas.

The agricultural operations and the energy inputs and output values of pistachio nut cultivated in the region were determined from a questionnaire given to farmers from 10 villages selected due to their regional properties. The random selection method was applied to determine the farm number. Firstly, the most common production systems for rain fed pistachio nut were determined; and then all inputs and outputs from the system, were identified and quantified, and later they were transformed into energy units. The energy equivalents of the inputs and outputs are shown in Table 1.

RESULTS AND DISCUSSION

Agricultural operations and use of power sources

In this research, 61 similar farms working on rainfed pistachio nut cultivation in the South-eastern Anatolia were carried out. The total area of those farms is about 322.5 ha. The use of power sources for the pistachio nut production in the region are given in Table 2. While some agricultural operations were done manually, the others were powered by tractor. Animal power was not used for any applications during the production process. In the cultivation, there was no irrigation operation due to rainfed conditions, the main agricultural operations realized by farmers were tillage, hoeing-wedding, fertilizer appli-cation, spraying, harvesting, pruning, transporting and separation.

Tillage is usually operated by a 7 to 9 unit cultivator for five times or rarely once by plough before cultivator during cropping time. In the operations of agricultural production, usage values of manpower, tractor and diesel fuel were determined as 8.4, 8.4 h ha^{-1} and 62.0 L ha^{-1}, respectively. On the other hand, it was determined that total man time of 24.3 h ha^{-1} was required for hoeing and weeding. The power values of man, tractor and diesel fuel of pistachio nut orchards in which fertilizer application was done were realized as 1.8, 1.8 h ha^{-1} and 1.5 L ha^{-1}, respectively. An orchard sprayer powered by tractor is generally used for spraying operations; the spraying operation is realized approximately 2 times in a season in the research regions. The values of manpower, tractor and diesel fuel used for spraying operation were determined to be 4.2, 4.2 h ha^{-1}, and 1.6 L ha^{-1}, respectively. The pruning operation was done manually between the months of October and April. The value of manpower used for pruning operation was determined to be 31.7 h ha^{-1}. In the research area, pistachio nut fruits were harvested by hand, and the maximum manpower usage was seen during the harvesting period with the value of 127.8 h ha^{-1}. The distance between orchard and farms affected the usage of man, tractor-machinery and diesel consumption with the average value of 500 m approximately.

Table 2. Use of power sources for rainfed pistachio nut cultivation.

Operation	Man (h ha^{-1})	Tractor (h ha^{-1})	Diesel fuel (L ha^{-1})
Tillage	8.4	8.4	62.0
Hoeing-wedding	24.3	-	-
Fertilizer application	1.8	1.8	1.5
Spraying	4.2	4.2	1.6
Pruning	31.7	-	-
Harvesting	127.8	-	-
Transporting	1.4	1.4	3.7
Separation	35.1	-	-
Total	234.7	15.8	68.8

Table 3. Energy use pattern for rainfed pistachio nut cultivation.

Input	Value	%
Operations, MJ/ha		
Tillage	3229.2	75.3
Hoeing, wedding	47.6	1.1
Fertilizer application	123.5	2.9
Spraying	258.1	6.0
Harvesting	250.5	5.8
Pruning	62.1	1.4
Transporting	246.9	5.8
Separating	68.8	1.6
Total	4286.8	100.0
Energy source, MJ/ha		
Human	460.0	3.8
Machines	538.2	4.5
Diesel fuel	3288.6	27.3
Fertilizer	7457.2	61.9
Chemicals	300.0	2.5
Total	12044.0	100.0
Others		
Yield of pistachio nut, kg/ha	1500	
Output energy, MJ/ha	17700	
Net energy, MJ/ha	5656	
Energy ratio	1.47	
Specific energy, MJ/t	8029	
Energy productivity, kg/MJ	0.12	
N, kg/ha	112	
P_2O_5, kg/ha	100	
Chemicals, kg/ha	2.5	

These values were 1.4, 1.4 h ha^{-1} and 3.7 L ha^{-1}, respec-tively. In the research region, after harvesting operation, pistachio nut fruits were separated manually; time req-uirement value for this operation for unit area was determined as 35.1 h ha^{-1}.

Energy use pattern

The distribution of the energy use pattern for cultivating the rainfed pistachio nut is shown in Table 3. In the evaluation of energy usage, operational energy and energy sources were taken into consideration separately.

The total energy input used in various farm operations for cultivating the pistachio nut fruit was calculated to be 4286.8 MJ ha^{-1}. Out of all the operations, tillage consumed the maximum energy with the ratio of 75.31%. It can be said that the higher energy usage for tillage resulted in higher diesel fuel consumption with respect to the other operations. This operation was followed by spraying (6.09%), then by harvesting (5.8%), transportation (5.8%), and fertilizer application (2.9%). These energies for unit area were 258.1, 250.5, 246.9 and 123.5 MJ ha^{-1}, res-pectively. Energy usage values were found to be very close to each other in hoeing, pruning and separating operations. The shares of these operations done manually varied between the ranges of 1.1 to 1.6%.

It could be said that there was no diversity with respect to the use of energy sources in the rainfed pistachio nut cultivation. Among the energy sources which include human, machines, diesel fuel, fertilizer and chemicals, the fertilizer energy was the highest with a mean of 7457.2 MJ ha^{-1} and its ratio was approximately 62%. The farmers used 112 kg N and 100 kg P_2O_5 for the unit hectare of orchard area. With the highest ratio of energy usage, the finding obtained for fertilizer application was similar to the findings in the literature. In some research, the share of the fertilizer energy varied between 50 to 90% (Hetz, 1992; Ozkan et al., 2004) and was followed by diesel energy (27.3%) (Hetz, 1992; Ozkan et al., 2004).

The energy usage to operate the agricultural machinery powered by a tractor was 3288.6 MJ ha^{-1}. The machine energy used for fertilizer application, spraying and trans-portation operations affected total machinery usage energy with a share of 4.5%. Also, human and chemical energies for the above operation were found to be lower, with a share of 3.8 and 2.5%, respectively. It could be said that chemical energy ratio was determined as 300 MJ ha^{-1}, so that plant production operations by using

Table 4. Distribution of different energy types.

Type of energy	Value	%
Direct *	3748.7	31.1
Indirect **	8295.4	68.9
Renewable ***	460.0	3.8
Non-renewable ****	11584.0	96.2
Total energy input	12044.0	100.0

*Direct, the sum of human and diesel fuel energies; **indirect, the sum of machines, fertilizer and chemicals energies; ***renewable, the sum of human energies; ****non-renewable, the sum of machines, diesel fuel, fertilizer and chemicals energies.

chemical methods were not applied intensively. The total energy requirement consumed in various energy sources for the pistachio nut fruit was calculated as 12 044.0 MJ ha^{-1}. It was determined that the energy usage in pistachio nut cultivation was lower than that of apricot, citrus, grape and raspberry (Hetz, 1998; Gezer et al., 2003; Ozkan et al., 2004; Esengun et al., 2007).

The fruit yield of pistachio nut was determined as 1500 kg ha^{-1} and its output energy was calculated as 17 700 s, output/input energy ratio and specific energy values were 1.47 and 8029 MJ t^{-1}, respectively. Also, the energy productivity in the pistachio nut cultivation was calculated as 0.12 kg MJ^{-1}.

The usage ratios of the direct energy (human and diesel fuel) sources and the indirect energy (machines, fertilizers and chemicals) sources were 3747.8 MJ ha^{-1} (31.1%) and 8295.4 MJ ha^{-1} (68.9%), respectively as given in Table 4. Also, it was seen that most of the total energy input was from non-renewable sources (96.2%). Among them, renewable energy contained only human energy. The findings obtained for non-renewable energy usage (fertilizer and diesel fuel having the maximum ratio) were similar to the findings in the literature (Hetz, 1998; Gezer et al., 2003; Ozkan et al., 2004).

REFERENCES

Acar I (2004). Effects of Pistachio (*P.Vera.*L) pollinator types selected in Ceylanpinar on fruit set and fruit quality of some pistachio cultivars (in Turkish). Institute of Natural and Applied Science. Universty of Cukurova, PhD Thesis, Adana, Turkey, p. 159.

Anonymous (2002). Türkiye İstatistik Enstitüsü. Necati Bey Caddesi Ankara.

De D, Singh RS, Chandra H (2001). Technological impact an energy consumption in rainfed soybean cultivation in Madhya Pradesh. Appl. Energ. 70: 193-213.

Canakci M, Akinci I (2006). Energy use pattern analyses of greenhouse vegetable production. Energy, 31: 1243e56.

Emeksiz F, Songul S (1999). Determining production export potential of pistachio inTurkey. XI GREMPA Seminar on Pistachios and Almonds, 56: 201-208.

Esengun K, Erdal G, Gunduz O, Erdal H (2007). An economic analysis and energy use in stake-tomato production in Tokat province of Turkey, Renew Energy 32(11): 1873-1881.

FAO (2005). Faostat Statistical Database.

FAO (2004). Faostat Statistical Database.

Gezer I, Acaroglu M, Haciseferogullari H (2003). Use of energy and labour in apricot agriculture in Turkey. Biomass Bioenerg. 24: 215-219.

Heidari MD, Omid M (2011). Energy use patterns and econometric models of major greenhouse vegetable productions in Iran. Energy, 36: 220-225.

Hetz EJ (1992). Energy utilization in Chilean agriculture. Agricultural Mechanization in Asia, Afr. Latin Am. (AMA). 23(2): 52-56.

Hetz EJ (1998). Energy utilization in fruit production in Chile. Agric. Mechanization Asia, Afr. Latin Am. (AMA), 298(2): 17-20.

Hatirli SA, Ozkan B, Aktas A (2004). Factors Affecting Fluid Milk Purchasing Sources in Turkey, Food Quality and Preference, 15(6): 509-515.

Kaska N (1995). Pistachio nut growing in Turkey. Acta Horticulturae, 419: 161-164.

Ozkan B, Akcaoz H, Fert C (2004). Energy input output analysis in Turkish agriculture. Ren. Energ. 29: 39-51.

Ozeker E, Misirli A, Isfendiyaroglu M (2001). Description of fruit characteristics of some Pistachia spp. in Manisa-Yunt mountain area. Preliminary results. In XI Grempa seminar on pistachio and almonds. Proceedings, 56: 283-286.

Polat R, Gezer I, Guner M, Dursun E, Erdogan D, Bilim HC (2007). Mechanical harvesting of pistachio nuts. J. Food Eng. 79: 1131-1135.

Polat R, Toy M, Atay U (2005). Present situation and problems of Pistachio processing plants and Recommendations. J. Faculty Agric., Harran Univ. 9(4): 43-47.

Polat R, Ulger P (2001). A Research on Determination of Fhysico-Mechanical Properties of Pistachio Nut (in Turkish). 20th National Congres of Agricultural Mechanization. 13-15 September, Şanlıurfa, Turkey, pp. 523-529.

Singh JM (2002). On farm energy use pattern in different cropping systems in Haryana, India. Master of Science Thesis, International Institute of Management, University of Flensburg, Germany. p. 106.

Shresta DS (1998). Energy input-output and their cost analysis in Nepalese agriculture. http://www.public.iastate.edu.

Woodroof JC (1982). Tree nuts: production, processing, porducts (seconded.). Wesport (CT): Avi Publishing Company Inc.

Yildiz F (1998). Şanlıurfa Antep Fıstığı İşletmelerinde Girdilerin Fiziki Miktarları ve Antep Fıstığı Maliyetinin Tesbiti Üzerine Bir Araştırma (in Turkish). Master thesis, Department of Agricultural Economy, Harran University, Sanliurfa, Turkey.

Zengeneh M, Omid M, Akram A (2010). A comparative study on energy use and cost analysis of potato production under different farming technologies in Hamadan province of Iran. Energy, 35: 2927-2933

Yilmaz I, Akcaoz H, Ozkan B (2005). An analysis of energy use and input costs for cotton production in Turkey. Ren. Energ, 30(2): 145-155.