Erwerbs-Obstbau (2019) 61:323–329
https://doi.org/10.1007/s10341-019-00434-4

ORIGINAL ARTICLE

Energy Use Efficiency and Economic Analysis of Nectarine (*Prunus persica* var. *nucipersica*) Production: A Case Study from Niğde Province

Halil İbrahim Oğuz[1] · Oktay Erdoğan[2] · Osman Gökdoğan[1]

Received: 19 December 2017 / Accepted: 3 April 2019 / Published online: 9 May 2019

Abstract
This study was aimed to determine the energy use efficiency and economic analysis of nectarine production for the 2015–2016 production seasons in Niğde province in Turkey. A survey data were collected in 2017 and the farms were selected according to the full counting method and the survey was applied to these farms. In order to determine the energy use efficiency and economic analysis in the production of nectarine, a survey was made with 8 farms that can be reached over 20 decares of nectarine production in Niğde province. According to results of study, human labour energy, machinery energy, chemical fertilizers energy, chemicals energy, organic fertilizers energy, diesel fuel energy, irrigation water energy and electricity energy were calculated as energy inputs. Nectarine fruit was calculated as output. In nectarine production, total input energy was calculated as 29,893.35 MJ ha^{-1} and total energy output was calculated as 55,731.09 MJ ha^{-1}. The energy inputs in nectarine production were calculated respectively as chemical fertilizers energy 12,900.69 MJ ha^{-1} (43.15%), electricity energy 6698.27 MJ ha^{-1} (22.41%), irrigation water energy 4142.05 MJ ha^{-1} (13.86%), human labour energy 1826.29 MJ ha^{-1} (6.11%), chemicals energy 1660.69 MJ ha^{-1} (5.56%), diesel fuel energy 1479.26 MJ ha^{-1} (4.95%), machinery energy 1134.65 MJ ha^{-1} (3.80%) and organic fertilizers energy 51.45 MJ ha^{-1} (0.17%). The energy use efficiency, specific energy, energy productivity and net energy calculations were calculated in nectarine production respectively as 1.86, 1.02 MJ kg^{-1}, 0.98 kg MJ^{-1} and 25,837.74 MJ ha^{-1}. Benefit-cost ratio was calculated as 2.02 for nectarine production.

Keywords Economic analysis · Energy use efficiency · Energy productivity · Nectarine · Niğde · Turkey

Energiebilanz und Wirtschaftlichkeitsberechnung für die Produktion von Nektarinen (*Prunus persica* var. *nucipersica*), eine Fallstudie aus der Provinz Niğde

Schlüsselwörter Wirtschaftlichkeitsberechnung · Energiebilanz · Energieproduktivität · Nektarine · Niğde · Türkei

Introduction

Nectarine is known as a fruit that is performing better than peach in dry and warm climate zones with low precipitation and humidity. Peach and particularly nectarines are the fruit types whose cultivation is most rapidly spreading with the new cultivars acquired by fruit breeders (Bolat and İkinci 2016). Being a subtype of peach, nectarines (*Prunus persica* var. *nectarina*, Maxim.) display a similar growth and development to peach (Özelkök et al. 1997; Koyuncu et al. 2005). Known as "hairless peach" in public, nectarine is a type that is related to peach. The areas for this type is mostly juice, cake, marmalade but it is also used for table consumption. Being juicy and aromatic particularly increases the sale and economic importance of the fruit. In addition, it is also a lovely alternative for people who love to enjoy the tasty peach but cannot do so due to its hair. When compared to peach, it has about a month of longer storage duration, therefore putting a smile on the faces of people selling it (Anonymous 2017a). Again compared to

This paper was submitted as oral abstract in 4th National Agricultural Congress (19–22 October 2017, Afyonkarahisar-Turkey).

✉ Osman Gökdoğan
osmangokdogan@gmail.com

[1] Department of Biosystem Engineering, Faculty of Engineering-Architecture, University of Nevşehir Hacı Bektaş Veli, 50300 Nevşehir, Turkey

[2] Department of Organic Farming Business Management, School of Applied Sciences, University of Pamukkale, Denizli, Turkey

peach, nectarine is more suitable for transportation too, and this increases the possibility of sending it to long-distance markets, thus making sales to abroad (Ağar et al. 1994; Koyuncu et al. 2005). In Turkey, the production area and quantity of nectarine are 62,213 decares and 88,926 tons. The province of Niğde in Turkey in terms of nectarine production and 1728 tons of production are made from an area of 1560 decares (Anonymous 2017b).

Energy analyses to be performed in relation to agricultural production is an important approach in terms of identifying and grouping agricultural systems for energy consumption. In order to increase efficiency and reduce inputs when producing it, it is necessary to carefully analyse the inputs and outputs used for production (Sabah 2010; Çelen 2016). Even though it supports and increases production, energy production is not part of the conversion process. The unwanted side effects that occur due to lack and careless use of energy resources, makes it necessary to have a good planning and a careful assessment of energy consumption (Öztürk et al. 2015; Çelen 2016). The input and output of energy are two important factors for defining the energetic and ecological efficiency of agricultural production. The energy analysis is important to ascertain more efficient and environment sociable production systems (Schroll 1994; Özkan et al. 2004a; Rathke and Diepenbrock 2006). Rathke and Diepenbrock (2006) reported that "Energy indicators depict the efficiency of production systems but also allow comparison of different production intensities (Hacıseferoğulları et al. 2003) and are therefore a suitable supplement to economic analyses (Jones 1989)". Economic sustainability in agriculture contributes to profitability, compatibility, energy efficiency, yields and productivity (Singh et al. 2000; Özkan et al. 2007; Özgöz et al. 2017).

Different studies were done on energy use efficiency of agricultural and animal products. For example, studies were done on energy use efficiency analysis of nectarine (Qasemikordkheili et al. 2013), peach (Göktolga et al. 2006; Gündoğmuş 2014; Yıldız et al. 2016), apricot (Gezer et al. 2003; Gündoğmuş 2006; Esengün et al. 2007), grape (Özkan et al. 2007; Koçtürk and Engindeniz 2009; Baran et al. 2017), apple (Dilay et al. 2010; Yılmaz et al. 2010; Çelen et al. 2017), rape (Unakıtan et al. 2010; Eren et al. 2011; Rathke and Diepenbrock 2006), wheat (Tipi et al. 2009; Çiçek et al. 2011; Abbas et al. 2017), sunflower (Sabah et al. 2011; Akdemir et al. 2017; Bayhan 2016), corn (Öztürk et al. 2006; Barut et al. 2011; Baran and Gokdogan 2016a), cotton (Yılmaz et al. 2005; Polat et al. 2006; Dagistan et al. 2009), sugar beet (Hacıseferoğulları et al. 2003; Asgharipour et al. 2012; Baran and Gokdogan 2016b), sweet sorghum (Eren and Öztürk 2011), vetchs (Kökten et al. 2017), lettuce (Kamburoğlu Çebi et al. 2017), tomato (Bayramoglu and Gundogmuş 2009), broiler (Atılgan and Koknaroglu 2006; Incı et al. 2016; Kılıç 2016), layer (Kılıç 2016), lamb (Koknaroglu et al. 2007), egg (Ojo 2003), beef cattle (Demircan and Koknaroglu 2007) etc. Although many experimental studies were done on energy use efficiency analysis in agriculture, there is no study on the energy use efficiency analysis of nectarine production in Turkey in literature reviews. In this study, it was aimed to determine the energy use efficiency and economic analysis of nectarine production.

Table 1 Energy equivalents in agriculture production

Inputs and outputs	Unit	Energy equivalent (MJ unit^{-1})	References
Human labour	h	1.96	Mani et al. (2007); Karaağaç et al. (2011)
Machinery	h	64.80	Singh (2002); Kızılaslan (2009)
N	kg	60.60	Singh (2002)
P	kg	11.10	Singh (2002)
K	kg	6.70	Singh (2002)
Mg	kg	8.80	Mudahar and Hignett (1987a); Mudahar and Hignett (1987b); Kavargiris et al. (2009)
S	kg	1.12	Nagy (1999); Mohammadi et al. (2010)
Micro elements	kg	120	Mandal et al. (2002); Singh (2002); Çanakcı and Akıncı (2006); Banaeian et al. (2011)
Organic fertilizer	kg	10.50	Guzman and Alonso (2008); Bilalis et al. (2013)
Chemicals	kg	101.20	Yaldız et al. (1993)
Diesel fuel	l	56.31	Singh (2002); Demircan et al. (2006)
Irrigation water	m^3	0.63	Yaldız et al. (1993)
Electricity	kWh	3.60	Özkan et al. (2004b)
Outputs	**Unit**	**Energy equivalent (MJ unit^{-1})**	**References**
Nectarine fruit	MJ kg^{-1}	1.90	Singh and Mittal (1992); Qasemikordkheili et al. (2013)

Table 2 Energy balance in nectarine production

Inputs	Unit	Energy equivalent (MJ/unit)	Input used per hectare (unit ha^{-1})	Energy value (MJ ha^{-1})	Ratio (%)
Human labour	h	1.96	931.78	1826.29	6.11
Machinery	h	64.80	17.51	1134.65	3.80
N	kg	60.60	167.24	10,134.74	33.90
P	kg	11.10	107.51	1193.36	3.99
K	kg	6.70	163.69	1096.72	3.67
Mg	kg	8.80	7.44	65.47	0.22
S	kg	1.12	44.99	50.39	0.17
Micro elements	kg	120	3	360	1.20
Organic fertilizer	kg	10.50	4.90	51.45	0.17
Chemicals	kg	101.20	16.41	1660.69	5.56
Diesel fuel	l	56.31	26.27	1479.26	4.95
Irrigation water	m^3	0.63	6574.68	4142.05	13.86
Electricity[a]	kWh	3.60	1860.63	6698.27	22.41
Total inputs	–	–	–	29,893.35	100.00
Outputs	**Unit**	**Energy equivalent (MJ/unit)**	**Output per hectare (unit ha^{-1})**	**Energy value (MJ ha^{-1})**	**Ratio (%)**
Nectarine fruit	kg	1.90	29,332.15	55,731.09	100.00
Total output	–	–	–	55,731.09	100.00

[a]Pump electricity consumption (Mrini 1999; Mrini et al. 2002)

Materials and Method

The province of Niğde is located in the south-eastern part of the Central Anatolian Region and in the northern part of the area where Bolkarlar and Aladağlar mountains of central Taurus Mountains curl towards the north. Mathematically, the location of the province is between 37° 25′ and 38° 58′ north latitudes and 33° 10′ile 35° 25′ east longitudes. The land area of the province is 7795.22 km^2. The average temperature in Niğde for the year 2016 was 12 °C, average relative humidity was 56.7% while average total precipitation was 293.9 mm (Anonymous 2017c). This study was practiced to determine the energy use efficiency and economic analysis of nectarine production for the 2015–2016 production seasons in Niğde province in Turkey. A survey data were collected in 2017 and the farms were selected according to the full counting method (Karagölge and Peker 2002) and the survey was applied (face to face) to these farms. In order to determine the energy use efficiency and economic analysis in the production of nectarine, a survey was made with 8 farms that can be reached over 20 decares of nectarine production in Niğde province. According to results of study, human labour energy, machinery energy, chemical fertilizers energy, chemicals energy, organic fertilizers energy, diesel fuel energy, irrigation water energy and electricity energy were calculated as energy inputs. Nectarine fruit was calculated as output.

Table 3 Energy use efficiency indicators in nectarine fruit production

Computations	Unit	Values
Nectarine fruit	kg ha^{-1}	29,332.15
Energy input	MJ ha^{-1}	29,893.35
Energy output	MJ ha^{-1}	55,731.09
Energy use efficiency	–	1.86
Specific energy	MJ kg $^{-1}$	1.02
Energy productivity	Kg MJ^{-1}	0.98
Net energy	MJ ha^{-1}	25,837.74

The units shown in Table 1 were used to calculate the values of the inputs of nectarine production. Input data analysis was conducted by using Microsoft Excel program; before the results were tabulated Table 2 and related to nectarine production input-output values and the suitable calculations were provided in Table 3. Economic analysis of nectarine production was given in Table 4. Previous energy use efficiency analysis studies were used when determining the energy equivalent coefficients and energy equivalent was determined by adding energy equivalents of all inputs in MJ unit. In order to determine the energy use efficiency analysis in nectarine production, "Energy use efficiency, energy productivity, specific energy and net energy were calculated by using the following formulates (Mandal et al. 2002; Mohammadi et al. 2008, 2010)".

$$\text{Energy efficiency} = \text{Energy output}\ (\text{MJ ha}^{-1}) / \text{Energy input}\ (\text{MJ ha}^{-1}) \tag{1}$$

$$\text{Energy productivity} = \text{Yield output}\ (\text{kg ha}^{-1}) / \text{Energy input}\ (\text{MJ ha}^{-1}) \tag{2}$$

Table 4 Net return and benefit-cost ratio of the nectarine fruit production

Cost and return components	Value
Yield (kg ha^{-1})	29,332.15
Sale price (TL kg^{-1})	1.70
Gross value of production (TL ha^{-1})	49,864.66
Variable cost of production (TL ha^{-1})	23,097.25
Fixed cost of production (TL ha^{-1})	1621.91
Total cost of production (TL ha^{-1})	24,719.16
Total cost of production (TL kg^{-1})	0.84
Gross return (TL ha^{-1})	26,767.41
Net return (TL ha^{-1})	25,145.50
Benefit-cost ratio	2.02

1 US$ = 3.051 TL in 2016 (Anonymous 2017d; on average)

$$\text{Specific energy} = \text{Energy input}\,(\text{MJ ha}^{-1}) / \text{Yield output}\,(\text{kg ha}^{-1}) \quad (3)$$

$$\text{Net energy} = \text{Energy output}\,(\text{MJ ha}^{-1}) - \text{Energy input}\,(\text{MJ ha}^{-1}) \quad (4)$$

Results and Discussion

In the nectarine farms, the average amount of nectarine produced per hectare for 2015–2016 production seasons was calculated as 29,332.15 kg. According to the study results (Table 2) the energy inputs in nectarine production were calculated respectively as chemical fertilizers energy 12,900.69 MJ ha^{-1} (43.15%), electricity energy 6698.27 MJ ha^{-1} (22.41%), irrigation water energy 4142.05 MJ ha^{-1} (13.86%), human labour energy 1826.29 MJ ha^{-1} (6.11%), chemicals energy 1660.69 MJ ha^{-1} (5.56%), diesel fuel energy 1479.26 MJ ha^{-1} (4.95%), machinery energy 1134.65 MJ ha^{-1} (3.80%) and organic fertilizers energy 51.45 MJ ha^{-1} (0.17%). Similarly, in previous agricultural studies related to fruit production, Qasemikordkheili et al. (2013) calculated that the fertilizer application energy had the biggest share by 36.93%, Mohammadi et al. (2010) calculated that fertilizer application energy had the biggest share by 47.23%, Demircan et al. (2006) calculated that fertilizer application energy had the biggest share by 45.35%, Kızılaslan (2009) calculated that fertilizer application energy had the biggest share by 42%, Akçaöz et al. (2009) calculated that fertilizer application energy had the biggest share by 40.22%.

Nectarine fruit, energy input, energy output, energy output-input ratio, specific energy, energy productivity and net energy in nectarine fruit production were calculated as 29,332.15 kg ha^{-1}, 29,893.35 MJ ha^{-1}, 55,731.09 MJ ha^{-1}, 1.86, 1.02 MJ kg^{-1}, 0.98 kg MJ^{-1} and 25,837.74 MJ ha^{-1}, respectively (Table 3). In previous agricultural production studies, Qasemikordkheili et al. (2013) calculated (nectarine) energy output-input ratio as 1.36, Göktolga (2006) calculated (peach) energy output-input ratio as 0.93, Yılmaz et al. (2010) calculated (apple) energy output-input ratio as 2.69, Aydın et al. (2017) calculated (applied good agriculture pear) energy output-input ratio as 1.20, Çelik et al. (2010) calculated (conventional-organic carrot) energy output-input ratio as 1.30–1.90, Beigi et al. (2016) calculated (almond) energy output-input ratio as 0.62, Koçtürk and Engindeniz (2009) calculated (grape) energy output-input ratio as 8.64, Gündoğmuş (2013) calculated (quince) energy output-input ratio as 1.07, Çanakcı et al. (2005) calculated (tomato) energy output-input ratio as 0.70, Gokdogan et al. (2016) calculated (cotton) energy output-input ratio as 1.92, Gökdoğan and Erdoğan (2017) calculated (olive) energy output-input ratio as 2.72.

Economic analysis of nectarine fruit production was given in Table 4. The total cost of nectarine fruit production per kg was explained in Turkish Lira (TL), which was equal to 0.33 US dollars (US$) in 2016 (on average). Demircan et al. (2006) reported that, "The net return was calculated by subtracting the total cost of production per hectare (variable + fixed cost) from the gross value of production". The gross return was calculated by subtracting the variable cost of production per hectare (23,097.25 TL ha^{-1}) from the gross value of production (49,864.66 TL ha^{-1}) and was calculated as 26,767.41 TL ha^{-1}. In the evaluation study, the profit margin per kg of nectarine fruit (TL kg^{-1}) was calculated as 0.86. This situation can be explained that the net return of 2.02 TL was obtained per 1 TL invested and was a cost effective business for 2016 season of nectarine fruit production. In previous agricultural studies, Qasemikordkheili et al. (2013) calculated (nectarine) benefit-cost ratio as 16.74, Banaeian et al. (2011) calculated (strawberry) benefit-cost ratio as 1.74, Demircan et al. (2006) calculated (sweet cherry) benefit-cost ratio as 2.53, Esengün et al. (2007) calculated (apricot) benefit-cost ratio as 1.11–1.19, Çelik et al. (2010) calculated (conventional-organic carrot) benefit-cost ratio as 1.83–2.05, Mohammadi et al. (2010) calculated (kiwi) benefit-cost ratio as 1.94.

In this study, the energy use efficiency and economic analysis in nectarine production was determined. According to the results, nectarine fruit production is a profitable activity in terms of energy output-input ratio (1.86). In this study, economic analysis results, the net return from nectarine production, when compared to the total cost of production in the nectarine farms, was at a satisfactory level (2.02). The benefit-cost ratio was calculated by dividing the gross value of production by the total cost of production per hectare, resulting in 2.02. Nectarine production was a cost effective business based on the data from the 2015–2016 production season. Among the inputs used for nectarine production, the highest input is chemical fertilizers with a ratio of 43.15%. And the reason for the ratio of chemical fertilizers being high is because the use of organic fertilizers in nectarine production has a very low ratio of 0.17%.

In the agricultural sector, the economic feasibility and application method of renewable energy resources differ, depending on the regional conditions. With the use of ecologic and organic agricultural production systems, which are becoming more and more popular, it can be possible to reduce the agricultural use of fossil based fuels. In those production systems, the partial reduction in efficiency can be compensated by a reduction in the use of input (Ekinci et al. 2005). The current problem of land use and management is important in terms of the sustainability of the system. Carbon is a dense input. Therefore, reducing the use of nitrogen by lowering erosion, leakage and evaporation, using more bio-nitrogen, using animal fertilizers and other bio-fuels, implementing waste and left-over management in harvest residues and having minimum soil processing are compulsory (Çelen 2016).

Conflict of interest H.İ. Oğuz, O. Erdoğan and O. Gökdoğan declare that they have no competing interests.

References

Abbas A, Yang M, Ahmad R, Yousaf K, Iqbal (2017) Energy use efficiency in wheat production, a case study of Punjab Pakistan. Fresenius Environ Bull 26(11):6773–6779

Akdemir S, Cavalaris C, Gemtos T (2017) Energy balance of sunflower production. Agron Res 15(4):1463–1473

Akçaöz H, Özçatalbaş O, Kızılay H (2009) Analysis of energy use for pomegranate production in Turkey. J Food Agric Environ 7(2):475–480

Anonymous (2017a) Alara Fidan A.Ş. http://www.alarafidan.com.tr. Accessed 12 Dec 2017 (In Turkish)

Anonymous (2017b) Türkiye İstatistik Kurumu. http://www.tuik.gov.tr. Accessed 14 Dec 2017 (In Turkish)

Anonymous (2017c) Türkiye Cumhuriyeti Niğde Valiliği. http://www.nigde.gov.tr/tarihi-vecografi-yapisi. Accessed 12 Dec 2017 (In Turkish)

Anonymous (2017d) http://www.bumko.gov.tr/TR,150/doviz-kurlari.html. Accessed 13 Dec 2017 (In Turkish)

Asgharipour MR, Mondani F, Riahinia S (2012) Energy use efficiency and economic analysis of sugar beet production system in Iran: a case study in Khorasan Razavi province. Energy 44:1078–1084

Atılgan A, Koknaroglu H (2006) Cultural energy analysis on broilers reared in different capacticy poultry houses. Italian J Animal Sci 5:393–400

Aydın B, Aktürk D, Özkan E, Hurma H, Kiracı MA (2017) Armut üretiminde karşılaştırmalı enerji kullanım etkinliği ve ekonomik analiz: Trakya bölgesi örneği. Türk Tarım-gıda Bilim ve Teknoloji Dergisi 5(9):1072–1079

Ağar Tİ, Son L, Kaşka N (1994) Bazı nektarin çeşitlerinin derim sonrası fizyolojileri. ÇÜ. Ziraat Fakültesi Dergisi, Adana (In Turkish)

Banaeian N, Omid M, Ahmadi H (2011) Energy and economic analysis of greenhouse strawberry production in Tehran province of Iran. Energy Convers Manag 52:1020–1025

Baran MF, Gokdogan O (2016a) Comparison of energy use efficiency of different tillage methods on the secondary crop corn silage production. Fresenius Environ Bull 25(9):3808–3814

Baran MF, Gokdogan O (2016b) Determination of energy balance of sugar beet production in Turkey: a case study of Kırklareli Province. Energy Effic 9:487–494

Baran MF, Lüle F, Gökdoğan O (2017) Energy input-output analysis of organic grape production: a case study from Adiyaman Province. Erwerbs-Obstbau 59(4):275–279

Barut ZB, Ertekin C, Karaağaç HA (2011) Tillage effects on energy use for corn silage in Mediterranean Coastal of Turkey. Energy 36:5466–5475

Bayhan Y (2016) İkinci ürün ayçiçeği üretiminde farklı toprak işleme ve doğrudan ekim yöntemlerinin enerji kullanım etkinliğinin karşılaştırılması. Tekirdağ Ziraat Fakültesi Dergisi 13(2):102–109

Bayramoglu Z, Gundogmuş E (2009) The effect of EurepGAP standards on energy input use: a comparative analysis between certified and uncertified greenhouse tomato producers in Turkey. J Energy Convers Manag 50(2009):52–56

Beigi M, Torki-Harchegani M, Ghanbarian D (2016) Energy use efficiency and economical analysis of almond production: a case study in Chaharmahal-Va-Bakhtiari province, Iran. Energy Effic 9:745–754

Bilalis D, Kamariari PE, Karkanis A, Efthimiadou A, Zorpas A, Kakabouki I (2013) Energy inputs, output and productivity in organic and conventional maize and tomato production, under Mediterranean Conditions. Not Bot Horti Agrobo 41(1):190–194

Bolat İ, İkinci A (2016) Yarı kurak iklim (Güneydoğu Anadolu) koşullarında bazı nektairn çeşitlerinin verim ve kalite performanslarının incelenmesi. Bahçe 45:236–241 (In Turkish)

Çanakcı M, Akıncı İ (2006) Energy use pattern analyses of greenhouse vegetable production. Energy 31:1243–1256

Çanakcı M, Topakcı M, Akıncı İ, Özmerzi A (2005) Energy use pattern of some field crops and vegetable production: Case study for Antalya region, Turkey. Energy Convers Manag 46(2005):655–666

Çelen İ (2016) Tarımsal uygulamalarda enerji kullanımı üzerine bir değerlendirme. Electron J Vocat Coll December(2016):18–29

Çelen İ, Baran MF, Önler E, Bayhan Y (2017) Determination of energy balance of apple (Malus domestica) production in Turkey: A case study for Tekirdag province. Anadolu J Agric Sci 32:40–45

Çelik Y, Peker K, Oğuz C (2010) Comparative analysis of energy efficiency in organic and conventional gardening systems: A case study of black carrot (Daucus carota L.) production in Turkey. Philipp Agric Scientist 93(2):224–231

Çiçek A, Altıntas G, Erdal G (2011) Energy consumption patterns and economic analysis of irrigated wheat and rainfed wheat production: Case study for Tokat region, Turkey. Bulg J Agric Sci 17(3):378–388

Dagistan E, Akçaöz H, Demirtaş B, Yılmaz Y (2009) Energy usage and benefitcost analysis of cotton production in Turkey. Afr J Agric Res 4(7):599–604

Demircan V, Koknaroglu H (2007) Effect of farm size on sustainability of beef cattle production. J Sustain Agric 31(1):75–87

Demircan V, Ekinci K, Keener HM, Akbolat D, Ekinci C (2006) Energy and economic analysis of sweet cherry production in Turkey: A case study from Isparta province. Energy Convers Manag 47:1761–1769

Dilay Y, Özkan A, Aydın C (2010) Karaman ili elma üretiminde enerji bilançosu ve enerji kullanım etkinliğinin belirlenmesi. 26th Ulusal Tarımsal Mekanizasyon Kongresi, Hata, 22–23 Eylül 2010, pp 400–405 (In Turkish)

Ekinci K, Akbolat D, Demircan V, Ekinci Ç (2005) Determination of energy use efficiency apple production in Isparta province. Turkey 3th Renewable Energy Sources Symposium, Mersin, pp 19–21 (InTurkish)

Eren Ö, Öztürk HH (2011) Çukurova bölgesinde tatlı sorgum (Sorghum bicolor (L.) Moench) üretiminde enerji kullanımı. Çukurova Üniversitesi Fen Ve Mühendislik Bilimleri Dergisi 26(1):155–164 (InTurkish)

Eren Ö, Turgut MM, Öztürk HH, Barut ZB, Özgüven M (2011) Çukurova koşullarında kolza üretiminde farklı mekanizasyon

uygulamalatının enerji etkinliğinin belirlenmesi. Çukurova Üniversitesi Ziraat Fakültesi Dergisi 26(1):11–24
Esengün K, Gündüz O, Erdal G (2007) Input-output energy analysis in dry apricot production of Turkey. Energy Convers Manag 48:592–598
Gezer İ, Acaroğlu M, Hacıseferoğulları H (2003) Use of energy and labor in apricot agriculture in Turkey. Biomass Bioenergy 24:215–219
Gokdogan O, Erdogan O, Eralp O, Zeybek A (2016) Energy efficiency anaysis of cotton production in Turkey: A case study from Aydın province. Fresenius Environ Bull 25(11):4959–4964
Gökdoğan O, Erdoğan O (2017) Evaluation of energy balance in organic olive (Olea europaea L.) production in Turkey, A case study of Aydın-Karpuzlu region. Erwerbs-Obstbau. https://doi.org/10.1007/s10341-017-0338-6
Göktolga ZG, Gözener B, Karkacıer O (2006) Şeftali üretiminde enerji kullanımı: Tokat ili örneği. Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi 23(2):39–44 (in Turkish)
Gündoğmuş E (2006) Energy use on organic farming: A comparative analysis on organic versus conventional apricot production on small holdings in Turkey. Energy Convers Manag 47:3351–3359
Gündoğmuş E (2013) Energy use patterns and econometric models of quince production. Actual Probl Econ 5(143):236–246
Gündoğmuş E (2014) Does energy efficiency increase with orchard size? A case study from peach production. Energy Effic 7:833–839
Guzman GI, Alonso AM (2008) A comparison of energy use in conventional and organic olive oil production in Spain. Agric Syst 98:167–176
Hacıseferoğulları H, Acaroğlu M, Gezer İ (2003) Determination of the energy balance of the sugar beet plant. Energy Sources 25:15–22
Incı H, Sogut B, Gokdogan O, Ayasan T, Sengul T (2016) Determining the energy usage efficiency and economic analysis of broiler chickens raised under organic conditions. Indian J Animal Sci 86(11):1323–1327
Jones MR (1989) Analysis of the use of energy in agriculture-approaches and problems. Agric Syst 29:339–355
Kamburoğlu Çebi Ü, Aydın B, Çakır R, Altıntaş S (2017) Örtü altı baş salata (Lactuca sativa cv Salinas) üretiminin enerji kullanım etkinliği ve ekonomik analizi. Türk Tarım Ve Doğa Bilimleri Dergisi 4(4):426–433 (In Turkish)
Karaağaç MA, Aykanat S, Çakır B, Eren Ö, Turgut MM, Barut ZB, Öztürk HH (2011) Energy balance of wheat and maize crops production in Hacıali undertaking. 11th International Congress on Mechanization and Energy in Agriculture Congress, Istanbul, Turkey, 21–23 September, pp 388–391
Karagölge C, Peker K (2002) Tarım ekonomisi araştırmalarında tabakalı örnekleme yönteminin kullanılması. Atatürk Üniversitesi Ziraat Fakültesi Dergisi 33(3):313–316 (In Turkish)
Kavargiris SE, Mamolos AP, Tsatsarelis CA, Nikolaidou AE, Kalburtji KL (2009) Energy resources' utilization in organic and conventional vineyards: Energy flow, greenhouse gas emissions and biofuel production. Biomass Bioenergy 33:1239–1250
Koknaroglu H, Ali A, Ekinci K, Morrical DG, Hoffman MP (2007) Cultural energy analysis of lamb production in the feedlot or on pasture and in the feedlot. J Sustain Agric 30(4):95–108
Kökten K, Çeçen E, Gökdoğan O, Baran MF (2017) Determination of energy balance of common vetch (Vicia sativa L.), hungarian vetch (Vicia pannonica C.) and narbonne vetch (Vicia narbonensis L.) production in Turkey. Legum Res 40(3):491–496
Koyuncu MA, Eren İ, Güven K (2005) Eğirdir (Isparta) koşullarında yetiştirilen fantasia ve stark red gold nektarin çeşitlerinin soğukta muhafazası. Omü Zir Fak Dergisi 20(1):6–11 (In Turkish)
Koçtürk OM, Engindeniz S (2009) Energy and cost analysis of sultana grape growing: A case study of Manisa, west Turkey. Afr J Agric Res 4(10):938–943
Kılıç İ (2016) Analysis of the energy efficiency of poultry houses in the Bursa region of Turkey. J Appl Animal Res 44(1):165–172
Kızılaslan H (2009) Input-output energy analysis of cherries production in Tokat province of Turkey. Appl Energy 86:1354–1358
Mandal KG, Saha KP, Ghosh PK, Hati KM, Bandyopadhyay KK (2002) Bioenergy and economic analysis of soybean based crop production systems in central India. Biomass Bioenergy 23:337–345
Mani I, Kumar P, Panwar JS, Kant K (2007) Variation in energy consumption in production of wheat-maize with varying altitudes in hill regions of Himachal Prades. India Energy 32:2336–2339
Mohammadi A, Rafiee S, Mohtasebi SS, Rafiee H (2010) Energy inputs-yield relationship and cost analysis of kiwifruit production in Iran. Renew Energy 35:1071–1075
Mohammadi A, Tabatabaeefar A, Shahin S, Rafiee S, Keyhani A (2008) Energy use and economical analysis of potato production in Iran a case study: Ardabil province. Energy Convers Manag 49:3566–3570
Mrini M (1999) Le cout energetique de l'irrigation des cultures sucrieres au Gharb, 2eme rapport d'atat d'avancement, Ecole Doctorale. Institut Agronomique et Veterinaire Hassan II. BP 6202, Rabat, Morocco
Mrini M, Senhaji F, Pimentel D (2002) Energy analysis of sugar beet production under traditional and intensive farming systems and impacts on sustainable agriculture in Morocco. Research, Reviews, Practices, Policy and Technology. J Sustain Agric 20(4):5–28
Mudahar MS, Hignett TP (1987a) Fertilizer and energy use. In: Helsel ZR (ed) Energy in world agriculture. Energy in plant nutrition and pest control, vol 2. Elsevier, Amsterdam, pp 1–23
Mudahar MS, Hignett TP (1987b) Energy requirements, technology, and resources in the fertilizer sector. In: Helsel ZR (ed) Energy in world agriculture. Energy in plant nutrition and pest control, vol 2. Elsevier, Amsterdam, pp 25–61
Nagy CN (1999) Energy coefficients for agriculture inputs in western Canada. http://www.csale.usask.ca/PDFDocuments/energyCoefficientsAg.pdf;. Accessed 31 May 1999
Ojo SO (2003) Productivity and technical efficiency of poultry egg production in Nigeria. Int J Poult Sci 2(6):459–464
Özelkök S, Ertan Ü, Kaynaş K (1997) Maturity and Ripening Concepts on Nectarines. A Case Study on "Nectared-6" and "Independence" Proceedings V International Symposium on Temperate Zone Fruits, Acta Hort., 441., ISHS
Özgöz E, Altuntaş E, Asiltürk M (2017) Effects of soil tillage on energy use in potato farming in Central Anatolia of Turkey. Energy 141:1517–1523
Özkan B, Akçaöz H, Fert C (2004a) Energy input-output analysis in Turkish agriculture. Renew Energy 29:39–51
Özkan B, Fert C, Karadeniz CF (2007) Energy and cost analysis for greenhouse and open-field grape production. Energy 32:1500–1504
Özkan B, Kürklü A, Akçaöz H (2004b) An input-output energy analysis in greenhouse vegetable production: A case study for Antalya region of Turkey. Biomass Bioenergy 26:89–95
Öztürk H, Yaşar B, Eren Ö (2015) Tarımda enerji kullanımı ve yenilenebilir enerji kaynaklari. www.zmo.org.tr/resimler/ekler/ce30eeb956b8bbd_ek.pdf
Öztürk HH, Ekinci K, Barut ZB (2006) Energy analysis of the tillage systems in second crop corn production. J Sustain Agric 28(3):25–37
Polat R, Çopur O, Sağlam R, Sağlam C (2006) Energy use pattern and cost analysis of cotton agriculture: A case study for Sanliurfa, Turkey. Philipp Agric Sci 89(4):368–371
Qasemikordkheili P, Kazemi N, Hemmati A, Taki M (2013) Energy consumption, input-output relationship and economic analysis for nectarine production in Sari region, Iran. Int J Agric Crop Sci 5–2:125–131
Rathke GW, Diepenbrock W (2006) Energy balance of winter oilseed rape (Brassica napus L.) cropping as related to nitrogen supply and preceding crop. Eur J Agron 24:35–44

Sabah M (2010) Söke ovasında ikinci ürün yağlık ayçiçeği üretiminde enerji kullanımı. Çukurova Üniversitesi Fen Bilimleri Enstitüsü Tarım Makinaları Anabilim Dalı, Yüksek Lisans Tezi, Türkiye (In Turkish)

Sabah M, Eren Ö, Öztürk HH (2011) Söke ovasında ikinci ürün yağlık ayçiçeği üretiminde enerji kullanımı. Çukurova Üniversitesi Fen Bilimleri Enstitüsü Fen Ve Mühendislik Bilimleri Dergisi 25(6):70–79 (InTurkish)

Schroll H (1994) Energy-flow and ecological sustainability in Danish agriculture. Agric Ecosyst Environ 51(3):301–310

Singh JM (2002) On garden energy use pattern in different cropping systems in Haryana, India. International Institute of Management University of Flensburg, Sustainable Energy Systems and Management. Master of Science, Germany

Singh S, Mittal JP (1992) Energy in production agriculture. Mittol Pub, New Delhi

Singh S, Pannu CJS, Singh J (2000) Optimization of energy input for raising cotton crop in Punjab. Energy Convers Manag 41(17):1851–1861

Tipi T, Çetin B, Vardar A (2009) An analysis of energy use and input costs for wheat production in Turkey. J Food Agric Environ 7(2):352–356

Unakıtan G, Hurma H, Yılmaz F (2010) An analysis of energy use efficiency of canola production in Turkey. Energy 35:3623–3627

Yaldız O, Öztürk HH, Zeren Y, Başçetinçelik A (1993) Energy usage in production of field crops in Turkey. 5th international congress on mechanization and energy in agriculture, Kuşadası, 11–14. October, pp 527–536 (In Turkish)

Yıldız T, Hazneci K, Hazneci E, Özkaraman F (2016) The energy use efficiency determinants of peach production in Samsun province of Turkey. Fresenius Environ Bull 25(11):4685–4693

Yılmaz I, Akçaöz H, Özkan B (2005) An Analysis of energy use and input costs for cotton production in Turkey. Renew Energy 30(2005):145–155

Yılmaz İ, Özalp A, Aydoğmuş F (2010) Antalya ili bodur elma üretiminde enerji kullanım etkinliğinin belirlenmesi: Elmalı ilçesi örneği. Akdeniz Üniversitesi Ziraat Fakültesi Dergisi 23(2):93–97