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An Input-Output Energy Analysis of Wheat Production in Çarşamba District of Samsun Province

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Abstract: The objective of the present study was to evaluate the efficiency of energy use in wheat production in Çarşamba district of Samsun province. The study also aimed to analyse the wheat production costs and the profitability. The research data were collected from randomly selected 54 wheat producers by using a questionnaire. The values of energy use efficiency, energy productivity, specific energy and net energy were used to explore the efficiency of energy use in wheat production. The research results showed that total energy consumption in wheat was diesel (44.61%). Chemical fertilizers (23.54%) mainly nitrogen, irrigation water (10.58%), seed (10.11%), machinery (9.86%), chemicals (0.92%) and labor (0.38%) followed the diesel. Energy output was 84427.33 MJ ha^{-1}. Energy use efficiency, spesific energy, energy productivity and net energy for wheat production were 2.36, 8.96 MJ kg^{-1}, 0.112 kg MJ^{-1} and 48690.20 MJ ha^{-1}, respectively. The benefit-cost ratio was 0.64. Integrated pest control techniques should be put in practice to improve pesticide use and energy inefficient fertilizer applicaiton should be transformed to efficient one to reduce negative effects to environment, human health, maintaining sustainability and decreasing production costs.

Keywords: Energy equivalent, energy use, input–output analysis, wheat, economic analysis

Samsun İli Çarşamba İlçesinde Buğday Üretiminin Enerji Girdi-Çıktı Analizi

Öz: Bu çalışmanın amacı, Samsun ili Çarşamba ilçesindeki buğday üretiminde enerji kullanım etkinliğinin belirlenmesidir. Bu çalışmada, buğday üretim masrafları ve karlılığı da analiz edilmiştir. Araştırma verileri basit tesadüfi örnekleme metodu ile seçilmiş 54 buğday üreticisinden anket yoluyla elde edilmiştir. İnceleme alanında buğday üretiminde enerji kullanım etkinliğinin ortaya konulması için enerji kullanım etkinliği, enerji verimliliği, spesifik enerji ve net enerji değerleri hesaplanmış ve kullanılmıştır. Araştırma sonuçları, buğday üretiminde, toplam enerji tüketiminin 35737.13 MJ ha^{-1} olduğunu göstermiştir. En yüksek enerji girdisi, diesel yakıtı olarak (%44.61) olarak belirlenmiştir. Başta nitrojen olmak üzere, diesel yakıtını kimyasal gübreler (%23.54), sulama suyu (%10.58), tohum (%10.11), makinalar (%9.86), kimyasal ilaçlar (%0.92) ve insan iş gücü (%0.38) izlemiştir. Çıktı enerjisi 84427.33 MJ ha^{-1} olarak hesaplamıştır. Enerji kullanım etkinliği, özgül enerji, enerji verimliliği ve net enerji değerleri sırasıyla 2.36, 8.96 MJ kg^{-1}, 0.112 kg MJ^{-1} ve 48690.20 MJ ha^{-1} olarak belirlenmiştir. Buğday üretiminde kar-masraf oranı 0.64'tür. Enerji etkinlğini artırmak, insan sağlığını korumak, sürdürülebilirliği sağlamak ve üretim masraflarını azaltmak için, pestisit uygulamalarını ıslah edecek entegre mücadele yöntemleri uygulanmalı ve enerji kullanımı açısından etkin olmayan gübreleme uygulamaları etkinleştirilmelidir.

Anahtar kelimeler: Enerji eş değeri, enerji kullanımı, girdi-çıktı analizi, buğday, ekonomik analiz

1. Introduction

Cereal production is of great importance on the nutrition of all over the world. Not only in human nutrition but also grain and hay which require the animal feeding are provided by means of cereals. In addition, cereals have a great of importance in the economic and social life rather than other agricultural products. Therefore, this product is directly or indirectly related to livelihood of a wide mass producer (Anonymous, 2013). Wheat is worldwide the third most-important cereal after maize and rice, but it is the most important cereal of the temperate regions. It has been cultivated domestically for at least 11.000 years (Anonymous, 2016). Wheat (*Triticum* spp.) is a cereal grain and essential for human civilization, originally from the Levant region of the Near East, Mesopotamia but now cultivated worldwide (Shewry, 2009).

Wheat is produced of 220 million hectares of land in the world with total 716 million tons, approximately. Most of this amount is procuced by People's Republic of China (17.03%). India (13.06%), USA (8.10%), Russian Federation (7.28%), France (5.39%), Canada (5.24%), Australia (3.19%), Pakistan (3.13%) and Turkey (3.08%) follow China, respectively. 65.50% of the world productions of these 9 countries' reputation are produced (FAO, 2013). More than 60% of wheat is produced in backward and developing countries. China and India together produce nearly twice as much wheat as the USA and Russia combined (Anonymous, 2016a). According to Turkish Statistical Institute data, Turkey produced 22 million tones wheat on the 65 million hectares area in 2013, approximately (TUIK, 2013).

Wheat production may vary from country to country and also from region to region within a country, including the region's ecology, crop patterns, the social living standard and the region's agricultural products according to market its unique features. Increase the efficiency of agricultural production alongside the most important criteria considering the reduction of costs in agriculture, one of the most expensive inputs for these purpose agricultural mechanization activities. Mechanization of agricultural operations of a business often can be interpreted with the energy balance (Anonymous, 2016b).

However, wheat is one of the most strategic essential nutrients for backward and underdeveloped countries, especially. Because of this reason agricultural production must be increased in order to meet the nutritional needs of increasing world population. Agricultural areas have now reached its limit all over the World. Therefore, it is necessary to acquire more crop per unit area. This is related to between the obtained agricultural products and agricultural input sources. In other words, it will be possible to make with effective energy use of agricultural arable areas.

Energy use in agriculture has been increasing in response to increasing population, limited supply of arable land, and a desire for higher standards of living (Kizilaslan, 2009). The increased use of inputs such as fertilizer, irrigation water, diesel, plant protection chemicals, electricity etc. demands more energy in the form of human, animal and machinery (Yadav and Khandelwal, 2013).

Energy has an influencing role in the development of key sectors of economic importance such as industry, transport and agriculture. This has motivated many researchers to focus their research on energy management. Energy has been a key input of agriculture since the age of subsistence agriculture. It is an established fact worldwide that agricultural production is positively correlated with energy input (Singh et al. 1999).

Many researches have conducted input-output energy and economic analysis to determine the energy efficiency of various products such as soybean, maize and wheat in Italy (Sartori et al. 2005), some field crops and vegetable in Turkey (Canakci et al. 2005), sweet cherry in Turkey (Demircan et al. 2006), apple production in Greece (Strapasta et al. 2006), sugar beet in Turkey (Erdal et al. 2007), dry apricot in Turkey (Esengun et al. 2007); wheat in Iran (Shahan et al. 2008), cotton in Turkey (Dagistan et al. 2009), canola and sunflower production in Iran (Taheri Garavand et al. 2010), wheat in Iran (Moghimi et al. 2013), wheat in Iran (Kardoni et al. 2013), wheat in Iran (Ghorbani et al. 2011), wheat in Germany (Meyer-Aurich et al. 2012) wheat in India (Yadav and Khandelwal., 2013), wheat, rice and barley in Australia (Khan et al. 2010), peach in Iran (Royan et al. 2012); canola in Iran (Mousavi-Avval et al. 2011); kiwifruit in Iran (Mohammadi et al. 2010); wheat in Pakistan (Hussain et al. 2010); wheat in New Zealand

(Safa et al. 2011); garlic in Iran (Samavatean et al. 2011); sugarbeet in Turkey (Baran and Gökdoğan, 2016); lavender in Turkey (Gökdoğan, 2016); cotton in Turkey (Baran, 2016); barley in Turkey (Baran and Gökdoğan, 2014); black seed oil in Turkey (Gökdoğan et al. 2015); durum wheat in Iran (Heidari et al. 2015); wheat in Iran (Mirasi et al. 2015) and hazelnut in Guilan province of Iran (Nabavi-Pelesaraei et al. 2013a) the last decade.

The present study was conducted to determine the efficiency of energy use in wheat production in Çarşamba District, Samsun Province of Turkey. In this study also aimed to analyse the wheat production costs and the profitability.

2. Materials and Methods

The study was carried out in 54 wheat producers in Çarşamba province of Samsun, Turkey. The province is located in the northwest of Samsun, Turkey, within 41° 17' and 25" North latitude and 36° 20' 01" East longitude (Figure 1). Samsun province is 958.000 hectares in area, 47% of it is used for agricultural production, and there are 104.000 farms. The research area constituted approximately 1.56% of the total wheat production in Turkey (TUİK, 2014). And also Çarşamba district revealed 1.68% of this production amount. Samsun has a mild climate. Its average temperature is 14.2^{0}C and the average rainfall is 664.9 mm annually (Anonymous, 2014). Data were collected from the wheat growers by using a face-to-face questionnaire performed in 2013. he research data covered the production period of 2012–2013. The secondary material used in this study was collected from the previous studies and publications by some institutions like FAO. The sample size was calculated by using simple random sampling (Yamane, 1967). Sample wheat producers were selected via random numbers generators. Energy equivalents for different inputs and outputs in wheat production were given in Table 1.

A 285 MF tractor, 75 HP, was used in different operations as tillage, hoeing, fertilizer application, sprayer, transporting etc. The sources of mechanical energy used on the selected farms included diesel for tractors (Table 1) computed on the basis of total fuel consumption (L ha^{-1}) in different operations. The energy consumed was calculated using conversion factors (1 liter diesel = 56,31 MJ) and was expressed in MJ ha^{-1}.

Based on the energy equivalents of the inputs and output (Table 1), the energy ratio (energy use efficiency), energy productivity and the specific energy were calculated as follow (Sartori et al. 2005; Demircan et al. 2006; Shahan et al. 2008).

Energy which used as an production input was also examined in detail in the non-renewable forms of energy, direct energy, indirect energy and renewable energy. Also, economic analysis of the agricultural production processes were determined to make their businesses whether profitable production or not.

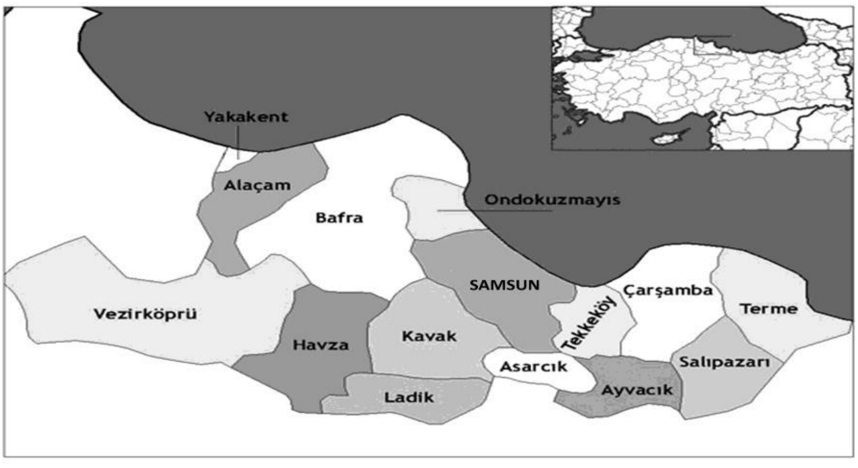

Figure 1. Location of Çarşamba district on the map of Samsun
Şekil 1.*Samsun haritası üzerinde Çarşamba ilçesinin konumu*

Table 1. Energy equivalents for different inputs and outputs in wheat production
Çizelge 1. *Buğday üretiminde farklı girdi ve çıktılar için enerji eşdeğerleri*

Particulars	Unit	Energy equivalent ($MJ\ ha^{-1}$)	Reference
A.Inputs			
1. Human labor	H	1.95	Mohammadi et al. 2008
2. Machinery	H	62.70	Erdal et al. 2007; Singh, 2002
3. Diesel fuel	L	50.23	Mohammadi et al. 2008
4. Chemical fertilizers			
a) Nitrogen (N)	kg	75.46	Mohammadi et al. 2008
b) Phosphate (P_2O_5)	kg	13.07	Mohammadi et al. 2008
c) Potassium (K_2O)	kg	11.15	Esengun et al. 2007; Shrestha, 1998
5. Chemicals			
a) Topic	L	271.38	Mohammadi et al. 2008
b) 2.4D	L	84.91	Mohammadi et al. 2008
c) Pesticide (Phenitrion)	L	280.44	Mohammadi et al. 2008
d) Fungicide (Carboxin)	kg	181.90	Mohammadi et al. 2008
6. Electricity	kWh	3.60	Mohammadi et al. 2008
7. Water for irrigation	m^3	1.02	Acaroglu, 1998; Acaroglu and Aksoy,2005
8. Seeds (wheat)	kg	20.10	Mohammadi et al. 2008
B) Outputs			
1. Wheat grain yield	kg	14.48	Kuesters et al. 1999
2. Wheat straw yield	kg	2.25	Kuesters et al. 1999

$$\text{Energy use efficiency} = \frac{\text{Energy Output (MJ ha}^{-1})}{\text{Energy Input (MJ ha}^{-1})} \quad (1)$$

$$\text{Energy Productivity} = \frac{\text{Wheat Output (kg ha}^{-1})}{\text{Energy Input (MJ ha}^{-1})} \quad (2)$$

$$\text{Spesific Energy} = \frac{\text{Energy Input (MJ ha}^{-1})}{\text{Wheat Input (kg ha}^{-1})} \quad (3)$$

$$\text{Net energy} = \text{Energy Output (MJ ha}^{-1}) - \text{Energy Input (MJ ha}^{-1}) \quad (4)$$

3. Results and Discussion

Results were composed under the three headings, including the socio-economic characteristics of the management practices in wheat production, analysis of input-output energy of the wheat production and the economic analysis of the wheat production.

3.1. Socio-economic structure of the wheat farms and management practices in wheat production

Characteristics of the surveyed farms were presented in Table 2. As seen the Table 2, the average number of people were found 4.81 person per farm. Total farmland assets have been calculated as an average of 7.02 ha per farm. In general average, wheat and irrigated area were calculated 2.61 ha, 5.06 ha respectively. The number of tractors per farm was founded 0.81 and the education level of managers was calculated as 54.76 years (Table 2).

Management practices for the wheat growth of the research were given in Table 3. As seen in Table 3; number of tilling, fertilization, irrigation and spraying of the research area was three, one, three and two times, respectively.

Table 2. Characteristics of the sample farms
Çizelge 2. *Örnek işletmelerin özellikleri*

Items	Mean
Family size (person per farm)	4.81
Female (person per farm)	2.38
Male (person per farm)	2.43
Total farmland (ha per farm)	7.02
Irrigated area (ha per farm)	5.06
Wheat area (ha per farm)	2.61
Tractor (number per farm)	0.81
Education level of farm manager (year)	5.81
Age of farm manager (year)	54.76

Table 3. Management practices for the wheat growth
Çizelge 3. *Buğday yetiştiriciliğinde yönetim uygulamaları*

Agronomic practices	
Varieties used	Wheat
Land preparation tractor used (285 MF 75 HP)	Disc harrows, plow, land leveller
Land preparation period	September-November
Tilling number	3
Sowing, seedling, planting period	November
Quantity of seed (kg ha^{-1})	179.78
Fertilization period (pre-planting)	October-November
Fertilization period (post planting)	Unfortunately
Average number of fertilization	1
Irrigation period	November-July (average two times per farm)
Average number of irrigation	3 (because of more rainfall in the region)
Spraying period	March-July
Average number of spraying	2
Harvesting period	July-August

3.2. Analysis of input-output energy use in wheat production

Energy use and distribution of energy use in the wheat production in Çarşamba province of Samsun was given Table 4. The total energy input was calculated as the average of 35737.13 MJha^{-1}. It was found that an negative relationship compared to the size of the surveyed farms for energy use in wheat production. It was determined that small farms consumed the more energy. Table 4 shows that the distribution of energy inputs in wheat production the highest energy input was provided by diesel fuel. In average, the most consumed energy was determined the diesel (44.61%), chemical fertilizers (23.54%), irrigation (10.58%), seed (10.11%), machinery (9.86%) and chemical (0.92%) in the surveyed farms, respectively (Table 4). The average yield of wheat production was found to be 3987.72 kg ha^{-1}. Therefore, the total energy output per hectare was computed 84427.33 MJ ha^{-1}.

Nabavi-Pelesaraei et al (2013a), emphasized that the total energy consumption of hazelnut production was calculated to be 2862.62 MJ ha^{-1}. The energy use efficiency was approximately 3.93. The nitrogen consumption (34.18%) had the highest share of total energy use in hazelnut production; followed by diesel fuel (18.73%) and human labor (11.97%). The shares of direct and indirect energy calculated as 30.70% and 69.70%, respectively. Renewable and non-renewable energy was determined the 16.00% and 84.00% of total energy consumption in hazelnut production. The energy ratio, energy productivity, specific energy, net energy was calculated as 3.93, 0.16 kg MJ^{-1}, 6.36 MJ kg^{-1} and 8392.38 MJ ha^{-1}, respectively. Moghimi et al (2013) and Kardoni et al (2013) reported that total energy inputs in wheat production were 42998.44 and 35604.9 MJ ha^{-1} while total energy outputs were 97935.63 and 62989.5 MJ ha^{-1} MJ ha^{-1} respectively, in Iran conditions. And also, Yadav and Khandelwal

(2013) reported that wheat production consumed 4345 MJ ha^{-1} input energy and revealed 56595 MJ ha^{-1} output energy in India. In a nectarine study conducted in Iran by Kordkheili et al (2013) total energy requirement was found 40.2 GJ ha^{-1}. In India Singh et al (2007) reported that yield, total energy input and output, in wheat production were computed 2550.5 kg ha^{-1}, 15572.2 and 63846.02 MJ ha^{-1}, respectively. In peanut production, input energy was found 19248.04 MJ ha^{-1} and output energy was calculated 87209.68 MJ ha^{-1} in Iran (Nabavi-Pelesaraei et al. 2013b).

Most of the cultural operations of the labor and machinery were used in post-harvest processing. 75.35%, 16.68% and 7.97% of machine power was consumed to harvesting and transporting, cultural practises and land preparation, respectively. 103.10 kg ha^{-1} nitrogen, 48.40 kg ha^{-1} phosporus were used in the investigated farms. Potassium never has been used. The energy input and output, grain yield, energy use efficiency, spesific energy, energy productivity and net energy values of wheat production were calculated and given in Table 5.

Table 4. Energy use in the wheat production
***Çizelge 4.** Buğday üretiminde enerji kullanımı*

Inputs/Outputs	Quantity per unit area (ha)	Total energy equivalent (MJ ha^{-1})		Percentage of the total energy input (%)
A. Inputs				
1. Labor (h ha^{-1})		134.88	Total	0.38
Land preparation	5.59	10.90		
Cultural practices*	7.40	14.43		
Harvesting and transporting	56.18	109.55		
2. Machinery (h ha^{-1})		3523.11	Total	9.86
Land preparation	9.37	587.50		
Cultural practices	4.48	280.90		
Harvesting and transporting	42.34	2654.72		
3. Chemical fertilizers (kg ha^{-1})		8412.51	Total	23.54
Nitrogen (N)	103.10	7779.93		
Phosphorus (P_2O_5)	48.40	632.59		
Potassium (K_2O)	--			
4. Diesel (L ha^{-1})	283.12	15942.49		44.61
5. Chemicals (kg ha^{-1})		330.56	Total	0.92
Pesticides	--			
Fungicides	0.23	21.16		
Herbicides	1.3	309.40		
6. Water for irrigation (m^3 ha^{-1})	6000	3780.00		10.58
7. Seed (kg ha^{-1})	179.78	3613.58		10.11
Total energy input (I)		35737.13		100.00
B. Outputs				
1. Wheat grain yield (kg ha^{-1})	3987.72	57742.19		
2. Wheat straw yield (kg ha^{-1})	2884.88	26685.14		
Total energy output (II)		84427.33		

**Cultural practices are include irrigation, fertilizing, spraying, etc.*

Table 5. Energy input-output ratio in wheat production
***Çizelge 5.** Buğday üretiminde enerji girdi-çıktı oranı*

Items	Unit	Value
Energy input	MJ ha^{-1}	35737.13
Energy output (Grain and straw)	MJ ha^{-1}	84427.33
Grain yield	kg ha^{-1}	3987.72
Energy use efficiency	-	2.36
Spesific energy	MJ kg^{-1}	8.96
Energy productivity	kg MJ^{-1}	0.112
Net energy	MJ ha^{-1}	48690.20

The results indicated that the energy use was found effectively in the research area. Average energy use efficiency was determined as 2.36 value. It means that farms gained 2.36 unit crop energy per unit energy input. Energy productivity of farms was calculated as 0.112 in the present study. This means that one unit of energy use revealed the 0.112 unit grain output. (Table 4).

There are a lot of literatures about energy input-output ratio. For example, energy ratio, energy productivity and net energy for wheat production were 0.717, 0.048 kg MJ $^{-1}$ and 35.57 GJ ha^{-1}, respectively (Mirasi et al. 2015). Esengun et al (2007) reported that the energy value of total inputs used in stake-tomato production was found to be about 97 000 MJ ha^{-1}. The energy input–output ratio was 0.80. The profit–expense ratio was found to be 1.03 in the result of economic analysis of staketomato. In Khuzestan Province of Iran energy use efficiency, energy productivity, and net energy were 1.76, 0.12 kg MJ^{-1}, and 27384.5 MJ ha^{-1} in wheat production, respectively. About 68% of the total energy inputs used in wheat production was indirect while only about 32% was direct (Kardoni et al. 2013).

Energy used in wheat production were given in Table 6 as direct, indirect and in the form of renewable and non-renewable energy.

As seen the Table 6, indirect energy ratio has been less than the rate of direct energy. In average, 44.43% of total input was consumed as indirect energy input while 55.57% of total input energy consumed by direct energy.

Renewable and non-renewable energy forms were constituted 21.07% and 78.93% of total energy input, respectively (Table 6).

Table 6. Total energy input in the form of direct, indirect and renewable energy for wheat production in Çarşamba district of Samsun province, Turkey
Çizelge 6. *Samsun ili Çarşamba ilçesinde buğday üretimi için doğrudan, dolaylı ve yenilenebilir toplam enerji girdisi*

Type of energy	Total energy equivalent (MJ ha^{-1})		%[a]
Direct energy[b]	19857.37		55.57
Indirect energy[c]	15879.77		44.43
Total energy input	35737.13	Total	100
Renewable energy[d]	7528.46		21.07
Non-renewable energy[e]	28208.67		78.93
Total energy input	35737.13	Total	100.00

[a] *Indicate percentage of total energy input.*
[b] *Indicates human labor, diesel and water.*
[c] *Indicates seeds, chemical fertilizers (N,P,K), chemicals and machinery.*
[d] *Indicates human labor, seeds and water.*
[e] *Indicates diesel, chemical fertilizers (N,P,K), chemicals and machinery.*

3.3. Economic analysis of wheat production

An economic analysis was performed in wheat production and was given in Table 7. The variable costs for the wheat production was 4442.99 TL ha^{-1} while the fixed costs value was found to be 2351.43 TL ha^{-1} (Table 7). 65.39% of the total costs were variable costs whereas 32% were fixed costs. The benefit–cost ratio from wheat production in the surveyed farms was calculated to be 0.64. It means that farms obtained an average 0.64 unit wheat versus one unit production cost. Some results about the benefit–cost ratio reported by other researchers, such as 16.74 for nectarine in Iran (Kordkheili et al. 2013), 1.43 for wheat in Iran (Sahahan et al. 2008), 3.33 for rice, 2.82 for wheat and 2.50 for barley in Australia (Khan et al. 2010), 0.86 for cotton in Turkey (Yilmaz et al. 2005), 1.17 for sugar beet (Erdal et al. 2007), 1.88 for potato (Mohammadi et al. 2008) and 2.09 for canola production in Turkey (Unakitan et al. 2010).

The share of the variable character of the production costs was higher than those fixed costs. In average, variable costs and fixed costs were determined 65.39% and 34.61%, respectively. The highest share of in variable costs was temporary labor and diesel while family labor and land rent was in the fixed costs.

Table 7. Cost analysis of wheat production in Çarşamba district of Samsun, Turkey.

Items	TL ha^{-1}	%
Variable costs (A)	4442.99	65.39
Seeds	164.37	2.42
Fertilizers	479.23	7.05
Chemicals	150.36	2.21
Water	600.00	8.83
Hired labor	1517.60	22.34
Diesel	1121.12	16.50
Repairs and maintenance	128.91	1.90
Others (bag, rope, etc.)	12.15	0.18
Vehicle rent	57.68	0.85
Operating interest charges	211.57	3.11
Fixed Costs (B)	2351.43	34.61
Family labor	1128.42	16.61
Depreciation (farm buildings and vehicle)	483.12	7.11
Land rent	671.40	9.88
General overhead costs	68.49	1.01
Total production costs (A+B)	6794.42	100.00
Unit cost (TL kg^{-1})	0.48	
Total Production value	4322.07	
Benefit/cost ratio	0.64	

4. Conclusions

This study was conducted to determine energy consumption for input and output energy in wheat production in Çarşamba district of Samsun province. Data were collected from 54 farmers which were selected based on random sampling method. Face-to face questionnaire method was used in obtained the data. The results obtained can be summarized as follows:

Total energy consumption in wheat production was found 35737.13 MJ ha^{-1}. Energy output was calculated as 84427.33 MJ ha^{-1}. The highest input energy item was determined as diesel (44.61%). Chemical fertilizer (23.54%) mainly nitrogen, water for irrigation (10.58%), seed (10.11%), machinery (9.86%), chemicals (0.92%) and labor (0.38%) followed the diesel. Harvesting and transporting (2654.72 MJ ha^{-1}) was the highest share in the machinery item (3523.11 MJ ha^{-1}). Indirect energy (44.43%) was found to be less than the direct energy (55.57%). Non-renewable energy (78.93%) included the diesel, chemical fertilizers (N,P,K), chemicals and machinery was calculated the higher than renewable energy (21.07%). Temporary labor (22.34%) and family labor (16.61%) had the highest value in the variable and fixed costs, respectively.

The benefit-cost ratio was found to be 0.64. Energy use efficiency, spesific energy, energy productivity and net energy for wheat production were 2.36, 8.96 MJ kg^{-1}, 0.112 kg MJ^{-1} and 48690.20 MJ ha^{-1}, respectively.

According to the results of the present study, despite the effective use of energy it does not reflect the product profitability. In other words, it was indicated that wheat production was not profitable activity in the research area. The production costs spent on energy inputs are relatively high. However, it is necessary to product the wheat for livestock in the region.

Therefore, all of the inputs must be used more efficiently for a profitable wheat production. Mechanization planning is inevitable. Considering the entire agricultural production, agricultural mechanization, which is a major source of energy consumption along with other resources in the application, must be assessed. Only in this way about the possibilities of increasing the efficiency of agricultural production can be progress (Yoldaş, 2009).

Energy has a great importance for the development of life cycle continuation and civilization. In connection with this energy, which is decisive in the national development process belonging to the various manufacturing sector is essential for economic activities in different sizes. As in other sectors, one of the most effective methods for reduce energy use in the agricultural sector is to increase the efficiency of energy use. In the world of today's industry, the use of energy and other resources has reached a significant level. However, the technical improvements to the energy conversion are not carried out effectively enough. In order to determine the level of future energy production and consumption must be considered many factors; such as population growth, economic productivity, consumer habits and technological advances in the backward, developing and developed countries. Forms of management for the energy sector will play an important role to the future of energy production, distribution and consumption levels (Ozturk and Barut, 2006; Yoldaş, 2009).

Energy analyses is a fundamental approach in defining and classifying the agricultural production systems in terms of energy consumption level. In recent years, economics, energy consumption and environmental awareness are all together essential considerations which refer the sustainable agriculture concept in evaluating the agricultural production projects. The ratio between energy consumption per unit agricultural production area and having equilavent crop energy from same field is a good indication for how much the production is profitable (Yoldaş, 2009).

Energy management is an important issue in terms of efficient, sustainable and economic use of energy. Energy use in wheat production is not efficient and detrimental to the environment due to mainly excess input use. Therefore, reducing these inputs would provide more efficient fertilizer application and diesel. Furthermore, integrated pest control techniques should be put in practice to improve pesticide use. It can be expected that all these measurements would be useful not only for reducing negative effects to environment, human health, maintaining sustainability and decreasing production costs, but also for providing higher energy use efficiency (Shahan et al. 2008).

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