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Energy Input-Output Analysis of Barley Production In Thrace Region of Turkey

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Abstract: In this research, our aim was to make an energy analysis of barley production in Thrace region of Turkey. In order to determine the energy input-output of barley production, the surveys were done in the 82 barley farms in Thrace region. 82 farms were selected to be analyzed by Neyman method. The data obtained in our research were collected from 82 different farms, through face to face questionnaires and observations. In barley farms, energy input-output was also determined through observation and survey methods, during the 2012-2013 production season. In barley production, energy input was calculated as 16950.15 MJ ha^{-1} and energy output was calculated as 92233.60 MJ ha^{-1}. Energy inputs consist of 59.33% chemical fertilizers energy, 20.10% diesel fuel energy, 15.80% barley seed energy, 3.67% machinery energy, 0.96% chemicals energy and 0.15% human labour energy. Energy use efficiency, energy productivity, specific energy and net energy in barley production were calculated as 5.44; 0.25 kg MJ^{-1}; 2.79 MJ kg^{-1} and 75283.45 MJ ha^{-1}, respectively.

Key words: Barley · Energy · Output/input Rate · Thrace · Turkey

INTRODUCTION

Yilmaz [1] reported that, "In terms of cultivation area size, barley ranks third in the world, following wheat and corn. Among the field products in Turkey, barley follows wheat, in terms of cultivation area. Similar to wheat, it is being cultivated in all regions of Turkey. In terms of harvested product per unit area, it is more advantageous than wheat [2]. Cereal products make up the basis of world economy, as well as the economy of Turkey. Barley is a member of this group and it is rarely used directly in human nutrition. In terms of animal breeding, it is being directly consumed; in addition, it is also an important raw material for mixed feed and malt industry. Regarding coarse barley, those with higher protein rates are being preferred. Higher husk value would decrease the nutritional value. Malt, which is required for beer production, is obtained from bilateral white barleys. In contrast to coarse types, beer barley is preferred to have a lower protein value, such as 9-10.50 % [3]".

Kizilaslan [4] reported that, "Agriculture is both a producer and consumer of energy. It uses large quantities of locally available non-commercial energies, such as seed, manure and animate energy and commercial energies directly and indirectly in the form of diesel, electricity, fertilizer, plant protection, chemicals, irrigation water and machinery [4]. Efficient use of energies helps to achieve increased production and productivity and contributes to the economy, profitability and competitiveness of agriculture sustainability in rural living [5]. Although energy consumption in agriculture is much lower than the other sectors in Turkey, energy usage as input and output in the agriculture sector is a very important issue due to its large agricultural potential and the size of rural area [6]". Azizi and Heidari [7] reported, "Energy consumption per unit area in agriculture is directly related to the development of farming technology and the production level. Energy use is one of the key indicators for developing more sustainable agricultural practice [8]. The amount of energy used in agricultural production, processing and distribution is significantly high. A sufficient supply of the right amount of energy and its effective and efficient use are necessary for an improved agricultural production [9]".

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Mobtaker *et al*. [10] reported that, "Barley is a major staple food in several regions of the world and food barley is generally found in regions where other cereals do not grow well due to altitude, low amounts of rainfall, or soil salinity. It remains the most viable option in dry areas (<300mm of rainfall). Food barley is used either for bread making (usually mixed with bread wheat) or for specific recipes [11]. Efficient use of energy is one of the principal requirements of sustainable agriculture. Energy use in agriculture has been increasing in response to increasing population, limited supply of arable lands and a desire for higher standards of living. Continuous demand in increasing food production resulted in intensive use of energy inputs and natural resources. However, intensive use of energy causes problems, which are threatening public health and environment. Efficient use of energy in agriculture will minimize environmental problems, prevent destruction of natural resources and promote sustainable agriculture as an economical production system [12-40]".

This research was conducted in line with other researches. Researches were performed on energy input-output analysis in agricultural products. For example, researches have been performed on energy usage activities of barley [7], lentil [8], wheat [14], wheat [15], wheat [16], chick pea [17], maize [18], canola [19], pumpkin seed [20], black carrot [21], maize [22] and wheat [23] etc. In this research, it was aimed to determine input-output energy use in barley production in Thrace region of Turkey.

MATERIALS AND METHODS

The research was performed in the Thrace region, particularly in various towns and villages of Edirne, Kırklareli and Tekirdag. Thrace Region is located at north-western part of Turkey and it is like a peninsula extension of the European continent. The land area is 2 372 100 ha and the region makes up 3.10% of Turkey's general land area [24]. The provinces of Edirne, Kirklareli and Tekirdag are located in the Thrace region of Turkey. In order to determine the energy balances of barley plant, surveys and observations have been performed in barley producing farms in Thrace Region. Surveys and observations have been performed face to face with 82 barley producers, during the 2012-2013 production season. Main material of research was composed of data accumaleted by face to face surveys made with 82 barley producers in Edirne, Kirklareli and Tekirdag provinces. The Survey was conducted with a total of 82 barley producers in Edirne, Kirklareli and Tekirdag. and Neyman method was employed. According to Ikiz and Demircan [25] "The Neyman stratified sampling method was used to determine the appropriate size of the study sample [26], using equation (1)".

$$n = \frac{(\Sigma N_h S_h)^2}{N^2 * D^2 + \Sigma N_h S_h^2} \qquad (1)$$

In the formula, n is the required sample size; N, the number of total business in population; N_h, the number of the population in h (small or large); Sh^2, the variance of h; $D^2 = d^2 / z^2$; d is the precision and z is the reliability coefficient (1.96 which represents 95% confidence). The permissible error in sample population was defined to be 5% and the sample size was calculated to be 82 for 95% reliability. Total energy input in unit area (ha) consists of the total of both input energies. Human labour, machinery, chemical fertilizers, chemicals, diesel fuel and barley seed were the calculated inputs. Barley grain and straw were the calculated outputs.

Following the surveys and observations held at the barley facilities in Thrace region, energy input and output values were defined. As energy inputs, human labour energy, machinery energy, chemical fertilizers energy, chemicals energy, diesel fuel energy and barley seed energy values were taken into consideration. Energy output/input rates of the enterprises involved in barley agriculture in Edirne, Kirklareli and Tekirdag provinces have been found. In the agricultural production in Table 1, energy equivalents of input and outputs have been taken as energy values. Energy balance calculations were made to determine the barley production productivity. The units shown in Table 1 were used to find out the values of the inputs in barley production. Input amounts have been calculated and then these input data have been multiplied by the energy equivalent coefficient. When determining the energy equivalent coefficients, previous energy analysis studies (sources) have been used. By adding energy equivalents of all inputs in MJ unit, the total energy equivalent has been found. For example, in order to determine the energy usage efficiency in wheat production, Mohammadi *et al*. [8] reported that, "The energy ratio (energy use efficiency), energy productivity, specific energy and net energy were calculated using the following formulates [27, 28]".

$$Energy\ use\ efficiency = \frac{Energy\ output\ (\frac{MJ}{ha})}{Energy\ Input\ (\frac{MJ}{ha})} \qquad (2)$$

Table 1: Energy equivalents of inputs and outputs in agricultural production of barley

Inputs and outputs	Unit	Energy equivalent coefficient	Sources
Inputs	Unit	Values (MJ/unit)	Sources
Human labour	h	1.96	Karaagac *et al*[31] (Mani *et al*[32])
Machinery	h	64.80	Kizilaslan[4] (Singh[5])
Chemical fertilizers			
Nitrogen	kg	60.60	Singh[5]
Phosphorous	kg	11.10	Singh[5]
Potassium	kg	6.70	Singh[5]
Chemicals	kg	101.20	Yaldiz *et al*.[33]
Diesel fuel	l	56.31	Demircan *et al*.[34] (Singh[5])
Barley seed	kg	14	Kitani[35] (Heichel[36])
Outputs	Unit	Values (MJ/unit)	Sources
Barley	kg	14.70	Mobtaker *et al*.[10] (Ozkan *et al*.[37])
Straw	kg	16.22	Kitani[35] (Kitani and Hall[38])

Table 2: Energy input-output analysis in barley production

Inputs	Unit	Energy equivalent (MJ / unit)	Input used per hectare (unit ha^{-1})	Energy value (MJ ha^{-1})	Rate(%)
Human labour	h	1.96	12.90	25.28	0.15
Land prepartion	h	1.96	4.30	8.43	0.05
Planting	h	1.96	3.10	6.08	0.04
Fertilizer application	h	1.96	1.40	2.74	0.02
Spraying	h	1.96	1.00	1.96	0.01
Harvesting	h	1.96	1.80	3.53	0.02
Baling	h	1.96	0.80	1.57	0.01
Transporting	h	1.96	0.50	0.98	0.01
Machinery	h	64.80	9.60	622.08	3.67
Land prepartion	h	64.80	4.30	278.64	0.73
Planting	h	64.80	1.90	123.12	0.27
Fertilizer application	h	64.80	0.70	45.36	0.19
Spraying	h	64.80	0.50	32.40	0.34
Harvesting	h	64.80	0.90	58.32	0.31
Baling	h	64.80	0.80	51.84	0.19
Transporting	h	64.80	0.50	32.40	0.73
Chemical fertilizers			172.18	10055.92	59.33
Nitrogen	kg	60.60	164.54	9971.12	58.83
Phosphorous	kg	11.10	7.64	84.80	0.50
Chemicals	kg	101.20	1.60	161.92	0.96
Diesel fuel	l	56.31	60.50	3406.75	20.10
Barley seed	kg	14	191.30	2678.20	15.80
Total inputs				16950.15	100.00
Outputs	Unit	Energy equivalent (MJ / unit)	Output per hectare (unit ha^{-1})	Energy value (MJ ha^{-1})	Rate(%)
Barley grain	kg	14.70	4200	61740	66.93
Barley straw	kg	16.22	1880	30493.60	33.07
Total outputs				92233.60	100.00

Table 3: Energy input-output and efficiency calculations in barley production

Calculations	Unit	Values
Barley grain	kg ha^{-1}	4200
Barley straw	kg ha^{-1}	1880
Energy input	MJ ha^{-1}	16950.15
Energy output	MJ ha^{-1}	92233.60
Energy use efficiency		5.44
Energy productivity	kg MJ^{-1}	0.25
Specific energy	MJ kg^{-1}	2.79
Net energy	MJ ha^{-1}	75283.45

$$Energy\ productivity = \frac{Barley\ output\ (\frac{kg}{ha})}{Energy\ input\ (\frac{kg}{ha})} \quad (3)$$

$$Specific\ energy = \frac{Energy\ output\ (\frac{MJ}{ha})}{Barley\ input\ (\frac{kg}{ha})} \quad (4)$$

$$\text{Net energy} = \text{Energy output (MJ ha}^{-1}\text{) - Energy input (MJ ha}^{-1}\text{)} \quad (5)$$

In the calculation of quantities of inputs used in barley production, energy equivalences in Table 1 were used. Quantities of inputs were calculated per hectare and then they were multiplied with the equivalence of these inputs. Resources of previous researches were used in determining the coefficients of energy equivalence. Other data was used from information released by organizations related to barley producers. The results were tabulated after the analysis of data was performed through Microsoft Excel program, by taking the inputs into account. Examining the values of barley input-output and calculations were given in Table 2. Kocturk and Engindeniz [29] reported that, "The input energy is also classified into direct and indirect and renewable and non-renewable forms. The indirect energy consists of pesticide and fertilizer while the direct energy includes human and animal power, diesel and electricity energy used in the production process. On the other hand, non-renewable energy includes petrol, diesel, electricity, chemicals, fertilizers, machinery and renewable energy consists of human and animal sources [27]". Energy input-output and efficiency calculations in barley production have been given in Table 3. Energy equivalents of input and outputs in barley agriculture are in Table 1.

RESULTS AND DISCUSSION

During the studies in the farms, the amount of barley grain and barley straw produced per hectare during the 2012-2013 production season was calculated as an average of 4200 kg and 1880 kg, respectively. In barley production, it is noteworthy that chemical fertilizers, diesel fuel energy and barley seed energy were used as the highest input. Regarding this study, practices for barley production and the energy input-output analysis of barley production in 2012-2013 has been given in Table 2 and the % distributions of the inputs were given in Figure 1. Looking at the figures, it can be seen that the first, second and third of the highest energy of inputs in barley production are chemical fertilizers energy by 59.33%, diesel fuel energy by 20.10% and barley seed energy by 15.80%.

Examining the values given in Table 2, chemical fertilizers energy, diesel fuel energy and barley seed energy are among the top in barley inputs. If the average values are examined by considering Table 2, it can be seen that the highest energy inputs in barley production are chemical fertilizers energy by 10055.92 MJ ha^{-1} (59.33%), diesel fuel energy by 3406.75 MJ ha^{-1} (20.10%), barley seed energy by 2678.20 MJ ha^{-1} (15.80%), machinery energy by 622.08 MJ ha^{-1} (3.67%), chemicals energy by 161.92 MJ ha^{-1} (0.96) and human labour energy by 25.28 MJ ha^{-1} (0.15%). In this study, fertilizer application energy had the biggest share by %59.33. Similarly, in previous studies, Mobtaker *et al*. [10] found that in barley study the fertilizer application energy had the biggest share with 6935.36 MJ ha^{-1}, Erdal *et al*. [12] found that in sugar beet study the fertilizer application energy had the biggest share with 16879.59 MJ ha^{-1} (42.53%), Shahin *et al*. [16] found that in wheat study the fertilizer application energy had the biggest share with 38.45%, Cicek *et al*. [14] found that in

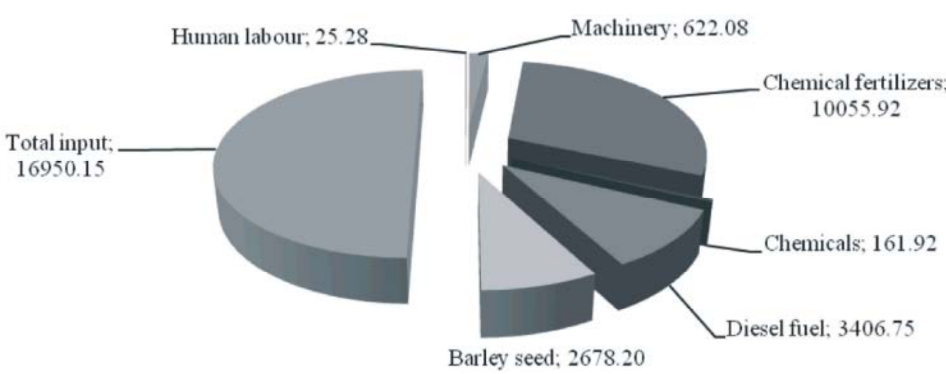

Fig. 1: Energy input ratio in barley production (MJ ha^{-1})

Table 4: Energy input in the form of direct and direct renewable and non-renewable energy for barley production

Type of energy	Energy input (MJ ha^{-1})	Ratio (%)
Direct energy [a]	3432.03	20.24
Indirect energy [b]	13518.12	79.76
Total	16950.15	100.00
Renewable energy [c]	2703.48	15.94
Non-renewable energy [d]	14246.67	84.06
Total	16950.15	100.00

[a] Includes human labour and diesel; [b]Includes barley seed, chemical fertilizers, chemicals and machinery; [c] Includes human labour and barley seed; [d] Includes diesel, chemicals, chemical fertilizers and machinery.

wheat study the fertilizer application energy had the biggest share with 36.48%, Karaagac [31] found that in wheat study the fertilizer application energy had the biggest share with 58.21% etc. The main reason for chemical fertilizers energy being so high is that, chemical fertilizers were used instead of farm fertilizers.

The results indicate that human labour energy input was calculated as 25.28 MJ ha^{-1} in barley production. Human labour energy was used for tractor and farm operations such as land prepartion, planting, fertilizer application, spraying, harvesting, bailing and transportation. Diesel energy input was calculated as 3406.75 MJ ha^{-1}. The diesel energy was used for operating tractor to perform the farm operations such as land prepartion, planting, fertilizer application, spraying, harvesting, bailing and transportation. Machinery energy input was calculated as 622.08 MJ ha^{-1}. Machinery energy was used for tractor and farm operations such as land prepartion, planting, fertilizer application, spraying, harvesting, bailing and transportation. The amount of chemical fertilizers used for barley production was 172.18 kg ha^{-1}. By 164.54 kg ha^{-1} (58.83%), nitrogen was the most common chemical fertilizer used in barley producion, while phosphorous amount was 7.64 kg ha^{-1} (0.50%).

Energy input, energy output, energy use efficiency, energy productivity, specific energy and net energy in barley production were calculated as 16950.15 MJ ha^{-1}, 92233.60 MJ ha^{-1}, 5.44; 0.25 kg MJ^{-1}; 2.79 MJ kg^{-1} and 75283.45 MJ ha^{-1}, respectively. In previous studies, Azizi and Heidari (2013) calculated energy use efficiency and energy productivity in barley study as 5.30 and 0.19 kg MJ^{-1}, Mobtaker *et al.* [10] calculated energy use efficiency and energy productivity in barley study as 2.86 and 0.19 kg MJ^{-1} and Ramah and Baali[39] calculated energy use efficiency in barley study as 4.20. Ramah and Baali [39] reported that, "Average energy intensity in case of Morocco is 4.90 for wheat, while in Greece, it was calculated to be between 5.20 and 6.45 and 6.45 MJ kg^{-1} and 3.50 to 4.50 in Italy (Pellizzi)".

The distribution of inputs used in the production of barley according to the direct, indirect, renewable and non-renewable energy groups were given in Table 4. It can be seen from Table 4 that the total energy input consumed could be classified as 20.24% direct and 79.76% indirect in barley production. Similarly, in previous studies of barley [7], wheat [14], sugar beet [12], maize [22], wheat [23], wheat [16] and wheat [40], it was discovered that the ratio of indirect energy is higher than ratio of direct energy. It can be seen from the Table 4 that the total energy input consumed could be classified as 15.94% renewable and 84.06% non-renewable in barley production. Similary, in previous studies of barley [10], barley [7], wheat [7], sugar beet [12], maize [22], lentil [13], wheat [23], wheat [16] and wheat [40], it was discovered that the ratio of non-renewable energy is higher than ratio of renewable energy.

Efficient use of energy is one of the principal requirements of sustainable agriculture. 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. Continuous demand in increasing food production resulted in intensive use of chemical fertilizers, pesticides, agricultural machinery and other natural resources. However, intensive use of energy causes problems which are threatening public health and environment. Efficient use of energy in agriculture will minimize environmental problems, prevent destruction of natural resources and promote sustainable agriculture as an economical production system [12]

CONCLUSION

In this research, the energy balance of barley production in the region of Thrace was defined. According to the evaluated results, barley production is an economic way of production in terms of energy usage. The research results indicate that the ratio of non-renewable energy is higher than the ratio of renewable energy and the ratio of indirect energy is higher than the ratio of direct energy. Farm fertilizers can be used in barley production, in place of chemical fertilizers, which make up an important part of the inputs. For example, Tipi *et al.* [40] reported that, "The use of renewable energy is very low, indicating wheat production depends mainly on fossil fuels. Continually rising fossil fuel prices have necessitated the more efficient use of diesel, chemicals and fertilizers for wheat production. Efficient use of energy helps to achieve increased production and productivity and contributes to economy, profitability and competitiveness of agricultural sustainability for rural living. Energy management should be considered an important field in terms of efficient, sustainable and economical use of energy". Consumption of optimal energy in agriculture is reflected in two ways: (a) increase to productivity with the existing level of energy inputs or (b) conservation of energy without affecting the productivity. Similarly, these facts are considered in barley production.

REFERENCE

1. Yilmaz, N., 2007. Barley. Tarimsal Ekonomi Arastirma Enstitusu, pp: 9(2).
2. Anonym, 2007. www.tarim.gov.tr (01.01.2007), (In Turkish).
3. Anonym, 2007. www.bahce.biz (01.01.2007), (In Turkish).
4. Kizilaslan, H., 2009. Input-output energy analysis of cherries production in Tokat province of Turkey. Applied Energy, 86: 1354-1358.
5. Singh, J.M., 2002. On farm 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.
6. Sayin, C., M.N. Mencet and B. Ozkan. 2005. Assessing of energy policies based on Turkish agriculture: current status and some implications. Energy Policy, 33(18): 2361-73.
7. Azizi, A. and S. Heidari. 2013. A comparative study on energy balance and economical indices in irrigated and dry land barley production systems, Int. J. Environ. Sci. Technol., 10: 1019-1028.
8. Mohammadi, A., S. Rafiee, S.S. Mohtasebi and H. Rafiee. 2010. Energy inputs-yield relationship and cost analysis of kiwifruit production in Iran. Renewable Energy, 35: 1071-1075.
9. Mohammadi, A. and M. Omid, 2010. Economical analysis and relation between energy inputs and yield of greenhouse cucumber production in Iran, Appl. Energy, 87: 191-196.
10. Mobtaker, H.G., A. Keyhani, A. Mohammadi, S. Rafiee and A. Akram. 2010. Sensitivity analysis of energy inputs for barley production in Hamedan Province of Iran, Agriculture, Ecosystems and Environment, 137: 367-372.
11. Anonym, 2007. Food and Agriculture Organization (FAO). http://www.fao.org.
12. Erdal, G., K. Esengun, H. Erdal and O. Gunduz, 2007. Energy use and economical analysis of sugar beet production in Tokat province of Turkey, Energy, 32: 35-41.
13. Mirzaee, E., M. Omid, A. Asakereh, M. Safaieenejad and M.J. Dalvand, 2011. 11th International Congress on Mechanization and Energy in Agriculture Congress, Istanbul, Turkey, pp: 383-387.
14. Cicek, A., G. Altintas and G. Erdal. 2011. Energy consumption patterns and economic analysis of irrigated wheat and rainfed wheat production: Case study for Tokat region, Turkey, Bulgarian Journal of Agricultural Science, 17(3): 378-388.
15. Ghorbani, R., F. Mondani, S. Amirmoradi, H. Feizi, S. Khorramdel, M. Teimouri, S. Sanjani, S. Anvarkhah and H. Aghel, 2011. A case study of energy use and economical analysis of irrigated and dryland wheat production systems, Applied Energy, 88: 283-288.
16. Shahin, S., A. Jafari, H. Mobli, S. Rafiee and M. Karimi, 2008. Effect of farm size on energy ratio for wheat production: A case study from Ardabil province of Iran, American-Eurasian J. Agric. and Environ. Sci., 3(4): 604-608.
17. Marakoglu, T. and K. Carman, 2010. Energy balance of direct seeding applications used in wheat production in middle Anatolia, African Journal of Agricultural Research, 5(10): 988-992.
18. Konak, M., T. Marakoglu and O. Ozbek. 2004. Energy balance at corn production. Selcuk University, Agriculture Faculty Journal, Konya, Turkey, 18(34): 28-30.
19. Unakitan, G., G. Hurma and F. Yilmaz. 2010. An analysis of energy use efficiency of canola production in Turkey, Energy, 35: 3623-3627.
20. Yildiz, M.U., H. Haciseferogullari, M. Acaroglu, S. Calisir and I. Gezer. 2006. Determination of energy balance of pumpkin seed production in Konya region. In: 23th National Congress on Mechanization in Agriculture, September 6-8, Canakkale, Turkey, pp: 287-291 (In Turkish).
21. Celik, Y., K. Peker and C . Oguz, 2010. Comparative analysis of energy efficiency in organic and conventional farming systems: A case study of black carrot (Daucus carota L.) production in Turkey. Philipp Agric Scientist, 93(2): 224-231.
22. Vural, H. and I. Efecan, 2012. An analysis of energy use and input costs for maize production in Turkey Journal of Food, Agriculture and Environment, 10(2): 613-616.
23. Ghahderijani, M., S.H.P. Komleh, A. Keyhani and P. Sefeedpari. 2013. Energy analysis and life cycle assessment of wheat production in Iran, African Journal of Agricultural Research, 8(18): 1929-1939.

24. Anonym, 1971. Topraksu, Meric Havzasi Topraklari, Topraksu Genel Mudurlugu Yayınlari: 205. Raporlar Serisi: 6, Ankara, (In Turkish).
25. Ikiz, M. and V. Demircan, 2013. Comparative Economic Analysis of Organic and Conventional Rose Oil (Rosa damascenae Mill.) Cultivation in Lakes Region, Turkey, Journal of Essential Oil Bearing Plants TEOP, 16(3): 352-363.
26. Yamane, T., 2001. Basic Sampling Methods. Translators: A. Esin, M.A. Bakir, C. Aydina and E. Gurbuzsel, Publishing of Literature, No:53, ISBN: 975-8431-34-X, Istanbul.
27. Mandal, K.G., K.P. Saha, P.K. Ghosh, K.M. Hatia and K.K. Bandyopadhyay, 2002. Bioenergy and economic analysis of soybean based crop production systems in central India, Biomass and Bioenergy, 23: 337-45.
28. Mohammadi, A., A. Tabatabaeefar, S. Shahin, S. Rafiee and A. Keyhani, 2008. Energy use and economical analysis of potato production in Iran a case study: Ardabil province, Energy Conversion Management, 49: 3566-3570.
29. Kocturk, O.M. and S. Engindeniz, 2009. Energy and cost analysis of sultana grape growing: A case study of Manisa, west Turkey, African Journal of Agricultural Research, 4(10): 938-943.
30. Singh, H., D. Mishra, N.M. Nahar and M. Ranjan, 2003. Energy use pattern in production agriculture of a typical village in Arid Zone India (Part II), Energy Conversion and Management, 44: 1053-1067.
31. Karaagac, H.A., S. Aykanat, B. Cakir, O. Eren, M.M. Turgut, Z.B. Barut and H.H. Ozturk, 2011. Energy balance of wheat and maize crops production in Haciali undertaking,11th International Congress on Mechanization and Energy in Agriculture Congress, 21-23 September, Istanbul, Turkey, pp: 388-391.
32. Mani, I., P. Kumar, J.S. Panwar and K. Kant, 2007. Variation in energy consumption in production of wheat-maize with varying altitudes in hill regions of Himachal Pradesh, India. Energy, 32: 2336-2339.
33. Yaldiz, O., H.H. Ozturk, Y. Zeren and A. Bascetincelik, 1993. Energy usage in production of field crops in Turkey,5th international congress on mechanization and energy in agriculture, Kusadasi, Turkey. October, 11(14): 527-536.
34. Demircan, V., K. Ekinci, H.M. Keener, D. Akbolat and C. Ekinci. 2006. Energy and economic analysis of sweet cherry production in Turkey: A case study from Isparta province, Energy Conversion and Management, 47: 1761-1769.
35. Kitani, O., 1999. Energy for biological systems. In: The International Commission of Agricultural Engineering, editor, CIGR handbook of agricultural engineering: Energy and biomass engineering, V. American Society of Agricultural Engineers,. (2.1. J. Ortiz-Canavate, J. and J.L. Hernanz, Energy Analysis), (3.3. P.C. Padger, Solid Fuels), pp: 351.
36. Heichel, G.H., 1980. Assessing the fossil energy costs of propagating agricultural crops. Handbook of Energy Utilization in Agriculture, ed. Pimentel, D.,. Boca Raton, FL: CRC Press. Inc., pp: 27-34
37. Ozkan, B., A. Kurklu and H. Akcaoz, 2004. An input-output energy analysis in greenhouse vegetable production: A case study for Antalya region of Turkey, Biomass and Bioenergy, 26: 89-95.
38. Kitani, O.and C.W. Hall, 1989. Physical properties of biomass. Biomass Handbook, New York: Gordon and Breach, pp: 880-882.
39. Ramah, M. and H. Baali, 2013. Energy balance of wheat and barley under Moroccan conditions, Journal of Energy Technologies and Policy, 3(10): 20-27.
40. Tipi, T., B. Cetin and C. Vardar, 2009. An analysis of energy use and input costs for wheat production in Turkey, Journal of Food, Agriculture and Environment, 7(2): 352-356.