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Review

A review on energy use for sustainable development in agriculture sector of Turkey

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Abstract

In this review, the energy consumption is examined in agricultural sector of Turkey. Several indicators are defined to evaluate for energy consumption in agriculture and some considerations are made taking into account these indicators. Energy conservation measures for the agricultural sector and suggestions for energy use are given. Energy used per cultivated area in Turkish agriculture is calculated as 82245.95 TOE/TL in the period of 2000-1010 years. Petroleum and electrical energy consumed per cultivated area in Turkish agriculture was 3996.83 thousand TOE and 4991 GWh respectively, in the period of 2000-2010 years.

Key words: Agriculture, energy use, sustainable development, Turkey

INTRODUCTION

The agricultural sector produces agricultural raw materials needed for industry and contributes to the economy more than other sectors in Turkey. Some indicators like as national income, population and active population shares in domestic and foreign trade are taken into account in order to determine the importance of the agricultural sector in the national economy. Individual sectors constitutes the overall gross domestic product (GDP) are considered separately, the importance of this situation is emerging more clearly. Because of the great agricultural potential of Turkey, this situation has a special importance in the overall economy.

In the recent years, energy use and associated greenhouse gas emissions and their potential impacts on the global climate change have been the worldwide concern. Improving the end-use energy efficiency is one of the most effective ways to reduce energy consumption in the industrial, commercial, transportation, utility, residential and agricultural sectors and their associated pollutant emissions [1]. Energy use in the agricultural sector depends on the size of the population engaged in agriculture, the amount of arable land and the level of mechanization. Effective energy use in agriculture is one of the conditions for sustainable agricultural production, since it provides financial savings, fossil resources preservation and air pollution reduction. The detailed studies based on the agricultural products and production systems and the total energy use have been conducted in the agricultural sector of the different countries. Considerable reviews have been performed on energy input and output in agricultural production of regional and across the countries of world [2-24].

In the world of today's industry, the usage of energy and energy resources have crucial value. While the amount of natural resources (especially fossil fuel resources) has been decreasing, the damage to the natural environment has been increasing with different types of pollution. Additionally, the technical improvements for the energy conversion can not be carried out as effective as it is needed. In order to determine the level of future energy production and consumption in developed and developing countries, many factors are to be considered, such as population growth, economic productivity, consumer habits and

Table 1: The share of agricultural production in the GDP in Turkey (TSI, 2011)

Years	The gross domestic product (GDP, Billion TL)	The share of agricultural production in the GDP at current prices (%)	Agricultural production (Billion TL)	Energy use in agriculture/ Agricultural production (TOE/TL)
2000	166.658	10.10	16.832	182568.9
2001	240.224	8.80	21.139	140214.8
2002	350.476	10.30	36.099	83935.84
2003	454.780	9.90	45.023	68542.74
2004	559.033	9.50	53.108	62401.14
2005	648.931	9.40	60.999	54755.00
2006	758.390	8.30	62.946	57318.97
2007	843.178	7.60	64.081	61547.10
2008	950.534	7.60	72.240	71622.37
2009	952.558	8.30	79.062	64164.83
2010	1103.749	8.00	88.299	57633.72
Mean		8.89		82245.95

technological advances. The style of energy sectors management will play an important role for the future of energy production, consumption and distribution. Careless use of energy resources and their scarcity, resulting unwanted side effects, so energy consumption must be planned and evaluated carefully and accurately. The benefits of the right evaluation of the energy consumption in agricultural sector can be summarized as follows:

(1) To ensure the usage of energy resources more effectively,
(2) To determine true value of losses and wastes of which types and places in the cultivation systems,
(3) To reduce inefficiency in current cultivation methods and develop more efficient methods,
(4) To ensure sustainable development by targeting the use of energy resources in a sustainable manner,
(5) To determine the priorities of energy sources those have high and low quality in terms of their usage areas and benefits,
(6) To identify the areas that improvements can be achieved by using effective technologies.

In this study, the energy consumption in Turkish agriculture has been investigated. In order to assess the energy consumption in agriculture, some indicators for energy use in agriculture was defined and evaluations was made considering these indicators for Turkish agriculture. Some conclusions related to energy use in the agricultural sector and energy conservation measures have been provided.

Agricultural Sector in Turkey

Agricultural gross domestic production (GDP) is a indicator of the contribution of the agricultural sector in the national economy, in other words the importance in national economy. The agricultural GDP determined by Turkey Statistical Institute (TSI) agricultural is calculated by the production method. The share of agricultural GDP in national economy reveals the magnitude of this contribution. The GDP in the production of goods and services is the basic parameter of economy efficiency. Similarly, the production of goods and services related to agriculture determine the performance of the economy in terms of the agricultural sector. This performance only shows the direction of agricultural production. The contribution of the agricultural sector to service production and other sectors of the economy indicates the importance of agriculture for the national economy.

Importance of agricultural sector in Turkey can be summarized as follow:

- It is very important for economic and social development.
- The share of GDP has fallen to the level of 15%.
- Agricultural sector is the employment source for 45% of the active labor force and 35% of Turkey population.
- The sector provides nutrition of the population of Turkey.
- Agricultural sector meets the raw material requirements of the industrial sector.
- The sector contributes directly and indirectly to exports.
- The geographical structure of the country has a large and diverse feature.
- Different climatic conditions in Turkey could be experienced.
- Wide variety of products and has broad prospects currently unavailable.
- The sector still holds being a great chance for Turkey.

In Turkey, the share of agricultural production in the GDP is given in Table 1. While the share of agricultural production in the GDP was 10.1% in 2000, it declined in 2009. In this period, Turkey has continued the economic transformation from agriculture sector towards industry

Table 2: Energy consumption in industry and agriculture in Turkey

Years	Energy consumption (Thousands TEO) TOE: tonne of oil equivalent (1 TOE = 11.63 MWh = 41.87 GJ)			The share of the total energy consumption (%)	
	Total	Industry	Agriculture	Industry	Agriculture
1990	52987	14543	1956	35	5
1995	63679	17372	2556	35	5
2000	80500	24501	3073	40	5
2001	75402	21324	2964	38	5
2002	78331	24782	3030	42	5
2003	83826	27777	3086	43	5
2004	87818	28789	3314	42	5
2005	91576	29396	3340	40	5
2006	77441	30996	3608	40	4.66
2007	82747	32466	3944	39	4.77
2008	79559	25677	5174	32	6.50
2009	80574	25966	5073	32	6.30
2010	83372	30628	5089	37	6.10
2011	86952	30830	5755	35	6.62
Mean				37.85	5.35

Table 3: Some indicators for energy consumption in agriculture

Indicators	Units
The total energy consumed per the cultivated area	TEO/ha
The total energy consumed per the sowed area	TEO/ha
The total oil consumed per the cultivated area	TEO/ha
The total electricity consumed per the cultivated area	MWh/ha
The total amount of energy consumed in fertilizer production per cultivated area	TEO/ha
The total amount of energy consumed per agriculture production value (agricultural GDP)	TEO/TL

and services sectors. Despite the fall in the share of the GDP, the agricultural production of Turkey has been increasing since 2000. The amount of production reduced due to drought in 2007, started to rise again from the beginning of 2008. In 2008, the agricultural production which was 73 billion TL, it was reached to 79 billion TL in 2009 (Table 1) (1 TL= 3.0317 euro=2.2087 USD).

According to harmonized data of the TSI in Turkey, in the period between 2000 – 2010 the share of agriculture in GDP is given in Table 1. While the value of agricultural production at current prices was 16.832 billion TL in 2000, it increased to 88.299 TL billion in 2010. Despite this increase, while the share of agriculture in GDP in 2000 was 10.1% it reduced to 8% in 2010. The average share of agriculture in GDP has been determined as 8.89% in 10-year period between 2000 and 2010. The amount of energy consumed in agriculture per Turkey's agricultural production value has followed a path parallel to the increase in agricultural production value. While it was 182568.9 TOE/TL in 2000, it has raised to the value 57633.72 TOE/TL in 2010. Energy consumed in agriculture per the value of agricultural production was calculated as 82245.95 TOE/TL in the period of between 2000 and 2010 (Table 1).

Turkey's agriculture sector, as of March 2010, 5.2 million people were provided employment. This figure is corresponding to approximately 24% of total employment in Turkey. Agricultural employment from 2000 until the first quarter of 2010 has fallen nearly 33%. Taking into account the increase in agricultural production in this period, it is observed that productivity in agriculture sector increased. Due to economic development is a natural consequence of the process, the ratio of agriculture production value to national income was reduced proportionally. However, in those countries that provide income from agriculture, this sector is important for the economy.

Energy Use in Turkish Agriculture

In Turkey, in the period between 1990–2011, total energy consumption in the industrial and agricultural sectors and value share in total energy consumption in this sector is given in Table 2. In Turkey in the 1990s, while the share of agricultural sector in total energy consumption at the 5% level, after 2008 it have reached a higher level than 6%. In this period, while the share of total energy consumption in the industrial sector was 37.85%, the share of the agricultural sector amounted to be 5.35% (Table 2). In order to assess the energy consumption in agriculture, some indicators was defined in Table 3.

The total energy consumed per cultivated and sowed farmland in the period between 1990 and 2011 years in Turkey is given in Table 4. The total energy consumed

Table 4: The energy consumed per cultivated and sowed farmland in agricultural sector of Turkey

Years	Energy consumption in agriculture (Thousands TEO)	The cultivated farmland (Thousands ha)	The sowed farmland (Thousands ha)	The total energy consumed per cultivated farmland (TOE/ha)	The total energy consumed per sowed farmland (TOE/ha)
1990	1956	24827	18868	0.078	0.103
1995	2556	24373	18464	0.104	0.138
2000	3073	23826	18207	0.128	0.168
2001	2964	23800	18087	0.124	0.163
2002	3030	23994	18123	0.126	0.167
2003	3086	23372	17563	0.132	0.175
2004	3314	23871	18110	0.138	0.182
2005	3340	23830	18148	0.140	0.184
2006	3608	22981	17440	0.156	0.206
2007	3944	21979	16945	0.179	0.232
2008	5174	21555	16460	0.240	0.314
2009	5073	21351	16217	0.237	0.312
2010	5089	21384	16333	0.237	0.311
2011	5755	20539	15712	0.280	0.366
Mean	3711.6	22977.3	17476.9	0.164	0.216

Table 5: Energy consumption of agricultural sector in Turkey

Years	Oil (thousands TOE)	Electricity (GWh)	The cultivated area (thousands ha)	The sowed area (thousands ha)	Oil consumption/ The cultivated area (TOE/ha)	Electricity consumption/ The cultivated area (MWh/ha)
2006	3119	4411	22981	17440	0.135	0.252
2007	3397	4981	21979	16945	0.154	0.293
2008	4304	5806	21555	16460	0.199	0.352
2009	4218	4879	21351	16217	0.197	0.300
2010	4134	5509	21384	16333	0.193	0.337
2011	4809	4360	20539	15712	0.234	0.277
Mean	3996.8	4991	21632	16518	0.185	0.302

per cultivated and sowed farmland were 0.072 TOE/ha and 0.136 TOE/ha, respectively in 10-year period between 1990-2000. The total energy consumption per cultivated and sowed farmlands regularly increased after 2005 until 2011. In this period, on average, the values of these indicators were 0.209 TOE/ha and 0.275 TOE/ha, respectively. The total energy consumed per cultivated and sowed farmland in 21-year period between the years 1990-2011 were calculated on average 0.164, TOE/ha and 0.216 TOE/ha, respectively.

The main primary energy consumed in Turkey's agriculture consists of oil, electricity, natural gas, and geothermal heat and the other heat sources. While the oil consumption per the cultivated area was 0.135 TOE/ha in 2006, it increased to 0.234 TOE/ha in 2011 (Table 5). Similarly, while the number of tractors and combine harvesters were1037383 tractors and 12359 combine harvesters in 2006, these figures increased to of 112500 tractors and 14313 combine harvesters in 2011 (Table 6). In this period, electricity consumption per the cultivated area is realized in a variable manner. In the period between the years 2006-2011, the total oil and electricity consumption in Turkish agriculture were on average 3996.83 thousand TOE (46483.13 GWh) and 4991 GWh, respectively. During this period, oil and electricity consumption per cultivated agricultural area, were on average 0.185 TOE/ ha and 0.302 MWh/ha, respectively.

One of the important energy input is indirect energy consumption used to produce fertilizers in agricultural production. In Turkey, natural gas is used mainly in fertilizer production process. In the period between 2006 and 2011 in Turkey, the amount of energy consumed in the production of fertilizers and energy consumed in the production of fertilizers per the cultivated area are given in Table 7.

While the total energy consumed in the production of fertilizer was 201.4 thousand TOE in 2006, it has increased to 650.4 thousand TOE in 2011.In this period, the total energy consumed for the production of fertilizers per the cultivated area was averagely 0.01 TOE/ha. Although the total production capacity of fertilizer factory in Turkey will be enough to level of fertilizer consumption,

Table 6: The number of tractors and combine harvesters in Turkey (TSI, 2011)

Years	The number of tractors	The number of combine harvesters
2000	941835	12578
2001	948416	12053
2002	970083	11539
2003	997670	11721
2004	1006065	11519
2005	1022365	11811
2006	1037383	12359
2007	1056128	12775
2008	1070746	13084
2009	1073538	13360
2010	1096683	13799
2011	1125001	14313

Table 7: Energy consumption in the production of fertilizers in Turkey

Years	Oil (thousands TEO)	Electricity (thousands TEO)	Natural gas (thousands TEO)	The total energy consumption (thousands TEO)	The cultivated area (thousands ha)	The total energy consumption/ The cultivated area (TOE/ha)
2006	7.4	44	150	201.4	22981	0.009
2007	5	17	0	22	21979	0.001
2008	7	22	214	243	21555	0.011
2009	5	20	26	51	21351	0.002
2010	4	12	64	80	21384	0.003
2011	5.5	26.6	618.3	650.4	20539	0.031
Mean	5.65	23.6	178.7	208	21631.5	0.01

because of the economic reasons (energy-raw materials-cost) the fertilizer factories don't work with the full production capacity. The average production capacity of the fertilizer factories is 60 % in Turkey. Therefore, the fertilizers demands in agriculture sector of Turkey are met by fertilizers import instead of raw material import.

CONCLUSIONS

The structure of agricultural holdings in Turkey should be required to improve the efficiency and competitive with the effective use of technology. In Turkey, although fertilizer consumption has showed a rapid increase, due to the support and encouragement, the rate of increase has slowed in recent years. Growing population and changing eating habits is inevitable to increase agricultural production. To increase agricultural production, it is necessary that increasing productivity obtained from the unit area using the fertilizer, quality seeds and emerging technologies, minimization of production losses, to achieve farm size for economic production and farmers' awareness. Because of the excessive and unplanned use of fertilizers is a clear negative impact on quantity and quality of products and the environment, fertilizer consumption should be controlled and planned. Adhering to the principles of sustainable agriculture, use of correct type and amount fertilizer is critical to prevent damage of the fertilization on the environment. The most effective way to apply the correct type and quantity of fertilizer is based on the soil and plant analysis.

In recent years, energy use, greenhouse gas emissions and their potential effects on global climate change is one of the most hotly debated topics. Problems with the use of energy, is not only limited to global warming. The environmental issues such as air pollution, acid rain and ozone depletion are closely related energy use. Environmental effects caused by the use of energy, to be at the lowest level, all of the mentioned subject should be considered together. Increasing energy efficiency is important in terms of environmental impact assessment of energy sources. The efficiency of system should be increased to use less energy and to harm the environment at the lowest level. Because of the scarcity and careless use of energy resources resulting unwanted side effects, it is required that energy consumption accurately and carefully planned.

REFERENCES

[1] Dincer I, Hussain MM, Al-Zahamah I. Analysis of sectoral energy and exergy use of Saudi Arabia. International Journal of Energy Research 2004;28(3):205–243.

[2] Alonso AM, Guzmán GJ. Comparison of the efficiency and use of energy in organic and conventional farming in Spanish agricultural systems. Journal of Sustainable Agriculture 2010;34(3):312–338.
[3] Dyer JA, Desjardins RL. A review and evaluation of fossil energy and carbon dioxide emissions in Canadian agriculture. Journal: Journal of Sustainable Agriculture 2009;33(2):210–228.
[4] Gundogmus E. Energy input use in environmentally friendly farming systems: a comparative analysis between organic and conventional dried fig production. Journal of Sustainable Agriculture 2010;34(7):744–757.
[5] Liu Y, Langer V, Høgh-Jensen H, Egelyng H. Energy use in organic, green and conventional pear producing systems—cases from China. Journal of Sustainable Agriculture 2010;34(6):630–646.
[6] MacRae RJ, Lynch D, Martin RC. Improving energy efficiency and GHG mitigation potentials in Canadian organic farming systems. Journal of Sustainable Agriculture 2010;34(5):549–580.
[7] Mandal KG, Saha KP, Hati KM, Singh VV, Misra AK, Ghosh PK, Bandyopadhyay KK. Cropping systems of central India: An energy and economic analysis. Journal of Sustainable Agriculture 2005;25(3):117–140.
[8] Neira DP, Montiel MS, Fernández XS. Energy analysis of organic farming in Andalusia (Spain). Agroecology and Sustainable Food Systems 2013;37(2):231–256.
[9] Topak R, Acar B, Ugurlu N. Analysis of energy use and input costs for irrigation in field crop production: a case study for the Konya plain of Turkey. Journal of Sustainable Agriculture 2009;33(7):757–771.
[10] Bayrakcı AG, Kocar G. Utilization of renewable energies in Turkey's agriculture. Renewable and Sustainable Energy Reviews, 2012;6(1):618–633.
[11] Mohammadi A, Rafiee S, Jafari A, Keyhani A, Avval SHM, Nonhebel S. Energy use efficiency and greenhouse gas emissions of farming systems in north Iran. Renewable and Sustainable Energy Reviews, 2014;30:724–733.
[12] Zaman K, Khan MM, Ahmad M. Factors affecting commercial energy consumption in Pakistan: Progress in energy. Renewable and Sustainable Energy Reviews, 2013;19:107–135.
[13] Mohammadshirazi A, Akram A, Rafiee S, Avval SHM, Kalhor EB. An analysis of energy use and relation between energy inputs and yield in tangerine production. Renewable and Sustainable Energy Reviews, 2012;16(7):4515–4521.
[14] Murphy F, Devlin G, McDonnell K. Miscanthus production and processing in Ireland: An analysis of energy requirements and environmental impacts. Renewable and Sustainable Energy Reviews, 2013;23:412–420.
[15] Mekhilef S, Faramarzi SZ, Saidur R, Salam Z. The application of solar technologies for sustainable development of agricultural sector. Renewable and Sustainable Energy Reviews, 2013;18(3):583–594.
[16] Ozyurt O. Energy issues and renewables for sustainable development in Turkey. Renewable and Sustainable Energy Reviews, 2010;14(9):2976–2985.
[17] Khoshnevisan B, Shariati HM, Rafiee S, Mousazadeh H. Comparison of energy consumption and GHG emissions of open field and greenhouse strawberry production. Renewable and Sustainable Energy Reviews, 2014;29:316–324.
[18] Wit M, Londo M, Faaij A. Productivity developments in European agriculture: Relations to and opportunities for biomass production. Renewable and Sustainable Energy Reviews, 2011;15(5):2397–2412.
[19] Bilen K, Ozyurt O, Bakırcı K, Karslı S, Erdogan S, Yılmaz M, Comaklı O. Energy production, consumption, and environmental pollution for sustainable development: A case study in Turkey. Renewable and Sustainable Energy Reviews, 2008;12(6):1529–1561.
[20] Kotcioğlu I. Clean and sustainable energy policies in Turkey. Renewable and Sustainable Energy Reviews, 2011;15(9):5111–5119.
[21] Ping X, Jiang Z, Li C. Status and future perspectives of energy consumption and its ecological impacts in the Qinghai–Tibet region. Renewable and Sustainable Energy Reviews, 2011;15(1):514–523.
[22] Hessari FA. Sectoral energy consumption in Iran. Renewable and Sustainable Energy Reviews, 2005;9(2):203–214.
[23] Serencam H, Serencam U. Toward a sustainable energy future in Turkey: An environmental perspective. Renewable and Sustainable Energy Reviews, 2013;27:325–333.
[24] Canakci M, Yasemin Emekli N, Bilgin S, Caglayan N. Heating requirement and its costs in greenhouse structures: A case study for Mediterranean region of Turkey. Renewable and Sustainable Energy Reviews, 2013;24:483–490.
[25] TSI, Turkey Statistical Institute 2011; Ankara-Turkey.