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Energy Consumption Pattern of Canola Production in Iran

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Abstract: This study was carried out to assess the energy consumption of canola production in two regions of Fars province, Iran. The data were collected from 163 canola farmers (83 from region 1 and 80 from region 2) for the year 2007-2008, using stratified random sampling method. The results revealed that total energy inputs were 31086.779 and 32315.076 MJ/ha for region 1 and 2, respectively. Three main energy consumers were fertilizer, electricity and diesel fuel in both regions. These inputs consumed more than 85% of total energy used in each region. The results also showed that Energy ratio, energy productivity and specific energy were 2.29, 0.096 kg/MJ and 10.44 MJ/kg for region 1 and 1.701, 0.071 kg/MJ and 14.107 MJ/kg for region 2, respectively. It was found that canola production in region 1 was more energy efficient in comparison to region 2.

Key words: Canola · Energy ratio · Energy productivity · Specific energy

INTRODUCTION

Energy and agriculture have a very close relationship and agricultural dependence on energy, especially on fossil fuels has increased during last decades. Efficient energy use is an essential component of sustainable agricultural production, because it reduces fossil fuel use and decreases air pollution and GHG (Green House Gas) emissions. Besides, it improves financial viability of agricultural production.

A study in Pakistan utilizing Long Range Energy Alternatives Planning System (LEAP) showed that energy demand of agriculture sector of Punjab would increase from 4.28% and 10.7% in 2010 to 23.8% and 52.3% in 2030 respectively. This study revealed that sustainable agricultural practices could be used to meet the accelerated growth targets with reduced energy demand [1].

Ozkan *et al.* [2] analyzed the amount of input energy in citrus production in Antalya province of Turkey and it was found that total energy consumption for lemon, orange and mandarin were 62977.87, 60949.69 and 48838.17 MJ/ha, respectively. The energy ratios for orange, mandarin and lemon were estimated to be 1.25, 1.17 and 1.06, respectively.

An evaluation of the amount of energy indices of breed and native rice in north of Iran demonstrated that breed rice has the highest yield and energy ratio by 7500 Kg/ha and 2.458 respectively [3].

Lack of sufficient oil and the high price of oil products have forced some countries to be more and more energy efficient in all sectors. Establishing a vast local research in developing countries like Iran toward achieving a sustainable agriculture and proper use of energy resources is essential. In Iran, for many years there was no proper plan in relation to using energy, mainly fuels, in an efficient way. Since 2007, it has been decided to ration the fuel of vehicles.

From the point of view of energy, there is a great lack of information about energy use in agriculture of Iran. Although Iran is one of the richest countries in Petroleum and natural gas resources, on the other hand a considerable amount of veg. oil (approximately 80%) has been imported. Rapeseed was reportedly grown in Europe in the 13th century, but it has been cultivated in Asia for thousands of years. It was used in Asia for cooking, but originally used in Europe as a source of fuel and lubricant.

Since 2001, canola was introduced to farmers as a step toward self sufficiency in veg. oil. In comparison to 16000 ha in 2002 Iranian farmers planted 230000 ha of canola through out the country in 2007 [4]. According to annual agricultural statistics from agricultural-Jihad of Iran [4], it was observed that there was almost a big difference of 700 kg/ha in canola production in two regions of Fars province. The soil types and climates of these regions are similar. So, this study was carried out to compare these two regions and to evaluate if there was any difference between energy consumptions.

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Table 1: Energy equivalent of inputs and outputs in agricultural production

Input(unit)	Energy equivalent(MJ/unit)	Reference
Liquid chemical(Lit)	102	7
Granular chemical(kg)	120	7
Human power(h)	1.96	8
Machinery(kg)	62.7	9
Nitrogen(kg)	66.14	10
Phosphorus(kg)	12.44	10
Potassium(kg)	11.15	10
Manure(kg)	0.3	9
Zinc sulphate(kg)	20.9	9
Diesel(L)	56.3	9
Canola seed(kg)	24	11

MATERIALS AND METHODS

This study was conducted in order to compare energy consumptions of canola production in two regions of Fars province, Iran. The regions were: 1- Seidan, with mean yield of 3000 kg/ha and 2- Houmeh, with mean yield of 2300 kg/ha. The data were collected for year 2007 from 163 canola growing farmers which 83 from region 1 and 80 from region 2. Appropriate questionnaires were designed and completed through face to face interviews.

According to different planting methods, farmers classified into three groups as:

- Those who used combined seeders.
- Those who used drill planters.
- Those who used hand applicators.

Sample farms were randomly selected using stratified random sampling method. The sample size was calculated by Neyman technique [5]:

$$n = (\Sigma N_h S_h)^2 / (N^2 D^2 + \Sigma N_h S_h^2) \qquad (1)$$

Where n is the required sample size; N is the number of holdings in target population; N_h is the number of the population in h; S_h is the standard deviation of h, S_h^2 is the variance of h; $D^2 = d^2/z^2$; d is the precision $(\bar{x} - \bar{X})$; z is the reliability coefficient (1.96 which represents the 95% reliability). The permissible error in the sample size was defined to be 5% for 95% confidence.

The amount of each input was evaluated per hectare and multiplied by its energy equivalent. In order to evaluate output and input energy, energy equivalents of inputs and output were converted into equivalent energy units. The energy equivalents of inputs used in this study are given in Table 1. Collected data on canola yields for two regions and those energy inputs were entered into Excel spread-sheets and energy efficiency parameters calculated as shown below:

Energy Ratio: Energy output/energy input (2)

Specific Energy: Energy input/grain yield output (MJ/kg) (3)

Energy Productivity: Grain yield output/energy input (kg/MJ) (4)

Net Energy Gain: Energy output-energy input (MJ/ha) (5)

Energy requirements in agriculture are divided into direct and indirect, renewable and non-renewable energies. Direct energy is required to perform various tasks related to crop production processes such as land preparation, irrigation, harvesting and threshing and it mainly consists of fuel, human power and electricity. It is seen that direct energy is directly used at farms and on fields. Indirect energy, on the other hand, consists of the energy used in manufacturing, packaging and transporting fertilizers, pesticides and farm machinery. Renewable energies are: human power, seed and manure and non-renewable energies are: fuel, electricity, fertilizers, pesticides, farm machinery and irrigation [6].

RESULTS AND DISCUSSION

Table 2 gives the energy analysis in different parts of canola production in two regions of Fars province, Iran. Total energy inputs were recorded as 31086.779 and 32315.076 MJ/ha for region 1 and 2, respectively. For both regions the highest energy consumers were fertilizer, electricity and diesel fuel. The share of these three inputs was m ore than 85% of total input energy in each region.

Table 2: Energy use status of canola production in two regions of Fars province (MJ/ha)

	Region 1 (Seidan)				Region 2 (Houmeh)			
Item	Combined Seeder (μ_1)	Drill Planter (μ_2)	Hand Applicator (μ_3)	Weighted Average ($\Sigma w_i\mu_i$)[a]	Combined Seeder (μ_1)	Drill Planter (μ_2)	Hand Applicator (μ_3)	Weighted Average ($\Sigma w_i\mu_i$)[b]
1-Machinery	1146.29	1413.65	1432.615	1261.178	1185.500	1482.083	1511.429	1390.100
1-1- land preparation	125.690	523.300	515.077	291.047	234.800	599.306	615.571	481.683
1-2- planting	321.780	168.800	188.923	260.720	254.667	198.806	273.143	234.579
1-3- fertilizer application + spraying	159.660	185.000	202.154	172.868	157.767	149.306	96.357	139.892
1-4- harvesting	539.160	536.550	526.462	536.543	538.267	534.667	526.357	533.946
2- Diesel fuel	6590.270	7872.560	7601.085	7086.557	6977.810	8206.325	7789.464	7700.935
2-1- land preparation	1886.490	4064.725	4103.600	2805.041	2221.293	4230.372	3978.964	3503.274
2-2- planting	3024.520	2200.625	1929.377	2638.350	3156.270	2254.878	2281.636	2561.222
2-3- fertilizer application + spraying	412.152	372.015	294.285	383.597	338.387	430.539	214.443	349.934
2-4- harvesting	1267.108	1235.195	1273.823	1259.569	1261.86	1290.536	1314.421	1286.504
3- Fertilizer	11317.741	10877.662	12053.270	11310.865	11559.58	12300.056	11721.836	11919.91
3-1- Nitrogen	10507.320	10244.637	11180.866	10538.626	10507.32	11382.930	10632.407	10917.981
3-2- Phosphorous	440.448	297.600	343.385	387.508	446.400	372.000	340.114	389.410
3-3- Potassium	117.065	292.575	257.250	185.270	167.250	162.604	79.643	144.987
3-4- Manure	222.000	0.000	230.769	163.828	400.000	333.333	642.857	427.033
3-5- Other (Zinc sulphate, iron, etc).	30.908	42.850	41.000	35.632	38.610	49.189	26.814	40.498
4- Human Power	409.406	445.659	482.123	430.102	446.624	442.450	479.079	452.301
5- Seed	219.240	225.300	227.077	222.047	232	242.639	263.143	243.833
6- Chemicals	372.890	340.564	395.115	367.583	575.473	560.933	717.114	601.853
7- Irrigation	1705.528	1729.180	1857.015	1734.741	1611.540	1641.356	1798.343	1667.691
8- Electricity	8527.640	8645.900	9285.077	8673.707	8057.700	8206.778	8991.714	8338.455
- Total input energy	30289.005	31550.475	33333.378	31086.779	30646.29	33082.620	33272.121	32315.076
- Direct energy	15527.316	16964.119	17368.285	16190.366	15482.14	16855.553	17260.257	16491.691
- Indirect energy	14761.689	14586.356	15965.093	14896.413	15164.14	16227.067	16011.864	15823.385
- Renewable energy	850.646	670.959	939.969	815.977	1078.624	1018.422	1385.079	1123.167
- Non-renewable energy	29438.359	30879.516	32393.409	30270.802	29567.61	32064.198	31887.042	31191.909
-Total output energy	77318.878	65922.600	56939.262	71187.354	64116.4	49881	51428.571	54978.877
- Energy output-input ratio	2.553	2.089	1.708	2.290	2.092	1.508	1.546	1.701
- Energy productivity (kg/MJ)	0.107	0.087	0.071	0.096	0.087	0.063	0.064	0.071
- Specific energy (MJ/kg)	9.344	11.486	14.050	10.440	11.471	15.918	15.527	14.107
- Net energy gain (MJ/ha)	47029.873	34372.125	23605.884	40100.575	33470.17	16798.380	18156.450	22663.801
- Yield (kg/ha)	3241.620	2746.775	2372.469	2977.760	2671.517	2078.375	2142.857	2290.787

[a] where μ_1, μ_2 and μ_3 for region 1 were 0.581, 0.268 and 0.151, respectively.

[b] where μ_1, μ_2 and μ_3 for region 2 were 0.333, 0.436 and 0.231, respectively.

According to results all energy efficiency parameters were better in region 1. Energy ratio, energy productivity and specific energy were 2.29, 0.096 kg/MJ and 10.44 MJ/kg for region 1 and 1.701, 0.071 kg/MJ and 14.107 MJ/kg for region 2, respectively. It was found that yield and net energy gain in region 1 were 1.3 and 1.77 times more than region 2, respectively.

Direct and indirect energy consumptions were 16190.366(52.08%) and 14896.413(47.92%) MJ/ha for region 1 and 16491.691(51.03%) and 15823.385(48.97%) MJ/ha for region 2, respectively. Among the indirect energy components, consumption of fertilizer energy recorded a maximum of 11919.91 MJ/ha in region 2 followed by 11310.865 MJ/ha in region 1. Nitrogen consumed more than 90% of total input energy on the part of fertilizer energy. Although appropriate N input enhances soil fertility and it is an important material in raising crops, improper management can be associated with a number of adverse affects on the environment and human health. Due to the fact that there is no limitation on using inputs (mainly fertilizer and chemicals) in Iran, the farmers not respond to this part easily.

It was observed that there were almost many of livestock production systems in both regions, producing enough available manure. But the farmers have used the manure just for summer crops because of expensive labor and lack of proper manure spreaders.

Chemicals consumed only 367.583 (1.19) and 601.853 (1.86) MJ/ha of total input energy in region 1 and 2, respectively. Even if the contribution of chemical energy is not high, it should not be underestimated. Proper chemical application is essential due to the fact that pesticides are toxic and they must be applied carefully to avoid negative impacts on other organisms.

Energy consumption on the form of electricity were 8673.707 (27.9%) and 8338.455 (25.8%) in region 1 and 2, respectively. Some factors that affected electricity energy consumption were: using depreciated engines to pump the water, using flood irrigation system and applying a considerable amount of water in each irrigation and unscheduled irrigation periods.

Fuel was the third energy consumer in both regions. It consumed more than 22% of total energy input in each region. The amount of fuel energy consumption in region 1 was lower than region 2, because the farmers in region 1 used combined machines in land preparation and planting. A lot of fuel is lost every year due to using conventional tillage system in Iran. Besides, there are soil degradation and a lot of environmental impacts. The analysis of data showed that there were no correlation between input energy and yield in each region.

With regard to the present situation in agriculture of Iran, the following offers would improve agricultural systems:

- There should be a restriction on using fertilizers and chemicals.
- There will be good results if governmental policies focused on researching and developing new agricultural technologies like: conservation agriculture equipments, precision farming practices and new irrigation systems.
- Using scientific methods in order to achieve an accurate weather forecasting leads to assuring and attracting farmers to schedule their irrigation rotations more accurately.

CONCLUSIONS

This study was carried on in order to analysis energy consumption of canola production in two regions of Fars province, Iran. Total energy inputs were 31086.779 and 32315.076 MJ/ha for region 1 and 2, respectively. It was observed that canola production was more energy efficient in region 1. Three main energy consumer inputs were fertilizer, electricity and diesel fuel. The share of these three inputs was more than 85% of total input energy in each region. It seems that the most important factor to reduce fertilizer and chemicals consumptions is a restriction on the using of these materials. In addition, researching and developing new agricultural technologies compatible with local conditions is essential as a basic step toward sustainable agriculture.

REFERENCES

1. Ahmad, S.S., S. Muhammad, R. Shabbir and A. Wahid, 2010. Predicting future energy requirements of Punjab (Pakistan) agriculture sector using leap model. World Applied Sciences J., 8(7): 833-838.
2. Ozkan, B., H. Akcaoz and F. Karadeniz, 2003. Energy requirement and economic analysis of citrus production in Turkey. Energy Conversion and Manage., 45: 1821-1830.
3. Moradi, M., E. Azarpour and H. Ziaeidoustan, 2011. Study of energy indices for native and breed rice varieties production in Iran. World Applied Sciences J., 13(1): 137-141.
4. Anonymous. 2008. Annual agricultural statistics for 2006-2008. http://www.maj.ir
5. Yamane, T., 1967. Elementary sampling theory. New Jersey, USA: Prentice Hall Englewood Cliffs.
6. Singh, H., A.K. Singh, H.L. Kushwaha and A. Singh, 2007. Energy consumption pattern of wheat production in India. Energy, 32: 1848-1854.
7. Chaudhary, V.P., B. Gangwar and DK. Pandey, 2006. Auditing of Energy Use and Output of Different Cropping Systems in India. Agricultural Engineering International: the CIGR Ejournal, Vol. VIII: 1-13.

8. Mani, I., P. Kumar, J.S. Panwar and K. Kant, 2007. Variation in energy consumption in production of wheat-maize with varying altitudes in hilly regions of Himachal Pradesh, India. Energy, 32: 2336-2339.
9. Verma, S.R., 1987. Energy in Production Agriculture and Food Processing. Proceedings of the National Conference held at the Punjab Agricultural University, Ludhana.
10. Shrestha, D.S., 1998. Energy use efficiency indicator for agriculture. http:\\www. usaskca/agriculture/caedac/PDF/mcrae.PDF.
11. Venturi, P. and G. Venturi, 2003. Analysis of energy comparison for crops in European agricultural systems. Biomass and Bioenergy, 25: 235-255.