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 use of energy 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 18th 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

<table>
<thead>
<tr>
<th>Input/Unit</th>
<th>Energy Equivalent (MJ/unit)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid chemical(Lt)</td>
<td>102</td>
<td>7</td>
</tr>
<tr>
<td>Granular chemical(kg)</td>
<td>120</td>
<td>7</td>
</tr>
<tr>
<td>Human power(h)</td>
<td>1.96</td>
<td>8</td>
</tr>
<tr>
<td>Machinery(kg)</td>
<td>62.7</td>
<td>9</td>
</tr>
<tr>
<td>Nitrogen(kg)</td>
<td>66.14</td>
<td>10</td>
</tr>
<tr>
<td>Phosphorus(kg)</td>
<td>12.44</td>
<td>10</td>
</tr>
<tr>
<td>Potassium(kg)</td>
<td>11.15</td>
<td>10</td>
</tr>
<tr>
<td>Manure(kg)</td>
<td>0.3</td>
<td>9</td>
</tr>
<tr>
<td>Zinc sulphate(kg)</td>
<td>20.9</td>
<td>9</td>
</tr>
<tr>
<td>Diesel(L)</td>
<td>56.3</td>
<td>9</td>
</tr>
<tr>
<td>Canola seed(kg)</td>
<td>24</td>
<td>11</td>
</tr>
</tbody>
</table>

MATERIALS AND METHODS

This study was conducted in order to compare energy consumption 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]:

\[
n = \frac{(\Sigma N_i S_i^2)}{(N^2 D^2 + \Sigma N_i S_i^4)}
\]

Where \( n \) is the required sample size; \( N \) is the number of holdings in target population; \( N_i \) is the number of the population in \( h \); \( S_h \) is the standard deviation of \( h \); \( S_i^2 \) 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 spreadsheets and energy efficiency parameters calculated as shown below:

- **Energy Ratio**: Energy output/energy input

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

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

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

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 more 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)

<table>
<thead>
<tr>
<th>Item</th>
<th>Region 1 (Seidan)</th>
<th>Region 2 (Houmeh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Combined Seeder (µL)</td>
<td>Drill Planter (µL)</td>
</tr>
<tr>
<td>1-1 Machinery</td>
<td>1146.29</td>
<td>1413.65</td>
</tr>
<tr>
<td>1-2 land preparation</td>
<td>125.690</td>
<td>523.300</td>
</tr>
<tr>
<td>2-2 planting</td>
<td>321.780</td>
<td>168.800</td>
</tr>
<tr>
<td>1-1-1 fertilizer application</td>
<td>159.660</td>
<td>185.000</td>
</tr>
<tr>
<td>+ spraying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-4-1 harvesting</td>
<td>539.160</td>
<td>556.550</td>
</tr>
<tr>
<td>2-1 Diesel fuel</td>
<td>6590.270</td>
<td>7872.560</td>
</tr>
<tr>
<td>2-1 land preparation</td>
<td>1886.450</td>
<td>4064.725</td>
</tr>
<tr>
<td>2-2-3-6 planting</td>
<td>3024.520</td>
<td>2200.625</td>
</tr>
<tr>
<td>3-3-2-1 fertilizer application</td>
<td>412.152</td>
<td>372.015</td>
</tr>
<tr>
<td>+ spraying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-4-1 harvesting</td>
<td>1267.108</td>
<td>1235.195</td>
</tr>
<tr>
<td>3-1 Fertilizer</td>
<td>1131.741</td>
<td>10877.662</td>
</tr>
<tr>
<td>3-2-1-6 Nitrogen</td>
<td>1050.320</td>
<td>10244.637</td>
</tr>
<tr>
<td>3-2-4-1 Phosphorus</td>
<td>440.448</td>
<td>297.600</td>
</tr>
<tr>
<td>3-2-3 Potassium</td>
<td>117.065</td>
<td>292.575</td>
</tr>
<tr>
<td>4-4-1 Marana</td>
<td>222.000</td>
<td>0.000</td>
</tr>
<tr>
<td>3-5-1 Other</td>
<td>30.908</td>
<td>42.850</td>
</tr>
</tbody>
</table>

(Zinc sulphate, iron, etc.)

4-1 Human Power

5-1 Seed

6-1 Chemicals

7-1 Irrigation

8-1 Electricity

- Total input energy
- Direct energy
- Indirect energy

- Renewable energy
- Non-renewable energy
- Total output energy
- Energy output/input ratio

- Energy productivity (kg/MJ)
- Specific energy (MJ/kg)
- Net energy gain (MJ/ha)
- Yield (kg/ha)

\(^a\) where µ₁, µ₂ and µ₃ for region 1 were 0.581, 0.208 and 0.151, respectively.

\(^b\) where µ₁, µ₂ and µ₃ 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 consumption 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


