INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 1, No 2 ,2010

Research article ISSN 0976 – 4402

Energy elevation and economic analysis of canola production in Iran a case study: Mazandaran province

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ABSTRACT

Energy in agriculture is important in terms of crop production and agroprocessing for value adding. Canola is one of important rapeseed that it is tilled in dry farming systems in north of Iran. The aims of this study were to determine direct input energy and indirect energy in dry farming canola production, to investigate the efficiency of energy consumption and to make an economic analysis of canola farming in Behshahr County of Iran. Data were collected from 62 canola farms by using a face to face questionnaire method. The results revealed that canola production consumed a total of 28705.3 MJ/ha of which chemical fertilizer and diesel fuel energy consumption was 65.5% and 30%, respectively. Output Energy was 41230 MJ/ha. Output– input energy ratio and specific energy of production were 1.44 and 15.1 MJ/kg, respectively. Non-renewable energy was 99% total input energy that concluded that canola production needs to improve the efficiency of energy consumption in production and to employ renewable energy. Total cost ware was 641.1 USD and Benefit- cost ratio and net income ware 0.86 and 550 USD respectively.

Key words: Canola, Energy ratio, Energy productivity, Economic analysis, Iran.

1. Introduction

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, 1999). Agriculture is both a producer and consumer of energy. It uses large quantities of locally available non-commercial energy, such as seed, manure and animate energy, as well as commercial energies, directly and indirectly, in the form of diesel, electricity, fertilizer, plant protection, chemical, irrigation water, machinery etc. Efficient use of these energies helps to achieve increased production and productivity and contributes to the profitability and competitiveness of agriculture sustainability in rural living (Singh *et al*., 2002). 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). However, more intensive energy use has brought some important human health and environment problems so efficient use of inputs has become important in terms of sustainable agricultural production (Yilmaz *et al*., 2005). Recently, environmental problems resulting from energy production, conversion and utilization have caused increased public awareness in all sectors of the public, industry and government in both developed and developing countries It is predicted that fossil fuels will be the primary source of energy for the next several decades (Dincer, 2001; Demirbas, 2003). Efficient use of resources is one of the major assets of eco-efficient and

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sustainable production, in agriculture (De Jonge, 2004). Energy use is one of the key indicators for developing more sustainable agricultural practices (Streimikiene *et al*., 2007) and efficient use of energy is one of the principal requirements of sustainable agriculture (Kizilaslan, 2009). It is important, therefore, to analyze cropping systems in energy terms and to evaluate alternative solutions, especially for arable crops, which account for more than half of the primary sector energy consumption (Sartori *et al*., 2005).

Original varieties of rapeseed had high levels of erucic acid and glucosinolates, making them unsuitable for human consumption. Breeding experiments led to the development of rapeseed varieties that contained lower amounts of these undesirable compounds. The improved varieties, called canola, became commercially important in the 1960s. (Edwards, 2005). canola was bred (using conventional breeding techniques) to have by definition less than 2 percent erucic acid in the oil and less than 30 micromoles per gram of glucosinolates in the oil-free meal and Canola oil is recognized as a high quality and healthy edible oil, or as a potential source for manufacturing a wide variety of environmentally-friendly products such as biodiesel and bioplastics; the residual canola meal after oil extraction usually contains 35–40% protein content and is mostly utilized as an animal feed or a fertilizer. It has previously been reported that rapeseed proteins contain excellent contents of essential amino acids (Ohlson and Anjou, 1979; Wu *et al*., 2008). These differences allow canola oil to be used for human consumption and the meal for a livestock feed protein supplement.
The aims of this study were to determine direct input energy and indirect energy in Canola production, to investigate the efficiency of energy consumption and to make an economic analysis of canola in Behshahr County of Iran.

2. Materials and method

Data were collected from 63 canola farms in the Mazanderan province of Iran by using a face to face questionnaire in September- December 2009. The simple random sampling method was used to determine survey volume (Kizilaslan, 2009).

$$N = \frac{N * s^2 * t^2}{(N-1)d^2 + s^2 * t^2} \quad (1)$$

In the formula, the below signs and letters represent: n is the required sample size, s is the standard deviation, t is the t value at 95% confidence limit (1.96), N is the number of holding in target population and d is the acceptable error (permissible error 5%).

Behshahr County is located in the north of Iran, within 36° 41' north latitude and 55° 32' east longitude. It is a semi wet region in west of Mazandaran province and its average of annual rainfall is 580 mm, (Anon, 2009). In this regain canola tilt in dray farming method. In order to calculate input–output ratios and other energy indicators, the data were converted into output and input energy levels using equivalent energy values for each commodity and input. Energy equivalents shown in Table 1 were used for estimation.

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

Item	Unit	Energy equivalent (MJ/unit)	Reference
input			
Labour	h	1.96	(Yaldiz *et al*., 1993; Yilmaz *et al*., 2005)
Diesel fuel	L	47.8	(Kitani, 1999)
Machinery			
Tractor	kg	138	(Kitani, 1999)
Plow	kg	180	(Kitani, 1999)
Sprayer	kg	129	(Kitani, 1999)
Equipment of fertilizing	kg	129	(Kitani, 1999)
Trails	kg	138	(Kitani, 1999)
Thresher	kg	148	(Kitani, 1999)
Chemical fertilizer			
Phosphorus (P_2O_5)	kg	17.4	(Kitani, 1999)
Nitrogen fertilizer (N)	kg	74.2	(Lockeretz, 1980)
pesticide	kg	295	(Kitani, 1999)
seed	kg	21.7	(Kitani, 1999)
Output			
canola	kg	21.7	(Shaw *et al*., 1990)

Firstly, the amounts of inputs used in the production of canola were specified in order to calculate the energy equivalences in the study. Energy input includes Human labor, machinery, diesel fuel, chemical fertilizer, pesticides and seed amounts and output yield include grain of Canola. Basic information on energy inputs and Canola yields were entered into SPSS 15 spreadsheets. Based on the energy equivalents of the inputs and output (Table 1), output–input energy ratio, energy productivity, specific and energy net energy gain were calculated (Singh, 2002; Mohammadi *et al*., 2008; Sartori *et al*., 2005; Demircan *et al*., 2006).

$$\text{Output- input ratio} = \frac{\text{Output energy (MJ/ha)}}{\text{Input energy (MJ/ha)}} \quad (2)$$

$$\text{Energy productivity} = \frac{\text{Canola output (kg/ha)}}{\text{Input energy (MJ/ha)}} \quad (3)$$

$$\text{Net energy gain} = \text{Energy output (MJ/ha)} - \text{Energy Input (MJ/ha)} \quad (4)$$

$$\text{Specific energy} = \frac{\text{Input energy (MJ/ha)}}{\text{canola output (kg/ha)}} \quad (5)$$

The input energy is also classified into direct and indirect and renewable and non-renewable forms Energy equivalents for different inputs and outputs in agricultural production (Mandal *et al*., 2002; Hatirli *et al*., 2006). Indirect energy consists of seeds, fertilizers, pesticide and machinery energy while direct energy covered human labor and diesel fuel used in the canola production. Non-renewable energy includes diesel, pesticide, fertilizers and machinery, and renewable energy consists of human

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labor and seeds. In the last part of the research, economic analysis of canola production was investigated. Net income and benefit–cost ratio as economic indicators was calculated based on the existing price of the inputs and outputs. The net income was calculated by subtracting the total cost of production from the gross income of production per hectare. The benefit–cost ratio was calculated by dividing the net income of production by the total cost of production per hectare.

3. Results and discussion

3.1. Socio-economic structure of canola farms

In Behshahr county cultivation of canola is in form of dry farming. The average of land size of canola in area is 1.77 hectares but the average of each plot size of cultivation is about o.64 hectares for reason of not being integration of farms. Tractor and equipment in canola production in region are about 78%, 12.5% and 9.5% in form of rental, private and partnership, respectively. About 95% of canola farms are private and the rest are rental. Canola production in region is mechanized and highly dependent on commercial input. A Massey Ferguson 285 tractor, 75 hp, was used in operations of tillage, transporting and fertilizing and spraying. Agricultural experience of farmers was 16.6 years while experience of canola production was 5.1 years. About 82.5% of farmers just did farming and the rest; in addition to doing farming did animal husbandry too.

3.2. Analysis of input–output energy use in canola production

The input and output energy values used in canola production are illustrated in Table 2. Total input energy in production was 28705.3 MJ/ha. Of all the inputs, the fertilizer (mostly N fertilizer) has the biggest share in the total energy with a 65.5% (18809.8 MJ/ha) that show, canola production severely dependent on fertilizer. Fertilizer energy is followed by diesel fuel energy which was 30% (8604.2 MJ/ha). Diesel fuel was mainly used for operating tractor and combine harvester. Because of mechanized operation in canola production, use of human labor was low that was 0.25% of total input energy but it was very important input in increasing production productivity. Energy of machinery and seed was 3.2% and 0.5% of total input energy, respectively. Average output energy of canola was found 41230 MJ/ha. Direct energy was 30.2% while indirect energy was 69.8% of total input energy.

Table 2: Inputs and outputs for canola production

Item	Energy	
	MJ/ha	%
Input		
Direct energy		30.22
Labour	70.84	0.25
Diesel fuel	8604.17	29.97
Indirect energy		69.78
Machinery	930.55	3.24
Fertilizer	18809.84	65.53
Nitrogen (N)	17572.5	61.22
Phosphorus (P_2O_5)	1237.34	4.31
Pesticide	134.54	0.47
Seed	155.37	0.54

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Total input	28705.31	100
Output		
Total output	41230	100

The percentage of renewable and nonrenewable energy and output- input energy ratio, net energy and energy productivity of canola production in the Behshahr County are illustrated in Table 3. The output– input energy ratio and energy productivity were calculated as 1.44 and 0.066 kg/MJ, respectively. Net energy gain and specific energy were 12524.69 MJ/ha and 15.1 MJ/kg, respectively.

Table 3: Energetic parameters in canola production

Renewable energy (%)	Nonrenewable energy (%)	Output-input energy ratio	Energy productivity (kg/MJ)	Specific energy (MJ/kg)	Net energy gain (MJ/ha)
0.79	99.21	1.44	0.066	15.1	12524.69

As it can be seen from Table 3, 99.2% of total energy input resulted from non-renewable and 0.8% from renewable energy. The results indicate that the current energy use pattern among the investigated farms is based on non-renewable energy in the canola production. Therefore this method of production caused environment problem.

3.3. Analysis of finance performance in canola production

The total cost of production, gross income, net income and benefit–cost ratio (B:C ratio) were calculated and is given in Table 4. Opportunity cost of land with 402.4 USD per hectare was the most cost in canola production and followed by machinery cost with 115.7 USD/ha. The total cost for the production was 641.1 USD/ha while the gross income was found to be 11191.3 USD/ha. The net income and benefit–cost ratio calculated 550.2 USD/ha and 0.86. Because the governments of Iran give subside to chemical fertilizer and pesticide, the cost of them was low.

Table 4: Economic analysis of canola production

Cost and return components	Value
Labour cost (USD/ha)	40.4
Opportunity cost of land (USD/ha)	402.4
Machinery cost (USD/ha)	115.7
Seed cost (USD/ha)	25.3
Pesticide cost (USD/ha)	25.6
Fertilizer cost (USD/ha)	32.7
Total cost (USD/ha)	641.1
gross income (USD/ha)	1191.3
Net income (USD/ha)	550.2
Benefit-Cost ratio	0.86

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4. Conclusion

In this study, energy consumption for input and output energies in canola production was investigated in Behshahr county of Iran. Data were collected from 63 farms which were selected based on random sampling method. Total energy consumption in canola production was 28705.3 MJ/ha. Chemical fertilizer and diesel fuel were the major energy inputs with 65.5% and 30% total input energy, respectively in production. Input-output energy ratio and energy productivity were calculated, 1.44 and 0/066 kg/MJ, respectively. Non-renewable energy was 99% total input energy that concluded that canola production needs to improve the efficiency of energy consumption in production and to employ renewable energy. Total cost ware was 641.1 USD that opportunity cost of land was 402.4 followed by machinery costs. Benefit- cost ratio and net income ware 0.86 and 550 USD respectively.

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