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EVALUATION ENERGY BALANCE OF CANOLA PRODUCTION UNDER RAIN FED FARMING IN NORTH OF IRAN

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ABSTRACT

Energy in agriculture is important in terms of crop production and agro processing for value adding. Canola is one of important rapeseed that it is tilled in dry farming systems in north of Iran. This method in an agricultural product system is the energy consuming in product operations and energy saving in produced crops. In this article, evaluation of energy indices under rain fed farming canola in north of Iran (Guilan province) was investigated. Data were collected from 72 farms by using a face to face questionnaire method during 2011 year in Guilan province. By using of consumed data as inputs and total production as output, and their concern equivalent energy, and energy indices were calculated. The average seed yield of canola was found to be 780 kg/ha and its energy equivalent was calculated to be 1820 MJ/ha. Energy efficiency (energy output to input energy ratio) for seed was calculated to be 1.29, showing the affective use of energy in the agro ecosystems canola production. Nonrenewable energy was 94.48% total input energy that concluded that canola production needs to improve the efficiency of energy consumption in production and to employ renewable energy.

Keywords: canola production, energy indices, rain fed farming, yield, Iran.

INTRODUCTION

Canola is an important oil crop growing in many part of the world. Canola in Iran is mostly cultivated as a winter annual for oil production and rarely livestock feed. It can be planted in spring as well as can be grown in summer but the seed yield would be decreased due to short growing season and lack of enough water at the end of growing season, thus, winter cropping is preferred. The canola cultivars are slow growing especially in winter and most of them will complete their life cycle in 210 to 270 days (Sharghi *et al*., 2011).

In developing countries like Iran, agricultural growth is essential for fostering the economic development and meeting the ever higher demands of the growing population. Energy in agriculture is important in terms of crop production and agro processing for value adding. The relation between agriculture and energy is very close. At present productivity and profitability of agriculture depends on energy consumption (Karimi *et al*., 2008).

Energy use in agriculture was developed in response to increasing populations, limited supply of arable land and a desire for higher standards of living. More intensive energy use of fossil fuel, chemical fertilizers, pesticides, machinery and electricity brought some important human health and environmental problems. Thus, efficient use of energy inputs is of prompt importance in terms of sustainable farming.

An input-output energy analysis provides farm planners and policy makers an opportunity to evaluate economic intersection of energy use (Ozkan *et al*., 2004). Considerable research studies were conducted on energy use in agriculture, however, relatively little attention was paid to apple production.

Agriculture is closely linked with energy and can as a consumer and supplier of energy in the form of biomass energy are (Alam *et al*., 2005). The energy consumption in the agricultural sector depends to the population employed in the agriculture, the amount of cultivable land and the level of mechanization (Ozkan *et al*., 2004). In future agriculture not only growing demand for food supply does not meet demand, but fuel and livestock feed will (Alam *et al*., 2005). Thus saving, efficient use and development or renewable energy sources available to create sustainable development and food security for future generations are very important (Singh, 2002).

The main aim of this study was to determine energy use in canola production, to investigate the efficiency of energy consumption and to make energy indices analysis of canola under watered rain fed farming in Guilan province of Iran.

MATERIALS AND METHODS

Data was collected from seventy two (72) farms by using a face to face questionnaire method during 2011 year in Guilan province (north of Iran). The random sampling of production agro ecosystems was done within whole population and the size of each sample was determined by using bottom Equation (Kizilaslan, 2009):

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

In the formula, 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.

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 was used for estimation (Sheikh Davoodi and Houshyar, 2009; Taheri Garavand *et al*., 2010; Moradi and azarpour, 2011). 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 include human labor, machinery, diesel fuel, chemical fertilizers, poison fertilizers and seed and output yield include grain yield of canola. The energy use efficiency, energy specific, energy productivity and net energy gain were calculated according to bottom equations (Sheikh Davoodi and Houshyar, 2009; Taheri Garavand *et al*., 2010; Moradi and azarpour, 2011).

$$\text{Energy ratio} = \frac{\text{Output energy (Mj/ha)}}{\text{Input energy (Mj/ha)}}$$

$$\text{Energy production} = \frac{\text{Grain yield (Kg/ha)}}{\text{Input energy (Mj/ha)}}$$

$$\text{Energy intensity} = \frac{\text{Input energy (Mj/ha)}}{\text{Grain yield (Kg/ha)}}$$

$$\text{Net energy gain} = \text{Output energy (Mj/ha)} - \text{Input energy (Mj/ha)}$$

The input energy was divided into direct, indirect, renewable and non-renewable energies (Kizilaslan, 2009; Ozkan *et al*., 2004). Direct energy covered human labor, water and diesel fuel, used in the canola production while indirect energy consists of seed, chemical fertilizers, poison fertilizers, and machinery energy. Renewable energy consists of human labor, water and seed and nonrenewable energy includes chemical fertilizers, poison fertilizers and machinery energy.

RESULTS AND DISCUSSIONS

Analysis of input-output energy use in canola production

The inputs used in canola production and their energy equivalents and output energy equivalent are illustrated in Table-1. About 7 kg seed, 324 h human labor, 1 L poison chemical, 12 h machinery power and 110 L diesel fuel for total operations were used in agro ecosystems canola production on a hectare basis. The use of nitrogen fertilizer, phosphorus and potassium were 92, 17 and 5 kg per one hectare respectively. The total energy equivalent of inputs was calculated as 14528 MJ/ha.

The highest shares of this amount were reported for nitrogen fertilizer (44.01%) and diesel fuel (42.63%) respectively. The energy inputs of potassium chemicals (0.38%), poison (0.83%), seed (1.16%), Phosphorus chemicals (1.44%), human labor (4.37%) and machinery (5.18%) were found to be quite low compared to the other inputs used in production (Figure-1).

The average seed yield of canola was found to be 780 kg/ha and its energy equivalent was calculated to be 1820 MJ/ha (Table-1).

Evaluation indicators of energy in canola production

The energy use efficiency, energy production, energy specific, energy productivity, net energy gain, and intensiveness of canola seed production were shown in Table-2. Energy efficiency (energy output-input ratio) in this study was calculated 1.29, showing the affective use of energy in the agro ecosystems canola production. Energy specific was 18.63 MJ/kg this means that 18.63 MJ is needed to obtain 1 kg of canola seed. Energy productivity calculated as 0.05 Kg/MJ in the study area. This means that 0.05 kg of output obtained per unit energy. Net energy gain was 4192 MJ/ha.

This means that the amount of output energy is more than input energy and production in this situation is logical. Direct, indirect, renewable and non-renewable energy forms used in canola production are also investigated in Table-2. The results show that the share of direct input energy was 47.01% (6829 MJ/ha) in the total energy input compared to 52.99% (7699 MJ/ha) for the indirect energy. On the other hand, nonrenewable and renewable energy contributed to 94.47% (13725 MJ/ha) and 5.33% (803 MJ/ha) of the total energy input, respectively.

Taheri Garavand *et al*. (2010) show that 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. 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. 99.2% of total energy input resulted from nonrenewable and 0.8% from renewable energy. The results indicate that the current energy use pattern among the investigated farms is based on nonrenewable energy in the canola production. Therefore this method of production caused environment problem.

CONCLUSIONS

Finally Energy use is one of the key indicators for developing more sustainable agricultural practices one of the principal requirements of sustainable agriculture. Therefore energy management in systems canola production should be considered an important field in terms of efficient, sustainable and economical use of energy. Using of combination machines, doing timely required repairs and services for tractors and representing a fit crop rotation are suggested to decrease energy consuming for dry farming canola in Guilan province.

Table-1. Amounts of inputs and output and their equivalent energy from calculated indicators of energy.

Parameter	Unit	Quantity per hectare	Energy equivalents	Total energy equivalents
Inputs				
Human labor	h/ha	324	1.96	635.04
Machinery	h/ha	12	62.7	752.40
Diesel fuel	L/ha	110	56.31	6194.10
Nitrogen	Kg/ha	92	69.5	6394
Phosphorus	Kg/ha	17	12.44	208.99
Potassium	Kg/ha	5	11.15	55.75
Poison	L/ha	1	120	120
Seed	Kg/ha	7	24	168
Output				
Straw yield	kg/ha	780	24	18720

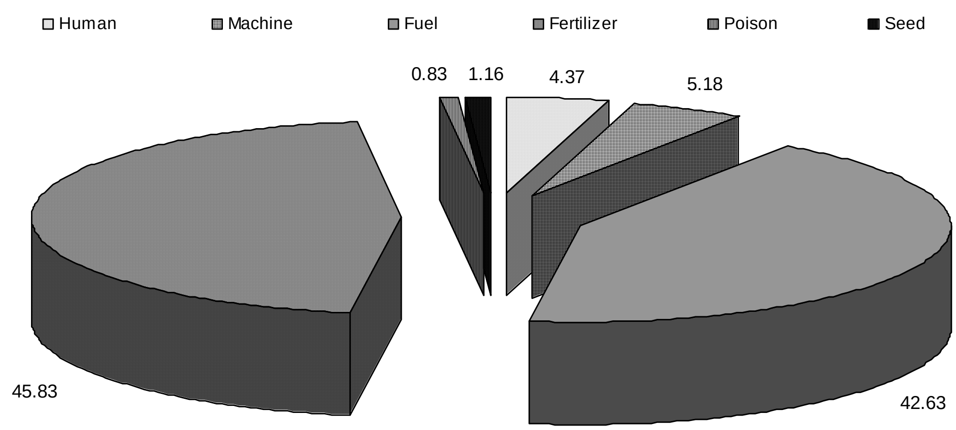

Figure-1. The share (%) production inputs in canola.

Table-2. Analysis of energy indices in canola production.

Item	Unit	Canola
Yield	Kg/ha	780
Input energy	Mj/ha	14528
Output energy	Mj/ha	18720
Energy use efficiency	-	1.29
Energy specific	Mj/Kg	18.63
Energy productivity	Kg/Mj	0.05
Net energy gain	Mj/ha	4192
Direct energy	Mj/ha	6829 (47.01%)
Indirect energy	Mj/ha	7699 (52.99%)
Renewable energy	Kg/Mj	803 (5.53%)
Nonrenewable energy	Mj/ha	13725 (94.47%)

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