Journal of Agricultural Technology 2011 Vol. 7(3): 547-555
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Energy and economic analysis of dry farming chickpea in Iran a case study: Lorestan province

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Asakereh, A., Safaienejad, M. and Sami, M. (2011). Energy and economic analysis of dry farming chickpea in Iran a case study: Lorestan province. Journal of Agricultural Technology 7(3): 547-555.

Energy in agriculture is important in terms of crop production and agroprocessing for value adding. Chickpea is one of important legumes that it is mainly tilled in dry farming systems in Iran. The aims of this study were to analyze the energy consumption and economic performance of dry farming chickpea production in Lorestan province of Iran. Data were collected from 83 chickpea farms by using a face to face questionnaire method. The results revealed that chickpea production consumed a total of 5981.3 MJ/ha of which diesel fuel and seed energy consumption was 64.68% and 12.24%, respectively. Output Energy of grain and straw were 7198 and 6855 MJ/ha. Output– input energy ratio and energy productivity of total production were 2.36 and 0.17 kg/MJ, respectively. Total cost was 411.9 $/ha that Labor cost and opportunity cost of land was the most cost. Benefit- cost ratio and net income ware -0.09 and -37.6 $/ha, respectively. Because most labors are domestic and opportunity cost of them isn't calculated by farmers, Chickpea production is continuing. Use of breeder's seed and mechanize the agronomic measures of this crop can decrease the need of labor and increase productivity and income of farmers.

Key words: Energy, economic analysis, chickpea, Iran

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

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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 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).

Chickpea (Cicer arietinum) is an annual grain legume crop grown mainly for human consumption. It plays an important role in human nutrition as a source of protein, energy, fiber, vitamins and minerals for large population sectors in the developing world and is considered a healthy food in many developed countries (Abbo *et al*., 2003; Anbessa *et al*., 2007). Chickpea (Cicer arietinum L.), a cool season grain legume crop, is cultivated across the world including the Mediterranean basin, the near east, central and south Asia, east Africa, South America, North America and Australia. Major producing countries include India, Pakistan and Iran (Soltani *et al*., 2006). The average of area of chickpea production in Iran is 212.2 thousand hectare that produce 105.4 k ton (Anon, 2009).

The aims of this study were to determine direct input energy and indirect energy in dry farming chickpea production, to investigate the efficiency of energy consumption and to make an economic analysis of dry farming chickpea in Lorestan province of Iran.

Materials and methods

Data were collected from 83 chickpea farms in the Lorestan province of Iran by using a face to face questionnaire in February- March 2009. The simple random sampling method was used to determine survey volume (Kizilaslan, 2009).

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

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%).

Lorestan province is located in the west of Iran, within 46° 51' and 50° 3' east longitude and 32° 37' and 34° 22' north latitude. This province is a semiarid region in west of Iran and the total area of it is 28300 square km, and the farming area is about 8000 square km. (Anon, 2010). 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. Firstly, the amounts of inputs used in the production of chickpea 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 and straw of chickpea. Basic information on energy inputs and chickpea yields were entered into SPSS 15 spreadsheets. Based on the energy equivalents of the inputs and output (Table 1), output- input energy ratio and energy productivity were calculated (Hatirli *et al*., 2005; Hatirli *et al*., 2006; Mohammadi *et al*., 2008).

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

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

$$\text{Specific energy} = \frac{\text{Input energy (MJ/ha)}}{\text{Chickpea production (kg/ha)}} \quad (4)$$

Net energy gain= total output energy – total input energy (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). Indirect energy consists of seeds, fertilizers, pesticide and machinery energy while direct energy covered human labor and diesel fuel used in the dry farming chickpea production. Non-renewable energy includes diesel, pesticide, fertilizers and machinery, and renewable energy consists of human labor and seeds. In the last part of the research, economic analysis of dry farming chickpea 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.

Table 1. Energy equivalent of inputs and outputs in chickpea production.

Item	unit	Energy equivalent (MJ/unit)	References
Input			
Labour	MJ/h	1.96	(Yaldiz *et al*., 1993, Yilmaz *et al*., 2005)
Diesel fuel	MJ/L	56.31	(Singh *et al*., 2002)
Machinery			
Tractor	MJ/kg	138	(Kitani, 1999)
Plow	MJ/kg	180	(Kitani, 1999)
Sprayer	MJ/kg	129	(Kitani, 1999)
Equipment of fertilizing	MJ/kg	129	(Kitani, 1999)
Trails	MJ/kg	138	(Kitani, 1999)
Thresher	MJ/kg	148	(Kitani, 1999)
Chemical fertilizer			
Phosphorus (P2O5)	MJ/kg	17.4	(Kitani, 1999)
Pesticide	MJ/kg	295	(Kitani, 1999)
Seed	MJ/kg	14.7	(Kitani, 1999)
Output			
Grain of chickpea	MJ/kg	14.7	(Singh and Mital, 1992)
Straw of chickpea	MJ/kg	12.5	(Singh and Mital, 1992)

Results and discussion

Socio-economic structure of dry chickpea farms

The average of land size of chickpea in area is 3.42 hectare but the average of each plot size of under cultivation is about 1.4 hectare for reason of not being integration of farms. Tractor and equipment in chickpea production in province are about 81%, 15% and 4% in form of rental, private and partnership and cooperative services, respectively. About 82% of chickpea farms are private and the rest are in form of rental and sharing. Chickpea production in region is low mechanized and dependent on the labor power that most labor is domestic. A Massey Ferguson 285 tractor, 75 hp, was used in operations of tillage, transporting and threshing and in some farms used in fertilizer application and spraying.

Analysis of input–output energy use in chickpea production

The input and output energy values used in chickpea production are illustrated in Table 2. Total input energy in operations was 5981.34 MJ/ha. Of all the inputs, the diesel fuel has the biggest share in the total energy with a 64.68% (3868.5 MJ/ha). The diesel fuel energy was mainly used for operation that is done by tractor. Diesel energy is followed by the seed and Phosphorus fertilizer energy which wear 12.24% and 7.45%, respectively. Because of non-mechanized mostly operation such planting, Thinning and harvesting, share of labor energy in chickpea production was bigger than other crop production in Iran by 6.14%. Tractor and plow with 3.55% and 1.99% respectively were the most energy use of whole machinery that mainly used for plowing. Average yield of grain and straw of chickpea were found 489.7 and 548.4 kg, respectively. Total output energy was 14053 MJ/ha, where 51.22% and 48.78% of it included grain and straw, respectively. Direct energy was 4235.8 MJ/ha with 70.8% of total input energy while indirect energy was 1745.54 with 29.2%.

The percentage of renewable and nonrenewable energy and output- input energy ratio, energy productivity, net energy and specific energy of chickpea production in the Lorestan province are illustrated in Table 3. The total output–input energy ratio was calculated as 2.36 that output- input energy ratio for grain and straw were 1.2 and 1.16 respectively. The results indicate that total energy productivity was 0.17 kg/ha that means, 0.17 output was obtained per unit energy and net energy gain was 8071.7 MJ/ha. Specific energy of grain and straw was 12.22 and 10.91 MJ/kg, respectively. In Ardabil province of Iran, Shahin *et al* (2008) reported irrigated wheat output/input ratio as 1.97. Mohamadi *et al* (2008) calculated potato output/input energy ratio 1.25 in Ardabil province while Haj Seyed Hadi (2006) calculated potato output/input energy ratio 0.98 in Khorasan, Hamadan and Ardabil provinces. Canakci *et al* (2005) reported specific energy for field crops and vegetable production in Turkey, such as 5.24 for wheat, 11.24 for cotton, 3.88 for maize, 16.21 for Sesame, 1.14 for tomato, 0.98 for melon and 0.97 for water-melon. As it can be seen from Table 3, 81.1% of total energy input resulted from non-renewable and 18.9% from renewable energy. The results indicate that the current energy use pattern among the investigated farms is based on non-renewable energy in the chickpea production.

Table 2. Inputs and outputs for chickpea production.

Item	Quantity/hectare	Energy	
		MJ/ha	%
Input			
Direct energy		4235.8	70.82
Labor	187.4 h	367.3	6.14
Diesel fuel	68.7 L	3868.5	64.68
Indirect energy		1745.54	29.18
Machinery		408.45	6.83
Tractor	1.54 kg	212.52	3.55
Plow	0.66 kg	118.8	1.99
Equipment of fertilizing	0.06 kg	7.74	0.13
Sprayer	0.07 kg	9.03	0.15
Trails	0.18 kg	24.84	0.42
Thresher	0.24 kg	35.52	0.59
Phosphorus (P_2O_5)	25.6 kg	445.44	7.45
Pesticide	0.54 kg	159.3	2.66
Seed	49.82 kg	732.35	12.24
Total input		5981.34	100
Output			
Chickpea grain	489.66	7198	51.22
Chickpea straw	548.4	6855	48.78
Total output		14053	100

Table 3. Energetic parameters in chickpea production.

Item	Grain	Straw	Total
Renewable energy (%)	-	-	18.9
Nonrenewable energy (%)	-	-	81.1
Output- input energy ratio	1.2	1.16	2.36
Energy productivity (kg/ha)	0.082	0.092	0.17
Net energy (MJ/ha)	1216.66	873.66	8071.66
Specific energy (MJ/kg)	12.22	10.91	5.76

Analysis of finance performance in chickpea 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. The total cost for the production was 411.9 $/ha while the gross income was found to be 374.3 $/ha. Labor cost and opportunity of land with 233.4 $/ha and 98.6 $/ha were the biggest cost of production, respectively. The net income and benefit–cost ratio calculated -37.6 $/ha and -0.09 that indicated, chickpea production isn't efficient in view point of economic. High manual operations and high cost of labor and low production of this crop have caused to this affair. Because most of labor is domestic and farmers don't consider it as cost, they continue to production of chickpea. Because fertilizer cost was negligible, it wasn't calculated (the government of Iran give the chemical fertilizer subside).

Table 4. Economic analysis of chickpea production.

Cost and return components	Value
Labor cost ($/ha)	233.4
Opportunity cost of land ($/ha)	98.6
Machinery cost ($/ha)	45.8
Seed cost ($/ha)	28.5
Pesticide cost ($/ha)	5.6
Total cost ($/ha)	411.9
Gross income of chickpea grain ($/ha)	308.8
Gross income of chickpea straw ($/ha)	65.5
Total gross income ($/ha)	374.3
Net income ($/ha)	-37.6
Benefit-Cost ratio	-0.09

In this study, energy consumption for input and output energies in chickpea production was investigated in Lorestan province of Iran. Data were collected from 83 farms which were selected based on random sampling method. Total energy consumption in chickpea production was 5981.34 MJ/ha. Diesel fuel, seed and Phosphorus fertilizer are the major energy inputs with 64.68%, 12.24% and 7.45% total input energy respectively in production. Input-output energy ratio and energy productivity were calculated, 2.36 and 0.17 kg/MJ, respectively. Total cost ware was 411.9 $/ha that Labor cost and opportunity cost of land were the biggest cost of production. Benefit- cost ratio and net income ware -0.09 and -37.6 $/ha, respectively. Because most labors are domestic and opportunity cost of them isn't calculated by farmers, Chickpea production is continuing. Use of breeder's seed and mechanize the agronomic measures of this crop can decrease the need labor and increase productivity and income of farmers.

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(Received 14 October 2010; accepted 25 March 2011)