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Research Article

LENTIL (*LENS CULINARIS MEDIK*) PRODUCTION SYSTEM IN TERM OF ENERGY USE EFFICIENCY AND ECONOMICAL ANALYSIS IN NORTH OF IRAN

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ABSTRACT
Energy and economic analysis of agro ecosystems seems to be a promising approach to assess environmental problems and their relations to sustainability. The objectives of this study were to perform energy indices, energy balance indices, economical indices and life cycle assessment emission for lentil production in north of Iran. Data were collected from 72 farms by used 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, energy balance and energy indices were calculated. Energy efficiency for rain fed farming lentil production in this study was calculated 0.47, showing the affective use of energy in the agro ecosystems lentil production. Energy balance efficiency for rain fed farming lentil production in this study was calculated 0.32, showing the affective use of energy in the agro ecosystems lentil production. Results showed the benefit to cost ratio in the studied farms was calculated to be 2.04. Also, Results showed that, total green house gases emissions for lentil production were calculated as1002.0 $kgCO_{2eq}ha^{-1}$.

Keywords: *Lentil, Economic Indices, Green House Gases, Energy Balance Indices, Energy Indices*

INTRODUCTION
Lentil (Lens culinaris medik) is one of the most important pulse crops in semiarid regions of Iran, India, Turky and Canadian. The mean of protein of seed is 26%, thereby very important for nutrition human and animal. Production under dry land farming systems in Iran is limited by moisture deficiency and lake of plant available nutrients in the soil. plant nutrient have significant effects on Yield and yield components, also suitable cultivars and correct consumption of fertilizers lead to optimum uses of soil and environmental factors that produce high yield and yield components (Dashadi *et al.,* 2013; Karadavut and Palta, 2010; Sarker *et al.,* 2003).
The energy concept is perceived differently among scientists, engineers, economists, environmentalists, natural securities analysts, farmers and consumers. Various segments within agriculture view the energy situation differently, depending on whether they are net consumers or net producers of energy (Schneeberger and Breimyer, 1974). Energy input-output relationships in cropping systems vary with crops being grown in sequence, by type of soils, nature of tillage operations for seedbed preparation, nature and amount of organic manure, chemical fertilizer, plant protection measures, harvesting and threshing operations and, finally, yield levels (Mandal *et al.,* 2002). Energy consumption in agriculture has increased year by year while more intensive energy use has led to some important human health and environmental problems. It is necessary to reduce fossil energy inputs in agricultural systems. It would help to reduce agricultural carbon dioxide emissions. Thus, efficient use of energy inputs has become important in terms of sustainable farming (Karimi *et al.,* 2008; Rathke and Diepenbrock, 2006), and is one of the principal requirements of sustainable agriculture. Energy use in agriculture section has been growing in reaction to population rise, limited supply of arable land, and a demand for higher standards of living (Ghasemi *et al.,* 2010). The agricultural sector, like other sectors, has become increasingly dependent upon energy resources such as electricity, fuels, natural gas and coke. This increase in energy use and its associated increase in capital intensive technology can be partially attributed to low energy

prices in relation to the resource for which it was being substituted (Gowdy *et al.*, 1978). During agricultural activities, carbon is released through land use changes and agricultural production, the burning of fossil fuels, the production of synthetic fertilizers and pesticides, microbial decay or the burning of plant litter and soil organic matter (Hillier *et al.*, 2011). The development of energy efficient agricultural systems with a low input of energy compared to the output of products should therefore help to reduce the emissions of greenhouse gasses in agricultural production (Dalgaard *et al.*, 2001).
The objectives of this study were to perform energy indices, energy balance indices, economical indices and life cycle assessment emission for lentil production in north of Iran.

MATERIALS AND METHODS

Materials

Guilan Province is one of the northern provinces of Iran with an area of 14711 square meters. This province is located at 36’ and 34” to 38’ and 27” northern latitude and 48’ and 53” to 50’ and 34” eastern longitude from the Greenwich meridian. In order to determine the energy indices, energy balance indices, economical indices in this research, Data on lentil production was collected from the farmers by using a face to face questionnaire performed in during 2011 production year. The number of operations involved in the lentil production and their energy requirements influence the final energy balance. A random sampling method was used, and the sample size was calculated using Equation (Unakitan *et al.*, 2010).

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

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 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.

Method to calculate the energy

The amount of inputs used in lentil production (Human labor, machinery, diesel fuel, chemical fertilizers, chemical poison and electricity power) were calculated per hectare and then, these data were converted to forms of energy to evaluate the output-input analysis. The sources of mechanical energy used on the selected farms included tractors and diesel fuel. The mechanical energy was computed on the basis of total fuel consumption (L/ha) in different farm operations. Therefore, the energy consumed was calculated, using conversion factors and expressed in MJ/ha. In order to calculate output and input energy, these input data and amount of output yield were multiplied with the coefficient of energy equivalent. Energy equivalents of inputs and output were converted into energy on area unit. The previous researches (Table 1) were used to determine the energy equivalents’ coefficients (Azarpour and Moraditochaee, 2013; Hatirli *et al.*, 2005; Jianbo, 2006; Ozkan *et al.*, 2004).
In this research, energy indices (energy use efficiency, energy specific, energy productivity and net energy gain) were calculated according to bottom equations (Azarpour and Moraditochaee, 2013; Hatirli *et al.*, 2005; Koocheki *et al.*, 2011; Ozkan te al., 2004).

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

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

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

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

For the growth and development, energy demand in agriculture can be classified into Direct Energy (DE), Indirect Energy (IDE), renewable energy (RE) and non-renewable energy (NRE) (Ozkan *et al.*, 2004; Koocheki *et al.*, 2011). The IDE includes energy embodied in seeds, fertilizers, farmyard manure (FYM), chemicals, machinery while the DE covers human labor, electricity, water and diesel fuel used in the lentil production. The NRE includes diesel, electricity, chemicals, fertilizers and machinery, and the RE consists of human labor, seeds, water and FYM.
In order to calculate energy balance indices, these input data and amount of output yield were multiplied with the coefficient of energy balance equivalent. Energy balance equivalents of inputs and output were converted into energy on area unit. The previous researches (Table 2) were used to determine the energy balance equivalents' coefficients (Azarpour and Moraditochaee, 2013; Azarpour, 2014; Azarpour and Farajpour, 2013). Energy balance input include human labor, machinery, diesel fuel, chemical fertilizers, poison fertilizers, machinery depreciation for per diesel fuel, electricity power and seeds and output include yield of lentil.

Method to calculate the economic

The economic inputs of lentil production contained variable costs. In the last part of the research, the economic analysis of lentil production was investigated. Net profit, gross profit, productivity and benefit to cost ratio were calculated using the following equations (Azarpour, 2014; Azarpour and Farajpour, 2013; Banaeian *et al.*, 2011; Koocheki *et al.*, 2011).

$$\text{Gross value of production (\$ ha}^{-1}) = \text{Yield (kg ha}^{-1}) \times \text{Sale price (\$ kg}^{-1})$$

$$\text{Net return (\$ ha}^{-1}) = \text{Gross value of production (\$ ha}^{-1}) - \text{Total cost of production (\$ ha}^{-1})$$

$$\text{Productivity (kg/\$)} = \frac{\text{Yield (kg/ha)}}{\text{Total cost of production (\$ ha)}}$$

$$\text{Benefit to cost ratio} = \frac{\text{Gross value of production (\$ ha}^{-1})}{\text{Total cost of production (\$ ha}^{-1})}$$

Method to calculate the green house gases

The amounts of GHG emissions from inputs in lentil production per hectare were calculated by using CO2 emissions coefficient of agricultural inputs (Table 3). The amount of produced CO2 was calculated by multiplying the input application rate (machinery, diesel fuel, chemical fertilizers, chemical poison and electricity power) by its corresponding emission coefficient that is given in Table 3 (Azarpour, 2014; Ghahderijani *et al.*, 2013; Khoshnevisan *et al.*, 2013; Nabavi-Pelesaraei *et al.*, 2013).

RESULT AND DISCUSSION

Analysis of input–output energy use in lentil production

Table 1 showed inputs used in lentil production and their energy equivalents and output energy equivalent were illustrated. Results show that, about 406 h human labor, 500 Kwh electricity power, 13 h machinery, 111 L diesel fuel, 43 kg/ha nitrogen fertilizer, 12 kg/ha phosphorus fertilizer, 10 kg/ha potassium fertilizer and 1 L chemical poison were used in agro ecosystems lentil production on a hectare basis. The total energy equivalent of inputs was calculated as 18784 MJ/ha. Figure 1 showed the energy use pattern in the surveyed farms. The highest shares of this amount were reported for diesel fuel (33.28%), electricity power (31.76%) and chemical fertilizer (15.77%). The energy inputs of seed (9.98%), machinery (4.34%), human labor (4.24%) and chemical poison (0.64%) were found to be quite low compared to the other inputs used in lentil production. The average yield of lentil was found to be 590 kg/ha and its energy equivalent was calculated to be 8673 MJ/ha (Table 1).

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Evaluation of energy indices in lentil production

Energy indices (energy use efficiency, energy production, energy specific, energy productivity and net energy gain) of lentil production were showed in table 4. Energy use efficiency (energy output-input ratio) in this study was calculated 0.47; showing the affective use of energy in the agro ecosystems lentil production. Energy specific was 31.84 MJ/kg this means that 31.84 MJ needed to obtain 1 kg of lentil. Energy productivity calculated as 0.31 Kg/MJ in the study area, this means that 0.31 kg of output obtained per unit energy. Net energy gain was -10111 MJ/ha.

Koocheki *et al.,* (2011) analyzed energy indices of pulses (lentil) production in Khorasan Razavi province (Iran), and found that total energy input and output in these production systems were 14114.79 and 25282.52 MJ/ha (grain and straw), respectively. The highest share of input energy was recorded for diesel fuel (24.36%). In research energy use efficiency, Specific energy, energy productivity and Net energy of lentil production agro ecosystems were 1.79, 20.26MJ/kg, 0.049 kg/MJ and 11167.73 MJ/ha respectively.

Direct-indirect energy forms used in lentil production were also investigated. Percentages of these energy forms were illustrated in Figure 2. The results show that the share of direct input energy was 69.27% (130111 MJ/ha) in total energy input compared to 30.73% (5773 MJ/ha) for indirect energy renewable-non-renewable energy forms used in lentil production were also investigated. Percentages of these energy forms were illustrated in Figure 3. The results show that the share of renewable input energy was 14.22% (2671 MJ/ha) in the total energy input compared to 85.78% (16113 MJ/ha) for the non-renewable energy.

Koocheki et al. (2011) showed that, direct energy, indirect energy, renewable energy and non-renewable energy in lentil production were 8822.49 MJ/ha (62.50 %), 5292.30 MJ/ha (37.50%), 4394.24 MJ/ha (31.13%) and 9720.55 MJ/ha (68.87%) respectively.

Analysis of energy balance in lentil production

Table 2 showed inputs used in lentil production and their balance energy equivalents and output balance energy equivalent were illustrated. Results show that, about 406 h human labor, 500 Kwh electricity power, 13 h machinery, 111 L diesel fuel, 43 kg/ha nitrogen fertilizer, 12 kg/ha phosphorus fertilizer, 10 kg/ha potassium fertilizer, 1 L chemical poison and 93.24 L depreciation for per diesel fuel were used in agro ecosystems lentil production on a hectare basis. The total energy balance equivalent of inputs was calculated as 5779688 MJ/ha. Figure 4 showed the energy balance use pattern in the surveyed farms. The highest shares of this amount were reported for electricity power (24.77%), machinery (20.24%), diesel fuel (17.74%), depreciation for per diesel fuel (15.46) and chemical fertilizer (13.95%). The energy inputs of human labor (3.51%), seed (3.85%) and chemical poison (0.47%) were found to be quite low compared to the other inputs used in lentil production.

Direct-indirect energy balance forms used in lentil production were also investigated. Percentages of these energy balance forms were illustrated in Figure 5. The results show that the share of direct input energy balance was 46.02% (2659807 MJ/ha) in the total energy balance input compared to 53.98% (3119881 MJ/ha) for the indirect energy balance. Renewable- non renewable energy forms used in lentil production were also investigated. Percentages of these energy balance forms were illustrated in Figure 6. The results show that the share of renewable input energy balance was 7.37% (425750 MJ/ha) in the total energy balance input compared to 92.63% (5353938 MJ/ha) for the non-renewable energy.

Evaluation of energy indices in lentil production

Energy indices balance in this research was showed in table 5. Consumption energy, production energy, energy per unit, production energy to consumption energy ratio and consumption energy to production energy ratio in lentil production were 5779688 kcal/ha, 182650 kcal/ha, 3095 kcal, 0.32, 72.38 respectively. Energy balance efficiency (production energy to consumption energy ratio) in this research was calculated 0.32; showing the affective use of energy in the agro ecosystems lentil production. The highest percent of compositions (48.8%), Amounts (287.9 kg/ha), production energy (1151680 kcal/ha) and production energy to consumption energy ratio (0.20) in lentil were obtained from starch as compared with protein and fat, The lowest consumption energy to production energy ratio (5.02) in lentil was obtained from starch as compared with fat and protein (Table 5).

Economic analysis of lentil production

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Research Article

The economic analysis of lentil production were calculated and shown in table 6. In the research area, the lentil sale price (0.67 $/kg), gross value of production (395.3 $/ha), total cost of production (194 $/ha), productivity (3.04 kg/ha) and net return (201.3 $/ha) were calculated. Results showed the benefit to cost ratio in the studied farms was calculated to be 2.04.

Koocheki et al. (2011) analyzed the economic indices of pulses (lentil) production in Khorasan Razavi province (Iran), and found that lentil sale price, gross value of production, total cost of production, productivity, net return and Benefit to cost ratio were 0.62 $/kg, 524.34 $/ha, 85.18 $/ha, 8.18 kg/$, 439.15 $/ha and 6.15 respectively.

Green house gases emissions

Results showed that, electricity power was the major source contributing 43.69% (437.76 $kgCO_{2eq}ha^{-1}$) of total green house gases emission and followed by diesel fuel (30.57%: 306.36 $kgCO_{2eq}ha^{-1}$), chemical fertilizer (24.29%: 243.40 $kgCO_{2eq}ha^{-1}$), machinery (0.94%: 9.44 $kgCO_{2eq}ha^{-1}$) and chemical poison (0.51%: 5.01 $kgCO_{2eq}ha^{-1}$) of global warming potential, respectively (Figure 7). Total green house gases emissions for lentil production was calculated as1002.0 $kgCO_{2eq}ha^{-1}$ (Table 7).

Conclusion

The objectives of this study were to perform energy indices, energy balance indices, economical indices and life cycle assessment emission for lentil production in north of Iran. Energy efficiency for rain fed farming lentil production in this study was calculated 0.47, showing the affective use of energy in the agro ecosystems lentil production. Energy balance efficiency for rain fed farming lentil production in this study was calculated 0.32, showing the affective use of energy in the agro ecosystems lentil production. Results showed the benefit to cost ratio in the studied farms was calculated to be 2.04. Also, Results showed that, total green house gases emissions for lentil production was calculated as1002.0 $kgCO_{2eq}ha^{-1}$.

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	Percent
Inputs					
Human labor	h/ha	406	1.96	795.76	4.24
Machinery	h/ha	13	62.7	815.10	4.34
Diesel fuel	L/ha	111	56.31	6250.41	33.28
Nitrogen	Kg/ha	43	64.4	2755.03	14.67
Phosphorus	Kg/ha	12	11.96	140.65	0.75
Potassium	Kg/ha	10	6.70	67.00	0.36
Poison	L/ha	1	120	120.00	0.64
Electricity	Kg/ha	500	11.93	5965.00	31.76
Seed	Kg/ha	75	25	1875.00	9.98
Output					
Yield	Kg/ha	590	14.7	53200	100

Table 2: Amounts of inputs and their equivalent energy from calculated indicators of energy balance

Parameter	Unit	Quantity per hectare	Energy equivalents	Total energy equivalents	Percent
Inputs					
Human labor	h/ha	406	500	203000.00	3.51
Machinery	h/ha	13	90000	1170000.00	20.24
Diesel fuel	L/ha	111	9237	1025307.00	17.74
Nitrogen	kg/ha	43	17600	752928.00	13.95
Phosphorus	kg/ha	12	3190	37514.40	0.47
Potassium	kg/ha	10	1600	16000.00	24.77
Poison	L/ha	1	27170	27170.00	3.85
Electricity	kg/ha	500	2863	1431500.00	15.46
Seed	kg/ha	75	2970	222750.00	3.51
Depreciation for per diesel fuel	L	93.24	9583	893518.92	20.24

Table 3: Amounts of inputs and their equivalent green house gas (GHG) emission

Parameter	Unit	Quantity per Hectare	GHG coefficient ($kgCO_{2eq}ha^{-1}$)
Machinery	h/ha	133	0.071
Diesel fuel	h/ha	111	2.76
Nitrogen	Kg/ha	184	1.3
Phosphorus	Kg/ha	11	0.2
Potassium	Kg/ha	10	0.2
Electricity	Kwh	720	0.608
Poison	L/ha	1	5.1

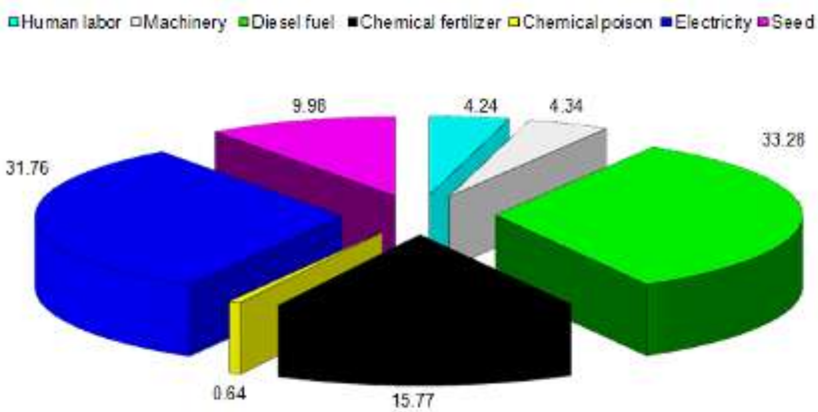

Figure 1: The share (%) production inputs in lentil (energy)

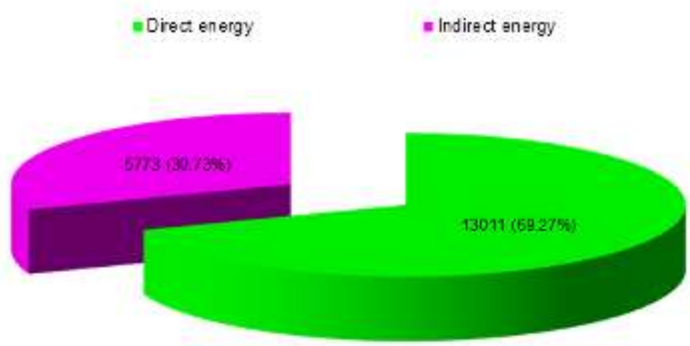

Figure 2: Percentage of total energy input in the form of direct and indirect for lentil production

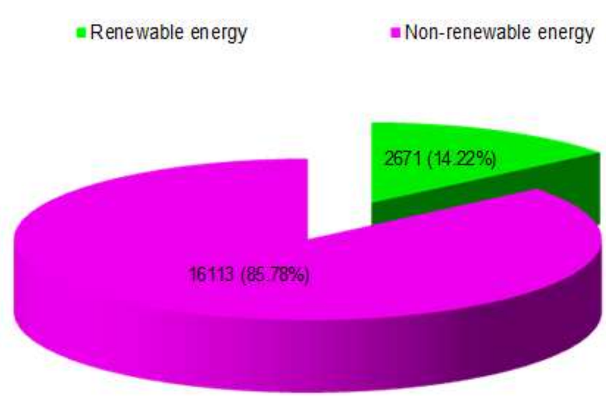

Figure 3: Percentage of total energy input in the form of renewable- non-renewable for lentil production

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2014 Vol. 4 (1) January-March, pp.379-387/Moraditochaee et al.

Research Article

Table 4: Analysis of energy indices in lentil production

Item	Unit	Lentil
Yield	Kg/ha	590
Input energy	Mj/ha	18784
Output energy	Mj/ha	8673
Energy use efficiency	-	0.47
Energy specific	Mj/Kg	31.84
Energy productivity	Kg/Mj	0.31
Net energy gain	Mj/ha	-10111

Table 5: Analysis of energy balance indices in lentil production

Item	Percent of compositions	Energy per gram (kcal)	Amounts (kg/ha)	production energy (kcal/ha)	Production energy /Consumption energy	Consumption energy/ Production energy
Protein	24.3	4	143.4	573480	0.10	10.08
Fat	1.9	9	11.2	100890	0.02	57.29
Starch	48.8	4	287.9	1151680	0.20	5.02
Item	Yield (kg/ha)	Consumption energy (kcal/ha)	Production energy (kcal/ha)	Energy per unit (kcal)	Production energy /Consumption energy	Consumption energy/ Production energy
	590	5779688	1826050	3095	0.32	72.38

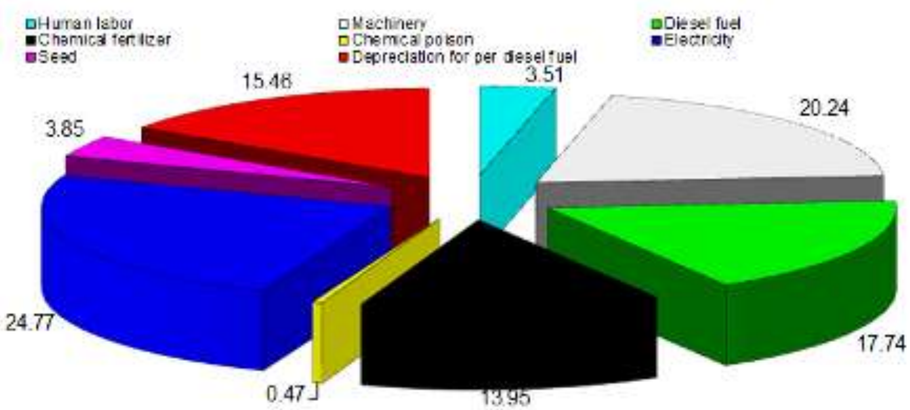

Figure 4: The share (%) production inputs in lentil (energy balance)

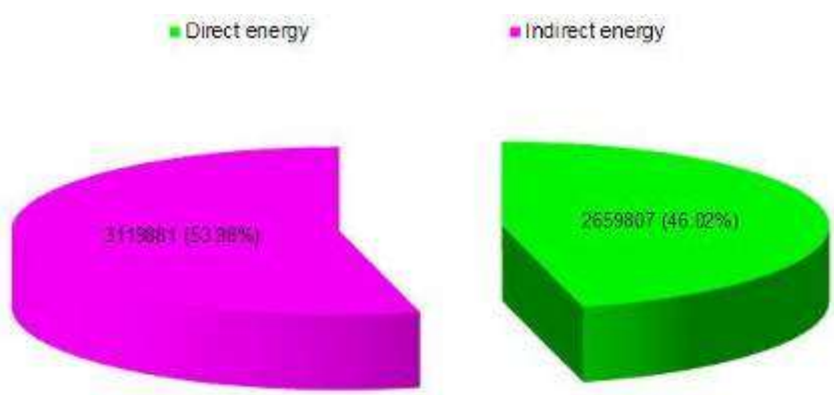

Figure 5: Percentage of total energy balance input in the form of direct and indirect for lentil production

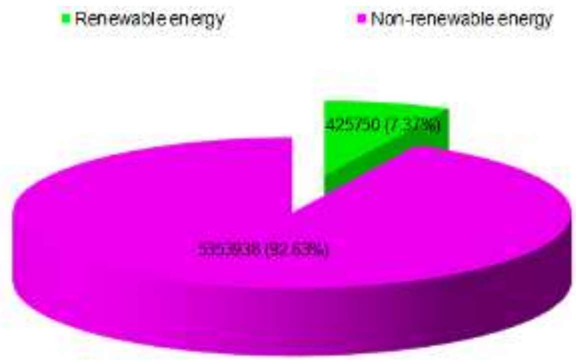

Figure 6: Percentage of total energy balance input in the form of renewable- non-renewable for lentil production

Table 6: Economic analysis of lentil

Cost and return components	
Yield (kg/ha)	590
Sale price ($/kg)	0.67
Gross value of production ($/ha)	395.3
Total cost of production ($/ha)	194
Net return ($/ha)	201.3
Benefit to cost ratio	2.04
Productivity (kg/$)	3.04

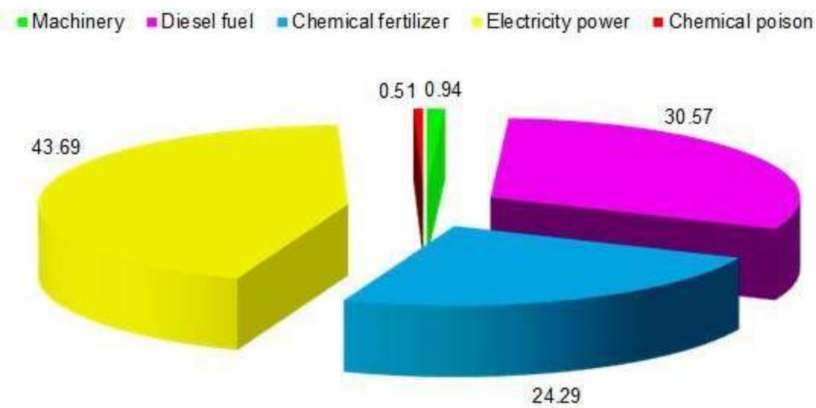

Figure 7: The contribution of GHG emissions in lentil production

Table 7: Greenhouse gas emissions of inputs for lentil production

Parameter	GHG emissions ($kgCO_{2eq}ha^{-1}$)
Machinery	9.44
Diesel fuel	306.36
Nitrogen fertilizer	239.20
Phosphorus fertilizer	2.20
Potassium fertilizer	2.00
Electricity power	437.76
Chemical poison	5.10
Total	1002.06

REFERENCES

Azarpour E (2014). Investigation life cycle assessment emission of varieties rice under traditional and semi-mechanized farming systems in Iran. *International Journal of Biosciences* **4**(1) 8-14.

Azarpour E and Farajpour GH (2013). Effect of nitrogen fertilizer different levels on economic indices, energy balance indices and greenhouse gases of current rice cultivars in Guilan. *Journal of Biodiversity and Environmental Sciences* **3**(10) 1-11.

Azarpour E and Moradi M (2013). A comparative study on energy use and cost analysis of Rice Varieties under Traditional and Semi-mechanized Farming Systems in North of Iran. Biomass Now – Sustainable Growth and Use, In *Tech-Open Access Company* 1-37.

Banaeian N, Omid M and Ahmadi H (2011). Energy and economic analysis of greenhouse strawberry production in Tehran province of Iran. *Energy Conversion and Management* **52** 1020-1025.

Dalgaard T, Halberg N and Porter JR (2001). A model for fossil energy use in Danish agriculture used to compare organic and conventional farming. *Agriculture, Ecosystems and Environment* **87**(1) 51-65.

Dashadi M, Hossein A, Radjabi R, babainejad T (2013). Investigation of effect different rates Phosphorus and Zinc fertilizers on two cultivars Lentil Gachsaran and Flip92-12L in irrigation complement condition. *International Journal of Agriculture and Crop Sciences* **5**(1) 1-5.

Ghahderijani M, Pishgar Komleh SH, Keyhani A and Sefeedpari P (2013). Energy analysis and life cycle assessment of wheat production in Iran. *African Journal of Agricultural Research* **8**(18) 1929-1939.

Ghasemi Mobtaker H, Keyhani A, Mohammadi A, Rafiee S and Akram A (2010). Sensitivity analysis of energy inputs for barley production in Hamedan Province of Iran. *Agriculture, Ecosystems and Environment* **137** 367-372.

Gowdy JM, Miller JL and Kherbachi H (1987). Energy use in US agriculture. *Southern Journal of Agricultural Economics* **19**(2) 33-41.

Hatirli SA, Ozkan B and Fert C (2005). An econometric analysis of energy input–output in Turkish agriculture. *Renewable and Sustainable Energy Reviews* **9** 608-623.

Hillier J, Walter C, Malin D, Garcia-Suarez T, Mila-i-Canals L and Smith P (2011). A farm focused calculator for emissions from crop and livestock production. *Environmental Modelling and Software* **26** 1070-1078.

Karadavut U and Palta C (2010). Chemical performance of multi environment trials in lens (Lens culinaris M). *Journal of the Science of Food and Agriculture* **90** 117-120.

Karimi M, Beheshti-Tabar I and Khubbakht GM (2008). Energy Production in Iran's Agronomy. *American-Eurasian Journal Agricultural Environ Science* **4** 172-177.

Koocheki AR, Ghorbani R, Mondani F, Alizade Y and Moradi r (2011). Pulses Production Systems in Term of Energy Use Efficiency and Economical Analysis in Iran. *International Journal of Energy Economics and Policy* **4**(1) 95-106.

Khoshnevisan B, Rafiee S, Omid M and Mousazadeh, H (2013). Developing an artificial neural networks model for predicting output energy and GHG emission of strawberry production. *International Journal of Applied Operational Research* **3**(4) 43-54.

Mandal KG, Saha KP, Gosh PL, Hati KM and Bandyopadhyay KK (2002). Bioenergy and economic analyses of soybean based crop production systems in central India. *Biomass Bio Energy* **23** 337-45.

Nabavi-Pelesaraei A, Abdi R, Rafiee S and Mobtaker HG (2013). Optimization of energy required and greenhouse gas emissions analysis for orange producers using data envelopment analysis approach. *Journal of Cleaner Production* 1-7.

Ozkan B, Akcaoz H and Fert C (2004). Energy input output analysis in Turkish agriculture. *Renewable Energy* **29** 39-51.

Rathke GW and Diepenbrock W (2006). Energy balance of winter oilseed rape (Brassica napus L.) cropping as related to nitrogen supply and preceding crop. *European Journal of Agronomy* **24** 35-44.

Sarker A, Erskine W and Singh M (2003). Regression models for lentil seed and straw yields in Near East. *Agricultural and Forest Meteorology* **116** 61-72.

Schneeberger KC and Breimyer HF (1974). Agriculture in an energy-hungry world. *Southern Journal of Agricultural Economics* **6**(1) 193-197.

Unakitan G, Hurma H and Yilmaz F (2010). An analysis of energy use efficiency of canola production in Turkey. *Energy* **35** 3623-3627.