COBISS Code 1.01

DOI: 10.2478/v10014-012-0013-4
Agrovoc descriptors: zea mays, maize, cereals, land varieties, energy consumption, energy value, efficiency, productivity, fertilizers, nitrogen fertilizers, plant production, input output analysis

Agris category code: f01, e16

Reasearch of Energy use efficiency for maize production systems in Izeh, Iran

SH. LORZADEH[1], A. MAHDAVIDAMGHANI[2], M. R. ENAYATGHOLIZADEH[3] and M. YOUSEFI [4]

Received March 04, 2012; accepted July 03, 2012.
Delo je prispelo 04. marca 2012, sprejeto 03. julij 2012.

ABSTRACT

This study was carried out in Khuzestan province in Iran and aim of investigation was energy analysis (input-output) of maize production systems in Izeh County of Iran. Data were collected from 30 maize farms by using a face to face questionnaire method in 2011. The results revealed that in maize production systems total energy input was 34.640 MJ.ha^{-1}. The highest share of energy consumed was recorded for N fertilizer (20.80%) which is a nonrenewable resource. Output energy was 102.973 MJ.ha^{-1}. Accordingly, energy use efficiency (output-input ratio) was 2.97, energy productivity calculated as 0.20 kg.MJ^{-1} and net energy was observed as 68.333 MJ.Kg^{-1}. Also, agrochemical energy ratio was 48.97% which is high ratio of input energy in this agro ecosystems.

Key words: Energy use efficiency, Energy productivity, Maize, Agrochemical

IZVLEČEK

RAZISKAVA ENERGETSKE UČINKOVITOSTI PRIDELAVE KORUZE V IZEHU, IRAN

Raziskava energetske učinkovitosti pridelave koruze je bila opravljena v provinci Khuzestan, okrožja Izeh v Iranu. Podatki za raziskavo so bili pridobljeni z ustnim anketiranjem 30 pridelovalcev koruze v letu 2011. Rezultati so pokazali, da je bil celokupen vnos energije v ta pridelovalni sistem 34,640 MJ.ha^{-1}. Največji delež porabljene energije odpade na dušikova gnojila (20,80 %), kar predstavlja neobnovljivi vir. Izplen energije je znašal 102, 973 MJ.ha^{-1}. Učinkovitost izrabe energije (vnos/iznos) je bila 2,97, izračunana energetska produktivnost je bila 0,20 kg.MJ^{-1}, neto energija pridelka je znašala 68,333 MJ.Kg^{-1}. Agrokemijsko energijsko razmerje je bilo 48,97 %, kar predstavlja dokaj velik vnos energije v tem agro-ekosistemu.

Ključne besede: izkoristek energije, energetska učinkovitost, koruza, agrokemikalije

[1, 3] Department of Agronomy and plant Breeding, Shoushtar Branch, Islamic Azad University, Shoushtar, Iran, Lorzadeh42@yahoo.com

[2, 4] Department of Agroecology, Environmental Sciences Research Institute, Shahid Beheshti Universtity, G.C., Tehran, Iran

1 INTRODUCTION

Maize (*Zea mays L.*) is an important cereal crop of Khuzestan province, Iran. It is grown for fodder as well as for grain purpose in Iran. Approximately 320000 hectares of field corn were grown with a production of 2.560.000 tons an average grain yield of 8000 kg per hectare in Iran in 2010. (*Anonymous, 2010*). 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 (*TaheriGaravand et al., 2010*). Agriculture is both a producer and consumer of energy. Energy input–output analysis is usually used to evaluate the efficiency and environmental impacts of production systems (*Ozkan et al., 2004*).

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). In modern agriculture system input energy is very much higher than in traditional agriculture system, but energy use efficiency has been reduced in response to no affective use of input energy. Efficient use of energies helps to achieve increased productivity and contributes to the economy, profitability and competitiveness of agriculture sustainability in rural areas (Ozkan et al., 2004; Singh et al., 2002).

The main objective of this study is analysis of energy use and energy indicator of maize production systems in Izeh county of Khuzestan province in Iran.

2 MATERIALS AND METHODS

Izeh(Izeh County (49 31' N, 52 49' E), south of Iran), is one of the important maize production areas in the south part of Iran in Khuzestan province. In this region maize is grown as second crop.

For this study data were collected from 30 farms applying a face-to-face questionnaire. Other information was collected from the Ministry of Agriculture. Total energy input and output in maize production systems was estimated by using questionnaires and data analysis. It should be clearly stated that parameters listed in Table 1 were obtained from the questionares and data analysis. Basic information on energy inputs and maize yield were entered into Excel spreadsheets and then energy indicators were calculated according Table 1.

Finally energy use efficiency, specific energy, energy productivity and net energy were determined applying standard equations (*Hatirli et al., 2006; Mohammadi et al., 2010*)

Energy use efficiency = (output energy ($MJ.ha^{-1}$)) / (input energy ($MJ.ha^{-1}$]) (1)

Specific energy = (input energy ($MJ.ha^{-1}$)) / (maize yield ($kgha^{-1}$)) (2)

Energy productivity = (maize yield ($kg.ha^{-1}$)) / (input energy ($MJha^{-1}$)) (3)

Net energy = output energy ($MJ.ha^{-1}$) - input energy ($MJ.ha^{-1}$) (4)

Agrochemical energy ratio was calculated by applying Equations 5 (*Khan et al., 2009*):

Agrochemical energy ratio= input energy of agrochemicals ($MJha^{-1}$) /total input energy ($MJ.ha^{-1}$) (5)

Table 1. Energy equivalents for input and output of **Maize** production systems in **Izeh** county

	Unit	Energy equivalents	Reference
A. Inputs			
1. Human labor	h	1.96	[Mohammadi and Omid, 2010]
2. Machinery	h	62.7	[Samavatean et al., 2010]
3. Diesel fuel	l	51.33	[Samavatean et al., 2010]
4. Chemical fertilizer	Kg		
(a) Nitrogen	Kg	66.14	[Erdal et al., 2007]
(b) Phosphate (P_2O_5)	Kg	12.44	[Erdal et al., 2007]
(c)Potassium (K_2O)	Kg	11.15	[Mohammadi and Omid, 2010]
5. Chemicals	Kg	120	[Demircan et al., 2006]
6. Electricity	Kwh	3.6	[Rafiee et al., 2010]
7. Water for irrigation	m^3	0.63	[Hatirli et al., 2005]
8. Seed	Kg	50.0	[Erdal et al., 2007]
B. Output			
1. Maize	Kg	14.7	[Ozkan et al, 2004; Mandal et al.,2002]

The input energy was divided into direct, indirect, renewable and non-renewable energies [*Kizilaslan, 2009*; *Samavatean et al., 2010*].Direct energy covered human labour, diesel fuel, water for irrigation, and electricity used in the corn production while indirect energy consists of seeds, pesticide, fertilizers, and machinery energy. Renewable energy consists of human labor and seeds and nonrenewable energy includes diesel, pesticide, fertilizers, electricity and machinery. Also in the last part of the research, economic analysis of corn production was investigated.

3 RESULTS AND DISCUSSION

3.1 Energy use in maize production systems in Izeh County

The inputs used and output in maize production systems, their energy equivalents, and percentages in the total energy input presented in Table 2. The results revealed that total energy input in maize production systems was 3464002 $MJ.ha^{-1}$. N fertilizer used in maize production systems had a high share with 20.80%. Diesel fuel energy used in maize production systems ranked in the second place with 31.60% in the total energy input. The lowest share of total energy was recorded for human 1Labour (0.56%) which is a renewable resource of energy. In this study maize grain yield was 7005$kg.ha^{-1}$ that total energy equivalents for this amount was 102.97$MJ.ha^{-1}$.

Table 2: Energy inputs, outputs and the ratio of maize production in **Izeh** county

Inputs and output - (unit)	Quantity per unit area (ha)	Total Energy equivalents(%)	
A. Inputs			
1. Human- labour (h)	99.32	194.68	0.56
2. Machinery (h)	17.50	1097.25	3.17
3. Diesel fuel (L)	213.51	10959.47	31.60
4. Chemical fertilizer (kg)			
(a) Nitrogen (N)	108.68	7188.10	20.80
(b) Phosphate (P_2O_5)	61.98	771.03	2.23
(c)Potassium (K_2O)	37.84	421.92	1.22
5. Chemicals(kg)	9.25	1110	3.20
6. Electricity(Kwh)	2000	7200	20.80
7. Water for irrigation(m^3)	7327.13	4616.10	13.30
8. Seed (kg)	21.63	1081.50	3.12
Total input energy		34640.02	100
B. Output			
1. maize grain yield (kg)	7005	102973.5	100
Total output energy		102973.5	100

Results of energy indicators for maize production systems are shown in Table 3. Accordingly, energy efficiency (output-input ratio) was 2.97. Lower energy use efficiency in maize production systems is due to higher energy inputs in these systems for example N fertilizer consumed. Such indicator was reported 2.8 for wheat production systems (*Streimikiene et al., 2007*) and 25.75 for sugar beet (*Erdal et al., 2007*) in Turkey.

Energy productivity (grain yield per energy input) and specific energy in maize production systems were 0.20 $kg.MJ^{-1}$ and 9.95 $MJ.kg^{-1}$ respectively. System net energy (output minus input) was as $68333MJha^{-1}$. Agrochemical energy ratio was 48.97% which is a high portion of input energy of maize production systems. It should be mentioned that maize production in south part of Iran could be limited using amounts of chemical fertilizers and pesticides.

Table 3: Indicators of energy use of Maize production systems in **Izeh** county

Indicators	Unit	Quantity
Inputs energy	$MJ.ha^{-1}$	34640
Output energy	$MJ.ha^{-1}$	102973
Energy use efficiency		2.97
Energy productivity	$kg.MJ^{-1}$	0.20
Net energy balance	$MJ.ha^{-1}$	68333

3.2 Energetic of producing maize systems in Izeh County

The total means energy input as direct and indirect, renewable, and non-renewable forms for greenhouse and open-field maize production was given in Table 4. The total energy input necessary for maize production was 34640.02 MJ/ha. Out of all 33.74% of the total energy, input use in maize production was in the form of indirect energy. The remaining part of energy input use (66.26%) was in the form of direct energy. On the other hand the research results indicate that the total energy input used in maize production systems was mainly dependent on non-renewable energy forms (Table 4). As can be seen from the table, on an average, the non-renewable form of energy input was 83.02% in maize

production systems of the total energy input while the 16.98% of input energy was renewable energy resource. The high rate of non-renewable and direct energy inputs indicates an intensive use of chemical fertilizer and diesel fuel consumption in these agroecosystems.

Table 4: Total energy input in form of direct, indirect, renewable and non-renewable for **maize** production in **Izeh** county

Indicators	Quantity (MJ ha^{-1})	Percentage (%)
Direct energy [a]	22952.48	66.26
Indirect energy [b]	11687.54	33.74
Renewable energy [c]	5881.88	16.98
Non-renewable energy [d]	28758.14	83.02
Total energy input	34640.02	100

[a] Includes human labour, diesel, water for irrigation, electricity, [b] Includes seeds, fertilizers, pesticides, machinery. [c] Includes human labor, seeds, and water for irrigation. [d] Includes diesel, pesticides, fertilizers, electricity and machinery.

4 CONCLUSION

The important following conclusions are drawn;

1. Total energy input and output in maize production systems were 34640 and 102973 MJ. ha^{-1}.

2. That the highest share of input energy was reported for nitrogen fertilizer, diesel fuel, and water for irrigation (20.80, 31.60 and 13.30%) respectively.

3. The energy use efficiency, energy productivity, specific energy, net energy of maize production systems were 2.97, 0.20 kg MJ^{-1},10.63MJ.kg^{-1} and 68333 MJ.ha^{-1} respectively.

4. The share of total input energy as direct, indirect, renewable and nonrenewable forms were 66.26, 33.74, 16.98 and 83.02% respectively.

5 ACKNOWLEDGEMENT

This article is part of a yield investigation in Islamic Azad university of Shoushtar. So we thanks of investigational domain of Shoushtar, specially miss Dialamepoor engineer for every cooperation.

6 REFERENCES

Anonymous., 2010. Department of statistics and information, Ministry of Jihad-e-Agriculture, Tehran, Iran. <http://www.maj.ir>.

Demircan V, Ekinci K, Keener HM, Akbolat D, Ekinci C. Energy and economic analysis of sweet cherry production in Turkey: A case study from Isparta province. Energy Convers Manage 2006; 47: 1761–1769.

Erdal G, Esengun K, Erdal H, Gunduz O.2007. Energy use and economical analysis of sugar beet production in Tokat province of Turkey. Energy., 32: 35–41.

Esengun K, Gunduz O, Erdal G .2007. Input–output energy analysis in dry apricot production of Turkey. Energy Convers Manage., 48:592–598.

Hatirli S. A, Ozkan B, Fert C .2008. Energy inputs and crop yield relationship in greenhouse tomato production. Renew Energy., 31: 427-438.

Khan S, Khan M. A, Hanjra M. A, Mu J. Pathways to redue the environmental footprints of water and energy input in food production. Food policy 2009; 34: 141-149.

Kizilaslan H. 2009."Input–output energy analysis of cherries production in Tokat Province of Turkey", Applied Energy., 86: pp: 1354–1358.

Mandal K.G, Saha K.P, Ghosh P.K, Hati K.M, Bandyopadhyay K. K. Bioenergy and economic analysis of soybean-based crop production systems in central India. Biomass Bioenergy 2002; 23(5): 337–345.

Mohammad A, Rafiee S, Mohtasebi S.S, Rafiee H. 2010. Energy inputs – yield relationship and cost analysis of kiwifruit production in Iran. Renewable Energy., 35: 1071–1075.

Ozkan B, Akcaoz H, Fert CEnergy input–output analysis in Turkish agriculture. Renew Energy 2004; 29: 39–51.

Ozkan B, Fert C, Karadeniz CF. Energy and cost analysis for greenhouse and open-field grape production. Energy 2007; 32: 1500–4.

Rafiee S, Mousavi avval SH, Mohammadi A. 2010. Modeling and sensitivity analysis of energy inputs for apple production in Iran. Energy., 35(8): 3301-6.

Samavatean, N., Rafiee, S., Mobil, H. and Mohammadi, A. 2011. An analysis of energy use and relation between energy inputs and yield, costs and income of garlic production in Iran. Renewable Energy36: 1808-1813.

Singh. H., Mishra. D., and Nahar. N. M. 2002. " Energy use pattern in production agriculture of typical village in arid zone", India—part–I. Energ Convers Manage, 43:2275–86.

Streimikiene D, Klevas V, Bubeliene J. Use of EU structural funds for sustainable energy development in new EU member states. Renew Sustain Energy Rev 2007; 116: 1167–87.

TaheriGaravand A., Asakereh A., Haghani K. 2010. Energy elevation and economic analysis of canola production in Iran a case study: Mazandaran province. International journal of environmental sciences 1 (2), 236-243.

Yilmaz I, Akcaoz, H, Ozkan, B. An analysis of energy use and input costs for cotton production in Turkey. Renewable Energy 2005; 30 (2): 145–55.