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Agrochemical Input Application and Energy Use Efficiency of Maize Production Systems in Dezful, Iran

[1]S.H. Lorzadeh, [2]A. Mahdavidamghani, [3]M.R. Enayatgholizadeh and [4]M. Yousefi

[1,3]Department of Agronomy and plant Breeding, Shoushtar Branch,
Islamic Azad University, Shoushtar, Iran
[2,4]Department of Agroecology, Environmental Sciences Research Institute,
Shahid Beheshti Universtity, G.C., Tehran, Iran

Abstract: The aim of this study was conducted to essay agrochemical application and energy use efficiency in the maize production systems in Dezful, Khuzestan Province in summer 2011. For this study data was collected using questionnaires and face to face interview with 30 farmers. Results showed that the average application of N and P (in form of P_2O_5) were 470 and132 Kgha^{-1} respectively. Total inputs energy in maize production systems was 29307.74 MJ/ha. 53% of input energy was related to agrochemical input that chemical fertilizer in which N and P and Pesticides consisted 48, 2.5 and 2.5 percent of total energy, respectively. Energy efficiency (output-input ratio) was 1.86 in the studied production systems. The total energy input consumed could be classified biological energy (11%) and industrial energy (89%).

Key words: Chemical fertilizers · Agrochemical input · Energy use efficiency · Maize

INTRODUCTION

Efficient use of energy is an important indicator of agricultural sustainability Chemical fertilizers affects substantially energy efficiency in farming systems due to high energy demand for their production and processing. Practices such as irrigation, chemical fertilizer application, heavy machinery use and heated greenhouses consume large amounts of energy [1]. These practices are utilized by both organic and conventional operations. Energy use associated with processing, packaging, storage and distribution must also be taken into account. Agrochemical input application is a major user of nonrenewable energy in agriculture production systems [2]. Modern agriculture is heavily dependent on agrochemical input application very much more than traditional agriculture system, but energy use efficiently has been redacting in response to no affective use of input energy. Managing agrochemical input in a way to realize sustainability in agriculture [3].

Although many experimental works have been conducted on energy use in agriculture [4-6], but the authors were not essay effects of chemical fertilizer application on energy use efficiency.

The objective of the present study was to analyze energy flow, examine energy use efficiency and essay agrochemical application and energy use efficiency in maize agroecosystems. This can exert positive effects on managing agroecosystems in a way to realize sustainability in agriculture.

MATERIALS AND METHODS

In this study, maize growers were surveyed in Dezful county of Khuzestan Province in Iran. Dezful County is located in the south of Iran, within 32° 38' north latitude and 48°39'east longitudes.

For this study data was collected employing questionnaire via face to face interviews with 30 farmers in summer 2011 in Dezful County. The Farmers were selected randomly among the farmers of this rejoin. The data was transformed to energy term by appropriate energy equivalent factors (Table 1). In the maize production agroecosystems of this region, input energy sources included human labor, machinery, diesel fuel, fertilizers (N, P), chemicals, irrigation water and seeds; while output energy sources was maize grain yield.

Corresponding Author: S.H. Lorzadeh, Department of Agronomy and plant Breeding, Shoushtar Branch, Islamic Azad University, Shoushtar, Iran.

Table 1: Energy equivalents of input and output in maize production systems

Equipment /inputs	Unit	Energy equivalents	Reference
A. Inputs			
1. Human Labor	H	1.96	[7,8]
2. Machinery	h	62.7	[9,10]
3. Diesel fuel	l	51.33	[9,10]
4. Chemical Fertilizer	kg		
(a) Nitrogen		66.14	[9,11]
(b) Phosphate (P_2O_5)		12.44	[9,11]
5. Chemical		120	[7,12]
6. Water for irrigation	M3	.63	[10,13]
7. Seed	kg	14.7	[7,14]
B. Output			
1. Maize	kg	14.7	[7,14]

In this study energy use efficiency, energy productivity, Net energy and agrochemical energy ratio were determined applying standard equations 3-6 [16,16];

$$\text{Energy use efficiency}=(\text{output energy } [\text{MJha}^{-1}])/(\text{input energy } [\text{Mjha}^{-1}]) \quad (3)$$

$$\text{Energy productivity}=(\text{Grain yield } [\text{Kgha}^{-1}])/(\text{input energy } [\text{MJha}^{-1}]) \quad (4)$$

$$\text{Net energy} = \text{output energy } (\text{MJha}^{-1})-\text{input energy } (\text{MJha}^{-1}) \quad (5)$$

For calculated Agrochemical energy ratio in this study used of Eq as follows [17];

$$\text{Agrochemical energy ratio}(\%)\frac{\text{input energy from chemical input}(\text{Mj/ha})}{\text{Total input energy}(\text{Mj/ha})}$$

The input energy was divided into biologic and industrial energies [18]: biologic energy consists of human labuor water for irrigation and seeds and industrial energy includes diesel fuel, pesticide, fertilizers and machinery.

RESULTS AND DISCUSSION

Analysis of Input-Output Energy Use: Table 2 shows the inputs used and output in maize production systems in the studied area. The total energy requirement for producing the maize crops was 29307.74 MJ ha^{-1}. Among the different energy sources N fertilizer was the highest energy consumer for studied crops. The average use of the N fertilizer was 470 Kgha^{-1} in the maize production. It is a common belief that increased use of fertilizer will increase the yield. Because of the high N fertilizer used in the production systems had the big values of 14299.47 MJ ha^{-1}.

The other inputs applied in the growing process in the surveyed area and percentage of each input of the total energy inputs are shown in Table 2. The share of important energy input of total input energy for two yields are shown in Fig. 1.

Indicators of Energy Use and Different Form in Producing Maize: Table 3 shows the energy indicators of maize production Agroecosystems. The energy use efficiency, energy productivity, net energy and Agrochemical energy ratio of maize production in the Dezful County are listed in Table 3. Energy use efficiency in this agriculture system was 1.86 that is low amount. By raising the crop yield and by decreasing energy inputs consumption the energy use efficiency can be increased. This amount in turkey for maize production recorded 3.66 [19], 1.58 for kiwifruit in Iran [16], for alfalfa in Iran 4.83 [2], respectively. Low amount of energy use efficiency showing the inefficiency use of energy in the maize production agroecosystems.

Energy productivity and specific energy in maize production systems were 0.13 KgMJ^{-1} and 7.88 MJKg^{-1} respectively. This means that produced maize grain yield

Table 2: Energy equivalents of input and output in maize production systems in Dezful

Quantity (input and output)	Quantity per unit area (ha)	Total energy equivalents (MJha^{-1})	Percentage of total energy (%)
A. Inputs			
1. Human Lab our (h)	84.90	166.41	0.57
2. Machinery (h)	19.16	1201.14	4.11
3. Diesel fuel(L)	178.16	9144.95	31.22
4. Chemical Fertilizer(kg)			
(a) Nitrogen	216.2	14299.47	47.83
(b) Phosphate (P_2O_5)	60.57	753.49	2.58
5. Pesticides(kg)	5.7	684	2.34
6. Seed(kg)	22.18	326.05	1.13
7.Water for irrigation	4336.87	2732.23	9.33
Total energy input(MJ)			
B. Output		29307.74	100
1. maize		54639.9	100
Total energy input (MJ)	3717	54639.9	100

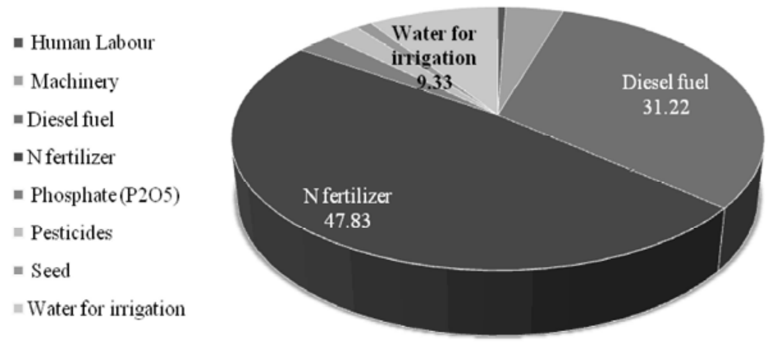

Fig. 1: Share of important energy input of total input energy in maize production system.

Table 3: Indicators of energy use in chickpea production systems

Indicators	Unit	Quantity
Inputs energy	$Mjha^{-1}$	29307.74
Output energy	$Mjha^{-1}$	54639.9
grain yield	$Kgha^{-1}$	3717
Energy use efficiency		1.86
Specific energy	$Mjkg^{-1}$	7.88
Energy productivity	$KgMJ^{-1}$	0.13
Agrochemical Energy Ratio	%	52.75
Net energy	$Mjha^{-1}$	25332.16
industrial energy [a]	$Mjha^{-1}$	3232.64(11.03%)
biological energy [b]	$MJha^{-1}$	26075.1(88.97%)

[a] Includes human labor, seeds and water for irrigation.

[b] includes diesel, pesticides, fertilizers, machinery, Electricity.

per input energy unit was 0.13kgMJ^{-1}, or in the other word, in maize production systems, 7.88MJ energy used for production one kg of grain yield. Also, Net energy per hectare, in this study for maize production Agroecosystems was 25332.16 MJ per hectare.

In the other part of this study agrochemical energy ratio of maize production agroecosystems was also calculated as 52.75 percent which illustrate more energy consumed per fertilizer and chemical inputs production [17].

Also the distribution of inputs used in the production according to the industrial and biological are given in Table 3. The total energy input consumed could be classified biological energy (11%) and industrial energy (89%). Several researchers have found that the ratio of industrial energy is greater than biological energy consumption in cropping systems [10,20].

In modern crop production systems large amount of industrial energy has been replaced instead of biological energy therefore energy use efficiently has been redacting in response to using of agrochemical input with high energy cost and ineffective use of input energy.

CONCLUSION

In this study, the energy flow of maize production systems in Dezful County, south of Iran has been investigated. The total energy consumption in maize production was 29307.74 MJ ha^{-1}. The energy input of chemical fertilizer had the biggest share (53%) of total energy inputs. On average, 89% of total energy input used in maize production was industrial energy, while the contribution of biological energy was 11%. Results show that reduce in chemicals and fertilizer consumptions are important for energy saving and decreasing the environmental risk problem in the area. Therefore, excessive application of chemical fertilizers would result in increasing energy consumption in production systems, reducing energy use efficiency and cause environmental challenges, including global warming, of soil and water pollution thereby affecting human health. This trend revealed that environmental challenges will worsen in the near future if there would not happen any consideration in fertilizer application pattern in these agroecosystems.

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