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Energy Requirement and Energy Efficiency for Production of Maize Crop

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Abstract

This research study was conducted to find out direct input energy and indirect energy in maize grain yield, to evaluate the inputs energy consumption and outputs energy gained for maize production in Islamabad, Pakistan season autumn-2014. The result showed that the grain harvest was the maximum under mouldboard plow compared with cultivator and zero tillage. The total energy input / output higher under mouldboard plow compared with cultivator, while the lowest in the zero tillage, net energy and input-output ratio were gain highest under mouldboard plow.

Keywords: energy, efficiency, input-output ratio, maize.

Introduction:

People have found ways to protect the food from the land of the Earth; agricultural production was continuous expansion of the population. The production plant is the purpose of energy consumption, depending on the environmental situation growing convert only 0.5-5% of the active photosynthetic radiation biomass (Hulsbergen et al., 2001). Source of energy other than sunlight, wind energy, etc. summarizes the energy (Alam et al., 2005). Entering the support schemes to increase the share of agricultural energy solar energy that is captured by plants. Direct aid of energy is required to perform a variety of tasks related to the processes of crop production, such

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as land preparation, irrigation, harvesting, processing, harvesting, and transport of agricultural inputs and outputs. In other words, direct energy includes fuel and electricity, which are directly used on the land (Hulsbergen et al., 2001). Indirect energy is not directly consumed on the farm. The main elements to support the indirect energy is the energy used in the production, packaging and transport of fertilizers, seeds, machinery and pesticides (Ozkan et al., 2004). The carrier for the cultivation of energy supply is very diverse, modern crop production is characterized by a high share of energy from fossil fuels and electricity, which is used as a direct and an indirect energy (fertilizers, pesticides, machinery, etc.) (Hulsbergen et al., 2001). Currently, the efficiency and profitability of agriculture depends on energy consumption. As a result of increased levels of agrochemicals and the use of more productive varieties of crops increased continuously. Although modern, energy-intensive agricultural systems are very efficient, their durability is questionable because: rapid population growth makes it necessary to continue to increase in the cultivated fields of energy and water resources-fossil (fertilizers and irrigation) measures that are necessary to provide fertilizers, pesticides, irrigation and mechanization are non-renewable and agricultural environment is degraded by erosion and water pollution both biological resources and fresh (Pimental and Pimental, 2005). The aim of the study was to provide a descriptive analysis of the energy consumption of agriculture in Islamabad in 2014. This analysis is important to carry out the necessary improvements that will lead to a more efficient and environmentally friendly production system.

Materials and Methods:

The present study was conducted at the Islamabad, Pakistan, during autumn season 2014. Experimental field consisted of 09 plots, each with length 10 m × width 10 m, organized randomized complete block design with three replications. Seeds of maize were dibbled 5 cm depth, keeping row to row distance 75 cm and seed to seed distance 20 cm. Maize was sown at the @ 25 kg ha^{-1} and fertilizer application @ 140-70-70 kg ha^{-1} NPK was applied. Complete dose of NPK applied at the time of sowing, the remaining doses of N were applied in two splits. Moreover, the process has been applied before the first thinning of irrigation to keep the plants at a distance suitable five stations were selected at random from each plot and tagged. All the data were subject to analysis of variance (ANOVA) using the investigation of variance procedure (Steel and Torrie, 1980). The treatment mean divided using least significant difference (LSD) at 0.05 level of probability. A MF diesel tractor 75 hp was used for tillage operation; implements included cultivator, mould board plow and zero tillage. Energy investigations were performed based on field operation; tillage, fuel, human labour, seed, fertilizing and harvesting, all these sources involved in the production process. The energy use per hectare for every field operation was computed by the following equation (Moerschner and Gerowitt, 2000):

$$ED = h \times AFU \times PEU \times RU$$

where:
ED = Specific direct energy use (fuel) for a field operation, MJ ha^{-1}.
h = Specific working hours per run, h ha^{-1}
AFU = Average fuel use per working hour, L h^{-1}
PEU = Specific energy value per liter of fuel, MJ L^{-1}
RU = Runs, number of applications in the considered field operation.

$$EID = RATE \times MATENF$$

Where,
EID = indirect energy input, MJ ha^{-1}
RATE = application rate of input, kg ha^{-1}
MATENF = energy factor of material used, MJ kg^{-1}

$$LABEN = \frac{Labour \times Time \times Labenf}{Area}$$

where:
LABEN= labour energy, MJ ha^{-1}
Labour = number of working laborers
Time= operating time, h
Area= operating area, ha
Labenf = labour energy factor, MJ h^{-1}

Energy equivalents of the input used in maize production are given in Table-1. The data on energy use have been taken from a number of references, as indicated in the Table 1.

Table 1 Energy equivalents of different input and output used in field crop production

Input	Energy equivalents (MJ)	Reference
Human labour (h)	2.3	Yaldiz *et al*, 1990
Diesel fuel (L)	47.80	Safa *et al*., 2002
Chemical Fertilizers (kg)		
Nitrogen	61.53	Pimental, 1979
Phosphorus	12.56	Pimental, 1979
Potassium	6.7	Pimental, 1979

Maize Seed (kg)	14.7	Panesar, B.S. 2002

Results and Discussions:

Yield: The field experiment was performed in order to evaluate the productivity of each tillage methods and to relate it to the input energy consumption. The mean yield results are shown in Fig. 1, the result revealed that significant increase in maize grain yield (4380 kg ha^{-1}) highest in mouldboard plow as compared to (3972 kg ha^{-1}) in cultivator, while the lowest maize grain yield in (3136 kg ha^{-1}) zero tillage. These results are compared with finding of Arora *et al* (1991), that deep plowing is beneficial for maize. Kersten and Hack (1991) observed that best results could be achieved by ploughing against no till cultivation.

Input-output energy: The input and output energy values used in maize production as can be showed Table. 2 the total input energy was observed maximum under mouldboard plow (12387 MJ ha^{-1}) followed by cultivator (11383 MJ ha^{-1}) and lowest input energy was found in zero tillage (11301 MJ ha^{-1}). The result indicated that higher output energy was obtained in mouldboard plow (64386 MJ ha^{-1}), followed by cultivator (58388 MJ ha^{-1}) and minimum output energy found in zero tillage (46099 MJ ha^{-1}). The net energy was find out maximum in mouldboard plow (51999 MJ ha^{-1}), followed by cultivator (47005 MJ ha^{-1}) and the minimum net energy observed in zero tillage (34798 MJ ha^{-1}).

Conclusion:

It was concluded that different tillage methods were evaluated on the basis of yield, input/output energy of maize crop. Mouldboard plow had the maximum input/output energy gain as compared to cultivator and zero tillage treatment gave the lowest input/output energy. Mouldboard plow used high energy as compared to cultivator and zero tillage, for the farmers who cannot afford much inputs energy cost, cultivator can be recommended to grow maize crop successfully on the basis of energy input-output. Further studies are also recommended for the researchers to carry out such similar studies in maize crop.

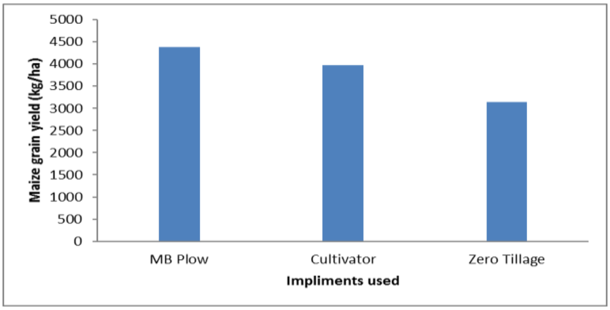

Fig. 1 Performance of Different Soil Tillage Systems on Grain Yield of Maize Crop using LSD at 5% probability.

Table 2. The energy input-output for autumn-2014 sown maize.

Input energy (MJ ha^{-1})	Mouldboard plow	Cultivator	Zero tillage
Human labour (MJ ha^{-1})			
- Sowing	184	184	-----
- Harvesting	368	368	368
Diesel (MJ ha^{-1})			
- Mouldboard plow	1505.5	-------	------
- Cultivator	------	502.3	--------
- Zero tillage	--------	------	603.8
Fertilizer(MJ ha^{-1})			
- Nitrogen (140 kg ha^{-1})	8614	8614	8614
- Phosphorus (70 kg ha^{-1})	879	879	879
- Potassium (70 kg ha^{-1})	469	469	469
Seed (MJ ha^{-1})	367.5	367.5	367.5
Total input energy (MJ ha^{-1})	12387	11383	11301
Output energy (MJ ha^{-1})	64386	58388	46099
Net energy gain (MJ ha^{-1})	51999	47005	34798
Output-input ratio	5.19	5.12	4.07

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