Journal of AgriSearch 1(3):168-172
Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Energy Requirement for *Kharif* Maize Cultivation in Panchmahal District of Gujarat

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ARTICLE INFO

Received on	: 30.06.2014
Revised received on	: 28.07.2014
Accepted on	: 18.08.2014
Published online	: 07.09.2014

ABSTRACT

A study was carried out to collect farm operations data of *kharif* maize cultivation in district Panchmahal of Gujarat and to estimate and analyze the total input energy requirement in kharif maize crop, both source wise and operation wise along with total output energy. To accomplish this, a survey was conducted through structured questionnaire to 93 randomly selected farmers in four rainfed villages of three talukas Kalol, Godhra and Khanpur of the district. The raw data obtained was analyzed after converting data into energy equivalents. It was concluded that total input energy requirement for kharif maize cultivation in Panchmahal district was 13205.10 MJ/ha. Out of which direct energy contributed 45.44% and indirect energy contributed 54.56%. Fuel energy was maximum utilizing direct energy source while fertilizer energy was maximum required indirect energy source. Seed bed preparation consumed maximum operation wise direct energy with a value of 2887.78 MJ/ha. Fertilizer application was maximum indirect energy consuming operation with energy consumption of 3702.59 MJ/ha. Total output energy for kharif maize cultivation was 52873.29 MJ/ha with net energy return of 39668.19 MJ/ha and energy productivity of 0.21 kg/MJ.

Keywords : Energy, Maize, Specific Energy, *Kharif*.

INTRODUCTION

Energy is one of the most valuable inputs in crop production. Energy needed for agricultural production is about 3% of the national energy consumption in developed countries and about 5 to 6% in developing countries (Stout, 1989). Sufficient availability of the exact energy and its effective and efficient use are prerequisites for improved agricultural production and profitability. All the farming operations in crop production require energy inputs in various forms and in varying magnitude. Input energy in agriculture is divided into two categories as direct and indirect. Direct energy is required to perform various tasks related to crop production processes such as land preparation, irrigation, intercultural, threshing, harvesting and transportation of agricultural inputs for farm produce (Singh, 2000). Efficient use of energies helps to achieve increased production and productivity and contributes to the economy, profitability and competitiveness of agriculture sustainability (Ozkan *et al.,* 2004 and Singh *et al.,* 2002).

Although energy consumption is increasing with time, the energy use efficiency is declining constantly. Energy analysis, therefore, is necessary for efficient management of scarce resources for improved agricultural production. It would identify production practices that are economical and effective. Other benefits of energy analysis are to determine the energy invested in every step of the production process (hence identifying the steps that require least energy inputs), to provide a basis for conservation and to aid in making sound management and policy decisions (Debendra and Bora, 2008).

Thus, it is our need to carry out energy analysis of crop production system and to establish optimum energy input at different levels of productivity prevailing in the area. In this regard, a research was aimed to assess the energy analysis of major crop of the area i.e. *kharif* maize production along with economic analysis with an

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objective to estimate and analyze the total input energy requirement (direct & indirect energy) in *kharif* maize crop, both source wise and operation wise along with total output energy.

MATERIALS AND METHODS

The study was conducted to investigate the energy and economic analysis of kharif maize crop grown in the Panchmahal district. The information was collected from farmers of four villages (Jakharipura, Kandach, Kankanpur and Ganagata) located in three talukas of the Panchmahal district. To conduct the research, district Panchmahal was selected as study area which is one of the highest producer districts of maize in Gujarat. The district is located in semi arid region with latitude of N 22°30′ to 23°23′ and longitude of E 73°15′ to 74°75 and at 119 m above mean sea level.

In the present study, the survey work was carried out to randomly select 93 farmers in the 4 villages to know the present status of consumption of various inputs by the farmers in *kharif* maize production along with the fodder and grain yield. To do this a structured questionnaire was prepared and compiled into a survey performa covering all the needful information required for the energy analysis of maize crop production. The surveyed area is considered under rainfed condition. Since, the data obtained from survey was primary data; it was difficult to obtain required information regarding energy involved in crop production directly from that data.

Thus, all the data related to various operations was converted into energy requirement on unit area basis for both operation wise and source wise. Energy from inputs and outputs were calculated by converting the physical units of inputs and outputs into respective energy units by using appropriate energy equivalents to find out the energy use pattern.

Total output energy produced by *kharif* maize production was calculated by adding the energy equivalents to fodder as well as maize grains (Eq.1) which were obtained by multiplying their Quantity per unit area to energy equivalent factors (Table 1).

Total output energy =
Energy from Maize grains + Energy from fodder [Eq.1]

Energy Efficiency Parameters

There are different energy efficiency parameters described in equation 2 to 5 below:

$$\text{Energy Ratio} = \frac{\text{Output Energy (MJ/ha)}}{\text{Input Energy (MJ/ha)}} \quad \text{[Eq.2]}$$

$$\text{Specific Energy (MJ/kg)} = \frac{\text{Input Energy (MJ/ha)}}{\text{Crop Yield (kg/ha)}} \quad \text{[Eq.3]}$$

$$\text{Energy Productivity (kg/MJ)} = \frac{\text{Crop Yield (kg/ha)}}{\text{Input Energy (MJ/ha)}} \quad \text{[Eq. 4]}$$

Net Energy Return (MJ/ha) =

Output energy (MJ/ha) – Input energy (MJ/ha) [Eq.5]

Table 1: Energy Equivalents of different parameters

Parameter	Unit	Energy equivalents (MJ)	References
Human labour	hr	1.96	Ozkan *et al.* (2004) and Yilmaz *et al.* (2005)
Animal (bullock)	Pair-hr	8.07	Lal *et al.* (2003)
Machinery	hr	62.7	Erdal *et al.* (2007) and Esengun *et al.* (2007)
Diesel	l	56.31	Kizilaslan (2009), Singh and Mittal (1992) and Erdal *et al.* (2007)
Farm yard manure	kg	0.3	Kizilaslan (2009) and Demircan et al. (2006)
Nitrogen	kg	60.6	Mandal (2002), De *et al.* (2001), Mani (2007) and Shrestha (1998)
Phosphate	kg	11.1	Mandal (2002), De *et al.* (2001), Mani (2007) and Shrestha (1998)
Small equipment	kg	6 – 8	Kitani (1999)
Fodder	100 kg	293	Lal *et al.* (2003)
Seed	kg	14.7	Ozkan *et al.* (2004) and Mandal (2002)

RESULTS AND DISCUSSION

Primary data regarding various field operations of *kharif* maize crop cultivation was collected through survey work in 4 villages. The data were examined and converted into energy equivalents and further analyzed to know the direct & indirect energy, total input energy for both source wise and operation wise along with total output energy.

Input-Output Energy Trends in Different Villages

The data collected from the villages was analyzed and it was found out that maximum requirement for energy was in village Gangata was 14469.67 MJ/ha and least in village Kankanpur was 11339.50 MJ/ha. Fig.1 shows the direct, indirect, total input and output energy in *kharif* maize production in different villages. The requirement of direct energy was maximum in Jakhripura village with value of 6949.38 MJ/ha whereas the maximum indirect energy requirement was in Gangta village with value of 8825.80 MJ/ha. Village Jakhripura produced highest value of energy output from *kharif* maize while Kankanpur village produced lowest.

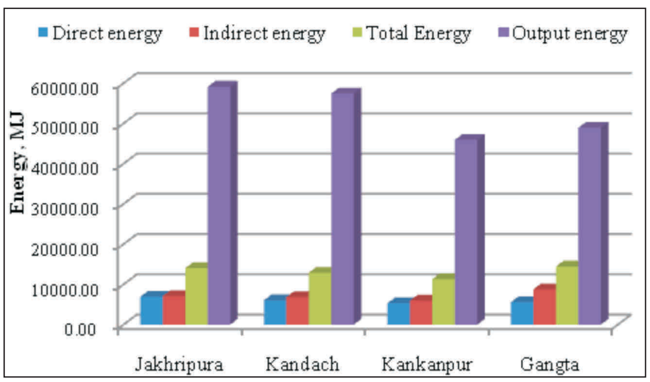

Fig 1: Input and output energy pattern in different villages

Operation Wise Average Input Energy

To assess the energy scenario of the area, average of energy input and outputs of all the villages were taken. The maize crop cultivation was divided into different operations and operation wise energy was calculated. The Energy involved in each operation was further divided into direct energy and indirect energy. Seed bed preparation consumed maximum operation wise direct energy followed by threshing with a value of 2887.78 MJ/ha and 1353.22 MJ/ha, respectively. In case of indirect energy, fertilizer application was maximum energy consuming operation with energy consumption of 3702.59 MJ/ha. FYM application came next With 1945.64 MJ/ha indirect energy as shown in fig. 2.

Source Wise Average Input Energy

Among different direct sources, fuel energy was used maximum with the value of 4240.81 MJ/ha (Table 2), whereas in case of indirect energy sources, fertilizer energy was consumed maximum with the average value of 3702.59 MJ/ha (Fig.3).

Total Input Energy

The average value of total input energy was 13205.10 MJ/ha. Out of which direct energy contributed 45.44 % and indirect energy contributed 54.56 %. Total direct energy was 6000.81 MJ/ha while total indirect energy was 7204.29 MJ/ha. Total energy requirement was maximum in fertilizer application with a value of 3917.42 MJ/ha. It was followed by seed bed preparation 3684.72 MJ/ha.

Total Output Energy

The average value of maize grain production in all the villages was 27.90 q/ha and fodder was 40.47 q/ha. Total output energy for *kharif* maize cultivation was 52873.29 MJ/ha. Out of which main produce i.e. maize contributed 41016.72 MJ/ha and rest by the fodder.

Energy Efficiency Parameters

Different energy efficiency parameters were calculated to know the usefulness of *kharif* maize production in the region and to find out the relationship between input and output parameters. The values of different parameters are given in Tab1e 3.

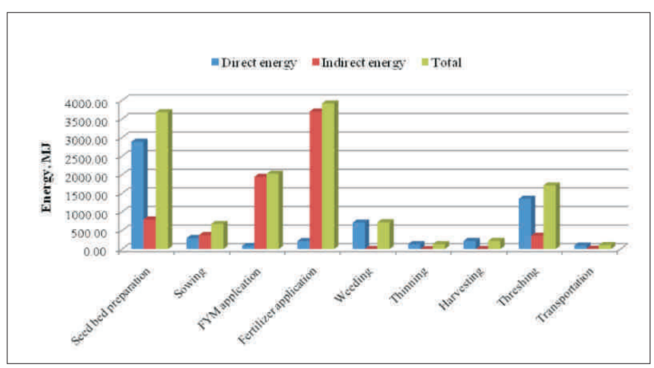

Fig 2: Operation wise direct and indirect input energy

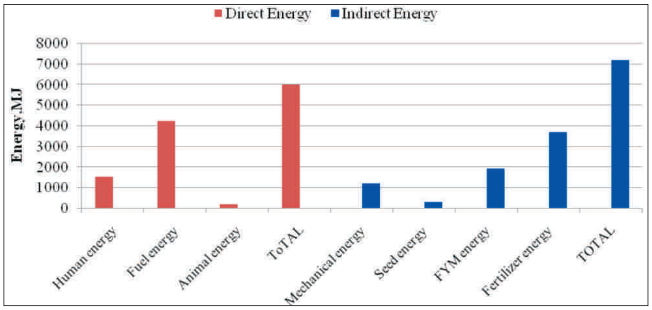

Fig 3: Source wise direct and indirect input energy

Table 2: Details of source wise usage

Sources	Unit	Usage per ha	Total energy (MJ)	Percentage of total energy (%)
Human	hr	795.41	1559.0	11.81
Fuel	l	75.31	4240.8	32.12
Animal	hr	24.91	201.0	1.52
Seed	kg	23.28	342.2	2.59
FYM	kg	6485.47	1945.7	14.73
Nitrogen	kg	55.02	3334.2	25.25
Phosphate	kg	33.18	368.3	2.79
Machinery	hr	18.64	1168.7	8.85
Small/stationary implement (seed drill, sickle)	hr	537.5	45.1	0.34
TOTAL			13205.1	100.00

Table 3: Different energy efficiency parameter

Parameter	Value
Energy Ratio	4.01
Specific energy	4.73 MJ/kg
Energy productivity	0.21 kg/MJ
Net Energy Return	39668.19 MJ/ha

CONCLUSION

Seed bed preparation and fertilizer application were maximum direct and indirect energy consuming operations, respectively. Among different energy sources fuel energy and fertilizer energy were maximum utilized direct and indirect energy sources, respectively. Total energy requirement was maximum in fertilizer application and followed by seed bed preparation. The average value of total input energy requirement for *kharif* maize was 13205.10 MJ/ha. Out of which direct energy contributed 45.44 % and indirect energy contributed 54.56 %.

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Correct Citation: Patel PG, Bhut AC and Gupta P. 2014. Energy requirement for kharif maize cultivation in panchmahal district of Gujarat. *Journal of AgriSearch* **1**(3):168-172