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Research Article

EVALUATION OF ENERGY REQUIREMENT FOR WHEAT PRODUCTION IN MADHYA PRADESH

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Abstract: In this Research, our aim was to make an energy analysis of wheat production in MP. This study wear to determine the energy input-output of wheat production to investigate the efficiency of energy consumption of wheat production the surveys wear done in the 120 farmers field. In wheat production, energy input was calculated as 17212.33 MJ/ha and energy output was calculated as 97100.67 MJ/ha. Energy inputs consist of 23.6 % chemical fertilizers energy, 29.2 % diesel fuel energy, 19.9 % electric energy, 2.7 % machinery energy, 4.4 % FYM and 7.5 % human labour energy. Output– input energy ratio and specific energy of production were 5.64, 4.84 MJ/kg respectively.

Keywords: *Wheat, Energy Ratio, Yield, Specific energy*

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Introduction

Energy has an influencing role in the development of key sectors of economic importance such as agriculture, industry and transport. Many researchers motivate and focus their research on energy management for different area works. Energy consumption in agriculture for developing countries has been increasing rapidly due to recent economic growth and development [1]. However, increased input use in agricultural production may not bring maximum profits due to increasing production costs [2]. Energy, economics, and the environment are mutually dependent [3]. The productivity and profitability of agriculture depend upon energy use. The amount of energy used depends on the mechanization level, quantity of active agricultural work and cultivable land [4,5].

Agriculture is both a producer and consumer of energy. It uses large quantities of locally available non-commercial energy, such as seed, manure and animate energy, as well as commercial energies, directly and indirectly, in the form of diesel, electricity, fertilizer, plant protection, chemical, irrigation water, machinery etc [6]. Efficient use of these energies helps to achieve increased production, productivity and contributes to the profitability and competitiveness of agricultural sustainability in rural living [7]. However, more intensive energy use has brought some important human health and environment problems so efficient use of inputs has become important in terms of sustainable agricultural production [8].

Wheat (*Triticum aestivum* L.) is among the oldest and most extensively grown of all crops. It is a main cereal cultivated throughout the world along with rice, barley, maize, rye, sorghum, oats and millet. Nowadays, wheat cultivars have been developed for different qualities in accordance with the development of genetic recombination [9]. Wheat is grown under irrigated as well as rain-fed conditions worldwide. Under rain-fed conditions the developing grains are frequently exposed to mild to severe stress sat different stages of grain development [10].

The total area under wheat cultivation in India is 28.46 million hectare and total production is 80.81 million tonnes with average productivity of 2830 Kg/ha (reff. 2009-10 data). The area, production and productivity of wheat in the state of Madhya Pradesh are 5.81 million hectare, 6.68 million tonnes and 1050 kg/ha, respectively [11].

Material and Methods

A preliminary survey was conducted from 120 farmers in different villages by using a face to face questionnaire to investigate the energy utilization pattern for wheat production during 2009-10 in Madhya Pradesh. A stratified random sampling method was adopted to find the sample size [12].

$$n=\frac{(\sum N_h S_h)^2}{(N^2D^2+\sum N_h S_h^2)}$$

Where n is the required sample size, N is the number of total holding in the target population, Nh is the number of the population in the h stratification, S_h is the standard deviation in the h stratification, S_h^2 is the variation in the h stratification, D^2 is equal to d^2/z^2, d is the precision, where 5% is permissible error and z is the reliability coefficient (1.96, which represents 95% reliability). Farmers were randomly selected and contacted with the help of Gram-pradhan. Collecting preliminary information's related to their inventory, irrigation sources and type of farming system. The source wise energy input used for wheat production including human power, animal power, diesel fuel, electricity, seeds, farm yard manure, fertilizer, chemicals and machinery were determined per hectare. In order to determined input and output energy, multiplying the physical quantities of input and output with their energy conversion factors gave the energy equivalents in MJ per hectare unit. The energy output arises mainly from the product and by-products of crops. Energy output is calculated from main products by multiplying production and their corresponding energy equivalent. The energy vales were calculated by transforming data using energy equivalents shown in [Table-1].

The energetic efficiency of the agricultural systems was calculated by the relation between energy input and output. Based on the energy equivalents of inputs and outputs, the indices of energy use efficiency, energy ratio, specific energy, energy productivity and net energy were calculated by using the following equations.

Energy Ratio = Output Energy (MJ/ha) / Input Energy (MJ/ha)

Specific Energy = Input Energy (MJ/ha) / Grain Output (Kg/ha)

The primary data were computerized as per requirement of FORTRAN programme available with energy requirement scheme.

The collected raw data were coded in to required format (MS DOS) and processed by using different programmes to being usable tabular form. These processed data in FORTRAN then translated to MS-EXCEL worksheet for further analysis work.

Table-1 *Energy equivalents of input and output in wheat production*

Energy sources	Units	Equivalent energy, MJ/unit	Reference
Input			
Human labour			
Man	h	1.96	[13,14]
Woman	h	1.57	[13,14,15]
Animal-pair	h	10.1	[13,14,15]
Machinery	h	64.8	[7,15]
Diesel	l	56.31	[7,13,14]
Petrol	l	48.2	[13]
Fertilizers			
Nitrogen (N)	Kg	60.6	[13,16]
Phosphorus (P_2O_5)	Kg	11.1	[13,16]
Potassium (K_2O)	Kg	6.7	[13,16]
Farm yard manure	Kg	0.3	[7,17]
Electricity	kWh	11.93	[15,17]
Chemical			
Superior	l	120	[7,15]
Inferior	kg	10	[7,15]
Output			
Wheat	Kg	14.7	[5,13,15]
Straw	Kg	12.5	[5]

Result and Discussion

[Table-2] shows that the operation wise energy use pattern for wheat crop in different farmers category. The variation of energy use pattern in different farmers category was 8884 - 11319.67 MJ/ha with mean value is 10215.83 MJ/ha. The significant difference in the energy utilization amongst all the farmers category was observed in performing all the operations for wheat cultivation. The maximum energy consumption was observed in large farmers (11319.67 MJ/ha) compared to medium farmers (10604.33 MJ/ha), small farmers (10055.33 MJ/ha) and marginal farmers (8884 MJ/ha). Large category farmers were use large machinery's and high horse power tractor in field operation so large farmers higher energy expenditure as compared to other category farmers.

Table-2 *Operation wise energy use pattern (MJ/ha) for wheat crop*

Field operations	MF	SF	MSF	LF	Wt. avg.
Seedbed preparation	1641.33	1905.67	2160.33	2286.67	1998.50
Sowing	1074.00	1096.67	1151.00	1219.67	1135.33
irrigation	3896.67	4335.67	4510.33	4964.00	4426.67
Fertilizer application	13.00	19.33	15.67	104.33	38.08
Harvesting	518.33	615.33	615.67	726.33	618.92
Threshing	1223.67	1366.00	1372.33	1056.67	1254.67
Transportation	517.00	716.67	779.00	962.00	743.67
Total	8884.00	10055.33	10604.33	11319.67	10215.83

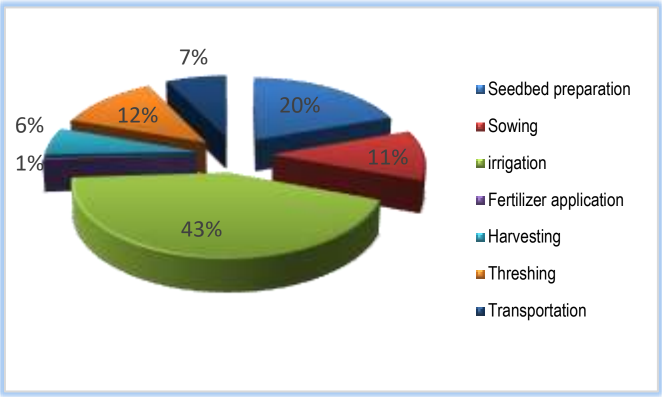

Fig-1 Operation wise energy

[Fig-1] show that percentage of operation wise energy required in irrigation was maximum (43%) of total energy followed by seedbed preparation (tillage) (20%), threshing (12%), sowing (11%), transportation (7%), harvesting (6%) and fertilizer application (1%). Higher energy use in irrigation by all category farmers due to wheat is *rabi* season crop and in this season no rainfall so this crop depend only irrigation due to this reason farmers was more energy consume in irrigation in field. After this seedbed preparation activity farmers use machinery lick tractors and tillage implements in field so in operation wise activity second highest energy consumption in seedbed preparation.

[Table-3] shows that the field total energy input from different source was 17841.42 MJ/ha. The variation of source wise energy use pattern in different farmers category was 15567.33 - 19687 MJ/ha. Highest source wise energy input in large category farmers and lowest in marginal category farmers. The energy inflow through diesel was 5203.25 MJ/ha followed by fertilizer 4210.92 MJ/ha.

Table-3 *Source wise energy use pattern (MJ/ha) for wheat crop*

Source of energy	MF	SF	MSF	LF	average
Human	1314.33	1233.00	1589.67	1181.00	1329.50
Diesel	3579.33	4747.67	5777.33	6708.67	5203.25
Electric	2721.67	3060.00	4241.67	4207.00	3557.58
Seeds	2188.67	2371.00	2361.67	2202.33	2280.92
FYM	901.67	1135.67	621.67	450.00	777.25
Fertilizer	4502.33	4069.33	3961.00	4311.00	4210.92
Machinery	356.33	397.00	547.67	627.00	482.00
Total	15564.33	17013.67	19100.67	19687.00	17841.42

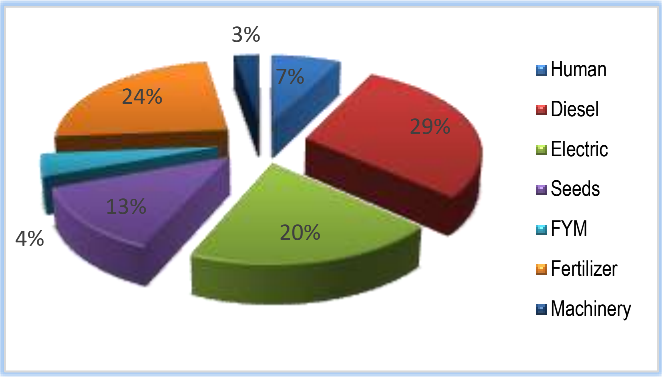

Fig-2 Source wise energy

In [Fig-2] show that percentage of source wise energy consumption, maximum energy consumes in diesel (29 %) for tillage and irrigation by diesel pumps. The indirect source of energy the fertilizer consumption energy is 24% is second largest source wise energy consumption. Other source electric, seed, human, FYM and machinery energy consumption was 20%, 13%, 7%, 4% & 3%.

Table-4 *Energy indicates of wheat production*

	Average
Energy use in tillage (MJ/ha)	1998.00
Energy use in pre harvest operation (MJ/ha)	13940.67
Energy use in post-harvest operation (MJ/ha)	3272.33
Total direct energy (MJ/ha)	9455.00
Total indirect energy (MJ/ha)	7758.33
Ratio of direct/indirect energy	1.22:1
Avg. Yield of wheat kg/ha	3596.33
output energy through grains (MJ/ha)	52146.67
output energy through by products (MJ/ha)	44954.00
Total output energy (MJ/ha)	97100.67
Output input energy ratio	5.64
Specific energy	4.84

Total direct and indirect energy was used by farmers is 9455 MJ/ha and 7758.33 MJ/ha and average production of wheat is 3596.33 kg/ha. The output input ratio was 5.73 and specific energy was 4.84 shows in [Table-4].

Conclusion

This study was undertaken to evaluate the energy use pattern for the growing wheat crop in Madhya Pradesh. Data were collected from 120 farmers which were selected based on random sampling method, where wheat is cultivated as one of the major crops. Total energy consumption in wheat production was 17212.33MJ/ha of which chemical fertilizer, diesel fuel and electric energy consumption was 23.6 %, 29.2 %and 19.9 %, respectively.

Direct and Indirect energy were 54.9 % and 45.1 % respectively. Output Energy was 97100.67 MJ/ha. Output- input energy ratio and specific energy of production were 5.64, 4.84 MJ/kg respectively. On the basis of linear programming the prediction of energy requirement for different levels of yield reveals that there exists significant scope to enhance wheat productivity through increased use of input energy through fertilizer and machinery.

Application of research: Energy requirement for wheat production.

Research Category: Energy requirement, Wheat cultivation

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Study area / Sample Collection: Madhya Pradesh, India

Cultivar / Variety / Breed name: Wheat

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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