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ENERGY INPUT : OUTPUT RATIO IN WHEAT CROP IN VILLAGE CHARKHI OF DISTRICT CHARKHI DADRI OF HARYANA

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Abstract: The present study examines the energy input : output ratio in wheat crop in village Charkhi of district Charkhi Dadri of Haryana. The study is primarily based on primary data but for physical, and socio-economic aspects of the village, secondary data are also utilized. The primary data regarding energy consumption in various agricultural operations or activities like field preparation, sowing, irrigation, fertilizer application, harvesting, and threshing under wheat cultivation is collected from the farmers of this village through a structured interview method in 2021. Agricultural operation-wise energy consumption in wheat cultivation is recorded maximum in irrigation followed by fertilizer application, field preparation, sowing, harvesting, and threshing. Source-wise energy consumption is recorded maximum in chemical fertilizers followed by electric power, seeds, tractor power, and human power. The energy input : output ratio of the wheat crop is 0.365 which shows that it is an energy-efficient crop. In order to reduce the energy consumption in various agricultural operations, rainwater harvesting and natural farming should be adopted in this area.

Keywords: Wheat, agricultural activities, threshing, agricultural production, energy efficiency, crop residues

1. INTRODUCTION

Energy is an essential component for the development of human society and it also improves the standard of living. In the present global economy, the use of energy has become an indicator of a country's modernization including economic growth and development. The economic development of a country can be measured by structure, quality and quantity of energy consumption. Energy is produced by consuming various resources which are utilized by different activities of human beings. Agriculture is one of the traditional and imperative occupations of human beings which has consumed energy as vital input since primitive age.

The share of energy consumption in agriculture sector of the world economy especially in developing countries like India has been increasing over the period due to the increasing modernization and mechanization of traditional agriculture to meet the requirement of food production, economic growth and other important development objectives. In the present time, agriculture uses various types of energy such as commercial energy in the form of diesel and electricity, non-commercial energy in the form of human energy, animal power, crop residues, animal residues and farm yard manure, chemical energy in the form of chemical fertilizers, pesticides and insecticides, mechanical energy in the shape of diesel pump set, electric motor, tractor, thresher, reaper, crusher etc.

Though, it is a fact that the increasing use of energy in agriculture has increased agricultural production but it has also created various environmental problems such as global warming, soil and water pollution and destruction of biodiversity. Therefore, there is a need for sustainable agricultural development in India. This type of agricultural production system includes the balance and efficient use of energy inputs, efficient use of irrigation water by using micro-irrigation methods, greater use of organic and green manure, improved agricultural operations and application of integrated pest management.

The effective and efficient use of energy inputs in agriculture will reduce environmental problems, conserve the destruction of natural resources and promote sustainable agriculture as an economical and profitable production system (Zehadi et al., 2015). The energy inputs and outputs are prime factors of agriculture to determine the energy efficiency and environmental impact of crop production. The energy efficiency of the agricultural production system has been calculated by the ratio of energy input and output (Alam et al., 2005). The present study examines the energy input-output ratio in wheat crop in village Charkhi of district Charkhi Dadri of Haryana.

2. THE STUDY AREA

Charkhi Dadri is one of the districts of Haryana which came into existence on 01 December 2016 after being separated from district Bhiwani. Charkhi Dadri district comprises three community development blocks namely Dadri, Bond Kalan, and Badhra. Village Charkhi comes under Dadri community development block and the village is having an area of 18.82 sq. km with a population of 6,822 persons as per 2011 census. The density of population of this village is 362 persons per sq. km. and the sex ratio is 902 females per thousand males. The literates in the village are 4,527 persons. The total workers (main and marginal) in the village are 40.09 per cent to the total population of the village. The persons under main workers are 77.40 per cent to the total workers of the village. The persons under cultivators are 65.04 per cent to the total main workers of the village, while it is 01.70 per cent in case of agricultural labourers in the village. Village Charkhi is mainly a plain area which comprises of sandy and sandy loamy soil. The climate of this village is semi-arid and tropical steppe in nature. The summer and winter seasons are very hot and cool respectively. The maximum temperature in summer season reaches to 47°C and falls to 2°C in winter season. The average annual rainfall is 35 cm with unequal distribution throughout the year. The major *kharif* crops grown in this village are bajra, and moong, while the major *rabi* crops are wheat, barley, gram, and mustard. Wheat crop is a *rabi* crop and it is grown after *zaid kharif* season. *Zaid kharif* season falls between *kharif* and *rabi* season during which the land is vacant free for some days so that it may retain its fertility.

3. OBJECTIVES

The major objectives of the present study are as follows:

a. To find out the agricultural operation-wise, and source-wise energy input in wheat crop per unit area in village Charkhi of district Charkhi Dadri.
b. To find out the energy input : output ratio in wheat crop per unit area in village Charkhi of district Charkhi Dadri.

4. RESEARCH DESIGN AND METHODOLOGY

The present study is primarily based on primary data but for the geographical background of the area regarding the physical, and socio-economic aspects, secondary data are utilized. For physical setting, the data is mainly collected from the Encyclopedia of Haryana. For socio-economic aspects, the data is mainly collected from the Statistical Abstract of Haryana, District Census Handbook Bhiwani and from other official documents.

The present study deals with energy input : output ratio in wheat crop in village Charkhi of district Charkhi Dadri for which primary data is collected from the farmers of this village through structured interview method in 2021 to know the information regarding energy consumption in various agricultural operations or activities namely land preparation, sowing, irrigation, fertilizer application, harvesting, and threshing under wheat cultivation. The major sources of energy like human, electricity, chemical fertilizers, seeds, and tractor power have been considered for this study. Varied sources of energy taken have been converted into kilo calories (k.cal) with the help of a standard conversion table as given below:

Table 4.1: Energy Equivalents for different Inputs and Outputs

Category	Energy Equivalents
Man	470 k.cal/hr
Electric Tubewell (20 hp)	12,820 k.cal/hr
Tractor (30 hp)	19,230 k.cal/hr
Nitrogen (Fertilizer)	14,325 k.cal/kg
Phosphate (Fertilizer)	2,650 k.cal/kg
Potash (Fertilizer)	1,600 k.cal/kg
Seeds and Outputs : Cereals (wheat)	3,510 k.cal/kg

Source: Tata Energy Research Institute, 1987-88, **TERI Energy Data, Directory and Yearbook**, New Delhi.

As per conversion table 4.1, the total energy used per acre of land by each respondent is calculated and finally the average energy input in agriculture in kilo calories per acre of land for village Charkhi is calculated by dividing the total energy input per acre of land of all the selected respondents by the total number of selected respondents of this village. Likewise, agricultural productivity or output have been measured in term of kilo calories per acre of land and the average agricultural productivity per acre of land in wheat crop is calculated for this village by dividing the total agricultural productivity of all the selected respondents by the total number of selected respondents of this village. Energy input : output ratio in wheat cultivation is also worked out. The data regarding socio-economic characteristics of the village are presented by per cent method.

5. RESULTS AND DISCUSSION

5.1. Agricultural Operation-wise Energy Input

Although, there may be many agricultural operations or activities involved in wheat cultivation but here in this study the main agricultural operations or activities in wheat cultivation as taken into account for village Charkhi are as follows:

Table 5.1.1:Agricultural Operation-wise Energy Input in Wheat Crop in Village Charkhi of District Charkhi Dadri, 2021 (Average k.cal/acre)

Agricultural Operation	Energy Input (Average k.cal/acre)
Field Preparation	7,50,110.63
Sowing	1,60,100.00
Irrigation	7,97,400.00
Fertilizer Application	7,86,660.00
Harvesting	37,600.00
Threshing	31,665.00
Total	25,63,535.63

Source: Structured Interview, 2021 conducted by Dr. Mohinder Singh Kadayan

Table 5.1.1 reveals that in field preparation the total average energy input is 7,50,110.63 k.cal/acre in wheat cultivation in village Charkhi. Generally, there are 3 ploughings done in this village by tractor (30 hp) (with harrow) and in each ploughing the tractor consumes 45 minutes or 0.75 hour (14,422.5 k.cal/hr), thus making a total of 32,450.63 k.cal/acre (3 x 0.75 hr x 14,422.5 k.cal/hr). The man-hours required per ploughing per acre of land along with tractor operation is 1 i.e. 470 k.cal/hr thus, making a total of 1,410 k.cal/acre (3 hrs x 470 k.cal/hr). Field preparation or ploughing is an important activity under wheat cultivation as it softens the soil which helps the roots to penetrate deep inside the soil and make them breathe easily. By ploughing various micro-nutrients are mixed properly in the soil which helps in the proper growth of plants. The field is levelled by a leveller for the purpose of sowing. On the day of final ploughing Di-ammonium Phosphate (DAP) amounting to 50 kg per acre of land is also sown at the depth of 10 cm in the soil with the help of a tractor-driven cultivator. The total energy consumption in DAP is 7,16,250 k.cal/acre (50 kg x 14,325 k.cal/kg).

The total average energy consumed in case of sowing wheat seed is 1,60,100 k.cal/acre. 40 kg of wheat seed per acre of land is required in this area. Thus, the total energy consumed by wheat seed is 1,40,400 k.cal/acre (40 kg x 3,510 k.cal/kg). The man-hour required in sowing wheat seed per acre of land is 1, thus, making a total of 470 k.cal/acre (1 hr x 470 k.cal/hr). The tractor (30 hp) (with seed driller) requires 1 hour for sowing wheat seed per acre of land, thus, making a total of 19,230 k.cal/hr (1 hr x 19,230 k.cal/hr). Wheat is cultivated in the month of November in this village.

The total average energy consumed in case of irrigation is 7,97,400 k.cal/acre. Generally, 5 waterings are required for wheat cultivation in this area and each watering consumes 12 hrs per acre of land. Therefore, in case of electric tubewell (20 hp) the energy consumed is 7,69,200 k.cal/hr (5 waterings x 12 hrs each x 12,820 k.cal/hr). The man-hours required are 60 for 5 waterings, thus, making a total of 28,200 k.cal/acre (60 hrs x 470 k.cal/hr). After one month of sowing wheat seeds, the farmers irrigate their fields mainly by sprinklers. The sprinkling irrigation in this sandy area is mainly dependent upon underground water and the underground water is bored by an electric tubewell (20 hp). The remaining irrigations are given at an interval of 20 days each.

The total average energy consumed in chemical fertilizer application is 7,86,660 k.cal/acre. The quantity of chemical fertilizer used in this village is in a ratio of 50 : 20 : 10 per acre of land as Nitrogen : Phosphate : Potash respectively. Thus, the total energy input in fertilizer application is 7,85,250 k.cal/acre {[50 x 14,325 k.cal/kg (Nitrogen)] + [20 x 2,650 k.cal/kg (Phosphate)] + [10 x 1,600 k.cal/kg (Potash)]}. The man-hours required in broadcasting of chemical fertilizer per acre of land is 3, thus, making a total of 1,410 k.cal/acre (3 hrs x 470 k.cal/hr). Di-ammonium Phosphate (DAP) amounting to 50 kg per acre of land is sown before the sowing of wheat seed i.e. on the final day of ploughing.

The average energy consumed in harvesting wheat crop is 37,600 k.cal/acre. Harvesting is done manually and the man-hours required are 80 (10 men x 8 hrs). Thus, making a total of 37,600 k.cal/acre (80 hrs x 470 k.cal/hr). The harvesting of wheat crop is done in the month of April. Harvesting is done manually by a traditional instrument known as *Daranti* (sickle).

The average energy consumed in threshing of wheat crop is 31,665 k.cal/acre. Threshing is done by tractor (30 hp) (with thresher) which takes 1.5 hrs per acre of land accounting to 28,845 k.cal/acre (1.5 hrs x 19,230 k.cal/hr) and the total man-hours required are 6 (4 men x 1.5 hrs) thus, making a total of 2,820 k.cal/acre (6 hrs x 470 k.cal/hr).

5.2. Source-wise Energy Input

Although, there may be many sources of energy involved in wheat cultivation but in this study, the main sources of energy in wheat cultivation as taken into account for village Charkhi are as follows:

Table 5.2.1: Source-wise Energy Input in Wheat Crop in Village Charkhi of District Charkhi Dadri, 2021 (Average k.cal/acre)

Source of Energy	Energy Input (Average k.cal/acre)
Human Power	71,910.00
Tractor Power (30 hp)	80,525.63
Electric Power (20 hp)	7,69,200.00
Seeds	1,40,400.00
Chemical Fertilizers	15,01,500.00
Total	25,63,535.63

Source: Structured Interview, 2021 conducted by Dr. Mohinder Singh Kadayan

Table 5.2.1 reveals that chemical fertilizers are consuming maximum energy followed by electric power, seeds, tractor power, and human power amounting to 15,01,500, 7,69,200, 1,40,400, 80,525.63, and 71,910 average k.cal/acre respectively. The main chemical fertilizers used in wheat cultivation in village Charkhi are Nitrogen, Phosphate, and Potash amounting to 14,32,500, 53,000, and 16,000 average k.cal/acre respectively. Electric power is mainly used to bore underground water for sprinkling irrigation, while tractor power is used in field preparation or ploughing, sowing, and threshing in this village. Human power plays a vital role in wheat cultivation and it is mainly used in all agricultural operations or activities like field preparation, sowing, irrigation, chemical fertilizer application, harvesting, and threshing amounting to 1,410, 470, 28,200, 1,410, 37,600, and 2,820 average k.cal/acre respectively in this village.

5.3. Energy Input : Output Ratio

Wheat plays an important role in providing food security to the people of this area. As per the structured interview 2021, the production of wheat in village Charkhi amounts to 20 quintals per acre of land thus, making an energy output of 70,20,000 average k.cal/acre (2000 kg x 3,510 k.cal/kg). The energy input in wheat cultivation is recorded 25,63,535.63 average k.cal/acre for this village. Thus, the energy input : output ratio of wheat crop is 0.365. The energy input : output ratio is below 1 which states that this is an energy-efficient crop.

6. CONCLUSION

Agricultural operation-wise energy consumption in wheat cultivation is recorded maximum in irrigation followed by fertilizer application, field preparation, sowing, harvesting, and threshing amounting to 7,97,400, 7,86,660, 7,50,110.63, 1,60,100, 37,600, and 31,665 average k.cal/acre respectively in village Charkhi. Source-wise energy consumption is recorded maximum in chemical fertilizers followed by electric power, seeds, tractor power, and human power amounting to 15,01,500, 7,69,200, 1,40,400, 80,525.63, and 71,910 average k.cal/acre respectively. The energy input : output ratio of wheat crop is 0.365 which represents that it is an energy-efficient crop. The amount of energy consumption in irrigation is maximum in this area therefore, there is a great need for rainwater harvesting practices in order to conserve water. Rainwater harvesting should be adopted to get rid of water crises in this area. The network of canal irrigation should be widely spread for the development of agriculture in this area. Natural farming should be adopted to get rid of chemical fertilizers used in agriculture.

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