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Energetic analysis of rice production: A case study of Rohtak district in Haryana

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ABSTRACT : Paddy covers approximately 40-45 per cent of the total area covered by cereal crops in India. Rice production needs to be augmented to meet the growing demand. Rice crop cultivated under watery condition either by storing canal water or pumping water or both, by utilizing a lot of electric/diesel energy especially when pumping is carried out. The amount of rice production is a direct function of energy inputs and outputs. The aim of this study was to examine the operation-wise and source-wise energy consumption pattern in rice crop production in western agro-climatic zone of Haryana. The data was collected through a questionnaire by face to face interviews. The amount of energy consumed in seedlings, land development, land preparation, transplanting, irrigation, weeding, fertilizer, harvesting and threshing and transportation were calculated for rice crop cultivation. The energy inputs in seed, human, diesel, electricity, machinery and fertilizer were taken into consideration to determine the source wise energy that was used in rice production. The average energy input of large farmers (LF), marginal farmers (MF) and small farmers (SF) was observed to be 35589.38, 35251.64 and 31432.07 MJ/ha, respectively while output energy was 144730, 166309 and 172180 MJ/ha, respectively. Specific energy of small, medium and large category framers was 4.43, 5.12, and 6.25 MJ/kg, respectively. The result revealed that fertilizer consumed highest energy in case of small farmers and on the other hand electricity consumed the bulk of energy in case of medium and large category of farmer. The result also showed that energy ratio, energy productivity and net energy gain of all category farmers were lie between 3.89 to 4.26, 6.64 to 7.12 kg/MJ and 89236.17 to 94073.10 MJ/ha, respectively.

KEY WORDS : Rice, Energy input, Energy output

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In the Indo-gangetic plain (IGP) and other parts of Asia, water is progressively more becoming scarce. Per capita availability of water has declined in many Asian countries by 40-60 per cent between 1955 and 1990 (Gleik, 1993). Agriculture's share of freshwater supplies is likely to decline by 8-10 per cent because of increasing competition from the urban and industrial sectors (Toung and Bhuiyan, 1994 and Seckler *et al.*, 1998). Poor–quality irrigation systems and greater reliance on ground water have led to water table decline of 0.1-1.0 myr-1 in parts of the IGP, resulting is a scarcity and higher cost of pumping water (Gill, 1994; Harrington *et al.*,1993;Sharma *et al.*,1994 and Sondhi *et al.*, 1994). The growing labour and water shortages are likely to adversely affect the productivity of the rice crop (Ladha *et al.*, 2003).

Energy is one of the major inputs for the economic development of any country (Deshmukh and Patil, 2013). Nothing could be completed in our life without the use of energy. In the developed countries, increase in the crop yield was mainly due to the increase in commercial energy inputs in addition to improved varieties (Faidley, 1992). 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. Efficient use of these energies help to achieve increased production and productivity and contributes to the profitability and competitiveness of agriculture sustainability in rural living (Singh, 2002). Energy use in agriculture has been increasing in response to increasing population, limited supply of arable land and a desire for higher standards of living (Kizilaslan, 2009). The increase use of inputs such as fertilizer, irrigation water, diesel, plant protection chemicals, electricity etc. demand more energy in the form of human, animal and machinery.

India is the 2nd largest producer of rice next to China. In India, it is grown in an area of 40 mha annually with a production of 90 Mt and accounts for 45 per cent of food grain production in the country (Singh *et al.*, 2013). Punjab and Haryana are the major contributor in the national food basket. In Haryana, rice was grown over an area of 1.38 mha with total production of 4.45 Mt and productivity 3450 kg/ha during 2016-17(Anonymous, 2017). Rice is the second most important cereal crop of Haryana after wheat. For production of rice crop, more energy is used in comparisons to other cereal crop like wheat, barley, pearl millet etc. Thus, the purpose of the present study was to carry out an analysis of energy use pattern in rice crop production system for efficient use of available natural resources, proper energy management/conservation and minimization of energy losses during different unit operations of rice crop production. Keeping the above facts in view, present study was conducted at farmer's field of Rohtak district in Haryana with the objective to study energy use pattern of rice crop production.

■ METHODOLOGY

The study area included villages of Rohtak district of Haryana. The village's selection criteria were based on the spatial variability along with cropping pattern, cultural practices, irrigation facility and energy use levels. Questionnaire was prepared for collecting data in a face to face interview schedule from farmers regarding different operations and quantity of each input (*i.e.* machinery, fuel, fertilizer, irrigation water, labour, etc.). Energy used was calculated in the production of rice crop by using energy analysis technique. The farmers were grouped in to three categories *viz.*, small, medium and large farmers on the basis of cultivable land available with farmers. The following classification was used in accordance with the classification used by the Indian Council of Agricultural Research (ICAR) (Mittal *et al.*, 1985). Energy efficiency, energy productivity, specific energy and net energy gain for rice production were also calculated using the equations as suggested in literature (Khan and Singh, 1997; Mandal *et al.*, 2002; Khan *et al.*, 2004 and Canakci *et al.*, 2005). Total output energy was determined based on the energy value associated with paddy grain (14.7 MJ/kg dry grain) and energy associated with the paddy straw (13.75MJ/kg dry straw).

■ RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Source wise energy use pattern:

Fig. 1 illustrate the source wise energy use pattern (MJ/ha) of small farmers (SF) for production of rice crop. It is clear from the pie chart 1 that among all the total energy sources, fertilizer (41.11%) represents the largest energy consuming source followed by electricity (36.77%), diesel (10.94%), human (6.03%), animal (1.98%), chemical (1.85%), seed (0.91%) and machinery (0.41%) is undoubtedly the smallest. As far as source-wise energy consumption pattern of marginal farmers is concerned, it can be observed from Fig. 2 that electricity made the highest contribution in energy consumption followed by fertilizer while mechanized energy contributed in an significant manner. Diesel, human, chemical, animal and seed contributed 11.07 per cent, 5.45 per cent, 1.65 per cent, 1.25 per cent and 0.77 per cent, respectively in energy use pattern. Fig. 3 illustrate the source-wise energy use pattern of large farmers (LF) for production of rice crop. There were eight main operations which consumed energy during rice crop production. As in case of large farmers electricity was the main energy consuming operation which consumed almost 47.54 per cent of total energy followed by fertilizer which contributed around 33.90 per cent. Machinery played a least role in energy consumption. The contribution of other operations in energy consumption was in range of 8.95 per cent to 0.58 per cent as represented in pie chart in Fig. 3.

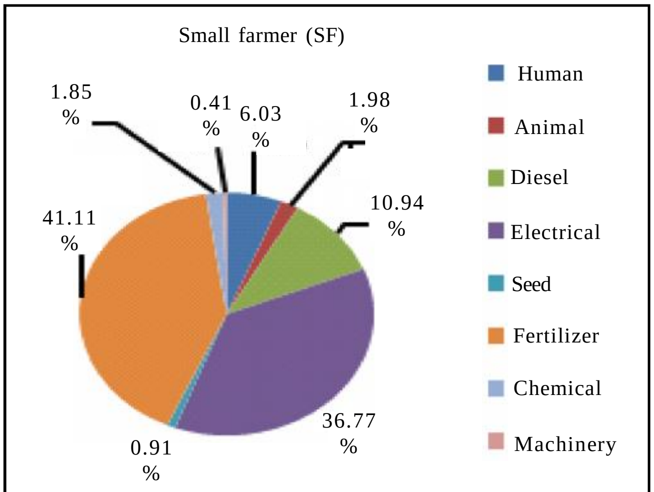

Fig. 1 : Source-wise energy consumption (MJ/ha) of SF

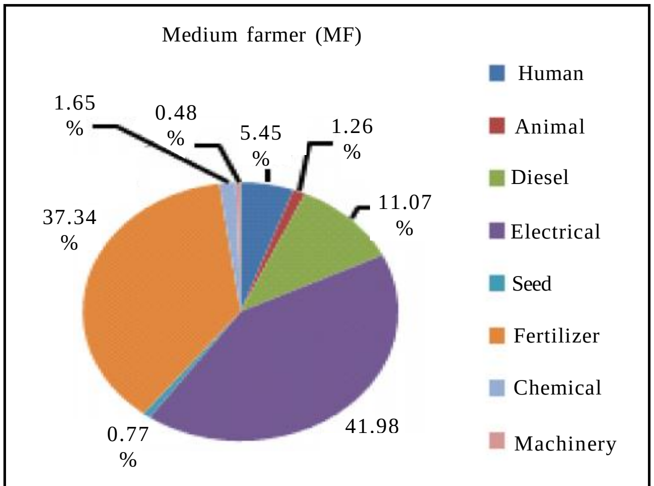

Fig. 2 : Source-wise energy consumption (MJ/ha) of MF

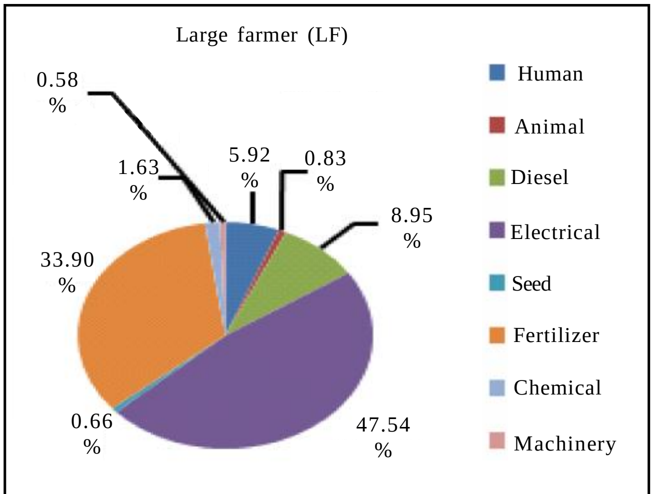

Fig. 3 : Source-wise energy consumption (MJ/ha) of LF

Variation of indicators of energy usage efficiency for different category of farmers:

Table 1 present different indicators of energy usage efficiency like net energy gain, energy ratio, specific energy, energy productivity etc. These would help in analysis of energy use efficiency during rice crop production. It can be seen from table that input energy of large farmers was high (35589.38 MJ/ha) as compared to medium farmers (35251.64 MJ/ha) and small farmers (31432.07 MJ/ha). In case of total output energy, the

Table 1: Energy usage efficiency indicators for different category of farmers

Energy indicators	Small farmer	Medium farmer	Large farmer
Total energy input (MJ/ha)	31,432.07	35,251.64	35,589.38
Total energy output (MJ/ha)	1,72,180	1,66,309	1,44,730
Yield (kg/ha)	7,080	6,875	5,689
Net energy gain (MJ/ha)	1,40,748	1,31,057	1,09,141
Energy productivity (kg/MJ)	0.225247653	0.195026387	0.159851057
Energy ratio	5.477844762	4.717766322	4.066662583
Specific energy (MJ/kg)	4.43955791	5.127511273	6.255823519

relative energy used by LF and MF were 15.94 per cent and 3.40 per cent, respectively as compared to SF. Net energy gain varied from 140748-109141 MJ/ha among all categories of farmers. Specific energy of large, medium and small category framers was 4.43, 5.12 and 6.25 MJ/ha, respectively. Energy productivity varied between 0.22 to 0.15 kg/MJ among all categories.

Conclusion:

Energy analysis has been carried out to evaluate the energy requirement in rice crop. The result revealed that, manual energy increased with the size of land holding which indicate that use of more number of labours by small farmers as compared to larger ones. This indicated the large farmers used less labour for performing different operations which took more time and more energy. On the basis of source wise energy use pattern, fertilizer application was found to be highest energy consuming source followed by electricity in all categories farmer. The result indicated that the energy productivity was lowest for large farmers followed by medium and small farmers. Seed energy decreased with the size of land holding which indicated the higher used of seed by small farmers. From farmer group discussion, it was revealed that farmers did not adopt puddling and green mannuring operations in their cultivation practice.

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