RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 12 | Issue 2 | October, 2019 | 186-190
ISSN–0974–2662 | Visit us : *www.researchjournal.co.in* | **DOI: 10.15740/HAS/IJAE/12.2/186-190**

Energy use pattern of rice production in western agro-climatic zone of Haryana

Kanishk Verma, Parmod Sharma, Yadvika and Y.K.Yadav

Received : 14.06.2019; **Revised :** 16.08.2019; **Accepted :** 02.09.2019

See end of the Paper for authors' affiliation

Correspondence to :

Kanishk Verma
Department of Renewable and Bio-Energy Engineering, C.C.S. Haryana Agricultural University, **Hisar (Haryana) India**
Email : kanishk57@gmail.com

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 were 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 small farmers (SF), marginal farmers (MF) and large farmers (LF) was observed to be 28,238.83, 28,419.00 and 32,051.57 MJ/ha, respectively while output energy was 1,17,475, 1,22,915 and 1,24,900 MJ/ha respectively. Specific energy of large, medium and small category framers were 7.12, 6.48, and 6.44 MJ/ha, respectively. The result revealed that fertilizer, irrigation and electricity consumed the bulk of energy. 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. Yield rice grain of large, medium and small category framers were 4500, 4450 and 4250 kg/ha, respectively.

KEY WORDS : Rice, Energy input, Energy output, Specific energy

HOW TO CITE THIS PAPER : Verma, Kanishk, Sharma, Parmod, Yadvika and Yadav, Y.K. (2019). Energy use pattern of rice production in western agro-climatic zone of Haryana. *Internat. J. Agric. Engg.*, **12**(2) : 186-190, **DOI: 10.15740/HAS/IJAE/12.2/186-190.**

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 in a western agro-climatic zone of Haryana with the objective to study energy use pattern of rice crop production.

METHODOLOGY

The study area included villages of western agro-climatic zone of Haryana. The village's selection criteria was 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 :

Operation and source wise energy use pattern:

The two pie charts (Fig. 1 and 2) illustrate the operation wise and source wise energy use pattern (MJ/ha) of small farmers (SF) for production of rice crop. It is clear from the Fig.1 that fertilizer represents the largest

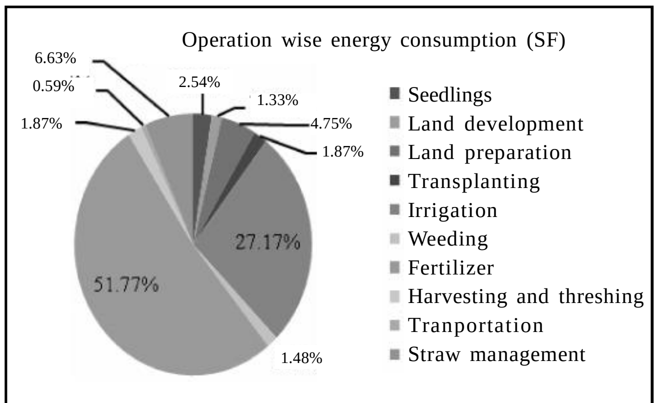

Fig. 1 : Operation-wise energy consumption

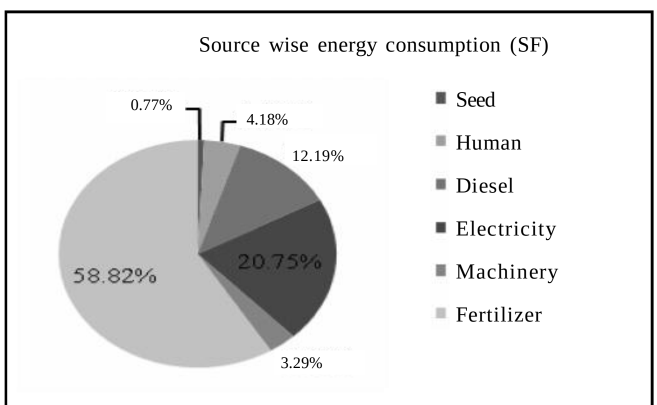

Fig. 2 : Source-wise energy consumption

energy consuming operation followed by irrigation among all the operations whereas transportation is undoubtedly the smallest. Straw management, land preparation, seedling preparation, transplanting, harvesting and threshing, weeding and land development contributed 6.63, 4.75, 2.54, 1.87,1.87,1.48 and 1.33 per cent, respectively. It can be seen from Fig. 2 that among the total energy sources, fertilizer was found to be the major source of energy consumption followed by electricity (20.75%), diesel (12.19%), human (4.18%), machinery (3.29%) and seed (0.77%).

The Fig. 3 and 4 depict the operation-wise and source-wise energy consumption per hectare of marginal farmers (MF) for paddy crop production, respectively. It can be seen from Fig. 3, the fertilizer consumed large energy *i.e.* more than 50 per cent of the energy used in other operations. Irrigation consumed 27.48 per cent and the second largest energy consuming operation. Straw management, land preparation, seedling preparation, transplanting, harvesting and threshing, weeding and land development contributed 6.50, 5.32, 2.47, 1.92, 1.93, 1.48 and 1.22 per cent, respectively. While transportation as operation has the smallest role to play in energy consumption. As far as source-wise energy consumption pattern of marginal farmers is concerned, it can be observed from Fig. 4 that fertilizer made the highest contribution in energy consumption followed by electricity while seed energy contributed in an significant manner. Diesel, human and machinery contributed 12.42 per cent, 5.06 per cent and 3.28 per cent, respectively in energy use pattern.

Fig. 5 and 6 illustrate the operation-wise and source-wise energy use pattern of large farmers (LF) for production of rice crop. There were ten main operations which consumed energy during rice crop production. As in case of large farmers fertilizer was the main energy consuming operation which consumed almost 50 per cent of total energy followed by irrigation which contributed

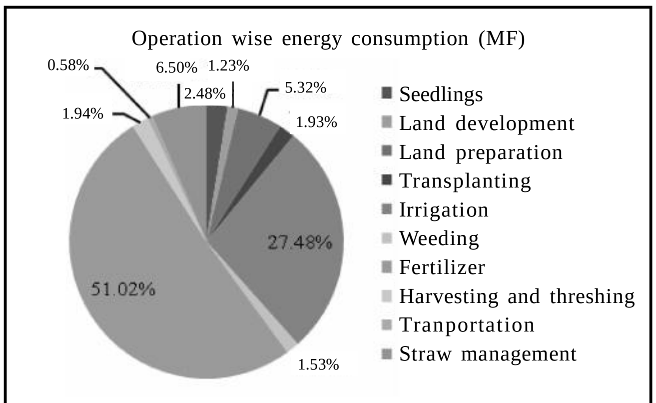

Fig. 3 : Operation-wise energy consumption

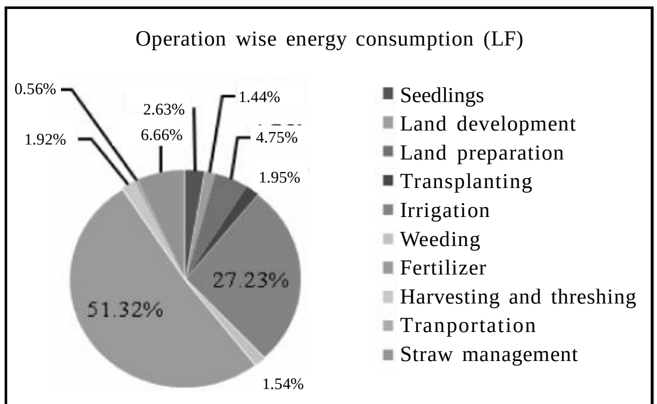

Fig. 5 : Operation-wise energy consumption

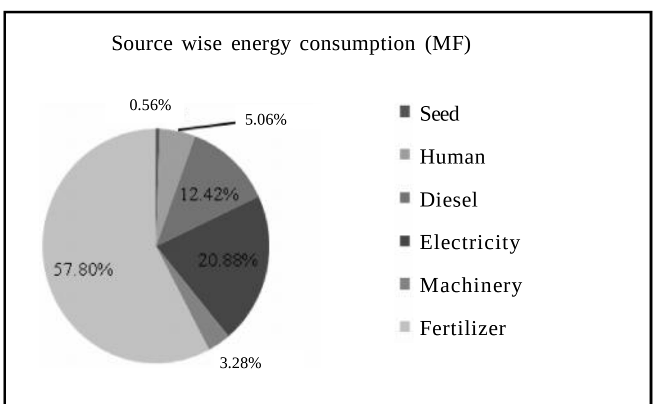

Fig. 4 : Source-wise energy consumption

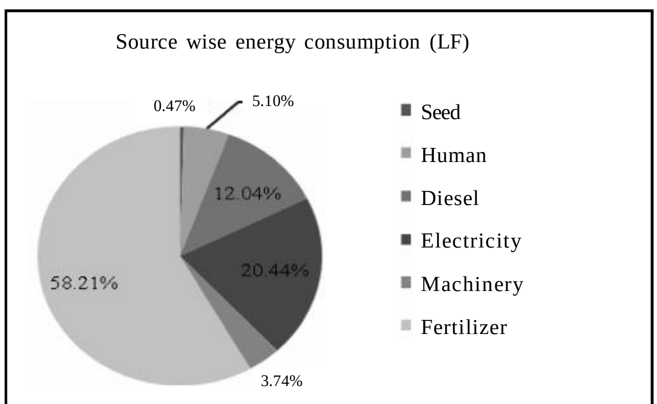

Fig. 6 : Source-wise energy consumption

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

Energy indicators	Large farmers	Medium farmers	Small farmers
Total input energy MJ/ha	32,051.57	28,841.90	28,238.83
Total output MJ/ha	1,24,900.00	1,22,915.00	1,17,475.00
Net energy gain MJ/ha	92,848.43	94,073.10	89,236.17
Energy ratio	3.89	4.26	4.16
Specific energy MJ/kg	7.12	6.48	6.64
Energy productivity kg/MJ	0.14	0.15	0.15
Yield rice grain kg/ha	4500.00	4450.00	4250.00

around 27.23 per cent. Transportation played a least role in energy consumption. Other operations contributed between 6.66 per cent to 1.44 per cent. It can be seen from the Fig. 6 that amongst the total energy sources, fertilizer was the major source of energy consumption followed by electricity (20.44%), diesel (12.04%), human (5.10%), machinery (3.74%) and seed (0.47%).

Energy inputs:

Direct energy inputs include human and fuel, whereas, indirect energy inputs include machinery, seed, fertilizer and pesticide for rice production. Direct and indirect energy were computed using the equations adopted by Khambalkar *et al*. (2010); Chaudhary *et al.* (2006) and Bockari-Gevao *et al.* (2005). In case of indirect energy inputs per hectare, the relative energy used by MF and SF were 4.02 and 4.90 per cent, respectively as compared to LF. In case of direct energy inputs per hectare, the relative energy used by MF and SF were 1.68 and 10.04 per cent, respectively as compared to LF category.

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 (32051.57 MJ/ha) as compared to medium farmers (28841.90 MJ/ha) and small farmers (28238.83 MJ/ha). In case of total output energy, the relative energy used by MF and SF were 1.58 and 5.94 per cent, respectively as compared to LF. Net energy gain varied from 92848.43-89236 MJ/ha among all categories of farmers. Specific energy of large, medium and small category framers was 7.12, 6.48 and 6.44 MJ/ha, respectively. This indicated that energy input per kg of product was quite high in case of large farmers. Energy productivity varied between 0.14 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.

Authors' affiliations:
Parmod Sharma, Yadvika and Y.K.Yadav, Department of Renewable and Bio-Energy Engineering, C.C.S. Haryana Agricultural University, **Hisar (Haryana) India**

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