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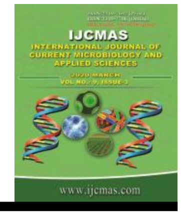

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Comparison of Energy Consumption for Different Sowing Techniques and Seed Rate of Direct Seeded Rice (*Oryza sativa* L.) under Medium Land Situation of Manipur

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ABSTRACT

A field experiment involving two sowing techniques (broadcasting and line sowing) and five different seed rates (80, 90, 100, 110 and 120 kg/ha) with a total of ten treatments in factorial randomized block design with three replications to compare the energy consumption for different sowing techniques and seed rate of direct seeded rice (*Oryza sativa* L.) under medium land situation of Manipur was conducted during *kharif* 2016 at Research Farm of College of Agriculture, Central Agricultural University, Imphal. The result revealed that highest total energy input was observed from broadcasting of seed at the rate of 120 kg/ha (17790 MJ/ha) whereas the lowest total energy input (17135 MJ/ha) from broadcasting of seed at the rate of 80 kg/ha. In contrast highest output energy (217542 MJ/ha), energy efficiency and highest energy productivity of grain (0.35) were obtained from line sowing with seed rate 100 kg/ha. Energy intensity shows that the highest energy consumption was from broadcasting of seed at the rate of 120 kg/ha (3.44 MJ/ha) and the lowest from line sowing with seed rate 100 kg/ha (2.90 MJ/ha).

Keywords

Direct seeded rice, energy productivity, seed rate, sowing technique

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Introduction

Rice cultivation requires many energy consuming operations such as tillage, transplanting, irrigation, application of fertilizers, agro-chemicals for plant protection, harvesting, transportation etc. In order to sustain agricultural production, effective energy use is required, since it provides ultimate financial saving, preservation of fossil resources and reduction of environment distortion. The energy consumption in the agricultural sector depends to the population employed in the agriculture, the amount of cultivable land and the level of mechanization (Ozkan *et al.*, 2004). In the present era of energy crisis, for formulating any policy on energy use and conservation, it is imperative to examine the pattern of energy consumption for agricultural production especially rice.

Since efficient use of the energy resources is vital in terms of increasing production, productivity, competitiveness of agriculture as well as sustainability of rural living, energy auditing is one of the most common approaches to examining energy efficiency and environmental impact of the production system. It enables researchers to calculate out-put-input ratio, relevant indicators, and energy use patterns in an agricultural activity (Adem *et al.,* 2006). When a natural system capable of producing a certain amount of energy containing biomass is converted into an agro-ecological system, the natural capability limit is often exceeded by adding energy inputs. The greater the input of external energy, the more the natural capability of the system can be exceeded, and the less sustainable the system becomes. Because of this relationship, an analysis of agro-ecosystem's input/output energy balance can be a comprehensive indicator of its sustainability (Farshad and Zinck, 2001). In this regard, efficient use of energy by the agriculture sector seems as one of the conditions for sustainable agriculture because it allows financial savings, fossil resources preservation and air pollution decrease (Pervanchon *et al.*, 2002).

Energy requirement in agriculture are divided into two groups – direct and indirect. Direct energy is essential in performing various tasks related to crop production processes such as land preparation, planting, crop management, irrigation, harvesting, post-harvest operations and transportation of agricultural inputs. Energy that is used directly at farms and fields are fuel, electricity and human energy. On the other hand, indirect energy consists of energy used for fertilizer, pesticides, seeds and farm machinery. Paddy production is one of the most energy intensive production systems. As a result of increasing world crude oil and fertilizer prices, input costs will increase. The increase input costs will reduce the use of inputs and paddy yields. On the other hand, if there is excess input usage, energy efficiency will also be reduced.

The aims of the study were to survey input energy in rice production under two sowing techniques and different seed rate, to investigate the energy consumption and to make an economic analysis of rice in Manipur.

Materials and Methods

The experiment was consists of two sowing techniques (Broadcasting and Line sowing) with five seed rate (80 kg ha^{-1}, 90 kg ha^{-1}, 100 kg ha^{-1}, 110 kg ha^{-1} and 120 kg ha^{-1}) and replicated thrice in factorial randomised block design. The recommended dose of N:P:K was 60:40:30 kg ha^{-1}. The fertilizers were used in the form of urea, single super phosphate and muriate of potash. Full dose of phosphorous and potash along with half dose of urea were applied uniformly as a basal to all the plots three days before sowing. The remaining half dose of nitrogen was applied in two equal splits at active tillering stage (25 DAS) and panicle initiation stages (65 DAS). The experiment was carried out under rainfed condition.

Energy equivalent inputs shown in Table 1 are used to calculate energy inputs and energy outputs. Energy indices were calculated using the following relationships (Sartori *et al.*, 2005).

Energy efficiency = [Output energy (MJ/ha)]/ Input energy (MJ/ha)

Energy productivity = [Grain yield (kg/ha)]/ Input energy (MJ/ha)

Energy Intensity = [Input energy (MJ/ha)]/ Grain yield (kg/ha)

Net energy gain = [Output energy (MJ/ha)] - Input energy (MJ/ha)

Each agricultural input was divided into as direct and indirect energy source. Direct energy sources were labour energy, tractor and/or other implement/machinery used for the particular operation and electric/diesel motor to run water pump, while indirect energy sources included seed of high yielding varieties, fertilizers and chemicals used in the production process; energy sources were classified into renewable and non-renewable. Renewable energy included human, labour, manure and seed, while non-renewable sources included diesel, electricity, chemicals, fertilizers, machinery.

Results and Discussion

Total energy inputs

The highest total energy input was observed from S_1R_5 (17790 MJ/ha) and S_2R_5 (17786 MJ/ha) whereas the lowest total energy input (17135 MJ/ha) and (17139 MJ/ha) recorded from S_1R_1 and S_2R_1 respectively. The highest in total energy input was due to higher seed rate thereby needs more human labour for harvesting and threshing. Among the energy inputs maximum consumption was contributed by chemical energy followed by mechanical energy and the lowest with human energy. A similar finding of higher energy input due to use of chemical fertilizer in rice production was also reported by Khan *et al.*, (2009).

Direct and indirect energy

Table 4 shows the direct and indirect energy consumption for different treatments in rice production system. Among the treatments maximum direct energy 4928 MJ/ha and 4924 MJ/ha were consumed in the treatment S_2R_5 and S_1R_5 respectively. Higher seed rate require more human labour for cultivation practices resulting to more direct energy. Line sowing required more energy than the broadcasting. Indirect energy consumption was also observed in the same trend. The highest indirect energy consumption (12862 MJ/ha) was observed from S_1R_5 and S_2R_5.

Renewable energy and Non-renewable energy

Renewable energy system in the rice production was very low and showed that rice production was based on non-renewable resources that these sources cause the environment pollution.

Total energy output

Highest output energy 217542 MJ/ha was obtained from S_2R_3 followed by S_2R_4 (211553 MJ/ha). The lowest output energy (199054 MJ/ha) was observed from S_1R_1 that is broadcasting of lower seed rate 80 kg/ha. This shows that broadcasting with lower seed rate produced less yield due to less plant population per unit area. On the other hand this observation could also be argued by the statement that overusing of inputs caused increment in consumed energy and lower yield of rice. Similar finding was also reported by Alipour *et al.*, (2012). Higher output energy can be obtained when 110 kg seed/ha was sown in line because of more grain yield per unit area.

Energy indices

Energy efficiency

Figure 1 shows the energy efficiency of different sowing technique with different seed rate. According to rice, energy output and energy expenditure, the highest energy efficiency of rice production was observed from S_2R_3 followed by S_2R_2. This shows a better use of input energy in line sowing with seed rate of 100 kg/ha and 90 kg/ha. The lowest energy efficiency observed in S_1R_5 could be as a result of inefficient use of some energy inputs due to inefficient irrigation system. This finding are in contrast with Alipour *et al.,* (2012) that rice energy ratio in Guilan province of Iran was 2.19 lower than 6.7 rice energy ratio index estimated in Australia by Khan *et al.,* (2010).

Energy productivity

Energy productivity is the yield of marketable product, that is, rice grain per unit of energy consumed. The higher the value (>1), the more energy efficient is the production system. The highest energy productivity of grain (0.35) was obtained from S_2R_3 and the lowest (0.29) from S_1R_5. The lowest energy productivity may be due to use of higher seed rate i.e. 120 kg/ha.

Table.1 Energy equivalents for different inputs and outputs in rice

	Items	Unit	Energy equivalent (MJ/unit)	Reference
	Input			
1.	Fuel			
	Diesel	L	56.31	Cherati *et al*., 2011
2.	Human labour	hr	2.31	Yaldiz et al., 1993
3.	Fertilizer			
	Nitrogen	kg	60.6	Esengun *et al*., 2007
	Phosphate (P_2O_5)	kg	11.93	Esengun *et al*., 2007
	Potassium (K_2O)	kg	6.7	Esengun *et al*., 2007
4.	Pesticides			
	Insecticide	kg	101.2	Yaldiz *et al*., 1993
	Herbicide	kg	238	Pathak and binning, 1985
	Fungicide	kg	216	Pathak and binning, 1985
5.	Seed	kg	17	Singh and Mital, 1992
	Output			
	Paddy	kg	14.7	Moradi and Azarpour, 2011
	Straw	kg	12.5	Moradi and Azarpour, 2011

Table.2 Energy inputs used in rice production system under different sowing technique and seed rate

Treatment	Mechanical energy (MJ/ha)	Chemical energy (MJ/ha)	Biological energy (MJ/ha)	Human energy (MJ/ha)	Total energy inputs (MJ/ha)
S_1R_1	4730	11002	1240	162.68	17135
S_1R_2	4730	11002	1395	170.52	17298
S_1R_3	4730	11002	1550	178.36	17461
S_1R_4	4730	11002	1705	186.20	17624
S_1R_5	4730	11002	1860	194.04	17786
S_2R_1	4730	11002	1240	166.60	17139
S_2R_2	4730	11002	1395	174.44	17302
S_2R_3	4730	11002	1550	182.28	17465
S_2R_4	4730	11002	1705	190.12	17628
S_2R_5	4730	11002	1860	197.96	17790

S_1 – Broadcasting; S_2 – Line sowing; R_1 - 80 kg ha^{-1}, R_2 - 90 kg ha^{-1}, R_3 - 100 kg ha^{-1}, R_4 - 110 kg ha^{-1} and R_5 -120 kg ha^{-1}

Table.3 Different energy requirement for different treatment

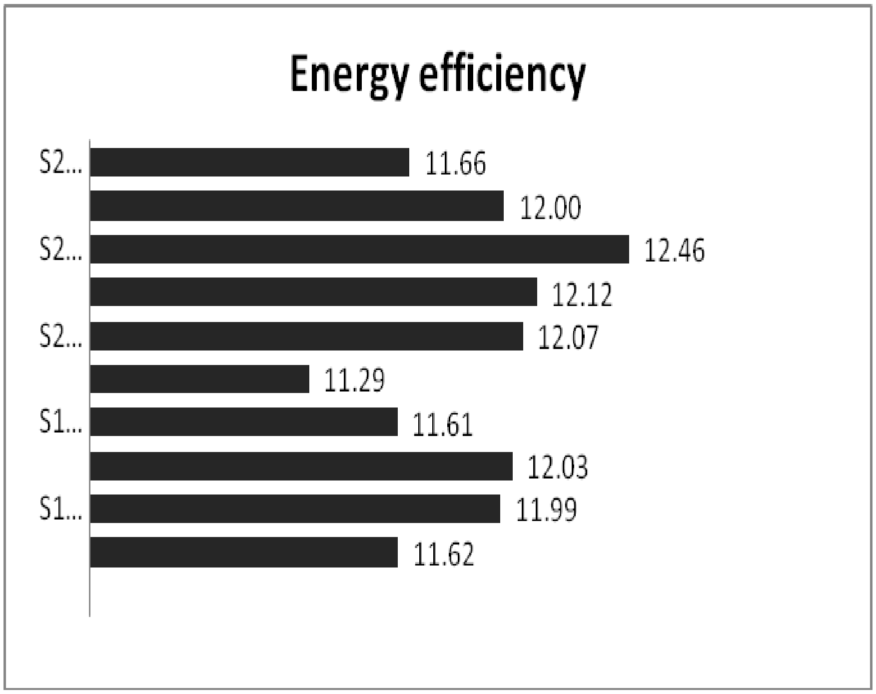
Treatment	Direct energy (MJ/ha)	Indirect energy (MJ/ha)	Renewable energy (MJ/ha)	Non-renewable energy (MJ/ha)
S_1R_1	4893	12242	1403	15732
S_1R_2	4901	12397	1566	15732
S_1R_3	4908	12552	1728	15732
S_1R_4	4916	12707	1891	15732
S_1R_5	4924	12862	2054	15732
S_2R_1	4897	12242	1407	15732
S_2R_2	4904	12397	1569	15732
S_2R_3	4912	12552	1732	15732
S_2R_4	4920	12707	1895	15732
S_2R_5	4928	12862	2058	15732

S_1 – Broadcasting; S_2 – Line sowing; R_1 - 80 kg ha^{-1}, R_2 - 90 kg ha^{-1}, R_3 - 100 kg ha^{-1}, R_4 - 110 kg ha^{-1} and R_5 -120 kg ha^{-1}

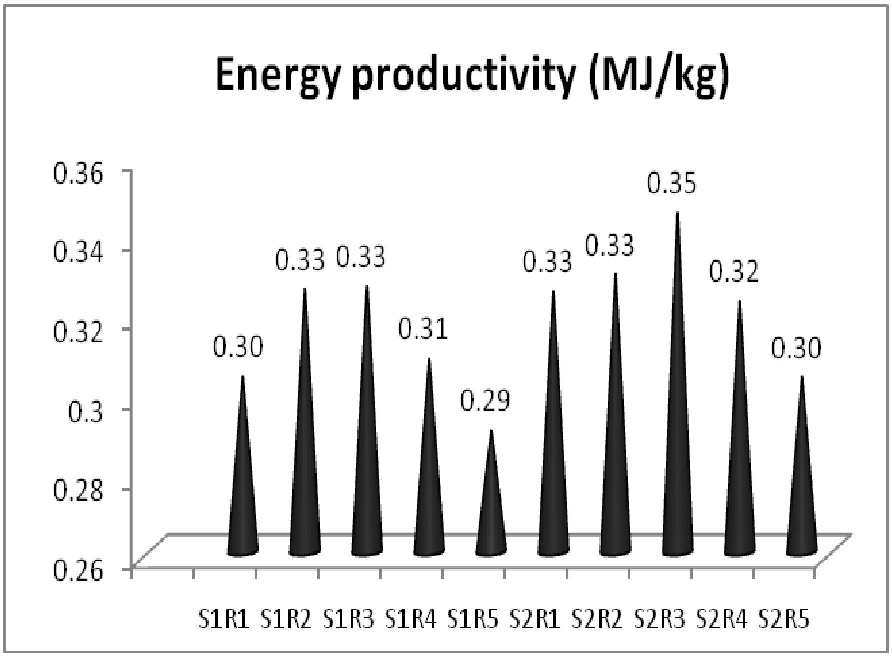
Table.4 Energy output obtained in rice production system under different sowing technique and seed rate

Treatment	Grain yield (kg ha^{-1})	By-product (kg ha^{-1})	Total energy output (MJ ha^{-1})
S_1R_1	5208	9466	199054
S_1R_2	5639	9597	207361
S_1R_3	5706	9733	210108
S_1R_4	5436	9633	204677
S_1R_5	5164	9667	200874
S_2R_1	5578	9633	206870
S_2R_2	5706	9700	209695
S_2R_3	6030	9926	217542
S_2R_4	5695	9863	211553
S_2R_5	5406	9889	207403
S_1 – Broadcasting; S_2 – Line sowing; R_1 - 80 kg ha^{-1}, R_2 - 90 kg ha^{-1}, R_3 - 100 kg ha^{-1}, R_4 - 110 kg ha^{-1} and R_5 -120 kg ha^{-1}			

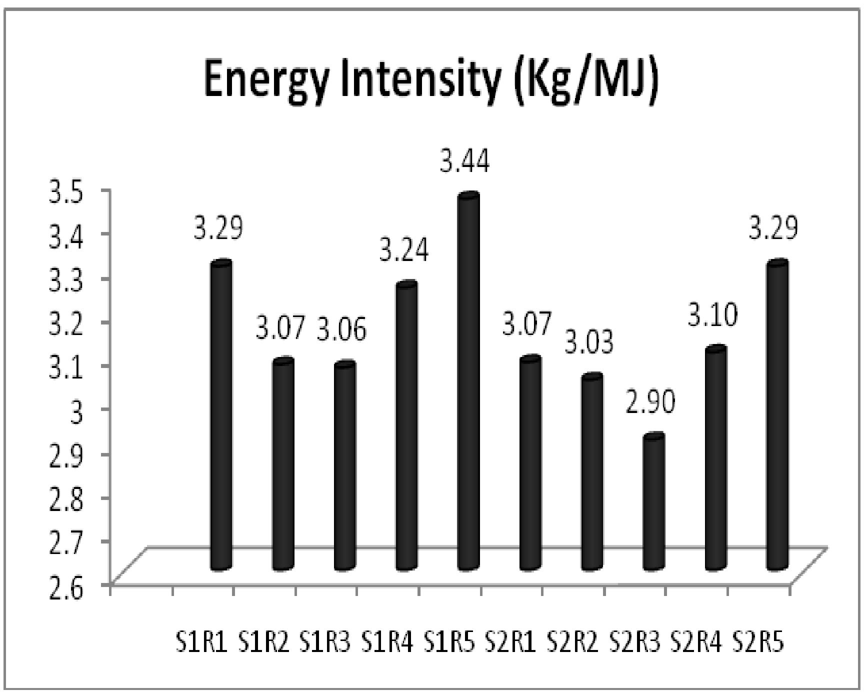
Fig 1 (a) Energy Efficiency



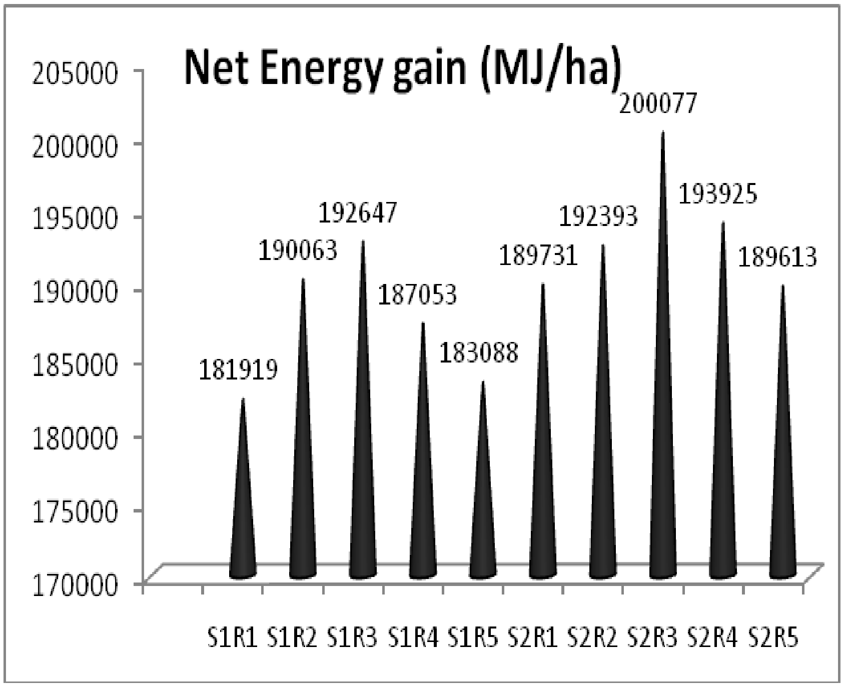
(b) Energy productivity



(c) Energy Intensity



(d) Net energy gain



Energy intensity

Energy intensity is an index which shows how much energy was used to produce one unit of disposable/ marketable yield (rice grain). The lower the index the more efficient is the use of energy in the production system. Energy intensity shows that the highest energy consumption was for S_1R_5 (3.44 MJ/ha) and the lowest for S_2R_3 (2.90 MJ/ha). Figure 1 (c) shows that about 3.44 MJ/ha of energy is required to produce only a kilogram of paddy in the treatment S_1R_5. This implies that there was low grain output in respect to energy inputs used in the production process due to inefficient energy inputs used. The highest net energy gain (200.08 GJ/ha) was from S_2R_3 and the lowest (181.92 GJ/ha) from S_1R_1.

In conclusion, a quantitative energy input-output analysis of rice production was studied based on the level of energy consumption, forms of energy and some energy indices such as energy ratio, specific energy, energy productivity and net energy. From the above investigation it can be concluded that highest energy output, energy efficiency and highest energy productivity of grain were obtained from line sowing with seed rate 100 kg/ha.

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References

Adem Hatirli, S., Ozkan, B. and Fert, C. (2006). Energy inputs and crop yield relationship in greenhouse tomato production. *Renewable Energy* 31: 427–438.

Alipour, A., Veisi, H., Darijani, F., Mirbagherim B, and Behbahani, A.G. (2012). Study and determination of energy consumption to produce conventional rice of the Guilan province. *Res. Agr. Eng.* 58(3):99-106.

Cherati, F.E., Bahrami, H. and Asakereh, A. (2011). Energy survey of mechanized and traditional rice production system in Mazandaran Province of Iran. *Afr. J. Agric. Res*. 6(11): 2565-2570.

Esengun, K., Gunduz, O. and Erdal, G. (2007). Input-output energy analysis in dry apricot production of Turkey. *Energy. Conver. Manage*. 48: 592-598.

Farshad, A., Zinck, J.A. (2001). Assessing Agricultural Sustainability Using the Six-Pillar Model: Iran as a Case Study. In: Gliessman S.R., Agroecosystem Sustainability: Developing Practical Strategies. Boca Raton, CRC Press: 137–152.

Khan, M.A., Awan, I.U. and Zafar, J. (2009). Energy requirement and economic analysis of rice production in western part of Pakistan. *Soil and Environment* 28(1), 60-67.

Khan, S., Khan, M.A., Latif, N. (2010). Energy Requirements and Economic Analysis of Wheat, Rice and Barley Production in Australia. *J. Soil Environ*. 29(1): 61-68.

Moradi, M. and Azarpour, E. (2011). Study of energy indices for native and breed rice varieties production in Iran. *World Appl. Sci. J*., 13(1): 137-141.0.

Ozkan, B., Akcaoz, H. and Karadeniz, F. (2004). Energy requirement and economic analysis of citrus production in Turkey. *Energy Conver. Manage*. 45: 1821-1830.

Pathak, B. and Binning, A. (1985). Energy use pattern and potential for energy saving in rice-wheat cultivation. *Agric. Energy*, 4: 271-280.

Pervanchon, F., Bockstaller, C. and Girardinc, P. (2002). Assessment of energy use in arable farming systems by means of an agro-ecological indicator: the energy indicator. *Agricultural Systems*, 72: 149–172.

Sartori, L., Basso, B., Bertocco, M. and Oliviero, G. (2005). Energy use and economic evaluation of a three year crop rotation for conservation and organic farming in NE Italy. *Biosyst. Eng*., 9(2): 245-250.

Singh, S. and Mital, J.P. (1992). Energy in Production Agriculture. Mittal Pub, New Delhi.

Sinha, S.K. and Talati, J. (2007). Productivity impacts of the system of rice intensification (SRI): A case study in West Bengal, India. *Agr. Water Manag*. 87: 55-60.

Yaldiz, O., Ozturk, H.H., Zeren, Y. and Bascetincelik, A. (1993). Energy Usage in Production of Field Crops in Turkey. In: Vth International Congress on Mechanization and Energy in Agriculture. *Izmir- Turkey* 527-536 pp

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