A Study on the Energy use Pattern and Cost of Production under Transplanted Paddy Production System in Chhattisgarh, India

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Abstract: **The study was carried out on energy requirement and energy input-output relationship in rice production by transplanting method. A study was under taken to obtain energy inputs and cost cost input in case of wet land transplanted paddy condition. Three research plots of IGKV research farm, Raipur, Chhattisgarh were selected for study during the period of 2013-14 in kharif season. The energy required for different field operation and sources were calculated by using energy equivalent. The energy requirement for paddy cultivation was found to be 13615.94 MJ/ha in which fertilizer consumed almost 60% i.e.7706.75MJ/ha of total energy use. The minimum energy use as observed in intercultural operation due to application of weedicide for control of weeds. The total input cost of rice cultivation was found to be Rs.35, 221.90/ ha. The benefit cost ratio was found to be 1.96:1.**

Keywords: Rice, Energy ratio, Specific Energy, Benefit Cost ratio, Yield, Productivity

I. INTRODUCTION

Paddy stands first among all food grain crops of the world and is the staple food of more than half of world's population. In India also rice is the major crop in terms of area, production and consumption. It occupies the enviable prime place among the food crops cultivated around the world and is grown in 147 million ha with a production of 525 MT. About 90 per cent of rice grown in the world is produced and consumed in Asian region. Food security, which is the condition of having enough food to provide adequate nutrition for a healthy life, is a critical issue in the developing countries. About 3 billion people, nearly half of the world's population, depend on rice for survival. Paddy cultivation is well-suited to countries and regions with low labor costs and high rainfall, as it is labor-intensive to cultivate and requires plenty of water. Rice can be grown practically anywhere (under various soil conditions (salt, alkali, peat) and different water and temperature regimes), even on a steep hill or mountain [1]. Energy requirement in agriculture are divided into two groups being direct and indirect. Direct energy is to required to perform various tasks related to crop production processes such as land preparation, irrigation, intercultural, threshing, harvesting, and transportation of agriculture inputs and farm produce [2]. It is seen that direct energy is directly used at farms and in the fields. Indirect energy used in the manufacture, packaging, and transport of fertilizer, pesticide, seed, and farm machinery [3]. Energy use patterns and contribution of energy inputs vary depending on farming system, crop season and farming conditions. Calculating energy inputs of agricultural production more difficult than in the industry sector due to the high number of factors affecting the production [4].

Chhattisgarh is known as the "rice bowl" of India. Chhattisgarh used to produce over seventy percent of the total paddy production in the state. In Chhattisgarh, average production and consumption of rice dominate the average production and consumption of other food grain crops. Chhattisgarh contributes 5.26 per cent of total rice production of the country. The crop is cultivated in 3.68 m ha in Chhattisgarh with a productivity of the state ranging between 1.2 to 1.6 t/ha depending upon the rain fed condition. Energy is one of the most valuable inputs in production agriculture. It is invested in various forms such as mechanical (farm machines, human labour, animal draft), chemical fertilizer (pesticides, herbicides), electrical, etc. Sufficient availability of the right energy and its effective and efficient use are prerequisites for improved agricultural production. Through using farm machines and implements can be increased productivity and minimize cost. The reduction, elimination or combination at machinery operation will reduce energy (fuel) input and also may reduce the uses of labor and time [5].

II. Materials and Methods

The study was carried out in IGKV, Research farm three plots were selected for conducting in experiment having plots size of 20×25 m², 15×25 m² and 15×25 m² respectively. The seedlings was prepared in nursery bed for transplanting of 1/10th of the total area, seed-rate is 75 kg/ha used for seedbed depending on the variety of seed as in local or hybrid. The data on energy use were recorded by practically in field. The proforma included all kinds of inputs like seed, fertilizers and chemicals, power sources and agricultural machinery. The energy and cost were calculated by operation-wise and source-wise consumption, energy ratio (output: input) and cost benefit ratio (output: input). The energy for commercial and non-commercial sources (human, animal) was also calculated. Cost of each operation is calculated at present rate in market of different inputs. The data was collected in field operation and energy use in different operation was calculating by using energy equivalent.

Table 1 Energy co-efficient of different input and outputs

No.	Particulars	Units	Energy Equivalent
A Input			
1.	Human	Man – hour	1.96
2.	Animal	Pair -hour	10.10
3.	Diesel	Litre	56.31
4.	Electricity	kW-h	11.93
5.	Machinery • Electric motor • Other prime mover including self propelled machine • Farm machinery excluding self propelled machine	 Kg Kg Kg	 64.80 64.80 62.70
6.	Wood	Kg	18.00
7.	Chemical fertilizers (i) Nitrogen N_2 (ii) Phosporous P_2O_5 (iii) Potash K_2O	 Kg Kg kg	 60.60 11.10 6.70
8.	Chemical	Kg	120.00
9.	Seed	Kg	14.70
B Output			
10.	Seed	Kg	14.70
11.	Straw	Kg	12.50

Source; [6]. Researches digest on energy requirement in Agriculture Sector (1971-1982), PAU, Ludhiana.

Input and output energy use in rice cultivation under transplanting were estimated in operation and source wise by using energy equivalent as given in (Table 1) while cost was estimated by operation wise as suggested by many authors [6]. The energy and cost input through land preparation, seed bed preparation, seed sowing, transplanting, fertilizer and pesticide application, intercultural operations, harvesting, transportation, threshing and winnowing operation Cost estimation rate is taken as standard government wage rate and market support price. The energy and cost output was calculated by accumulating the main product and by-product produced. Subtracting input energy from output energy derived the net return of energy and same methodlogy was also adopted for calculation of cost. The output-input ratio was worked out by dividing the total energy generated from main product and by-product by the total energy used for raising the crop in a particular unit area, same as for cost analysis. Benefits of energy analysis are to determine the energy invested in every step of the production process (hence identifying the steps that require least energy inputs), to provide a basis for conservation and to aid in making sound management and policy decisions [7]. The appropriate use of energy input to crop production could originate from several types of conservation practices. The gross value of production, net return and benefit to cost ratio were calculated using the following equations [8].

Gross value of production (Rs/ha) = Yield (kg/ha) × Sale price (Rs/kg)

Net return (Rs/ha) = Gross value of production (Rs/ha) - Total cost of production (Rs/ha)

$$\text{Productivity} = \frac{\text{Rice Yield (kg/ha)}}{\text{Total cost of production (Rs/ha)}}$$

Benifit to cost ratio

$$= \frac{\text{Gross value of production (Rs/ha)}}{\text{Total cost of production (Rs/ha)}}$$

Based on energy equivalent energy ratio (energy use efficiency), specific energy, net energy can be calculated by following equation given by [9].

$$\text{Energy ratio} = \frac{\text{Energy output MJ/ha}}{\text{Energy input MJ/ha}}$$

$$Specific\ Energy\ (MJ/kg) = \frac{Energy\ input\ MJ/ha}{Grain\ output\ kg/ha}$$

Net energy = Energy output (MJ/ha) - Enrgy input (MJ/ha)

Operation wise energy input and cost analysis

The main objective in agricultural production is to increase yield and decrease costs. In this respect, the energy budget is important. Energy budget is the numerical comparison of the relationship between inputs and out-put of a system in terms of energy [10]. The implement used in seedbed preparation was cultivator and rotavator. The energy used in seedbed preparation includes human energy, machinery energy and petroleum energy. Land preparation was performed by the tractor includes tractor charges, machinery charges, fuel cost and labor charges. Energy used in nursery bed preparation and transplanting was human energy and seed energy. Cost of nursery preparation includes fuel, tractor, machinery and labor charge. Sowing cost include the charges of uprooting of seedling, transportation of seedlings and transplanting by labor. Irrigation water applied to the field by 7 hp pump in four times with interval 15-16 days. Irrigation application includes human, electrical and machinery energy. Cost of irrigation is calculated by electricity charges. Weeds in transplanted rice control by chemically by applying weedicide. The energy use in intercultural operation includes human energy and chemical energy. Cost of weedicide includes labour wages charge and cost of pesticides. The DAP, MOP and urea are used for the paddy cultivation. The energy use for fertilizer application was calculated by human and fertilizer energy. Harvesting was done by manually in field with serrated sickle. It was observed that for harvesting process 8 labors were used for 8 hours in a day. Energy used in harvesting, transportation, threshing and winnowing were calculated as follows :

Human Energy (MJ/ha) = No of person × energy equivalent × time in hr

Sickle Energy (MJ/ha) =No of person× energy equivalent (Wood +iron) × time (h)

III. RESULTS AND DISCUSSION

Energy analysis

The cultivation of paddy under transplanting method was partially mechanized as seedbed preparation, puddling, threshing was done by tractor cultivator and rotavator while sowing, transplanting, fertilizing, harvesting was done by manually. Selection of farm machines was very important for matching field size, in some of the operation using farm machines can be reduce cost and human effort with getting maximum production. Energy used as input was 13615.95 MJ/ha out of which chemical fertilizer including N,P_2O_5, K_2O had the biggest share of total energy with 56.60%.energy used in the production of chemical fertilizers accounted for about 40%of total energy in agricultural production in developed countries[11]. Fertilizer energy is followed by petroleum energy 2192.53 MJ/ha. Petroleum energy was mainly used in land preparation tractor and other machinery operation. The share of nursery bed preparation was 1110.34 MJ/ha (8.15 %) in which including of human and seed energy (7.84 MJ/ha and 1102.5 MJ/ha). Using high quality of seed, seed energy can be reduced. Irrigation energy was contribute 6.03% of total as 820.43MJ/ha done by irrigation pump. Due to low mechanization in rice production machinery energy 561.49MJ/ha while human energy consumption was 1502.20 where great difference which cause of increase energy as well as cost. Lowest energy consumption was contributing by intercultural operation 33.80 MJ/ha.

Energy ratio is one of the best energy indices that shoes the efficiency of rice production is greater than obtained 1.97 by [12]. [12] Obtained that energy input, specific energy, energy productivity and net energy were 45707.06MJ/ha, 10.43 MJ/kg, 0.096 kg/MJ respectively. In this study the result indicated energy ratio, energy productivity, specific energy, and net energy of rice production were 2.34, 6.27, 12.84 and 161336.87 MJ/ha respectively.

Cost Analysis

The cost of each input and the market price of rice in research region were used to calculate the cost and return components of rice production. It was represented in table no 2.Total input cost in all operation was Rs.35221.90 for one ha where maximum input cost Rs. 9250.00 per hectare implied in manually transplanting where required number of labor, can be minimize through using rice transplanter which will save cost, time and as well as labor problem.

Required cost of seedbed operation and nursery bed operation was Rs 1817.39 per ha and Rs 833.25 per ha which was 5.15% and 2.36% of total input cost significantly. Nursery bed operation was the lowest cost of all other cost of operation. Cost of operation of sowing and intercultural was Rs 9250 per ha and Rs.925 per ha, which was 26.26% and 2.62% of total input cost significantly. Cost of operation of irrigation ,fertilizer, harvesting, transporting and bundling, threshing and winnowing was Rs 2081.70, Rs.5550.00, Rs. 3409.60 and Rs. 5321.25, Rs.3910.00,and Rs 2123.71 per ha and these were contributed 5.91%, 15.75%, 9.68%, 15.10%, 11.10%, 6.03% t of total input cost significantly. Out of which maxmimum cost was involved in fertilizer application. Gross and net return were Rs. 69025 per ha and Rs. 33803.10 per ha respectively. At the end of economic analysis of rice production, the economic productivity was calculated 0.12 kg/Rs. Benefit to cost ratio was revealed 1.96:1 that was lower than [13] research results of benefit-cost ratio (2.7).

Table 2:- Operation wise energy and cost analysis under rice transplanting

Sr. no.	Operation	Energy, (MJ/ha)	Percentage of total energy	Cost, (Rs/ha)
Input Operation				
1	Seed bed preparation	1223.44	8.99	1817.39
2	Nursery bed preparation	1110.34	8.15	833.25
3	Sowing and transplanting	643.20	4.72	9250.00
4	Irrigation	820.43	6.03	2081.70
5	Interculture	33.80	0.25	925.00
6	Fertilizer	7706.75	56.60	5550.00
7	Harvesting	275.94	2.03	3409.60
8	Transportation and bundling	921.60	6.77	5321.25
9	Threshing	739.41	5.43	3910.00
10	Winnowing	154.27	1.13	2123.71
	Total input energy	13615.94	100.00	35221.90
Output Operation				
11	Grain yield	85443.75	48.84	64900.00
12	Straw yield	103125.00	51.16	4125.00
13	Total energy MJ/ha	174952.81	100.00	-
14	Net energy MJ/ha	161336.87	-	-
15	Specific energy MJ/kg	12.84	-	-
16	Energy productivity kg/MJ	6.27	-	-
Output parameters				
1	Energy ratio	2.34	-	-
2	Gross value of production, Rs	69025.00	-	
3	Benefit to cost ratio	1.96:1	-	
4	Productivity kg/Rs	-	-	0.12
5	Net return, Rs/ha	-		33803.10

Table3 :- Source wise energy analysis under rice transplanting

Sr.no.	Energy source	Source	Energy Input, MJ/ha
1.	Non Commercial	Human	1502.20
2.	Commercial	Machinery	561.49
a.		Seed	1102.50
b.		Chemical	24.00
c.		Fertilizer	7706.75
d.		Petroleum	2192.53
e.		Electrical	518.47

It was also observed that land preparation, sowing and transplanting, fertilizer as well as harvesting contributed higher cost and energy in total due to many of these operations were done manually (Table 3). It was also observed that fertilizer contributes major source of input energy (56.6%) in paddy cultivation.

IV. CONCLUSIONS

The input energy for production of transplanted paddy was found to be 13615.94MJ/ha. In which 56.60% was contributed by fertilizer. The use of energy in crop production depends on availability of energy sources in farm and capacity of the farmer. The minimum energy use as observed in interculture operation due to application of weedicide for control of weeds. Cost can be minimized through using of transplanter, harvester as in this field human labour is used Rs 14764.55 per ha of total cost involved in harvesting, bundling, transportation, threshing and winnowing can be minimized. The average yield was 5812.5 kg/ha and straw is 8250 kg/ha obtained.

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