ECONOMIC ANALYSIS OF RICE CULTIVATION SYSTEM UNDER DIFFERENT ESTABLISHMENT METHODS

Abstract

Energy utilization efficiency depends on different factor of cropping systems such as physiochemical properties of soil, land preparing operation, plant protection, fertilizer application, threshing, harvesting operation and grain and straw yield. India is developing county and rice crops are one of the most energy intensive crop and its major component are irrigation, land development (tillage), FYM (Farmyard manure) and fertilizers. The importance of Mechanization in cultivation system involves higher input cost but at the same time, it can reduce operation cost of cultivation, increases grain yield and can reduce operational time. Cost of cultivation of rice in different treatment was calculated by adding the cost of all input parameter such as seeds, fertilizers, pesticides, fuel, and labourer. Grain output was observed considerably higher in mechanized transplanting seedling compare to direct sowing. Direct sowing and zero till mechanical transplanting methods produced the low grain yield because of poor crop growth as compare to transplanting seedling of rice in a standing water table. The grain yield in mechanical transplanting varied from 29.5 to 32.6 q/h where as in direct sowing treatment 31.2 to 32.1 q/ha

Key words: *rice transplanting, zero till drill, energy utilization etc.*

INTRODUCTION

The cost of energy in agriculture have increased day by day and it is one of the most important input parameter in the practice of crop cultivation and it is required at each step of crop production from initial phase (tillage) to final (harvesting). In each operation of crop production there is application of input that depends on energy base fossil fuel (mechanical machinery) consumption which emits carbon-di-oxide and other greenhouse gases. Energy utilization efficiency depends on different factor of cropping systems such as physiochemical properties of soil, land preparing operation, plant protection, fertilizer application, harvesting, threshing operation and grain and straw yield (Yogeswari & Porpavai, 2018). India is developing county and here the rate of energy consumption is rising day by day with the involvement of new technology in the field of agriculture (Das, 2012). However, there are advantages of the use of new technology and machineries in agriculture that can reduce the energy need by 18–83% in tillage operation with different cultivation system (Sørensen and Nielsen, 2005).

Rice crops is one of the most energy intensive crop and its major component are irrigation, land development (tillage), FYM (Farmyard manure) and fertilizers. In India per capita energy availability is 1.84 kW/ha (Department of agriculture cooperation and farmers welfare) and in Haryana is 2 kw/ha. Therefore, there is a need to classify energy-efficient rice cultivation system, (Sartori et al., 2005). The cost of cultivation is equally important for developing county like India where resources are limited and farmers are poor. Initial cost input for rice cultivation is higher and its output from rice cultivation is a major concern among the rice cultivators (Das et al., 2014). The importance of Mechanization in cultivation system involves higher input cost but at the same time it can reduces operation cost of cultivation, increase in grain yield and can reduce operational time (Mandal et al., 2002).Therefore, there is a need to analyse an efficient rice cultivation system in terms of benefit cost ratio. The present study was taken on rice cultivation with the objective to analyse economics and energy efficiency in the state of Haryana.

METHODOLOGY

EXPERIMANTAL SITE

Transplanting/sowing field preparation according to treatments

The study was conducted in flatland of Agricultural Engineering farms of the Choudhary Charan Singh Agricultural University at Hisar, Haryana State of India. The data were obtained from field experiments conducted in Kharif seasons.

Experimental plan was conducted for analysis of yield for different rice cultivation practices. Seven treatment was selected as described in Table 1. These systems involved direct sowing rice (vattar) (**T_1**), Zero till-direct sowing rice without residues (**T_2**), Zero till-direct seeded rice with residues/Sesbania (**T_3**), Zero till-mechanical transplanting (**T_4**),Unpuddle-mechanical transplanting(**T_5**), Puddle-mechanical transplanting(**T_6**) and Puddle-manual transplanting (**T_7**).

Table 1 Transplanting/sowing field preparation according to treatments

Treatments	**Methods**	**Description**	**Plot size(m^2)**
T_1	Direct seeded rice (vattar)	One Plough + harrow + planking (with cultivator) + sowing by drill	46.75
T_2	Zero till-direct seeded rice without residues	Sowing by drill (no tillage)	46.75
T_3	Zero till-direct seeded rice with residues/Sesbania	Sowing by drill + residues (no tillage)	46.75
T_4	Zero till-mechanical transplanting	Self propelled rice transplanting (no tillage in standing water)	46.75
T_5	Unpuddle-mechanical transplanting	One Plough + harrow + planking (with cultivator) + Self propelled rice transplanting (standing water)	46.75
T_6	Puddle-mechanical transplanting	One Plough + harrow + planking (with cultivator) + puddling (with rotavator) + Self propelled rice transplanting	46.75
T_7	Puddle-manual transplanting	One Plough + harrow + planking (with cultivator) + puddling (with rotavator) + manual planting	46.75

The University is situated 30 km away from Kurukshetra city at latitude $29^0$51’ N, longitude $76^0$41’ E and altitude 241 meters above mean sea level. The field was selected for the study and it was uniform fertile. A composite soil sample from 0-30 cm soil depth was taken randomly at three places from the field before layout of experiment. The sample were mixed thoroughly, dried and were subjected to mechanical and chemical analysis. The physio-chemical analysis of the soil is presented in table 2.

Table 2 Physio-chemical analysis of the soil of the experimental field

Soil components	**Content (%)**
Sand	**32.00**
Silt	**38.00**
Clay	**30.00**
Soil pH (1:2)	**8.20**
Organic carbon (%)	**0.32**
EC (ds/m)	**0.27**

Experimental management practices

Seven different experimental management practices were followed and different inputs were used in seven rice cultivation systems which are summarized in Table 1. Plot size for each treatment was 46.75 m^2. In Direct sowing rice land was prepared with single Mould Board Plough, one harrow, planking (with cultivator) operation were operated 10-15 days before sowing and seed was sown by seed drill. In T_2 treatment the seeds were sown with drill directly in the soil without any tillage operation. This treatment is zero till drill but in this treatment field was selected with no residue. In T_3 treatment which was similar to the T_2 treatment but the field was selected with residue for conserving moisture. In T_4 to T_7 treatments were done in standing water field and seedlings were grown for this treatment and transplanted into the field. For conventional and mechanized transplanting average 25 day-old seedlings with two to three seedlings per hill were transplanted at a spacing of 20 × 15 cm and 24 × 15 cm, respectively. Seedlings were grown on raised bed of 1 × 8 m area and 10 cm height. The seedbeds were sprinkled with water manually at regular interval. Taking care with transplanting seedlings, it was transplanted within 30 minutes after uprooting them from the nursery to avoid wilting and reduce transplanting shock. Transplanting in mechanized system was done by using 8-row self-propelled paddy transplanter.

In T_4 treatment no tillage operation was carried out and seedlings were transplanted with mechanical transplanter. And tillage operation is carried out in T_5. T_6 and T_7 treatments. Seedlings were transplanted mechanically in T_5 and T_6 treatment and manual transplanting was done in T_7 treatment.

Energy balance

Energy balance was calculated using the different equivalents of cultivation practices and outputs. Energy equivalents of the machines which was commonly available (Mittal and Dhawan, 1988) in India (Table 3).

Table 3: Energy equivalent of machineries for India

S.No.	Particulars	Energy equivalent(MJ/h)
1	Power tiller	6.693
2	Rice Transplanter	5.02
3	Power weeder	0.251
5	Knapsack sprayer	0.258
6	Power operated sprayer	1.703
7	Reaper	1.96
8	Pedal operated thresher	1.01
9	Power thresher	16.2

Economic analysis

Cost of cultivation of rice in different treatment was calculated by adding the cost of all input parameter such as seeds, fertilizers, pesticides, fuel, labourers, etc. and cost of operation machinery (Sartori et al., 2005). Costs of fertilizers, FYM, seeds and pesticides were calculated on the basis of the available market price in the corresponding years. Manual cost was used to estimate on the basis of available rate on the Government of India (Ministry of Labour and Employment). The cost of operation of the machinery was computed on hourly basis after including the cost of machine, depreciation of the machine, machine Life and rate of interest. Available fuel rates (petrol and diesel) were obtained from the locally available petrol pump. Gross returns were calculated on the basis of support price, price of rice announced by Government of India for *kharif* season of 2011.

Net returns (Rs/ha) were worked out by subtracting the total cost of cultivation of each treatment from the gross income of respective treatment. Benefit: Cost (B:C) ratio was calculated to ascertain economic viability of the treatment by using the following formula:

Net return = (Product cost + Byproduct cost) – Input cost

Benefit-cost ratio =Total output cost/Total Input cost

Result and Discussion

1. **Energy input**

Energy required for cultivation of the crop in seven cultivation systems are presented in Table 5. Significantly high amount of energy required in Haryana for irrigation which was 30 Rs/hr. Land preparation consumed 1468 Rs/ha for flat land without standing water table whereas 3033 Rs/ha for standing water table field. Consumption of considerably more energy for fertilizers and manure than that of other cultural systems (Verma et al., 1995; Mandal et al., 2002; Salami et al., 2010;Sørensena et al., 2014).

The cost analysis of different establishment methods were analyzed and given in Table 4. The comparative economics of different establishment methods were analyzed and reported in Table 4. Cost of operation was maximum (Rs. 8033) under treatment T_7 followed by T_6 then T_5, T_1 then T_4 and minimum (Rs. 629) was in treatment T_2 and T_3. It is clear from the table 4 maximum cost of operation was under manual method (8033 Rs/ha). It was minimum under treatment T_3 (Rs. 62/ha) because no tillage operation was performed in this treatment. The total cost of production was also maximum under treatments followed by T_6, T_5, T_4, T_1 and minimum was under treatment T_2 and T_3.

Table 4.Economics of rice cultivation as influenced by different crop establishment techniques

Sr. No.	**Particulars**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**
Input cost (Rs/ha)								
1	Preparatory tillage a. Harrowing @738 Rs/ha b. Planker along with cultivator @ 730 Rs/ha c. Rotavator two operation @ 1565 rs/ha	1468	-	-	-	1468	3033	3033
2	Sowing/transplanting	629	629	629	1372	1372	1372	5000
	Total operation cost	**2097**	**629**	**629**	**1372**	**2840**	**4405**	**8033**
3	Seed 20 kg/ha @ 40 Rs/kg	800	800	800	800	800	800	800
4	Nursery raising (6man/day/ha)	-	-	-	1014	1014	1014	1014
5	seed treatment emisalt @ 250 Rs/ha	250	250	250	250	250	250	250
6	Bund making	250	250	250	250	250	250	250

7	Fertilizers a. urea Rs 250/- 50 kg bag b. single superphosphate Rs 250/- 50 kg bag c. muriate of potash @ Rs 250/- 50 kg bag	1575	1575	1575	1575	1575	1575	1575
8	Irrigations30 Rs/ha	5700	5700	5700	8000	8000	8000	8000
9	Weeding 4man/day/ha	676	676	676	676	676	200	200
10	Plant protectionBrown spot, steam root cutter, indosulphan @2 kg/ha	1500	1500	1500	1500	1500	1500	1500
11	Harvesting/ threshing	2600	2600	2600	2600	2600	2600	2600
	Total cost	15936	14468	14468	18525	19993	20882	24510
13	Interest (3.5%) on total cost	558	506	506	648	700	731	878
14	**Total input cost**	**16494**	**14974**	**14974**	**19173**	**20693**	**21613**	**25388**
15	Rental value of land	37500	37500	37500	37500	37500	37500	37500

Tillage operations used great amount of energy for land preparation. The energy requirement was negligible in zero till systems for tillage operation, which were major advantages over the conventional tillage. Direct sowing (Rs 16491) and manual transplanting of seedling (Rs 25388) kind of treatment required higher energy input than compare to zero till treatment (Rs 14974) because it used energy for tillage, transplanting, and manpower to rise mat-type seedlings. On comparing other side direct sowing can reduced the energy input as compared to mechanical transplanting because there was no need to raise seedling. Land preparation, transplanting or sowing, harvesting, fertilizer, and FYM applications together accounted for great amount of energy input.

2. **Crop performance under different methods of rice establishment**

The plant height under different methods of rice establishment was given in Fig 1. The plant height was recorded at the time interval of 7, 14, 21, 35, 42 and 49 DAS/DAP. During these time interval the maximum plant height was obtained in 4.63, 12.7, 21.86, 29.97, 35.83 and 44 cm respectively. The minimum height of plant was obtained 4.04, 11.25, 18.73, 28.33, 34.42, and 42.60 cm with the T_1(7), T_2 (14 & 21), T_5 (35), T_4 (42) andT_4 (49)

day respectively. The overall plant height was maximum (126.59cm) under T_6 and minimum (121.00 cm) was obtained in T_2 respectively.

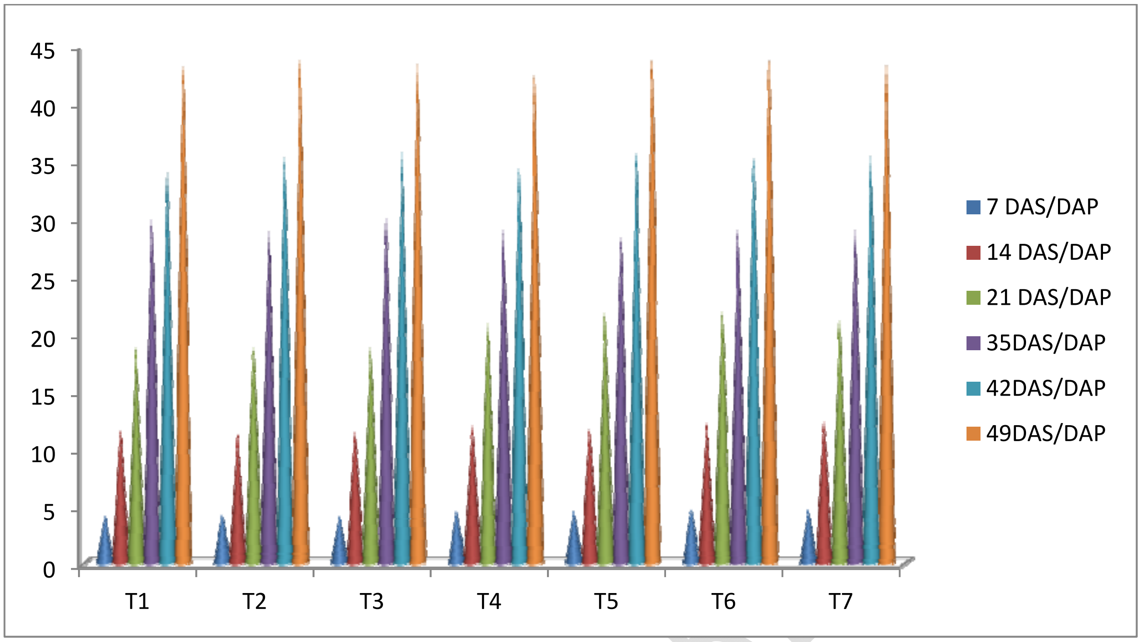

Fig.1 plant growth with time interval for different treatment

3. Crop yield under different methods of rice establishment

The effect of various treatments on crop yield was days to crop maturity, number of grain in a panicle, panicle length, number tillers/m^2, straw and crop yield (grain) were recorded at time of crop harvesting and results are reported in Table 5. the plant height at crop maturity in mechanical transplanting varied from 121.8 to 126.5 cm whereas in direct sowing the plant height at crop maturity was in the range 121 to 123.5 cm and manual transplanting it was found 126.4 cm. Duration of the crop maturity in all treatment was nearly same and it was 144-145 days. The number of effective tillers per square meter was found in the range of 218 to 220 when rice crop was transplanted with mechanical transplanter and sown with direct sowing method. In manual transplanting number of effective tillers per square meter were 221. The numbers of grains per panicle in mechanical transplanting varied from 73.3 to 78.7 whereas in direct sowing numbers of grains per panicle were 73.5 to 78.33 and in manual transplanting it was observed 79.55.

Grain output was also considerably higher in mechanized transplanting seedling compare to direct sowing. Direct sowing and zero till mechanical transplanting methods produced the low grain yield because of poor crop growth. Low productivity was observed in zero till mechanized transplanting the reason may be due to missing hills of the seedlings while transplanting with the machine or soil bed not prepared well in standing water. Further, production of straw or biomass was more in zero till direct sowing treatment with stubble leading to a higher straw production compare to other cultivation treatment. The grain yield in mechanical transplanting varied from 29.5 to 32.6 q/h where as in direct sowing treatment 31.2 to 32.1 q/ha. The maximum production kg/ha per hectare was from under treatment T_6 followed by T_7 and minimum was under treatment T_4.The gross return (69578 Rs/ha) was maximum under treatment T_6 followed by T_5 and T_2 and minimum was under treatment T_4.Net return (Rs. 63367/ha) was maximum under treatment T_3 followed by T_2. The benefit cost ratio was maximum (1.3) under treatment T_2 whereas in other treatment it varied from 1.27 to 1.30.

Table 5. Crop yield under different methods of rice establishment

Treatments	Days to crop maturity	Panicle length (cm)	No. of effective Tillers/m^2 at harvest	No. of grains/panicle	Grain Yield (kg/ha)	Straw (kg/Ha)
T_1	144	23.26	220	76.66	3178	4225.0
T_2	144	23.26	220	73.52	3129	4693.5
T_3	144	23.77	221	78.33	3219	4828.5
T_4	145	22.56	218	73.30	2975	3834.3
T_5	145	23.55	220	76.61	3194	4299.6
T_6	145	23.98	220	78.77	3267	4304.2
T_7	145	24.34	221	79.55	3202	4076.5

4. Economics

Zero till direct sowing (T2 and T3) was cost-effective energy saving rice cultivation treatment. Cost of cultivation in all mechanized treatment was considerably less as compare to the manual transplanting treatment. Total cost of cultivation in treatment T2 and T3 was lower and the amount was 52474 Rs/ha and the cost of cultivation in transplanting treatment was higher shown in Fig. 2. The cost of manual transplanting was highest among all the treatment and that was 62888 Rs/ ha. Above result suggest the requirements for mechanization of rice production in the Northern region of India. Advantages of mechanized system had requirement of labour was low as compare to manual transplanting, which effect cost of cultivation.

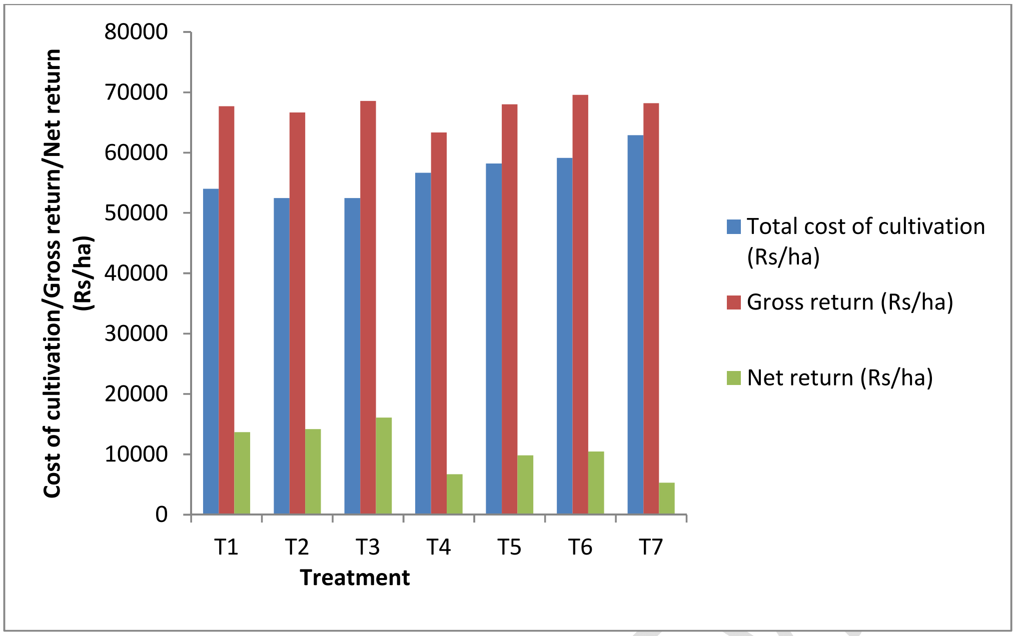

Fig.2 Cost of cultivation/Gross return/Net return (Rs/ha) for different treatment

Economic return of the crop cultivation was directly related to the yield (q/ha) of rice in different cultivation treatment. The benefit to cost ratio (B:C) of the T3 treatment was considerably higher than all other treatment and the lowest benefit to cost ratio was observed in manual transplanting.

Conclusion

Following conclusion from the above study:

1. Cost of manual transplanting was INR 62888 per Ha and it was observed highest compared with other treatments.
2. The numbers of grains per panicle in mechanical transplanting varied from 73.3 to 78.7 whereas in direct sowing numbers of grains per panicle were 73.5 to 78.33 and in manual transplanting it was observed 79.55.
3. The benefit to cost ratio for T3 treatment was 1.30 and it was highest as compared to other treatment.
4. The benefit cost ratio for treatment T_2 and T_3were obtained highest 1.21 and 1.25 respectively. However T_7 and T_4 were obtained lowest 1.08 and 1.16 respectively

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