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Optimizing the profits and enhancing productivity of rice through mechanization

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■ **ABSTRACT :** Paddy is the principal crop and the central plains of Chhattisgarh are known as rice bowl of central India. It is a labour intensive crop and requires about 800 to 900 labour-hours for cultivating one hectare of land. Of different field operations, seeding through seed drills, transplanting, weeding through mechanical weeder and harvesting together consume major labour force and if these are managed timely and efficiently by the farmers, could earns good profit. An experiment was conducted at Krishi Vigyan Kendra, Kanker to assess the performance of machines used in cultivation of rice. Different machines were evaluated for particular operations. For mechanical transplanting a self propelled rice planter and paddy seeding under wet conditions an eight row paddy drum seeder were used. For weeding manually operated weeder and self propelled paddy reaper for harvesting of paddy were also evaluated. An eight row self propelled paddy transplanter was found to be very effective for timely transplanting in a large area. Its average field capacity was 0.192 ha/hr and cost of transplanting almost 61 per cent less compared to manual transplanting. Use of manually operated 8 row drum seeder tested was most effective for line sowing of sprouted paddy in puddled condition. It reduces the cost of cultivation by saving 58 per cent seed compared to farmers practice. On the other hand, weed efficiency was found maximum 83.87 per cent with Ambika paddy weeder. It was observed that the average cost of mechanical transplanting with an eight row self propelled rice transplanter 74.71 %, mechanical weeding with ambica paddy weeder was 51.15 per cent and mechanical harvesting with a self propelled vertical conveyer reaper was 59.76 per cent less as compared to manual transplanting, weeding and harvesting operations, respectively.

■ **KEY WORDS :** Mechanization, Transplanter, Drum seeder, Productivity

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The farming a decade ago was input intensive amassing its strength from the number of working hands which were available due to the high rates of unemployment and illiteracy. With declining farm labour availability and their wages, farm operations have turned expensive calling for mechanical intervention. The overall level of mechanization in farming is below 50 per cent in the case of majority of the farming operation in India. The traction machines can produce a far higher output in much shorter time frame depending on their size and rated capacity. Besides the use of machines helps reduce the drudgery of farm work that distracts educated youth from farming (Anonymous, 2016).

Often the farmers face the problem of shortage of

labours during the peak sowing, transplanting, weeding and harvesting season. Due to this timely complete operation is a very difficult. It has been reported that delay in transplanting by one and two months has a yield reduction of about 25 to 70 per cent. Due to late transplanting the turn-around time available for the next crop is very small which again affects the yield of the subsequent crop. The following Table A gives the operation wise labour requirement in rice cultivation (Chaudhary and Varshney, 2003).

Table A : Labour requirements in rice cultivation

Sr. No.	Operation	Percentage of labour requirement
1.	Puddling	11
2.	Transplanting	38
3.	Weeding	19
4.	Harvesting	20
5.	Threshing	12

Keeping above facts an experiments were conducted at Krishi Vigyan Kendra, Kanker to evaluate the performance of farm machines for enhancing production and productivity of paddy.

METHODOLOGY

The trails were conducted at Krishi Vigyan Kendra, Kanker during *Kharif* season in the year2014, 2015 and 2016. The experiment consisted of evaluation of field performance of the mechanical transplanter, drum seeder and mechanical weeders in comparison with manual transplanting and weeding. For this an eight row self propelled paddy transplanter was used for transplanting sampling (14 to 17 days old), drum seeder for soaked seeds in puddled field, mechanical paddy weeder (ambika weeder) for weeding and a self propelled vertical conveyer reaper for harvesting operation.

The detailed technical specifications of self propelled eight row paddy transplanter used are shown in Table B. Speed of operation, width of working, total time required to cover the area and the fuel consumption were recorded. The same rice variety 'Maheshwari' was selected for the all trails.

Mechanical transplanting requires a special type of seedlings raised on mat type nursery. Raised beds of 58 cm length, 28 cm width and 19 cm height were prepared. Polythene sheet of 28 cm width and 50 micron thickness was used. Soil was sieved and mixed with equal proportion of sand and farm yard manure and spread over the polythene sheet to a depth of 1.9 cm. Sprouted seeds were spread uniformly on the polythene sheet and pressed gently. They were covered with paddy straw and watered for four days. After the fourth day paddy straw was removed and seedlings were grown normally by regular watering. After 15 days the seedlings mats were fed to the mechanical self propelled paddy transplanter. In case of manual transplanting method, paddy nursery was raised following the recommended package of practices. Transplanting was done using mechanical transplanter by running length wise of the field on the puddled and levelled land with water level in the field kept upto 2 cm only to avoid floating of the seedlings (Fig. A). Observations on speed of operation, depth of placement of seedlings, number of seedlings per hill, number of missed hills, time taken for turning, time taken for loading of seedling mat on to the transplanter, total time taken for transplanting, total area covered, width of coverage and fuel consumption for the transplanting operation were recorded.

Table B : Technical specifications of eight row self propelled paddy transplanter

Parameters	
Make	Redland
Type	Riding type
Overall dimensions (LxWxH), cm	250x234x118
Weight, kg	332
Engine specifications	4 hp single cylinder Air cooled, Diesel engine
No of rows,	8
Row spacing, cm	22
Hill spacing, cm	16
No. of sampling per hill	3

Fig. A : Paddy seedling transplanting with eight row paddy transplanter

Other method of line sowing in puddle field is with paddy drum seeder. This is a manually operated machine suitable to sow pre-germinated paddy seeds in rows. It consists of fibre drums, a metallic axle, a main frame and a handle (Fig. B). It is made of M.S. pipe, M.S. rod and plastics lugged wheel. The drums have holes through which seeds are dropped, while the machine is pulled backward on the prepared field. It has 8 rows with spacing of 20 cm between two consecutive rows. The technical detail of drum seeder is given in Table C.

Table C : Technical specifications of manually operated paddy drum seeder

Particulars	Dimensions
Power source	Hand operated
Number of drum	4
Number of rows	8
Shape of the seed drum	Hyperboloid
Diameter of drum, mm	200
Number of holes	36
Row spacing, mm	200
Diameter of lugged drive wheel, mm	600
Diameter of the opening, mm	9
Volume weight of seed drum, g	600
Material used	PP CP
Material of handle	GI Pipe
Operating speed, km/hr	1
Weight of unit, kg	10

Fig. B : Paddy line sowing with drum seeder and germinated seeds

Mechanical weeding was carried out with the help of ambika paddy weeder, 35 days after transplanting. The performance of weeder was evaluated in the field as per RNAM test codes. The field observations *i.e.* speed of operation, weeding index and field capacity were recorded and analyzed.

The harvesting of matured rice crop was carried out with help of a self propelled vertical conveyer reaper (Manjunatha *et al.*, 2009 and Singh *et al.*, 1988). The detail technical specification of the paddy reaper is shown in Table D.

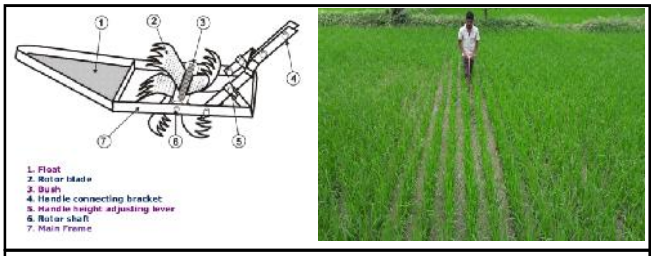

Fig. C : Schematic view of ambika weeder and mechanical weeder in operation

Table D : Specification of self propelled vertical conveyer reaper

Sr. No.	Parameter	Specifications
1.	Make	Kerala Agro Machinery Corporation Ltd (KAMACO), Kerala
2.	Model	KR 120
3.	Engine	Single cylinder 4 stroke Petrol start, kerosene run
4.	Dimensions (L × W × H)	239 × 147 × 90
5.	Fuel and tank capacity (lit.)	Kerosene-3.5 lits Petrol-0.5 lits
6.	Power (kW)	2.7
7.	Weight (kg)	116
8.	No. of rows	4
9.	Field capacity (ha/hr)	0.3
10.	No. Gears	3
11.	Type of Cutting device	Reciprocating knife bar
12.	Working width (cm)	120
13.	Effective height of cutting from ground level (cm)	10
14.	Forward speed of machine (km/hr)	3.5

■ RESULTS AND DISCUSSION

Paddy transplanting was carried out using self propelled eight row paddy transplanter. Based on the field testing conducted during *Kharif* season in the year 2014, 2015 and 2016. It was observed that the number of seedlings transplanted per hill was 3 to 4 per hill and the depth of seedlings transplanted about 5-6 cm in case of mechanical transplanting (Chaudhary *et al.*, 2003). The average actual field capacity of the self propelled eight row transplanter was 0.192 ha/h with a field efficiency of 78% at an average operating speed of 1.29 kmph (Table 1). It took 5.19 h to transplant 1 ha area and the fuel consumption was 6.5 lit./ha. The working performance of the self propelled eight row paddy transplanter was found to be satisfactory. The labour

requirement was found to be 3 man days per hectare compared to 28-30 man days of labour per hectare in manual transplanting of paddy. Thus, it saved 26 man days of labour per hectare (Tripathi *et al.*, 2004).

The effective field capacity of paddy drum seeder with seeding rates of 42.82 kg/ha was 0.14 ha/hr. However, field capacity of hand broadcasting was 0.20 ha/hr. The average plant population, after 35 days in the drum seeder was 328 and 308 Nos/m, respectively. In the drum seeder plot, the distance between rows was 20 cm, however, the distance between hill to hill along the rows varied with the seeding rate. On an average the hill to hill distances were found 4.2 cm in drum seeder. In conventional hand broadcasting, the seeds were scattered at random making no specific rows, so that, the operation of rotary type weeder is not possible for weed control. The study revealed use of drum seeder helps in timely sowing of crop resulting in more yield, saves costly seeds (requires 40-45 kg seeds/ha), reduces labour requirement and cost of sowing, line sowing by drum seeder reduces weeding cost.

Weeding efficiency is the per cent removal of weed per hectare. The average weeding efficiency was found 83.87 % in single row ambika weeder. Whereas average field capacity of ambika paddy weeder was found 0.0163 ha/hr (Table 2). Whereas with manual weeding, it was observed only 0.0076 ha/hr. Weeding, which is a labour intensive and time consuming operation could be minimize

Table 1 : Field performance of eight row self propelled paddy transplanter

Sr. No.	Parameters	2014	2015	2016
1.	Date of transplanting	28/07/2014	02/08/2015	23/07/2016
2.	Speed of operation, km/hr	1.28	1.34	1.26
3.	Actual Hill spacing, cm	16	16	16
4.	Fuel consumption, lit*hr	1.24	1.21	1.30
5.	Time required to transplant 1 ha area	5 hr 12 min	5 hr 18 min	5 hr 29
6.	Theoretical field capacity, ha/hr	0.235	0.236	0.232
7.	Field capacity, ha/hr	0.195	0.193	0.189
8.	Field efficiency,%	79	79	78
9.	Labour requirement, man-days/ha	4#	4#	4#
10.	Cost of mechanical transplanting, Rs./ha	1008.9	1028.1	1076.6

*average fuel cost @Rs. 60/lit and
Labour charges per person @Rs. 157/day, Rs. 163/day and Rs. 166/day for the year 2014, 2015 and 2016, respectively

Table 2 : Field performance of mechanical weeder (ambika weeder)

Sr. No.	Particulars	2014	2015	2016
1.	Effective width, cm	16.48	16.42	16.19
2.	Weeding efficiency, %	84.12	82.91	83.87
3.	Tiller damaged, %	1.52	1.89	1.8
4.	Field capacity, ha/hr	0.016	0.017	0.016
5.	Labour hours required per ha	62.50	58.82	62.50
6.	Cost of operation, Rs./ha	Rs. 1256	Rs. 1141	Rs. 1328

Table 3 : Performance of self propelled vertical conveyer reaper

Sr. No.	Parameters	2014	2015	2016
1.	Crop	Paddy	Paddy	Paddy
2.	Area	1.0	1.0	1.0
3.	Harvesting date	12/11/2014	14/11/2015	05/11/2016
4.	Fuel consumption (l/ha)	6.12	6.38	6.10
5.	Average speed of harvesting (km/hr)	2.32	2.15	2.43
6.	Actual field capacity (ha/hr)	0.276	0.249	0.295
7.	Field efficiency (%)	68.71	64.15	66.48
8.	Total Cost	Rs.1152	Rs. 1184	Rs. 1187

Table 4 : Operation wise cost of rice cultivation for particular manual operations

Particulars	2014	2015	2016
Date of transplanting	28/07/2014	02/08/2015	23/07/2016
Labour hour required per ha transplanting, hrs	198	208	196
Average hill to hill spacing, cm	8.42	6.98	9.41
Cost of transplanting, Rs.	3925	4238	4150
Labour hour required per ha weeding, hrs	115	134	128
Cost of weeding	2198	2771	2656
Labour hour required per ha weeding, hrs	138	146	152
Cost of harvesting	2669	2934	3154

Table 5 : Field observations of paddy crop

Methods of sowing	Number of effective tillers, Nos/m^2	Plant height, cm	Average hill spacing, cm	Panicle length, cm	Grain yield, qt/ha
Manually transplanted	321	112.81	10	15.13	40.83
Transplanted with eight row transplanter	331	114.30	16	16.84	41.12
Drum seeder	308	108.29	6.4	14.08	39.20
Broadcasting manually	218	109.60	3.1	12.12	34.28

using mechanical means. The cost of weeding with mechanical weeder was found almost half as compared to manual weeding (Singh *et al.*, 2012).

In *Kharif* season paddy crop was harvested using vertical conveyor power reaper. With working width of reaper 1.2 m and average speed of harvesting were 2.3 km/hr, the performance of reaper was found satisfactory. An average field capacity of reaper was found 0.273 ha/hr. Average fuel consumption required for per hectare of paddy harvesting with reaper was 6.2 lit (Makoto, 1977) (Table 3).

From the graph (Fig. 1), it was observed that the average cost of mechanical transplanting with an eight row self propelled rice transplanter 74.71 %, mechanical weeding with ambica paddy weeder was 51.15% and mechanical harvesting with a self propelled vertical conveyer reaper was 59.76% less as compared to manual transplanting, weeding and harvesting operations, respectively (Singh and Hensel, 2012).

The grain yield determined and has been presented in Table 5. The data showed maximum grain yield 41.12 q/ha with use of mechanical transplanted then 40.83 t/ha manually transplanted rice. The lowest yield was observed with manually broadcasted rice in puddled condition is 34.28 q/ha in sprouted rice broadcasted manually (Fig. 2).

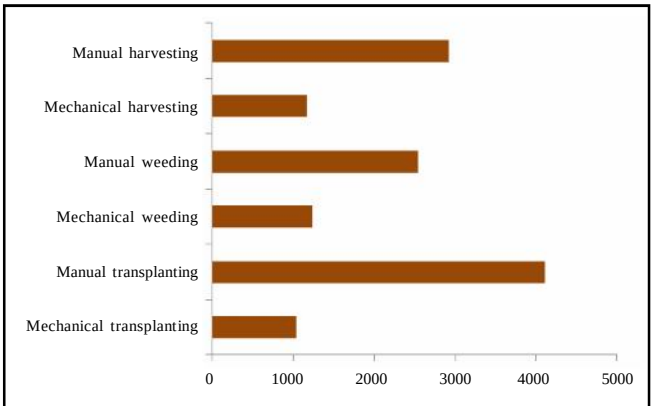

Fig. 1 : Comparative cost economics of manual and mechanical operation for rice cultivation

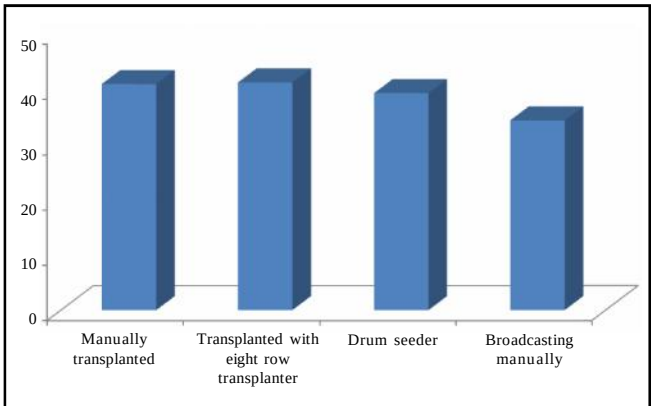

Fig. 2 : Rice yield (q/ha) recorded in different methods

Conclusion :

From the experiments it can be concluded that use of agri-machineries will help increase production and bring down the cost of cultivation by 30-45 per cent. It also saved time and valuable inputs *i.e.* seed, fertilizer, pesticides, insecticide, etc.

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