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Mechanised paddy transplanted to combat labour scarcity in rain fed paddy cultivation in Malnad regions of Uttar Kannada district

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Abstract
Studies were conducted by ICAR-Krishi Vigyan Kendra, Sirsi, Uttara Kannada, Karnataka state during 2013 and 2014 on the feasibility of mechanised transplanting operations in paddy crop with a view of timely planting and to combat labour scarcity and reduce the cost of cultivation. An eight row self-propelled paddy transplanter was used for the purpose. The performance of the mechanical transplanter was quite satisfactory. The actual field capacity, field efficiency and fuel consumption of the transplanter were 0.171 ha/hr, 70.4 per cent and 6.3 l/ha, respectively during kharif, 2013 and it was 0.152 ha/hr, 62.5 per cent and 6.3 l/ha during kharif 2014. Data recorded on growth and grain yield of paddy during 2013 and 2014 in mechanised transplanting plot was higher than manual transplanted plot. Cost of mechanical transplanting was Rs.9560/ha as compared to Rs.11250/ha in case of manual transplanting. There was 80 percent labour save in transplanting due to mechanisation. The higher net return and B:C ratio was recorded in mechanised transplanting over manual transplanting in both the years. Pooled data followed similar trend.

Keywords: Paddy mechanization, transplanter, Paddy growth and yield, economics

Introduction
Rice (*Oryza sativa* L.) is considered as the "global grain". It is the major staple food for more than half of the global population. Asian countries consume about 90 per cent of the rice grown and produced in the world and supplies 50 to 80 per cent calories of energy to Asians. Rice is the anchors of food security in the world with challenges of climate change which is grown under wide range of latitudes and altitudes (Anonymous, 2008) [1]. Paddy is largely grown traditionally by manual transplanting. Manual transplanting requires a lot of labours besides involving drudgery and is also very expensive. Scarcity of labours is another major problem in some paddy growing area of the country. Manual transplanting takes about 250-300 man hours/ha which is roughly about 25 per cent of the total labour requirement of the crop. Hence, less expensive, farmer friendly and labour saving method of paddy transplanting is urgently needed. The mechanical transplanting of paddy has been considered the most promising option, as it saves labour, ensures timely transplanting and attains optimum plant density that contributes to productivity. Keeping this in view, the study was conducted on eight row self-propelled paddy transplanter to minimize the cost of transplanting of paddy and popularization of mechanization in transplanting.

Material and Methods
Front line demonstrations were conducted by ICAR- Krishi Vigyan Kendra, Sirsi, Uttara Kannada, Karnataka during kharif 2013 and Kharif 2014 to study the practical and economic feasibility of self -propelled eight row paddy transplanter for transplanting of paddy and for popularization of the mechanised transplanting techniques among the farmers. The soil of the experimental site was sandy clay loam and lateritic soil during 2013 and 2014, respectively. The experiment consisted of evaluation of field performance of the eight row self-propelled mechanical transplanter in comparison with manual transplanting. The detailed technical specifications of self-propelled eight row paddy transplanter used are shown in Table 1. Demonstrations details in respect of crop variety, area covered, date of sowing, paddy transplanting and harvesting, etc. are presented in Table 2.

Nursery techniques
Mechanical transplanting requires a special type of seedlings raised on mat type nursery/

dopog method of nursery. Two raised beds of 8 m length, 1 m width and 15 cm height were prepared. Polythene sheet of 120 cm width and 100 micron thickness was spread over raised beds. Fifteen kilo gram paddy seeds required for one acre area of demonstration were soaked in 25 litres of solution of Carbendazim fungicide (2 g/ litre water) for 12 hours. After soaking, seeds were separated from solution and kept for sprouting in gunny bag for 24 hours. Dry Soil was collected during may month and was sieved and mixed with sieved farm yard manure in 60: 40 ratio. Readymade iron frame having 8 mats kept on polyethene sheet. One basket full of soil manure mixture was spread uniformly into readymade iron frame kept on polythene sheet to the thickness of 2.0 cm. water was sprayed by rose cane on spread soil mixture. Sprouted seeds were spread uniformly on the soil mixture and pressed gently by hand. They were covered with paddy straw and watered for five days. After the fourth day paddy straw was removed and seedlings were grown normally by regular watering. After 15-20 days, the seedlings were used for transplanting. Nursery mats were fed to the mechanical self-propelled eight row paddy transplanter. In case of manual transplanting method, paddy nursery was raised in wet method of nursery using 25 kg seeds per acre area following the recommended package of practices and after 25-29 days seedling were used for transplanting.

Table 1: Details of Paddy transplanter

S. No	Particulars	Machine specification
1	Supplier	M/s VST Agro Inputs, Mahadevapura, White-field road, Bangalore-560 048
2	Name of the machine	Yanji Shakti 8 row self- propelled rice transplanter
3	Make and Model	Model 2 ZT-238-8
4	Over all dimensions L x W x H (cm)	241 x 229 x 120
5	Weight (kg)	320
6	Fuel capacity of tank (Litre)	
7	Power	2.94 KW (4 HP) single cylinder air cooled diesel engine
8	Transplanting speed (kmph)	1-2
9	Travelling speed (kmph)	8.2
10	No. of Rows	8
11	Nursery Type	Mat
12	Row spacing (cm)	23.8
13	Hills spacing (cm)	12-14
14	No. of seedlings/hill	3-6 (Adjustable)
15	Depth of transplanting (cm)	0-6 (Adjustable)
16	Width of mat nursery (cm)	22
17	Length of mat nursery (cm)	45
18	Depth of mat nursery (cm)	2
19	Field capacity (sq.m/h)	1300-2000
20	Growing density of seedlings hill/m^2	34-42

Table 2: Details of the demonstrations

S. No	Particulars	Kharif 2013		Kharif 2014	
		Mechanised transplanting	Manual transplanting	Mechanised transplanting	Manual transplanting
1	Paddy variety	Abhilash	Abhilash	Sindu	Sindu
2	Area (ha) under each trail	0.4	0.2	0.4	0.2
3	Total area of demonstrations	5.0	1.4	4.0	1.2
4	No. of farmer or Demonstrations	7	7	6	6
5	Villages	Kantraji, Gudnapur, Yedurbail	Kantraji, Gundapur, Yedurbail	Mattihalli, Tyagli, Kodagadde and Kalagadde	Mattihalli, Tyagli, Kodagadde and Kalagadde
6	Taluk	Sirsi	Sirsi	Siddapur	Siddapur
7	Soil Type	Sandy clay loam	Sandy clay loam	Laterite	Laterite
8	Situation	Rainfed	Rainfed	Rainfed	Rainfed
9	Date of sowing of different demonstrations/ farmers	05.07.2013	05.07.2013	27.06.2014	27.06.2014
		10.07.2013	10.07.2013	02.07.2014	02.07.2014
		16.07.2013	16.07.2013	17.07.2014	17.07.2014
		20.07.2013	20.07.2013	19.07.2014	19.07.2014
				20.07.2014	20.07.2014
				21.07.2014	21.07.2014
10	Date of transplanting	23.07.2013	30.07.2013	14.07.2014	25.07.2014
		30.07.2013	06.08.2013	21.07.2014	30.07.2014
		02.08.2013	12.08.2013	01.08.2014	16.08.2014
		08.08.2013	19.08.2013	07.08.2014	16.08.2014
				10.08.2014	17.08.2014
				10.08.2014	18.08.2014
11	Date of harvest	1st, and 2nd week of Dec 2013	2nd and 3rd week of Dec 2013	3rdweek and 4th week Nov, 2014	4th week Nov and Ist week Dec, 2014

Land preparation

Main field was ploughed for two times followed by cultivator and brought soil to good tilth condition. Dolomites lime was applied at time of passing cultivator to bring soil pH to normal range. Nutrients were supplied to the crop as per the package of practices. After receiving rains, when main field was filled with water, puddling operation was done using tiller with rotovator. Field was levelled and eight kilogram of Zinc sulphate per acre was applied along with 100 kg of powder form of farm yard manure and done last tiller operation. After soil become good condition like cream on cake in the next day of puddling, transplanting was done.

Transplanting

Eighteen to twenty days age old seedlings were used for mechanised transplanter. Transplanting was done using eight row self-propelled mechanical transplanter by running lengthwise of the field on the puddled and levelled land with maximum of 1 cm water level in the field kept to avoid floating of the transplanted seedlings. Whereas, 25-29 days age old seedlings were used for manual transplantation and maintained 10-15 cm water level in the main field during transplanting.

Observations recorded

Observations on speed of operation, depth of placement of seedlings, number of seedlings per hill, total time taken for transplanting, total area covered, width of coverage and fuel consumption for the transplanting operation were recorded. The following parameters were studied to study the performance testing of the self-propelled four row paddy transplanter.

1. Theoretical field capacity was calculated based on the speed of operation and width of cutting of the machine.
2. Performance testing of eight row self-propelled Paddy transplanter.
3. Theoretical field capacity was calculated based on the speed of operation and width of cutting of the machine.
4. Actual field capacity was calculated based on area covered and actual time taken for covering the area including the time lost in turning
5. Field efficiency was obtained by dividing actual field capacity by the theoretical field capacity.
6. Labour saving by using the machine compared to manual transplanting was also studied.
7. Cost of mechanical transplanting per ha was worked out after taking into consideration machine hire charge, labour cost, field capacity of the equipment and usage of the machine in ha per year and was compared with the manual transplanting.
8. Percent save in expenditure on transplanting was also calculated.

Crop observations like plant height (cm), number of tillers per hill, number of hills/m^2, panicle length (cm), number of grains/panicle, grain weight/ plant (g), grain weight(q/ha) and straw yield (t/ha) were recorded at harvesting stage. The percentage increase in grain yield and straw yield in mechanised transplanting plot were calculated using data of manual transplanting plot. The gross returns, net returns, cost of production and B:C ratio were worked out based on the market.

Result and Discussion

Field performance of paddy transplanter

The performance of the eight row self-propelled mechanical transplanter was satisfactory. The details of the observations recorded while using the mechanical transplanter are given in table 3. Based on the field demonstration conducted during kharif 2013 and 2014, it was observed that the machine was run with the speed of 1.2 km/h and 1.0 km/h, respectively. During kharif 2013, demonstration conducted in Banavasi hobli of sirsi taluk, time taken by transplanting machine to cover one hectare are was 5 hour 50 minutes as compared to 6 hours 35 minutes in the demonstration conducted during Kharif 2014. In Mechanised paddy transplanter had 34 hills/m^2 and it was conformity with findings of Manjunath *et.al.* (2009) [2] and Patil *et al.* (2017) [3] The number of seedlings transplanted per hill was 3-4 and the depth of seedling transplanted was about 3-4 cm in case of mechanical transplanting. The actual field capacity of the eight self-propelled paddy transplanter was 0.171 ha/hr and 0.152 during 2013 and 2014, respectively. Field efficiency of 70.4 per cent was recorded during 2013 and it was 62.6 during 2014. Nine man days of labours were used in mechanised transplanting to cover one hectare area. Manjunath, *et al*., 2009 [2] conducted an experiment using eight row self-propelled paddy transplanter in black soil of Gangavati area and recorded actual field capacity of 0.192 ha/h with filed capacity of 79%. Field capacity of machine transplanter in malnad region quite low because soil type and topography. The Demonstrations conducted in Uttara kannada district were highly undulated land and small sized subplots. Operating speed of machine was slow and consumed more of time in shifting machine from one subplot to other subplots as compare to plain lands.

Table 3: Field performance of eight row self -propelled paddy transplanter

S. No	Parameters	Kharif 2013	Kharif 2014
1	Study area	0.40	0.40
2	No. of Replication or Farmers or demonstrations	6	6
3	Speed of operation (Km/h)	1.2	1.0
4	Road traveling speed (km/hr)	8.2	8.2
5	No. of rows transplanted	8	8
6	Width of operation(m)	1.904	1.904
7	Time taken to cover 1 ha area	5 hr 50 min	6 hr 35
8	No. of seedlings per hill	3-4	3-4
9	Depth of Seedlings transplanted (cm)	3	4
10	Row spacing	23.8 cm	23.8
11	Hill to hill spacing (cm)	14	14
12	Theoretical field capacity (ha/h)	0.243	0.243
13	Actual field capacity (ha/h)	0.171	0.152
14	Field efficiency (%)	70.4	62.6
15	Labour requirement (Man days/ha)	9	9
16	Fuel consumption (l/ha)	6.3	6.3

Economics on Paddy transplanting

Mechanical transplanter was found satisfactory in terms of performance, labour savings and cost involved for transplantation (Table 4). The labour requirement was 9 man days per hectare as against 45.4 man days per hectare in case of manual transplanting with 80 % labour save during 2013. Similarly, during 2014, labour retirement of 9 man days per hectare used in mechanised transplanting as compare to 43.7 man days in manual transplanting with labour save of 79.4 %. Cost of transplanting recorded in mechanised transplanting during 2013 was Rs.9560/ha as compare to Rs 11250/ha in manual transplanting and saved Rs 1690 /ha in cost of transplanting. Similarly during 2014, cost of transplanting in mechanised transplanting was Rs.8410 /ha as against Rs.10250 in case of manual transplanting with save of Rs.1840/ha. The percent save in expenditure on cost of transplanting was 15.02 and 17.95 during 2013 and 2014, respectively. The Pooled data also indicated the similar trend with respect to economics on paddy transplanting. Pradhan (2016) [4] reported lower cost of Rs 3800/ha for mechanised transplanting and higher cost of Rs 9000/ha for manual transplanting. Increased cost of transplanting in manual transplanting was due to higher labours involved for transplanting in manual method. *Whereas*, in mechanized transplanting, machine was performed with in place of labours in transplantation. Results were conformity with findings of Manjunath *et al*. (2009) [2].

Table 4: Economics on Paddy transplanting as influenced by Mechanised transplanter

Parameters	2013-14		2014-15		Pooled Data	
	Mechanised Transplanting	Manual Transplanting	Mechanised Transplanting	Manual Transplanting	Mechanised Transplanting	Manual Transplanting
No. of Labour requirement /ha	9.0	45.4	9.0	43.7	9.0	44.6
% Save in Labours for transplanting	80	-	79.4	-	79.7	-
Cost of Transplanting (Rs/ha)	9560	11250	8410	10250	8985	10750
Amount saved in Transplanting (Rs/ha)	1690	-	1840	-	1765	-
% Save in Expenditure	15.02	-	17.95	-	16.49	-

Growth and yield parameters of paddy

Paddy crop was raised by following the recommended package of practices except transplanting methods. In demonstration plot, transplanting was done by eight row self-propelled paddy transplanter. *Whereas*, in farmers check plot, seedlings were transplanted manually. Mechanised transplanting method had influence on growth and yield parameters of paddy during 2013 and 2014 as compare to manual transplanting method (Table 5). The results of field demonstrations indicated that, data on growth parameters of paddy like plant height (119.6 cm), no. of tillers/hill (25.3) and number of hills/m^2 (34) recorded higher in mechanised transplanting during 2013. *Whereas*, in case of manual transplanting, plant height, number of tillers/hill and number of hills/m^2 were 111.3cm, 20 and 41, respectively. Ananda babu (2013) [5] reported similar higher growth parameters of Paddy in mechanized transplanting plots. The yield parameters like Panicle length, Number of grains/panicle, grain weight/plant and test weight were recorded higher values of 17.3 cm, 165, 5.15 g and 31.2g, respectively in mechanised transplanting during 2013. The lower values of yield parameters were recorded in manual transplanting. The similar trend with respect to both growth and yield parameters of paddy was observed during 2014 also. The higher grain yield (63.7 q/ha) and straw yield (6.54 t/ha) were higher with mechanised transplanting during 2013.The lower grain yield of 60.0 q/ha and straw yield of 5.98 t/ha were recorded in manual transplanted plot. There was increase of 6.2 % in grain yield and 9.4 % in straw yield during 2013. During 2014, mechanised transplanting recorded higher grain yield and straw yield of paddy were 55.1 q/ha and 5.7 t/ha, respectively. *Whereas*, in case of manual transplanting, grain yield and straw yield were 43.0 q/ha and 4.51 t/ha. The percent increase in grain yield and straw yield during 2014 were 28.1 and 26.4, respectively. This may be attributed to higher number of tillers/hill due to transplanting of more seedlings /hill in case of mechanical transplanting. Similar results were also reported by Ved Prakash and Varshney (2002) [6]. The Pooled data also showed the similar trend with respect to growth and yield parameters of paddy. Improved in growth and yield parameters in mechanised transplanting might be due transplantation of younger aged seedlings, transplanting on ridges formed by machine, lesser depth of planting and planting in rows. Similar observations were reported by Negalur and Halepyati (2017) [7].

Table 5: Growth and yield parameters of Paddy as influenced by Mechanised transplanter.

Parameters	2013-14		2014-15		Pooled Data	
	Mechanised Transplanting	Manual Transplanting	Mechanised Transplanting	Manual Transplanting	Mechanised Transplanting	Manual Transplanting
Plant height (cm)	119.6	111.3	140.7	138.4	130.2	124.9
No. of Tillers	25.3	20.0	16.2	9.7	20.8	14.9
No. of Hills/m^2	34.0	41.0	34.0	39.0	34.0	40.0
Panicle length (cm)	17.3	16.6	16.3	14.3	16.8	15.5
No. of Grains/Panicle	165.0	159.5	154.8	143.3	162.3	151.4
Grain weight/plant (g)	5.15	4.83	3.93	3.53	4.99	4.18
Test weight (g/1000 grains)	31.2	30.3	25.4	24.6	28.30	27.45

Grain Yield (q/ha)	63.7	60.0	55.1	43.0	59.4	51.6
% increase in grain yield	6.2	-	28.1	28.1	17.2	-
Straw yield (t/ha)	6.54	5.98	5.70	4.51	6.12	5.25
% increase in straw yield	9.4	-	26.4	-	17.9	-

Economics on Paddy cultivation

The economics of paddy cultivation was influenced by different transplanting methods (Table 6). During 2013, the higher gross income (Rs.98280/ha) and net income (Rs.57780/ha) was recorded in mechanised transplanting. *Whereas*, manual transplanting had recorded lower gross income (Rs.92386/ha) and net income (Rs.50586/ha). Lower cost of paddy cultivation of Rs.40500/ha was recorded in mechanised transplanting as compared to Rs 41800/ha recorded in manual transplanting. Increased cost of prodcution in manual transplanting was due to higher labours involved for transplanting in manual method. *Whereas*, in mechanized transplanting, machine was performed with in place of labours in transplantation and hence, reduced the cost of cultivation. Sanjeev Kumar *et al*. (2012) [8] also recorded similar findings.The higher B: C ratio of 2.43 was recorded in mechanised transplanting. *Whereas*, the manual transplanting had recorded lower B: C ratio of 2.21. The similar trend was observed during 2014 also. The pooled data on economics of paddy cultivation also showed similar trend. Results recorded by Munnaf *et al*. (2014) [10], indicated that, there was increased gross returns, net returns and B: C ratio in mechanized transplanting as compared to manual transplanting. They reported reduced cost of production in mechanized transplanting and higher cost in manaual transplanting.

Table 6: Economics on Paddy cultivation as influenced by Mechanised transplanter

Parameters	2013-14		2014-15		Pooled Data	
	Mechanised Transplanting	Manual Transplanting	Mechanised Transplanting	Manual Transplanting	Mechanised Transplanting	Manual Transplanting
Gross Return (Rs./ha)	98280	92386	69123	54070	83702	73228
Cost of Cultivation (Rs./ha)	40500	41800	23632	26730	32066	32716
Net return (Rs./ha)	57780	50586	45491	20570	51636	35578
B:C Ratio	2.43	2.21	2.93	2.02	2.68	2.45

Concussion

From the study, it can be concluded that the Eight Row self-propelled paddy transplanter could be used successfully with a labour saving of about 80 % and eliminating the drudgery on the part of labourers with the field capacity of the transplanter being 0.17 ha/hr and problem of labour scarcity in malnad regions of Uttara Kannada district. An area of 1.0 ha can be transplanted in a day of 8 working hours in.

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