Original Research Article

Comparative study onCost Analysis of Mechanical and Manual Transplanting of Rice

Abstract

In Telangana most of the rice cultivation in the state done by traditional manual transplanting method which involves number of labourers. Shifting of agricultural labourer towards urban areas for better remuneration creates labour shortage during peak time of transplanting. To overcome labour shortage and to reduce cost of cultivation an affordable and flexible way of rice transplanting without compromising grain yield is the need of the time.

In this context, Thirty Front line demonstrations were conducted by Krishi Vigyan Kendra, Jammikunta, Karimnagar district, Telangana state from 2018-19 to 2020-21 to demonstrate mechanically transplanted rice cultivation in a few areas of Karimnagar district using a self-propelled walk behind six-row mechanical transplanter.

The data from the demonstrated plots like plant height (cm), number of productive tillers per hill, panicle length, number of grains/panicle and grain yield (kg/ha) were collected and were compared with a control plot where only manual transplanting was done. Also, cost of cultivation for both the demonstrated and control plots was found out and economic analysis was done. From the analysis, it has been found out that the gross return for mechanical and manual transplanting was Rs. 135956 and Rs. 128629 respectively and net return for mechanical and manual transplanting was Rs. 95106 and Rs. 82204 respectively for both the methods of transplanting. Benefit cost ratio was also calculated where it was found to be 3.32 and 2.77 respectively for mechanical and manual transplanting.Mechanical transplanting with rice transplanter can be used successfully as an economic, viable and alternative option for obtaining higher yield and reducing cost of cultivation as the manual transplanting involves more labour and drudgery.

Keywords: Rice,*Oryza sativa*, mechanization, front line demonstrations, mechanical transplanting

Introduction

Among cereals, rice (Oryza sativa L.) is the staple food of the majority of the Indian population and is one of the most important crops, grown in an area of 94.99 lakh hectares with a production of 129.66 million tonnes (Paddy Outlook, July 2022). The total rice cultivation area in Telangana is about 2.8 million hectares with a total production of 98 million tonnes and an average yield of 35 q/ha (Socio-Economic Outlook 2020).

Traditional manual transplanting is the most preferred method of rice cultivation in this area. Although it is an effective method of rice cultivation, it is tedious, labour-intensive, time-consuming, and requires drudgery, including labour shortages during the peak farming season. This increases the cost of transplanting, and results in delayed transplanting due to insufficient labour. Moreover, it is very difficult to cover a large area in a short period of time by manual labour. If transplanting is delayed compared to usual, rice yields decrease by 9%. (Islam *et al.*, 2008). Ved Prakash Chaudhary and Varshney (2003) reported that about 250-300 man-hours are required per hectare for transplanting, which is about 25% of the total labour required for the crop. In such a scenario,to overcome labour problem and to reduce cost of cultivation there is an urgent need for cheaper and labour-saving methods of transplanting rice without compromising the grain yield. Mechanical transplantation of riceis an alternative and promising option that can save labour, ensure timely transplantation and help in increasing the grain yield.Keeping this in view, Krishi Vigyan Kendra of Jammikuntaconducted 30 demonstrations on mechanical transplanting of rice cultivation in Karimnagar district using a self-propelled six-row mechanical transplanter.

Materials and Methods

The present study was carried out by the Krishi Vigyan Kendra during rabi season from 2018-19 to 2020-21 at the farmers' fields of different 4 villages (18^{o}08'28" N Latitude and 79^{o}18'02"E Longitude) of Karimnagar district of Telangana.In mechanical transplanting, seedlings wereraised by specialmat method of nursery.Raised beds of 10 m length, 1.2 m width and 2.5 cmheight were prepared and covered with polythenesheet of 1.2 m width and 50micron thickness. Onthe plastic sheet, 21x50 cm size iron frames were placed to get the uniform size of nurserymats which is suitable to feed in to the transplanterfor easy planting. These frames were filled withsoftened wet soil free from any trash and stones andmixed with well decomposed farm yard manure forbetter growth. Sprouted Paddy seed werespread

uniformly on the wet soil and covered withpaddy straw, as it prevents any damage from birdsand also helps in good seedling growth. These nurserybeds were watered using rose cans for 4-5 days andthereafter, the paddy straw was removed andseedlings were grown normally by regular watering.Seedlings were ready for transplanting by 16 to 18days after sowing, when the height of the plantreaches 10-15 cm height with 3-4 leaves. Self-propelled walk behind six row transplanter was used for mechanical transplanting.After the land preparation and levelling in the mainfield, the field was allowed for sedimentation for 12hours to avoid sinking of transplanter. The machinecovers 6 rows with spacing of 22.8 cm between therows and 15 cm between the hills in a row. Ricenursery was raised by adopting the recommendedpackage of practices for manual transplanting.

Different parameters data like plant height (cm), number of productive tillers/hill, panicle length, number of grains/panicle and yield (kg/ha) were collected and compared with control. Moreover, economic analysis for both the plots was done and benefit cost ratio (B: C) was also compared.

Results and discussion

In the experimental results conducted during three consecutive rabi seasons in 2019, 2020 and 2021, it was observed that the number of transplanted seedlings per hill was 4-6 and the depth of planting of seedlings was about 5 cm in case of mechanized transplanting. The productivity of the transplanter was 0.20 ha/hr and the time taken to cover 1 hectare was 5.10 hours. The transplanter cannot change the distance between rows but the spacing between hills can be adjusted to 12, 15 or 17 cm.

The studyfound that the average plant height (cm), productive number of tillers/hill, panicle length, number of grains/panicle and grain yield (kg/ha) of KNM-118 in mechanically transplanted plots were 106 cm, 21,16.8 cm, 130 and 7048 kg/ha respectively. In the control plots where manual transplantation was performed, they were 102 cm, 16, 14.9 cm, 108 and 6671 kg/ha.

The difference in yield and yield attributing characters may be due to age of seedlings in nursery. The transplanting of young aged seedlings (twenty days old seedling) along with soil and roots intact resulted in early adaptation of seedling to soil thereby showing better yield performances (Uphoff, 2002) than transplanting of twentyfive to thirty days old seedling in manual transplanting. Moreover, roots of seedlings in mat nursery are less likely to get damaged by uprooting or cutting of mat for transplanting. In mechanical transplanting,

2-3 seedlings per hill were planted whereas in manual transplanting generally, 4-5 seedlings were planted. The difference of number of seedlings while transplanting by both methods also contributed to difference in yield and yield attributing characters. The reason for difference is well explained by Maiti and Bhattacharya (2011) and Rasool *et al.,* (2013) where they reported that planting fewer numbers of seedlings per hill produced more healthy leaves and tillers and ultimately produced higher grain yield. More number of tillers and higher yield may also be due to proper row to row and plant to plant spacing in mechanically transplanted paddy over random manual transplanting.

The cost of cultivation of paddy by mechanical transplanting and manual transplanting was also studied and presented in Table 1. From table 1, it can be found out that cost of preparation of mat nursery for mechanical transplanting of paddy (Rs.1950) was higher than that of conventional nursery bed preparation for manual transplanting (Rs. 800). Also, from the table it can be concluded that transplanter charges for transplanting(Rs.8125/ha) and weeding operations (Rs.2250/ha) was reduced in mechanical transplanting over manual transplanting (Rs.12000/ha) and manual weeding (Rs.5250/ha) due to use of mechanical paddy transplanter and power weeder.

Table.1 Cost of cultivation (Rs/ha)

S.No	Operations	Manual transplanting	Mechanical transplanting
1	Nursery bed preparation	800	1950
2	Seed cost	2000	2000
3	Land preparation	6600	6600
4	Fertilizers	7875	7875
5	Labour cost for transplanting	12000	8125
6	Fuel cost for machine	-	648
7	Labour cost for weeding	5250	2250
8	Fuel for power weeder	-	825
9	Plant protection	2850	2185
10	Harvesting	5000	5000
11	Transport	1800	1800
12	Threshing	2250	2250

It can also be seen from the table that cost incurred in plant protection was also lesser in mechanical transplanting (Rs.2185) than that of manual transplanting (Rs.2850). This may be due to maintenance of proper row to row and plant to plant spacing in mechanical

transplanting. Previous study also shows that use of power weeder in paddy field reduces incidence of pests and diseases. Some pathogens overwinter or over summer in weeds and thus serve as inoculum for themain crop during its season and use of power weeder greatly reduces weed percentage in field thus contributing to better yield performance. According to Rajendran *et al.*, (2018), use of power weeder increases the sprouting of more tillers per hill through providing more aeration to the roots and also increases the nutrient uptake from soil which ultimately leads to better yield than conventional techniques.

The economic analysis of the two transplanting methods (Table 2) shows that the average cost of cultivation for manual transplanting (Rs.46425) was more than that of mechanical transplanting (Rs.41508). Gross return for both manual and mechanical transplanting was Rs. 128629 and Rs.135956 respectively. Net return for mechanical transplanting (Rs.95106) was also higher than manual transplanting (Rs.82204). From the study it was revealed that the average cost of cultivation in mechanical transplanting was reduced by Rs. 4917/hacompared to manual transplanting.

Table.2 Economic analysis

Particulars	Cost of Cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	C:B Ratio
Manual transplanting	46425	128629	82204	1:2.77
Mechanical transplanting	41508	135956	95106	1:3.32

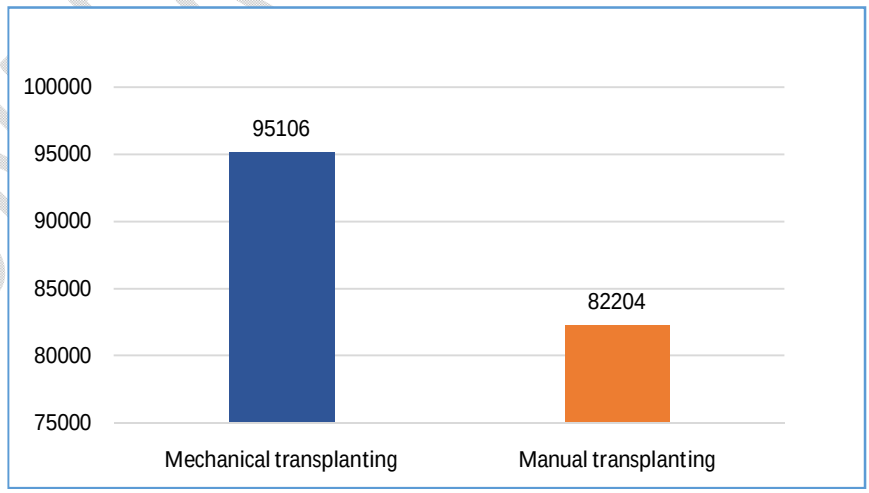

Fig 1: Comparative analysis of net returns (Rs/ha)

It was observed that an additional benefit of Rs.12,902/- was obtained through mechanical transplanting over manual transplanting. This was because the labour cost of transplanting and weeding was lower in mechanical transplanting. Mohapatra *et al.*, (2012) and Sheeja *etal.*, (2012) also reported that the cost of cultivation was reduced and net returns were increased by using transplanter in rice. Similarly, the highest benefit cost ratio (3.32) was obtained with mechanical transplanting compared to manual transplanting (2.77). Sajitha Rani and Jayakiran, (2010), Sreenivasulu *et al.*, (2014) also reported higher benefit-cost ratio in mechanical transplanting.

Conclusion

Mechanized transplanting was found to be the best method to obtain higher net returns and benefit -cost ratio compared to manual transplanting. Cost of cultivation was reduced by Rs. 4917/hain mechanical transplanting than manual transplanting and anadditional benefit of Rs. 12902/ha was obtained by mechanical transplanting.

The popularization of mechanical transplanting can be achieved through establishment of different custom hiring centres. Such centres will facilitate economic way of cultivation of paddy over conventional methods. Through mechanical transplanting of paddy cost of labourers, reduction of disease and pest incidence, reduction of weed incidence and less time for cultivation of paddy can be achieved.

It can be concluded that the rice transplanter can be used successfully as an alternative option to manual method of transplanting for obtaining higher grain yield and reducing cost of cultivation as it involves more labour and drudgery.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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