Archives of Current Research International

Volume 25, Issue 9, Page 681-688, 2025; Article no.ACRI.144152
ISSN: 2454-7077

Comparison of Use of Mechanical Transplanters and Manual Transplanting for Paddy Cultivation in Thiruvananthapuram District

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: https://doi.org/10.9734/acri/2025/v25i91532

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/144152

Short Research Article

Received: 16/07/2025
Published: 25/09/2025

ABSTRACT

Rice (*Oryza sativa* L.) continues to be the staple food of Kerala, yet the area under cultivation has declined considerably in recent decades due to crop diversification, labour scarcity, and escalating wage rates. Manual transplanting, which is predominantly performed by women labourers in the state, is labour-intensive (≈250 man-hours/ha), costly, and often results in poor planting geometry leading to reduced productivity and higher weed incidence. Mechanization offers a practical alternative. To assess its feasibility, ICAR-KVK, Mitraniketan conducted Front Line Demonstrations during *kharif* season of 2014 and 2017 at Amaravila and Vembayam *padashekharams* using two designs of self-propelled rice transplanters: an 8-row riding type (Chinese) and a 6-row walk-behind type (Japanese).

Field performance indicated that mechanized transplanting required only three labourers compared to forty in manual planting, with field efficiency of 1 ha/day against 0.2 ha/day. The average cost of

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Cite as: *Chithra G. 2025. "Comparison of Use of Mechanical Transplanters and Manual Transplanting for Paddy Cultivation in Thiruvananthapuram District". Archives of Current Research International 25 (9):681–688. https://doi.org/10.9734/acri/2025/v25i91532.*

cultivation reduced by 29.65% to Rs. 58,316/ha compared to manual transplanting where it was Rs. 72,584/ha. Economic analysis revealed higher net returns of Rs. 71,684/ha and benefit-cost ratio 2.24 in mechanized transplanting compared to returns and BC ratio of Rs. 34,083/ha and 1.46 using manual methods. Agronomic observations also showed improvements in plant establishment: higher tiller number (26 vs. 22), grains per tiller (63 vs. 52), and yield (65 q/ha vs. 53.33 q/ha). Farmers reported reduced drudgery, timely planting, uniform spacing, and faster crop recovery as major advantages.

The study demonstrates that mechanized transplanting significantly reduces labour and cost requirements while enhancing yield and profitability. Adoption of such technologies through custom hiring centres and farmer collectives could play a key role in sustaining and revitalizing paddy cultivation in Kerala.

Keywords: Rice transplanter; mechanization; labour saving; cost economics.

1. INTRODUCTION

Rice (*Oryza sativa* L.) remains the staple food of Kerala, though its area of cultivation has declined considerably over the years due to labour scarcity, rising wages, and a shift toward commercial crops. Currently, the state produces less than 20% of its rice requirement, with Thiruvananthapuram district reporting only 2140.71 ha under paddy cultivation (Department of Economics & Statistics, 2023). The acute shortage of labourers, especially for transplanting, has been a major constraint. Manual transplanting requires about 250 man-hours/ha, predominantly undertaken by women workers, fetching a wage of Rs. 450/day, yet resulting in poor line planting, high weed growth, and reduced productivity (Raj et al., 2013). Transplanting of paddy completely depends on manual labour in India. Rice transplanting is done manually and requires about 306 man-h/ha, which is roughly 42% of the total labour requirement of rice production (Manikyam et al., 2020).

Several studies have highlighted mechanization as a solution to address labour scarcity and reduce cost of cultivation. Transplanting mat type seedling is becoming more popular due to its superior performance and reduced labour requirement (50 man-h/ha) (Dixit et al., 2007). Transplanting machines also allow uniform placement of seedlings, enabling easier weeding and better crop stand. Mechanized transplanting has been reported to save 80–90% labour while ensuring higher grain yield and better economic returns (Shivashenkaramurthy et al., 2020).

Average field capacity and transplanting speed of the walking type transplanter were found to be 39.42 decimal/hr and 0.67 m/s respectively (Hossen et al., 2018). However, yield of mechanically transplanted paddy was found to vary from 3.75 t/ha to 5.70 t/ha with an average yield of 4.71 t/ha. Average yield in manually transplanted paddy was 4.50 t/ha (Baruah et al., 2001). Mechanized transplanting with rice transplanter adopting highest yield of (30 x 20 cm) row spacing recorded more 10.00 per cent more yield, when compared to 30 x 18 cm) method of planting (Jyothi & Krishna, 2017). The field capacity, field efficiency of self-propelled rice transplanter was 0.234 ha h-1, 75.16% respectively. It was observed that, the percentages of missing, floating and buried hills were 9.5%, 3.0% and 2.0% when self-propelled rice transplanter working in the field (Manikyam et al., 2020). A new multipurpose rice transplanter by providing additional tools for ploughing and clod crushing processes for small scale Indian farmer to reduce their efforts by combining multiple operation in one machine with reduced cost (Kadam et al., 2020).

Economic Analysis of Mechanical and Manual Transplanting of Rice was calculated based on that the benefit cost ratio was found to be 3.21 and 2.51 respectively.

In this context, ICAR-KVK Mitraniketan conducted case studies during *kharif* 2014 and 2017 to evaluate the technical performance and economic feasibility of self-propelled rice transplanters in *padashekharams* of Thiruvananthapuram district.

2. MATERIALS AND METHODS

KVK conducted Front Line Demonstrations during Kharif 2014 and 2017 to study the practical utility of mechanized transplanters at different locations. A 6-row self-propelled walk–behind type (Japanese design) transplanter and an 8-row self-propelled riding type (Chinese design) transplanter were operated at Amaravila and Vembayam padashekharam. It may please be noted that padashekharam implies a parcel of land cultivated for paddy and are typically large.

2.1 Study Area

2.1.1 At amaravila padashekharam, parassala

Amaravila is a village in Neyyattinkara town in Thiruvananthapuram district located geographically at 8.3885° N and 77.1054° E. The demonstration was carried out using self-propelled riding type (Chinese design) 8-row transplanter and operated in Kharif crop during 2014. For the current study, 10 ha area was covered in the village. Similar demonstrations in Tamil Nadu reported better performance of riding type machines compared to manual transplanting. Total cost of production in mat nursery method is much less than the conventional method and it saves 59% in cost of production when compared to conventional method. Increased yield, reduced cost of cultivation, more area coverage, labour drudgery reduction, less effort in nursery maintenance, reduced seed cost, efficient labour management and timely planting are the major merits of machine transplanting (Devi et al., 2020).

2.1.2 At konchiravila padashekharam, vembayam

Vembayam is another village in Thiruvananthapuram district located at 8.6393° N and 76.9369° E. The demonstration was carried out using a self-propelled walk–behind type (Japanese design) 6-row transplanter in a padashekharam spanning 6ha area. Paddy is cultivated during both virippu and puncha seasons. KVK conducted the study on 6 ha area during virippu season of 2017. Similar walk-behind designs have been successfully evaluated in Bangladesh, where they improved planting efficiency and reduced labour cost (Munnaf et al., 2014).

2.1.3 Mat nursery preparations

A mat-type nursery is a prerequisite for machine transplanting. It establishes seedlings on a layer of soil-farm yard manure (FYM) mixture at a firm surface such as polythene sheet or tray. The tray prevents the roots from penetrating the soil below and promotes the creation of a dense mat of seedlings. Seedlings are ready for planting within 15-20 days after sowing of seed.

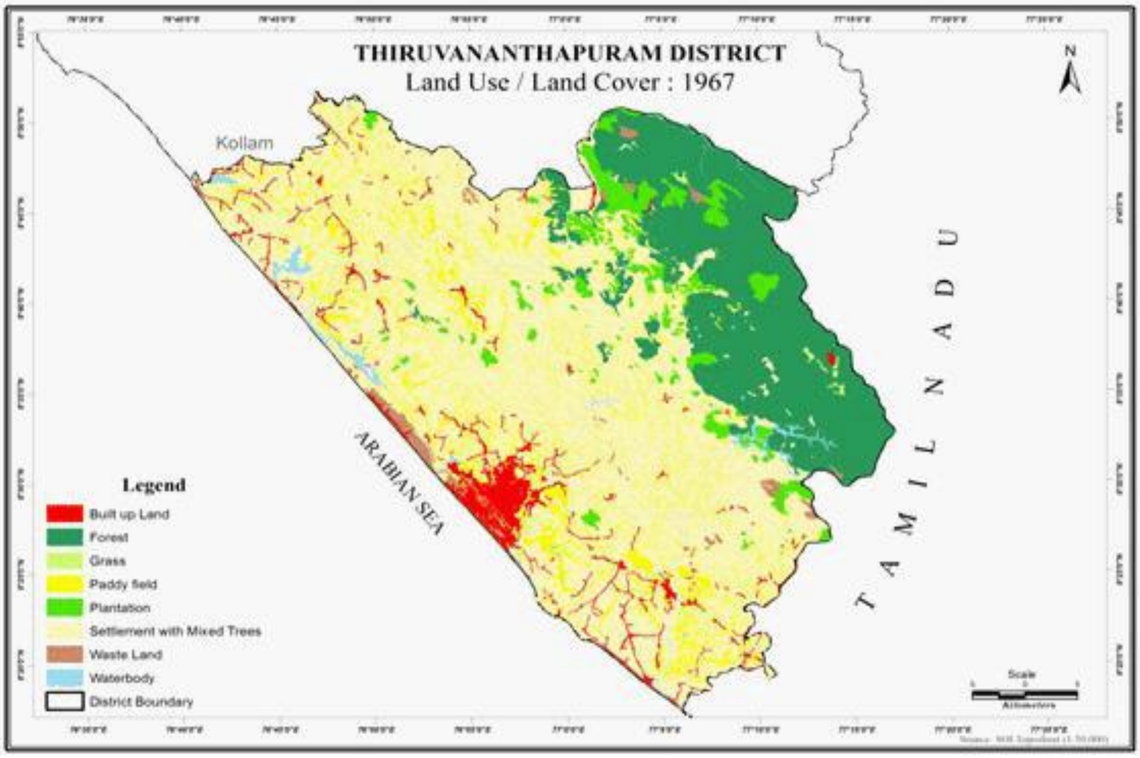

Fig. 1. Land use map of Thiruvananthapuram district

Pic. 1. Mat nursery

Mechanized paddy transplanting begins with land preparation, seedling raising, and transplanting with the machine. This method follows earlier recommendations by Dixit et al. (2007), who highlighted the efficiency of mat-type nurseries for mechanized transplanting. Mat nursery is prepared on 50 micron polythene sheets by mixing dry soil and cattle manure or vermicompost in equal proportions to an area of 75 m^2 and 0.5 inch thickness per ha of transplanting. It is mandatory to sieve the soil and manure because stones or clods create problems in the machine operation. Pre-germinated seeds are sown uniformly and covered with a thin soil layer (fill soil mix → sow seed → cover seed → water). To keep the soil moist, the nursery was sprinkled with water. After 12–15 days , seedlings reached 4–6 inches in height, ready for transplanting. Mats were cut to tray size and transplanted into the main field. The machine transplants 3–4 seedlings per hill.

2.2 Machine Description

2.2.1 Self-propelled riding type (Chinese design)

Yanji shakthi 8 Rows Riding type trasnaplanter has 4 HP diesel engine with a field capacity of 0.3 to 0.4ha/hr. Row spacing is 238 mm and the hill spacing can be varied with a standard setting of 140–170 mm. Optional distances include 100–120 mm, 120–140 mm, 170–200 mm, and 200–230 mm. The machine uses mat-type seedlings with a width of 220 mm. It can plant 3–8 seedlings per hill, adjustable based on density. The depth of planting is can be varied 0 to 60 mm. Performance results of similar models observed field capacity of 0.19 ha/hr and field efficiency of 78% (Manjunatha et al., 2009).

Fig. 2. Kubota transplanter in use

2.2.2 Self-propelled walk–behind type (Japanese design)

KUBOTA walk-behind type transplanter has 4 HP petrol engine with a field capacity of 0.24 ha/hr. The machine transplants at a row spacing of 300 mm, with a provision to vary plant-to-plant distance from 120-210 mm. The machine's planting depth varies from 7-37 mm in 4 lines with 3-9 seedlings per hill.. The depth of planting was fixed at 30 mm for the current study. The weight of the machine is 160 kg wihich is suitable for Kerala wet paddy lands. The machine demonstrated efficient seedling placement and adaptability to various soil conditions, providing reliable performance with minimal fatigue.

Similar machines have been successfully evaluated in Tamil Nadu (Senthilkumar et. al, 2016) and Bangladesh (Munnaf et al., 2014), where cost of operation and break-even usage varied significantly depending on design.

3. RESULTS AND DISCUSSIONS

Under this section, the field performance of the mechanized transplanters is discussed followed by economic analysis and yield parameters. Later, the feed back of farmers is also brought out.

3.1 Field Performance

The field demonstrations highlighted the comparative advantages of mechanized transplanting over manual methods in terms of labour requirement, field efficiency and fuel consumption. Table 1 presents the performance of different paddy transplanters in comparison to manual transplanting. Mechanized transplanting required only three labourers per hectare against 40 labourers for manual transplanting. The field capacity for mechanized and manual transplanting was 0.167ha/day and 0.2 ha/day respectively indicating fivefold increase for mechanized transplanting. Study at Bangladesh showed the field capacity 0.134ha/hr for mechanized transplanting (Fahmida et al., 2022). Fuel consumption was only 0.5 L/hr while using mechanized transplanters. This clearly indicates that mechanization is a practical solution to the acute labour scarcity and high wage rate issues prevailing in Kerala. Labour requirement for mechanical transplanting was 18 man-hr/ha while for manual transplanting was 240 man-hr/ha.

3.2 Economic Analysis

Economic analyses further reinforced the advantage of mechanical transplanting. As shown in Table 2, mechanized transplanting reduced the gross cost of cultivation from Rs. 72,584/ha for manual transplanting to Rs. 58,316/ha for mechanized means. The net return nearly doubled from Rs. 34,082.67/ha to Rs. 71,684/ha with mechanization. The benefit–cost ratio also improved significantly from 1.46 to 2.24. These findings are in line with earlier studies in Tamil Nadu (Manjunatha et al., 2009) and Assam (Senthilkumar & Nai, 2016), which reported similar improvements in profitability with transplanter adoption. Solar and battery-operated transplanters have a positive environmental effect. The use of automation and smart technology improves the general performance in rice transplanting (Rajendran & Ranganathan, 2025). For the three-row improved pull-type rice transplanter the cost-saving was 80.8% in addition to time-saving of 91.3% compared to hand transplanting (Muthamil et al., 2025).

Table 1. Performance of different paddy tansplanters over manual transplanting

Parameters	Mechanized transplanting	Manual transplanting
Labour Requirement (Nos.)	3	40
Actual field capacity (ha/day)	1	0.2
Fuel Consumption (Ltr./hr)	0.5	0

Table 2. Economic feasibility of mechanical transplanting method

Parameters	Mechanized transplanting	Manual transplanting
Gross Cost (Rs./-)	58316	72584
Net Return (Rs./-)	71684	34082.67
BCR	2.24	1.46

3.3 Yield Parameters

Mechanized plots recorded higher tillers per plant (26 vs. 22), grains per tiller (63 vs. 52), and yield (65 q/ha vs. 53.33 q/ha) (Table 3). These results corroborate earlier findings where mechanical transplanting ensured better stand establishment, vigorous tillering, and higher grain yield (Raj et al., 2013; Munnaf et al., 2014).

The comparative yield data (Fig. 3) clearly demonstrates the superiority of mechanized transplanting over manual methods. Across ten observations, yields under mechanized transplanting consistently ranged between 63–72 q/ha, except for one outlier at 45 q/ha, whereas manual transplanting yielded only 49–58 q/ha. The average yield advantage of mechanization was about 11–12 q/ha (20–22%) over manual planting. This improvement can be attributed to uniform spacing, better establishment of seedlings, and reduced intra-specific competition. Even in fields where manual transplanting performed relatively well, mechanized transplanting maintained a clear edge. Such results confirm the findings of earlier studies in Karnataka and Assam (Goswami et al., 2020; Manjunatha et al., 2009), where mechanization significantly improved productivity.

Farmers who participated in the demonstrations also reported that crop stands under mechanized transplanting appeared more uniform, matured evenly, and facilitated easier weeding operations. Thus, in addition to reducing labour costs, mechanization directly contributed to higher yields and profitability, making it a sustainable option for reviving paddy cultivation in Kerala.

3.4 Farmers’ Reactions and Local Issues

Farmers who participated in the demonstrations expressed satisfaction with the technology. Many noted that the machines ensured timely transplanting even during peak labour shortage, which is a recurring problem in Thiruvananthapuram. They observed that seedlings established quickly, tillered uniformly, and matured together, making harvesting easier. Women labourers, who are traditionally engaged in transplanting, reported relief from the drudgery of bending for long hours in muddy fields.

Table 3. Comparative yield performance for mechanical and manual transplanting methods

Parameters	Mechanized transplanting *Average	Manual transplanting *Average
No. of Tillers/Plant	26	22
Nos. of grains /tiller	63	52
Total grain weight/ plant (g)	40.95	24.24
Yield (q/ha)	65	53.33

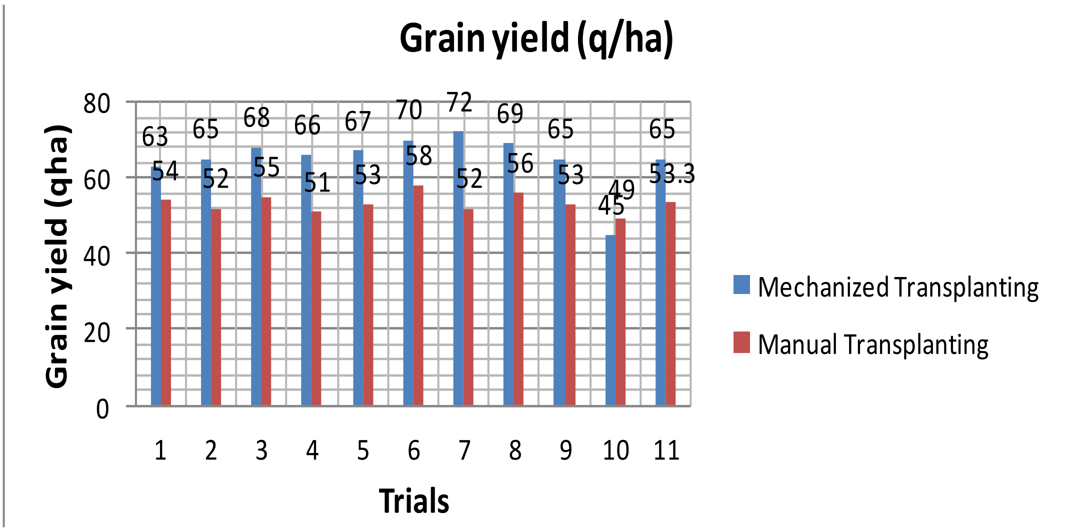

Fig. 3. Comparative yield data

Local issues, however, were also highlighted. Farmers mentioned difficulties in raising mat nurseries due to unavailability of suitable polythene sheets and quality soil in some areas. In addition, small and fragmented landholdings posed constraints for machine movement. Water management in certain padashekharams was another limiting factor, as uneven puddling reduced transplanting efficiency. Despite these challenges, the majority of farmers emphasized that mechanization reduced dependency on hired labour, cut costs, and improved crop management. They suggested that custom hiring centres and cooperative ownership would make access to such machines easier for smallholders. Development of two row rice planting machines are very useful for small farmers which addresses labour problems faced by small scale farmers (Pawar et al., 2017).

4. CONCLUSION

Mechanized transplanting using self-propelled transplanters significantly reduced labour requirements (by 92.5%) and cultivation costs (by 29.65%), while improving yield and profitability of paddy cultivation in Thiruvananthapuram district. It Is more efficient and reduced drudgery. The results are consistent with earlier studies across India and Asia, reaffirming mechanization as a sustainable solution to address labour scarcity and rising wage costs. Wider adoption through custom hiring centres and farmer collectives can enhance rice productivity and profitability in Kerala.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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 the writing or editing of this manuscript.

ACKNOWLEDGEMENTS

The author sincerely acknowledges the support of the Indian Council of Agricultural Research – Agricultural Technology Application Research Institute (ICAR-ATARI), Bengaluru for providing financial assistance, monitoring, and guidance in the conduct of the study. Heartfelt thanks are also extended to the Chairperson of Mitraniketan for continuous encouragement, guidance, and institutional support throughout the period of experimentation and documentation. The cooperation of the participating farmers of Amaravila and Vembayam Padashekharams is gratefully acknowledged for their active involvement and valuable feedback during the demonstrations.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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