POWERED TWO ROW PADDY TRANSPLANTER

by

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ABSTRACT OF THESIS

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ABSTRACT

Rice (*Oryza sativa*) is one of the most important commercial food crops and a staple diet, which provides the primary source of calories for nearly half of the global population. Moreover, India owns the largest area under rice cultivation. In the year 2024-2025, the area under rice cultivation in India was 512.67 lakh ha. The production and productivity of rice are 1501.84 lakh tonnes and 2929 kg ha $^{-1}$ respectively (Indiastat, 2024-2025). Rice cultivation can be implemented either by direct sowing of seeds or by transplanting raised seedlings into puddled fields. Typically, rice is grown by transplanting seedlings into puddled fields, either manually or mechanically, with a manual rice transplanter or by using self-propelled rice transplanter. The recommended spacing for planting rice is 20 cm × 15 cm (KAU PoP, 2016). Transplanting is a highly labour-intensive operation requiring about 300 man-hours ha^{-1}, and transplanting accounts for 25 % of labour force required in rice cultivation (Behera *et al*., 2009).

Due to labour scarcity, increased wage rates and the need for timely operations, mechanization of transplanting has become essential. Although mechanical rice transplanters are available, most of the commercially available multi-row machines are unsuitable for small and fragmented land holdings due to high initial cost, poor maneuverability and difficulty in transportation. Moreover, there is limited availability of powered two-row transplanters suitable for mat-type seedlings, which are widely adopted in modern nursery practices (Aware *et al*., 2025). Therefore, there is a need to develop a compact, lightweight, cost-effective and easily maneuverable powered two-row paddy transplanter suitable for small and marginal farmers and hilly areas where rice cultivation is practiced.

Mechanical transplantation offers advantages to manual transplanting, which involves timeliness of operation, reduction of drudgery, low cost of operation, faster transplanting and accomplishes ideal plant thickness that add to high efficiency. Transplanting by machine saved 45 % cost of operation and 50 % labour as compared to manual transplanting (Dixit *et al*., 2007). The non-availability of workers during peak season of transplanting forces them to pay huge amount of money to carry out this unit operation.

The existing paddy transplanters have limitations, such as being difficult to transport from one field to another and requiring a large initial investment for machine. Therefore, the present study is aimed to design, develop a compact and light weight powered two row paddy transplanter. The performance of transplanters depends on several factors such as seedling age, seedling mat strength, soil conditions and machine parameters. Studies indicate that

optimum seedling age, proper seed rate and adequate mat strength are essential for efficient transplanting. Efficient design of traction devices such as lugged wheels and proper synchronization of planting mechanisms are crucial for improving machine performance in puddled soil conditions. A powered two-row paddy transplanter was designed and fabricated incorporating two major primary units namely propelling unit and planting unit, the propelling unit comprises components such as engine, reduction gearbox, chain-sprocket transmission system, paddle wheels and the planting unit consists of chain case assembly, seedling board, mechanism for lateral moment of seedling board and float .

The developed prototype was evaluated under field conditions at different forward speeds of 0.5, 1.0 and 1.5 km h^{-1} and lug angles of 15° and 30°, and performance parameters such as field capacity, field efficiency, hill spacing, planting depth, and number of seedlings per hill, missing hills, fuel consumption, number of hills per square meter and wheel slip were analyzed statistically. The soil conditions during testing were found to be within the optimum range for transplanting, with moisture content ranging from 25 – 28 % for sandy loam soil and 26 – 30 % for clay loam soil The bulk density of the sandy loam soil ranged from 1.23 to 1.34 g cm^{-3} with an average of 1.285 g cm^{-3} and that of the clayey loam ranged from 1.04 to 1.16 g cm^{-3} with an average of 1.10 cm^{-3}. The seedling mats exhibited adequate density and rupture strength suitable for mechanical handling. The results revealed that hill spacing decreased with increase in forward speed and lug angle, and both factors had a statistically significant effect on hill spacing. Lug angle showed a consistent influence on actual field capacity across all operating speeds. Actual field capacity increased, reaching up to 0.045 ha h^{-1} at 1.5 km h^{-1}, while field efficiency was maximum at 1.0 km h^{-1} (70.83 %) and decreased at higher speeds. Fuel consumption increased from 0.92 to 1.2 l h^{-1} with increase in speed. The developed transplanter maintained recommended hill spacing of 12–15 cm and achieved an average planting depth of about 18 mm.

The cost of transplanting using the developed machine was less compared to manual transplanting. Economic analysis indicated that cost of transplanting with seedling mats by using powered two row paddy transplanter is Rs. 7281.08 ha^{-1} and Rs. 141.75 h^{-1} with a benefit cost ratio of 5.80 and a payback period of 0.57 years. Whereas the total cost of manual transplanting with seedling mats was significantly higher at Rs. 20266.40 ha^{-1}. The results of the study conclude that the developed powered two-row paddy transplanter is economically viable, labour-efficient, performs satisfactorily under puddled field conditions and suitable for small and marginal farmers, particularly in fragmented land holdings.