

POWERED TWO ROW PADDY TRANSPLANTER

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CHAPTER V

SUMMARY AND CONCLUSION

Rice 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. Manual transplanting is still widely practiced in rice cultivation which is highly labour intensive i.e. 300 man-hours ha⁻¹. Due to the severe lack of labour during peak seasons and the high cost of labour, mechanical transplanting is becoming more popular in India. Mechanical rice transplanters, particularly those with six or eight rows, are commercially available but are often unsuitable for Kerala's small landholdings, poor maneuverability, difficulties in transport and high initial investment. Mechanical transplantation offers advantages to manual transplanting, which involves timeliness of operation, reduction of drudgery and low cost of operation. To investigate the influence of soil and seedling mat characteristics, this study comprehensively evaluated the soil and seedling mat parameters which influence the design and operational parameters of mechanical transplanting under puddled field conditions.

Soil parameters such as moisture content, soil hardness, bulk density and puddling index were determined as they play an important role in mechanical transplanting. In puddled field conditions, mechanical transplanting was found to perform best at soil moisture content of 25 to 28 % and bulk density of sandy loam soil 1.23 to 1.34 g cm⁻³ and 1.04 to 1.16 g cm⁻³ for clay loam soil, soil hardness values of 16.65 kPa and 10.42 kPa for sandy loam and clay loam soils, as well as the puddling index of 80 % for sandy loam and 84 % for clay loam soils, confirmed that the soil was in a well-puddled and fully saturated condition which is favorable for mechanical transplanting. The interaction between the metal-soil for clayey loam was represented by a linear regression equation ($y = 0.3885x - 0.484$) with R² value of 0.9942. The lower slope compared to sandy loam soil signifies a reduced coefficient of friction, indicating smoother sliding behavior. The comparative analysis highlights that the coefficient of friction for metal-soil contact is found higher in sandy loam soil (0.535) compared to clayey loam soil (0.3885).

The planting mechanism components for a powered transplanter were selected based on agronomic considerations, physical and mechanical properties of soil and seedling mat. The prototype was fabricated based on the design considerations. The performance evaluation for combinations of different variables was conducted in the puddled fields.

The prototype with adjustable lug angle in the paddle wheels and having compact kinematic four-bar mechanism for the lateral moment of seedling tray was designed and tested at different levels of speed and lug angles. The selected paddy seed varieties were Jyothi, Uma and Shreyas to determine the physical morphological properties of seedlings at the time of transplanting. The selected physical and mechanical properties of the soil and seedling mat were determined at the time of transplanting for the design of powered two row paddy transplanter. Hill to hill spacing in the developed mechanical rice transplanter was regulated using a two-stage sprocket-chain power transmission system by changing the sprocket ratios. The effect of speed and lug angle on the different performance indices were studied and analyzed statistically. Desired combinations of treatment trials were tested in the field and the performance of the transplanter for accurate recommended spacing at an optimum lug angle and speed was evaluated.

The physical and mechanical parameters of soil and seedling mat were suitable for mechanical transplanting. From the statistical analysis of the performance indices forward speed and lug angle significantly influenced the hill spacing, wheel slip, filed capacity and fuel consumption and number of hills per square meter. Hill spacing remained within the recommended agronomic limits (12-15 cm) with an average transplanting depth of 18 mm. Field efficiency increased from 0.5 to 1.0 km h⁻¹ and subsequently decreased at 1.5 km h⁻¹ at both lug angles. The field efficiency increased approximately 58 % at 0.5 km h⁻¹ and nearly 67 % at 1.0 km h⁻¹ for 15° lug angle, gradually decreased at 1.5 km h⁻¹. Fuel consumption increased from 0.92 to 1.20 l h⁻¹ with increase in speed. The average field capacity of transplanter was 0.014 ha h⁻¹, 0.034 ha h⁻¹ and 0.045 ha h⁻¹ with field efficiency of 58.33 %, 70.83 % and 62.50 % at the forward speeds of 0.5, 1 and 1.5 km h⁻¹ respectively. The lug angle had a significant

effect on both number of hills per square meter and wheel slip. Number of missing hills per square meter results in approximately 24 hills per m^{-2} for 15 cm spacing and changed to 32 hills per m^{-2} as slip increases. The average slip observed under different combinations of speed and lug angles for the transplanter is 6.88 %, 14.9 % and 22.50 % at the forward speeds of 0.5 km h^{-1} , 1 km h^{-1} and 1.5 km h^{-1} respectively.

Cost of transplanting by power operated two row paddy transplanter is Rs. 7281.08 ha^{-1} and Rs. 141.75 h^{-1} . Cost of transplanting by manual method is Rs. 20266.40 ha^{-1} . Payback period and benefit cost ratio of the machine is 0.57 years and 5.80 respectively economically justify the adoption of the machine. The economic evaluation of the developed powered two-row paddy transplanter demonstrates its superiority over conventional manual transplanting. The cost economic analysis revealed a substantial cost saving of Rs. 12985.32 ha^{-1} compared to manual transplanting, corresponding to a 64.07 % reduction in transplanting cost. By evaluating the performance of the machine under puddled field conditions, it was found that the developed two-row transplanter achieved satisfactory operational performance, transplanting accuracy, and field efficiency, making it suitable for small and marginal paddy fields. This reduction in cost and time not only minimizes dependence on agricultural labour during peak seasons but also ensures timeliness of operation which is essential for achieving optimum crop yield. The results of cost economic analysis indicate that the developed transplanter is economically viable, labour-efficient and operationally effective, particularly under the small and fragmented landholding conditions. Therefore, mechanical transplanting using the developed machine can be recommended as a profitable alternative to manual transplanting to reduce drudgery and improve mechanization in rice cultivation. By evaluating the performance of the machine in puddled field conditions showed that the developed two row transplanter achieved satisfactory operational performance, transplanting accuracy and field efficiency suitable for small and marginal paddy fields.