ABSTRACT

In India, lowland rice is traditionally transplanted. This transplanting is a labour intensive operation. It is also a skilled job and involves working with a stooping posture in a puddled field. Availability of adequate number of labour in India during peak transplanting seasons is a problem. Timeliness of transplanting operation is again an important parameter in achieving high yield. Hence, there exists a need to mechanize this operation. A mechanical transplanter can ensure uniformity in planting of desired number of seedlings per hill at a predesigned depth, uniformity in spacings between hills and rows, higher coverage of area and mechanical weeding - all contributing towards higher yield. In India, attempts have been made to design and develop suitable transplanters under prevailing sizes of land holdings and socio-economic conditions of the farmers but there is nothing to support that any successful machine is commercially available.

Hence, an investigation was taken up to design and develop a self-propelled transplanter for Indian farmers. For this, the design of the mechanism was carried out following the method of analytical synthesis. A planar four-bar linkage with coupler extension was selected as the basic design. The path generated by the mechanism was plotted on a computer screen. By varying the dimensions of various links in the mechanism different paths of output motion of the coupler point were obtained. The potential link dimensions were identified based on the suitability of the path for picking, conveying and planting of seedlings as well as the return motion. Selection of link dimensions and analysis were continued around the dimensions of the potential design until the best design was identified. This continued covering nearly 0.3 million linkage designs before accepting the best one.

Due to simplicity in construction and effectiveness in picking and planting of seedlings the fixed fork type finger was selected to be used with the above mechanism. However, two design parameters of the finger, namely, included and orientation angles were to be optimized for best performance. Based on laboratory trials, the optimum values of the above parameters were found to be 7^0 and 35^0 respectively. Fixed fork fingers were then fabricated with the above values, to be used in the laboratory as well as in the field unit.

A single row laboratory model of the transplanter was designed and fabricated. It was incorporated with the selected four-bar linkage mechanism and one fixed fork type finger with the optimized values of included and orientation angles. Traditional root-washed seedlings were used with the machine and it was tested under controlled conditions in a laboratory. The performance of the machine was found to be satisfactory in terms of the number of seedlings planted per hill, the percentages of missed hills and of successive misplantings, percentage of floating seedling hills, percentage of damaged seedlings and the range of the angle of stand. The values were respectively 5.63 seedlings per hill, 11.2 per cent missed hills, 4.6 per cent successive misplantings, 3.3 per cent floating hills, 1.04 per cent damaged seedlings and 85.0 per cent hills in the range of $60\text{-}90^{0}$.

A four-row self-propelled transplanter using the above mechanism and the optimized finger was then designed and fabricated. This was tested under the actual field conditions. The planting speed was 40 strokes per minute. The forward speed of operation was 0.317 km/hr. From the results, it appeared that the average number of seedlings per hill was 3.95 and the planting accuracy was 78.2 per cent. The per cent damage was as low as 0.95 and the range of the angle of stand for 73.7 per cent of the seedlings was $60\text{-}90^{0}$.

The machine transplanting system was found to be technically viable and economically feasible. It can save 28.5 per cent of the transplanting cost over the traditional system.

Key words: ANALYTICAL SYNTHESIS, FOUR-BAR LINKAGE, FIXED FORK FINGER, OPTIMIZATION OF FINGERS, ROOT-WASHED SEEDLINGS, SELF-PROPELLED TRANSPLANTER, LABORATORY TESTING, FIELD TESTING, ECONOMICS.