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# Evaluation of a mechanical rice transplanter under minimum tillage unpuddled soil conditions

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## Introduction

Labour shortages for rice transplanting across Asia are stimulating interest in mechanical transplanting. While the transplanters have been evaluated in puddled soils, there is little understanding of their efficacy for transplanting into soils following minimum tillage such as zero tillage, strip tillage and raised beds. This study was conducted to evaluate the performance of a mechanical rice transplanter (4 rows walk-behind type daedong rice transplanter, model DP480) under minimum tillage options at Bangladesh Rice Research Institute research farm, Gazipur and on a farmer's field at Kumarkhali, Kushtia, Bangladesh during the irrigated dry season of 2012-13 and the non-irrigated wet season of 2013.

## Materials and methods

The bed, strip, zero and conventional tillage treatments were arranged in a randomized complete block (RCB) design with three replications. A Versatile Multi-crop Planter (Haque et al., 2001) was used to prepare the beds and strips during the irrigated dry season whereas the strips and beds were prepared using a conventional rotary tiller powered by a 2-wheel tractor (2WT) and manually during the non-irrigated wet season, respectively. A rotary tiller powered by a 2WT was used for the conventional tillage treatment, consisting of two dry pass, one wet passes and one leveling operation. Seedlings were prepared in plastic trays with 135 gm pre-germinated seeds in each tray. BRRI dhan28 and BRRI dhan49 varieties were used during the irrigated dry and the non-irrigated wet seasons, respectively. Textural classes of Gazipur and Kushtia soils were clay loam and loamy soil, respectively. The benefit-cost ratio (BCR) of each treatment was computed based on total income and production cost of rice under different tillage options. Break-even analysis was also conducted to predict the necessary annual use of the rice transplanter for making a profit.

## Results

The un-puddled strip tillage saved about 50-70% for tillage time and fuel consumption. Strip and zero tillage saved 22 and 28%, respectively, of the water required up to transplanting, compared to bed and conventional tillage. In loam and clay loam soil, soil resistance, measured by a hand penetrometer at 5 cm operating depth, during transplanting varied from 3 to 4 N/cm$^2$ and 15 to 24 N/cm$^2$ during the irrigated dry season of 2012-13 whereas it was 2 to 12 N/cm$^2$ and 0 to 9 N/cm$^2$ respectively during the non-irrigated wet season of 2013.

Overall, strip and zero tillage showed significantly higher field capacity (0.131 to 0.134 ha/hr) followed by conventional and bed tillage (0.115 to 1.21 ha/hr) whereas rice transplanter showed significantly better performance during Aman season in loamy soil conditions (0.140 ha/hr). In clay loam soil, strip tillage showed significantly higher field capacity (0.14 ha/hr) during the irrigated dry season of 2012-13 whereas field capacity of rice transplanter under strip and zero tillage was identical (0.13 ha/hr) during the non-irrigated wet season of 2013. In loam soil, significantly higher field capacity was observed in conventional tillage (0.13 ha/hr) followed by strip and zero tillage (1.2 ha/hr) during the irrigated dry season of 2012-13 whereas zero (0.16 ha/hr) and strip (0.15 ha/hr) tillage showed significantly highest field capacity during the non-irrigated wet season of 2013.

Tillage options also showed significant effects on fuel consumption of rice transplanter operations except on loamy soil during the non-irrigated wet season of 2013. In both loam and sandy loam soil, conventional tillage consumed significantly more fuel during irrigated dry season of 2012-13. In clay loam soil, strip tillage consumed significantly less fuel in both seasons. Averaged over two seasons, bed and conventional tillage consumed significantly more fuel (4.8 to 5.0 litre/ha) followed by strip and zero tillage (4.1 to 4.3 litre/ha). Overall, strip and zero tillage saved about 18 and 14%, respectively, of the fuel required for mechanical transplanting.

Highest percentage of missing hills was observed for bed and zero tillage (11.5 to 13.3%) because of more floating plants, followed by conventional tillage (9.9%). On the other hand, strip tillage resulted in the minimum number of missing hills (7.5%) due to fewer floating and deeply buried plants. In both seasons, minimum tillage resulted in more floating hills whereas buried hills occurred more often in conventional tillage due to differences in soil strength. Picker misses and mechanical damage to plants also varied with tillage treatment, soil condition and seasons. Transplanter slippage significantly reduced the plant to plant spacing during transplanting in conventional tillage from the pre-set spacing compared to minimum tillage in both irrigated dry and non-irrigated wet season soil conditions. Weed infestation and weeding cost increased substantially for un-puddled transplanting during the irrigated dry season.

Averaged over two seasons and two soil types, strip tillage gave significantly higher yield (5.3 t/ha) followed by zero, conventional and bed tillage (5.0 to 5.1 t/ha). On the other hand, Boro season gave more yields over Aman season whereas clay loam soil gave more yield advantages compared to loamy soil. However, zero tillage showed better performance in clay loam soil whereas zero tillage in loamy soil over other tillage options in both Boro and Aman season (Table 1).

**Table 1.** Grain yield overview of transplanted rice under different tillage systems

| Seasons | Soil type | Grain yield (t/ha) | | | | |
|---|---|---|---|---|---|---|
| | | BT | ST | ZT | CT | Mean |
| Boro/12-13 | Clay loam | 5.5 | 6.0 | 6.1 | 5.8 | 5.9a |
| | Loam | 5.1 | 5.4 | 5.0 | 5.1 | 5.2b |
| Aman/2013 | Clay loam | 4.6 | 4.9 | 5.0 | 4.8 | 4.8c |
| | Loam | 4.7 | 4.7 | 4.4 | 4.6 | 4.6d |
| Mean | | 5.0b | 5.3a | 5.1b | 5.1b | |
| $LSD_{0.05}$ | Season(S)=0.13, Soil type(St)=0.13, Tillage=0.18, S×St=0.18 and St×T=0.226 | | | | | |
| Level of significance | Season=**, Soil type=**, Tillage=* , S×St=**, S×T=NS, St×T=** and S×St×T=NS | | | | | |

Note: BT-Bed tillage, ST-Strip tillage, ZT-Zero tillage, CT-Conventional tillage, NS-Not significant, *-significant at 5%, **-significant at 1%, Data followed by different letters differ significantly.

However, strip tillage showed highest BCR (1.60) followed by zero tillage (1.56) compared to bed (1.50) and conventional tillage (1.52). Break-even usage of mechanical rice transplanter was about 6.5 ha/yr irrespective of tillage method.

## Conclusions

The mechanical rice transplanter Model DP480 was suitable to operate in both puddled and un-puddled conditions. However, the rice transplanter showed better performance under both strip tillage and zero tillage systems. Rice production under un-puddled strip tillage significantly increased BCR relative to conventional practices. The mechanical transplanter has promise as a means of decreasing labour for rice establishment even under minimum tillage and unpuddled transplanting of rice.

## References

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