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Techno-economic performance of 4-row self-propelled mechanical rice transplanter at farmers field in Bangladesh

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Abstract

Mechanical transplanting is an emerging technology in Bangladesh agriculture. Deadong DP480 rice transplanter was used to conduct the experiment which is imported from South Korea and China. The performance of this machine needs to be thoroughly investigated in local condition. This experiment was conducted in Boro (2015) season in the farmers' field at Gosaidanga in Shailkupa upazila under Jhenaidah district and at Rashidpur in Mithapukur upazila under Rangpur district. Two treatments, i.e. T1 = Hand transplanting (HT) and T2 = Mechanical transplanting (MT) were used in the experiment. The experiment was carried out in randomized complete block design (RCBD) and replicated in six plots in each location. Rice variety BRRI dhan28 was used to conduct the experiment in both locations. Fuel consumption of 4-row walking type mechanical transplanter obtained 5.25 L/ha. The field capacity and field efficiency of rice transplanter obtained 0.11-0.12 ha/hr and 64-70 percent, respectively. Conventional seedbed preparation required 37-55 man-hr/ha whereas 71-77 man-hr/ha required in mat type seedling suitable for mechanical transplanting. Labor requirement in hand and mechanical transplanting ranged from 123-150 and 9.0-10.5 man-hr per hectare which was 19-22 and 1.65-2.00 percent of total labor requirement in rice cultivation, respectively. Number of seedling tray requirement ranged from 215-230 per hectare. Calibration should be done on space and seedling density setting before operation in each plot to get optimum plant spacing and seedling tray requirement. Missing hill obtained 1-2 percent in mechanically transplanted plot. Mechanically transplanted plot showed significantly the higher grain yield (9-14%) than hand transplanted method due to use of infant seedling. The input cost in the form of labor and material was found similar in hand transplanting whereas in mechanical transplanting, labor cost found 12 percent lower than material cost. The cost of growing mat type seedling for mechanical transplanter found 53 percent whereas the cost of raising traditional seedbed found 34 percent of the cost of hand transplanting. Mechanical transplanting reduced 1.8 percent input cost than hand transplanting in crop cultivation. BCR of MT and HT showed 1.18-1.19 and 1.03-1.06, respectively. Mechanical intervention in crop production drastically reduced the labor requirement which can offset the peak labor demand. Mechanical transplanting systems increased yield, improved labor efficiency, ensured timeliness in operation and faster transplanting.

Key words: Fuel consumption, missing hill, labor requirement, yield, economics

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Introduction

In Bangladesh, manual transplanting of rice seedlings into heavy puddled soils is the most important agricultural operations in crop production. Manual paddy transplanting is the tedious, laborious and time consuming operations requiring about 250-300 man h ha^{-1} which is roughly 25% of total labor requirement of rice production (Singh *et al.,* 1985). The availability of labor becomes scarce and increases the wages, hand transplanting found costly leading to reduce profits in rice production. It was reported that a delay in transplanting by one month reduces the yield by 25% and a delay of two month reduced the yield by 70% (Rao and Pradhan, 1973). There is a very limited time between harvesting of one crop to sowing/transplanting of the next one. Due to shortage of human labor, farmers are compelled to practice delayed planting which results in yield loss. Farm labor is decreasing due to shifting on-farm to off-farm activity. Farm owners have been facing an acute crisis of labor in the peak time of transplanting due to shortage of labors and excessive cost in this season. Crisis of labor has created an unusual situation. The farm owners have to find the labors going door to door or they have to wait for the labors to finish the work in the nearby fields. Sometimes, they have to hire labor offering extra wages with additional facilities. As a result, the scheduled time of transplanting paddy expires in many places. Under such circumstances a less expensive and labor saving method of rice transplanting without yield loss is the urgent need of the hour (Tripathi *et.al.,* 2004). It is therefore essential to adopt the mechanical transplanter to ensure the timeliness in planting. Mechanization will bring a fundamental change in agricultural labor and cultivation process in Bangladesh. Mechanical rice transplanting method generates employment and alternate sources of income for rural youth through custom services on nursery raising and transplanting. The mechanical transplanting of rice has been considered the most promising option, as it saves labor, ensures timely transplanting and attains optimum plant density that contributes to high productivity. However, rice transplanters are considerably expensive for almost all Asian small-hold farmers. It is popular in industrialized countries where labor cost is high, for example in South Korea. Seedling age is an important factor because it has a tremendous influence on the plant height, tiller production, panicle length, grain formation, grain $panicle^{-1}$ and other yield contributing characters. Mechanical transplanters use infant seedlings and do not require extra land to raise seedlings. The farmer of Bangladesh does not give attention to the age of seedlings at transplanting and use 30 or more day's age of seedling. For optimum yield, age of seedlings at transplanting of a particular variety at a particular season may not be suitable for other varieties at that season. Therefore, it is very important to find out the optimum age of seedling of a particular variety for a particular season. The growth, development, yield and yield components of rice all are greatly influenced by plant spacing. Optimum plant spacing ensures the plants to grow properly with their aerial and underground parts utilizing more solar radiation and nutrients. There is a significant trend to mechanization of rice production resulting in reducing the labor work and time consuming. Rice planting is one of the important stages in this viewpoint particularly in transplanting method. According to above and necessity of time saving and crop yield, in recent years, farmers were encouraged to adopt mechanized methods of rice transplanting. Mechanical transplanter has high field capacity and farmers can transplant rice seedlings within very short time by using mechanical transplanter. Recently, mechanical transplanter is introduced in our country. As a new technology, this machine needs to be evaluated in different agro-ecological zone and in different rice season. Therefore, the present study was undertaken to compare the cost of mechanical over traditional method of transplanting.

Materials and Methods

This experiment was conducted in the farmers' field at Gosaidanga in Shailkupa upazila under Jhenaidah district and at Rashidpur in Mithapukur upazila under Rangpur district. The experiment was carried out in randomized complete block design (RCBD) and replicated in six plots. Twelve plots within one kilometer radius were selected to conduct this study.

Two treatments were used to conduct the experiments, which is T1 = Hand transplanting (HT) and T2 = Mechanical transplanting (MT). Rice variety BRRI dhan28 were used to conduct the experiment in both locations. Self-propelled four rows walking-type rice transplanter (DP-480) was used to transplant seedling. It has a fixed row spacing of 30 cm and has provisions for adjustments of planting depth, number of seedlings per hill, floats pressure against soil, hill spacing and planting speed. The field was prepared using common tillage practice, which was first plowing (primary tillage) once, followed by puddling (secondary tillage) twice and leveling using two-wheel tractor under the flooding conditions. After first rotary tilling, the field was flooded with water and kept as such for 7 days and then second rotary tilling was done on 8th day and the field was leveled by a plank. The plastic trays were used to raise mat-type seedlings. Dry soil was filled in tray in such a way that the soil was free from any stone, stubble and grass. Sprouted seeds were spread uniformly over the tray. The seed rate per tray for mechanical transplanting was 130-140 gm dry seed. Traditional seedbed preparation often involved secondary tillage using spade and puddling was done after inundating the field. The seed rate for hand transplanting was 37.5 kg/ha. The nursery bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted on 9th January 2015 without causing much mechanical injury to the roots and immediately transferred to the main field.

During final land preparation, all cares were taken for uniform leveling of the land. Irrigation water was applied time to time as when required uniformly in hand and mechanical transplanted plots for proper growth and development of crops. Maximum irrigation was needed at the panicle initiation stage. In hand transplanting plot, forty two days (for Rangpur site) and forty six days (for Jhenaidah site) old seedlings were uprooted carefully from the nursery field and transplanted in each of the well puddled unit plots on two different days. The date of hand transplanting for Boro rice was 10th January in Rangpur site and 30th January in Jhenaidah site (after harvesting mustard). In mechanical transplanting thirty three days (for Rangpur site) and twenty eight days (for Jhenaidah site) old seedlings were used for mechanical transplanting. Before starting the transplanter, seedling mat was rolled and fed to the mechanical transplanter and all the required adjustments such as hill spacing, number of plant per hill and planting depth were done based on the machine operator's manual. The date of transplanting for Boro rice was 9th January in Rangpur site and 30th January in Jhenaidah site. In mechanical transplanter, line to line distance was fixed at 30 cm and plant to plant spacing can be varied and set at 17 cm. The amount of human labor involved in each operation was investigated through field measurements. Field efficiency and costs are calculated following the method mentioned in Hunt (1995).

Comparative inputs

Comparative inputs in two practices are given in Table 1a and 1b. Inputs were almost similar in both practices. Seedling age was higher in MT than HT. Seedling were raised in tray for mechanical transplanter whereas, farmers raised seedling in traditional seedbed. Rice variety, fertilizer rate, cultural practices, disease infestation depended on rice season. Micronutrient was applied in both practices.

Cultural practices

Weed infestation was not severe due to application of weedicide. Few weeds were grown in the plot. For the removal of weeds, weeding was done manually by hand once at 55 days after transplanting (DAT). After that no other weeding operation was done up to harvest. Pest infestation was severe and controlled by a single application of Virtako and Nativo at the vegetative growth stage.

Yield and yield contributing character

Grain yield were recorded from pre-selected 10 m^2 land area and adjusted moisture content of 14% moisture level. For computing aboveground biomass and yield contributing characters, 4 hills were collected from the outside of the selected area. The dry weight of straw was determined after oven-drying at 70°C to constant weight. Panicle number of each hill was counted to determine the panicle number m^{-2}. Plant samples were separated into straw and panicles. Panicles were hand-threshed and the filled spikelets were separated from unfilled spikelets. Aboveground total biomass was the total dry matter of straw, rachis, and filled and unfilled spikelets. Spikelets per panicle, grain-filling percentage (100× filled spikelet number/total spikelet number), and harvest index (100×filled spikelet weight/aboveground total biomass) were calculated. Border areas of all sides of the plot were excluded to avoid border competition effects.

Economic analysis

In order to estimate the production cost, the data on working speed, total time and labor involvement and materials inputs to complete the operation were recorded.

Table 1a. Comparative input in two practices at Rangpur site

Sl. no.	Parameters	MT	HT
1	Variety	BRRI dhan28	BRRI dhan28
2	Date of Seeding	06/12/14	28/11/14
3	Seed rate	130-140 gm dry seed/tray	37.5 kg/ha
4	Seedling raising technique	Plastic tray method	Traditional seedbed
5	Transplanting	Mechanical	Hand
6	Date of transplanting	09/01/15	10/01/15
7	Age of seedling	33 days	42 days
8	Spacing	30 × 17 cm	Almost line sowing
9	Tray requirement	230 tray/ha	-
10	Seedling density setting	Medium	-
11a	Basal Fertilizer	TSP@136kgha^{-1} MOP@111kgha^{-1} Gypsum@111kgha^{-1}	TSP@136kgha^{-1} MOP@111kgha^{-1} Gypsum@111kgha^{-1}
11b	Micro Nutrient	Zn@11.25kgha^{-1}	Zn@11.25kgha^{-1}
12	Weedicide	Superclean@0.75kg ha^{-1}	Superclean@0.75kg ha^{-1}
13	Time of application	12/01/2015	13/01/2015
14	Weeding	one time	2 times
15	Top dressing	Urea 272 kgha^{-1}	Urea 272kgha^{-1}, DAP 50 kgha^{-1}
15a	1st top dress	Urea 99 kgha^{-1}	Urea 99 kgha^{-1}
15b	2nd top dress	Urea 124 kgha^{-1}	Urea 124 kgha^{-1}
15c	3rd top dress	Urea 49 kgha^{-1}	Urea 49 kgha^{-1}
16	Insecticide	Virtako one time @ 75 g ha^{-1}	Virtako one time @75 g ha^{-1}
17	Fungicide	Nativo one time @ 300 g ha^{-1} Trooper one time @ 2.25 kg ha^{-1}	Nativo one time @ 300 g ha^{-1} Trooper one time @ 2.25 kg ha^{-1}
18	Date of maturity	24/04/15	28/04/15

Table 1b. Comparative input in two practices at Jhenaidah site

Sl. no.	Parameters	MT	HT
1	Variety	BRRI dhan28	BRRI dhan28
2	Date of Seeding	02/01/15	15/12/14
3	Seed rate	130-140 gm dry seed/tray	37.5 kg/ha
4	Seedling raising technique	Plastic tray method	Traditional seedbed
5	Transplanting	Mechanical	Hand
6	Date of transplanting	30/01/15	30/01/15
7	Age of seedling	28 days	46 days
8	Spacing	30 × 17 cm	Almost line sowing
9	Tray requirement	215 tray/ha	-
10	Seedling density setting	Medium	-
11a	Basal Fertilizer	TSP@90kgha^{-1} MOP@112kgha^{-1} Gypsum@90kgha^{-1}	TSP@90kgha^{-1} MOP@112kgha^{-1} Gypsum@90kgha^{-1}
11b	Micro Nutrient	Zn @7.5kgha^{-1}	Zn @7.5 kg ha^{-1}
12	Weedicide	Pyrogold@ 124kgha^{-1}	Pyrogold@ 124kgha^{-1}
13	Time of application	04/02/2015	04/02/2015
14	Weeding	One time	2 times
15	Top dressing	Urea 198 kgha^{-1}	Urea 198 kgha^{-1}
15a	1st top dress	Urea 74 kgha^{-1} at 25 DAT	Urea 74 kgha^{-1} at 25 DAT
15b	2nd top dress	Urea 124 kgha^{-1} at 55 DAT	Urea 124 kgha^{-1} at 55 DAT
16	Insecticide	Virtako one time @ 75 g ha^{-1}	Virtako one time @75 g ha^{-1}
17	Fungicide	Nativo one time @ 300 g ha^{-1} Trooper one time @ 2.25 kg ha^{-1}	Nativo one time @ 300 g ha^{-1} Trooper one time @ 2.25 kg ha^{-1}
18	Date of maturity	13/05/15	14/05/15

Rental charge of the machines was also included in the cost estimation. Land rental value and interest on investment were considered to calculate the total input cost. Price of the produce was collected from the local markets to compute total production cost, gross return, gross margin and benefit-cost ratio.

Statistical analysis

Statistical analysis was done by using software Statistix 9.0. Least significant difference was used to compare the means.

Result and Discussion

Seedling age

In mat type seedling, 25-30 days age found optimum for transplanting whereas farmers transplant 45 days-old seedling in cold season Seedling age obtained higher in cold season than warm season.

Fuel consumption

Fuel consumption varied from 4.50-6.00 l/ha (Rangpur site) and 5.00-5.50 l/ha (Jhenaidah site) L/ha. The fuel consumption varied in two locations due to soil type, water height, plot size and shape. Average fuel consumption obtained 5.25 L/ha.

Field capacity of mechanical transplanting

Field capacity is an important factor for any kind of machine operation. Mechanical transplanter transplanted 0.10–0.12 ha/hr. The field efficiency of transplanter was 64-70 percent, respectively.

Seedling tray requirement

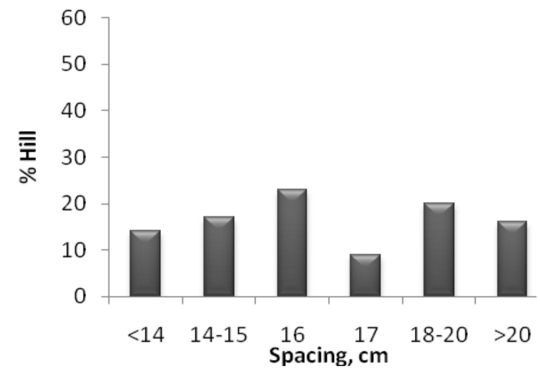
Seedling tray requirement depended on space setting. Seedling tray requirement in mechanical transplanting ranged from 215-230 number per hectare in both locations. Calibration should be done on seedling density setting to optimize seedling tray requirement.

Plant to plant spacing

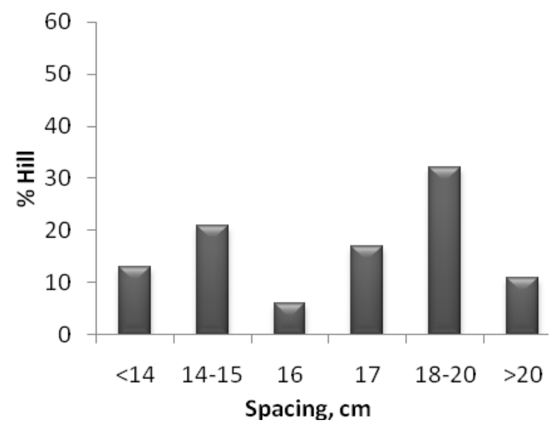
In mechanical transplanter, line to line spacing was fixed at 30 cm whereas, plant to plant spacing can be varied. Plant to plant spacing was set 17 cm. In practical situation, most of the places plant to plant spacing was not consistent and sometimes higher and lower than 17 cm (Figure 1). This might be due to skidding or slippage of the transplanter as a result of water height and depth of puddled soil. It was the common phenomenon which occurred frequently in the field. The average plant spacing of mechanical transplanter was obtained 18.06-18.41 cm which was higher than the set point. Behera *et al.* (2009) reported that the plant spacing not only depends on the puddling methods, but also influenced by sedimentation period (the period between the end of puddling and start of transplanting); higher sedimentation period more was plant spacing. Calibration should be done on space setting before operation in each plot to get optimum plant spacing.

Missing hill

In mechanical transplanting, missing hill was observed 1-2% in both sites. Missing hill was insignificant in mechanically transplanted plot. Missing hill was found lessthan the allowable limit of 5% (Mori, 1975). Gap filling was done 3-4 days after transplanting. Missing hill was not found in the manual transplanting as the laborers carefully transplant the seedlings into puddled soil.



(a) Rangpur site



(b) Jhenaidah site

Figure 1. Distribution of seedling spacing under machine spacing setting

Hill density

Figure 2 showed the hill density of mechanical transplanting over manual transplanting. In mechanically transplanted plot, hill density was higher in Rangpur than Jhenaidah site. Hill density of MT was inconsistent in both locations. It might be due to slippage and skidding of the machine caused by water height, puddled depth and land leveling. In HT, hill density showed higher in Jhenaidah which might be due to laborers transplanted seedling by eye estimation and unable to maintain proper plant spacing. In both locations, plant to plant spacing observed highest and line to line spacing observed lowest in HT than MT.

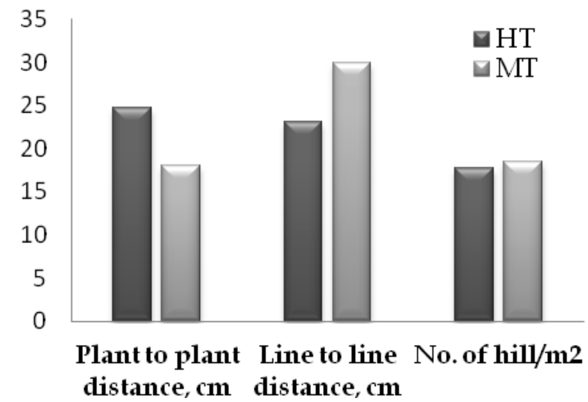
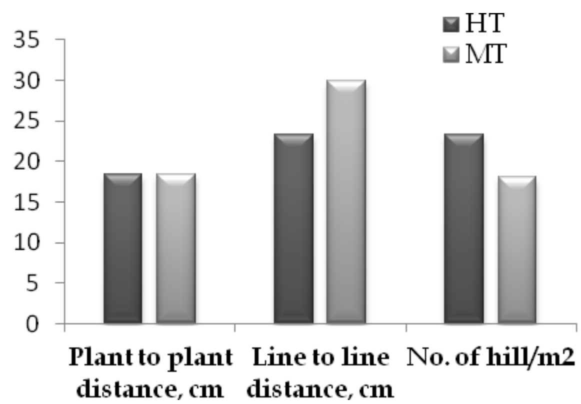


Figure 2a. Hill density at Rangpur site



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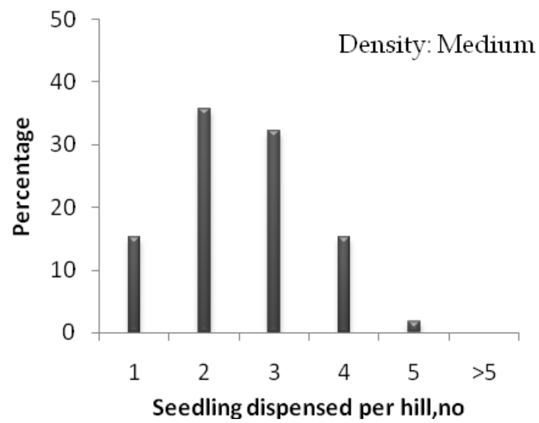
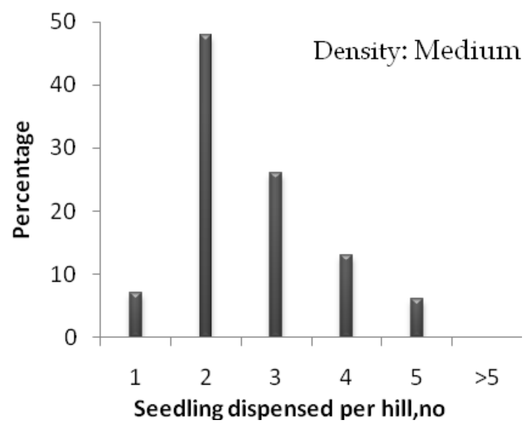
igure 2b. Hill density at Jhenaidah site

Number of seedlings dispensed per hill

Numbers of seedlings dispensed per hill in mechanically transplanted fields are given in Figure 3. Number of seedling dispensed per hill depends on the seedling density in tray and seedling density setting. Number of seedlings dispensed per hill varied in different plots. In most of the cases, 2-3 numbers of seedlings dispensed per hill. Single vigor seedling is enough to satisfy agronomic requirement. To avoid missing hill, number of seedling dispensed should be more than one.



(a)Rangpur



(b) Jhenaidah

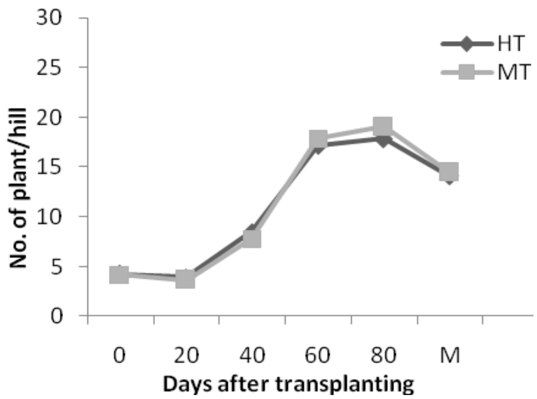
Figure 3. Seedling density in mechanical transplanted field

Plant population per hill

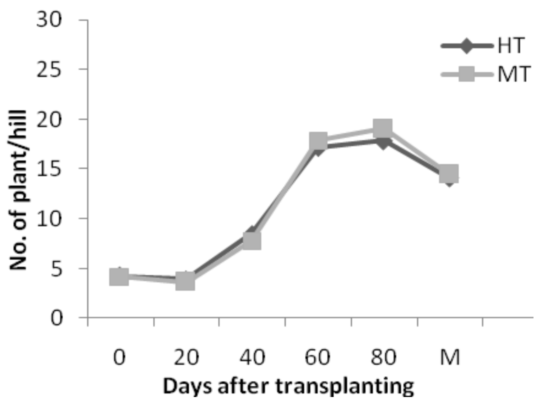
Yield is closely related to plant population. Figure 4 shows that, plant populations increased with time in both practices. Plant population was higher in mechanically transplanted plots than hand transplanted plots.

Plant height

Plant height observed similar in both practices (Figure 5). Plant height increased progressively overtime. Plant height followed rapid growth from 20 to 60 DAT in both practices.

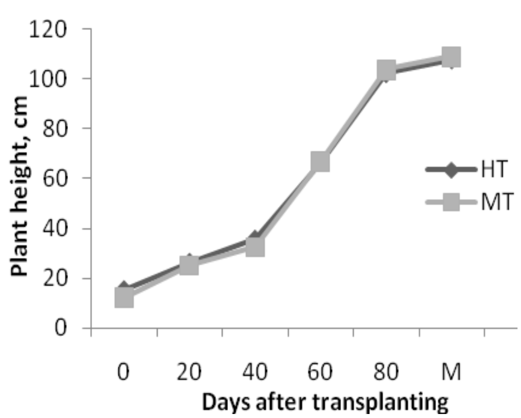


a.Rangpur

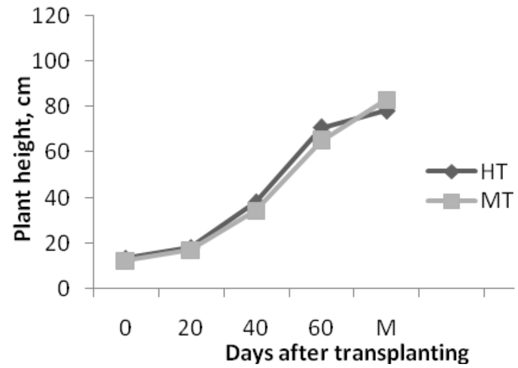


b. Jhenaidah

Figure 4. Hill density of mechanical and hand Transplanting



a.Rangpur



b. Jhenaidah

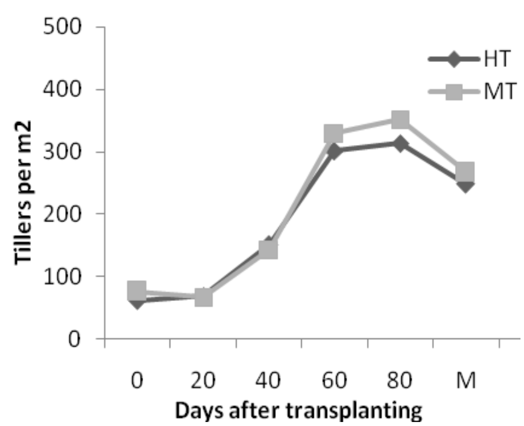
Figure 5. Plant height mechanical and hand transplanting

Tillering pattern

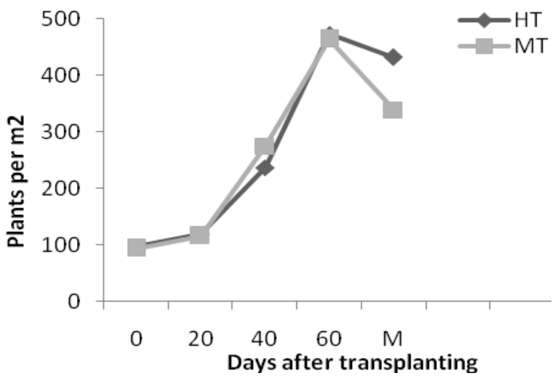
The effect of management practices on tillering pattern boro season rice in both locations is shown in Figure 6. In both practices, the tiller production sharply increased from 20 DAT and the maximum tillering stage reached in 60 DAT.

Stage-wise plant population

Figure 7 showed the stage-wise tiller production under different practices. MT produced higher tillers at all the studied stages and it was more pronounced at maximum tiller stage.

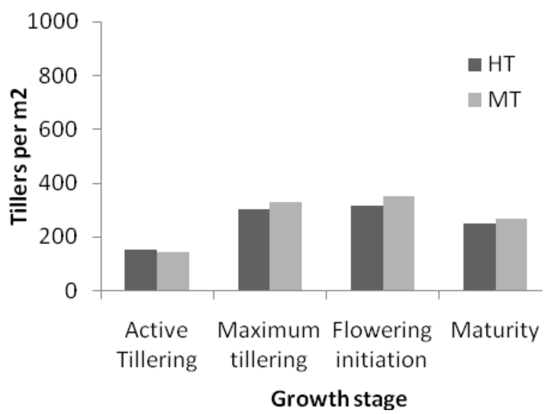


a. Rangpur



b. Jhenaidah

Figure 6. Tillering pattern of mechanical and hand transplanting



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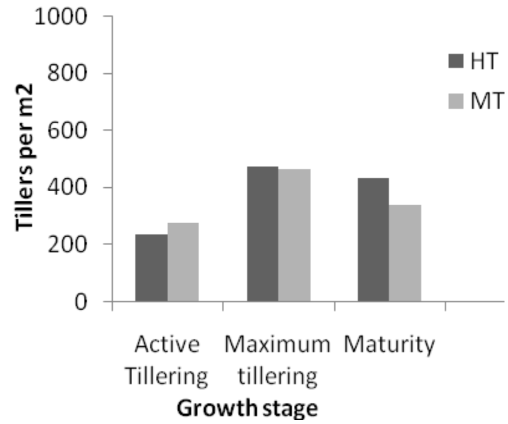
a. Rangpur



b. Jhenaidah

Figure 7. Stage-wise plant population in mechanical and hand transplanting

Yield and yield contributing character

Data were statistically analyzed on treatments over location. Table 2 shows the yield and yield contributing character under two transplanting methods. MT produced significantly higher grain yield (9-14%) than HT in both locations due to use of tender age seedling. Grain yield of both practices showed less in Jhenaidah due to damage crop by hail storm. Hail storm occurred after maximum tillering stage (after 60 days of transplanting, 06-04-2015) and some crops revived within the panicle initiation stage.

Table 2. Yield and yield contribution character

Location	Treatment	Grain yield, t/ha	Panicle, no./m^2	Panicle length, cm	Grain, no./m^2	Sterility, %	1000-grain mass
Rangpur	HT	5.05	211.50	21.21	18647	31.97	22.40
	MT	5.57	237.33	22.90	21306	29.68	22.32
Jhenaidah	HT	3.93	332.33	19.19	23418	26.47	22.43
	MT	4.50	265.50	20.79	25461	17.83	23.06
CV, %		7.98	18.21	6.55	16.91	13.75	8.01
$LSD_{0.05}$	L	0.33	41.46	1.20	3261	3.17	NS
	T	0.33	NS	1.20	NS	3.17	NS
	L x T	NS	58.64	NS	NS	4.48	NS

Transplanting methods showed significant effect on panicle length. MT produced longer panicle than HT in both site. Sterility percentage showed significantly higher in HT than MT. Combined effect of location and treatment showed insignificant on panicle number, grain per unit area and 1000 grain weight.

Labor requirement in crop production

Effect of transplanting method on labor requirement is very important. Table 3 showed the labor requirement from seedbed preparation to winnowing in rice production.

Table 3. Labor requirement in hand and mechanical transplanting in two locations

Activity	Rangpur, man-hr/ha		Jhenaidah, man-hr/ha	
	Hand	**Mechanical**	**Hand**	**Mechanical**
Seedbed preparation	1.96	-	1.82	-
Seeding	0.35	-	3.59	-
Irrigation	24	-	24.01	-
Seedling uprooting	29.01	-	8.13	-
Seedling raising	-	-	-	-
Sieving,	-	6.93	-	10.73
Tray preparation	-	41.58	-	42.93
Seeding	-	4.79	-	10.31
Irrigation	-	18.07	-	13.3
Subtotal	**55.32**	**71.37**	**37.55**	**77.27**
	(8.61%)	**(13.15%)**	**(5.31%)**	**(12.76%)**
Land preparation				
Tillage	8.53	10.23	9.04	9
	(1.33%)	(1.88%)	(1.28%)	(1.49%)
Leveling	4.35	4.74	2	2.02
	(0.68%)	(0.87%)	(0.28%)	(0.33%)
Transplanting	123.59	9.86	149.92	10.02
	(19.24%)	(1.82%)	(21.19%)	(1.65%)
Weeding	99.99	100.01	170.01	170.04
	(15.57%)	(18.43%)	(24.02%)	(28.08%)
Insecticide spray	9.96	5.89	5.01	5.04
	(1.55%)	(1.09%)	(0.71%)	(0.83%)
Fertilizer application	3.68	3.67	3.97	4
	(0.57%)	(0.68%)	(0.56%)	(0.66%)
Harvesting	129.97	130.01	149.95	150.03
	(20.23%)	(23.95%)	(21.19%)	(24.78%)
Carrying	45.01	44.99	41.99	42.02
	(7.01%)	(8.29%)	(5.93%)	6.94%
Threshing	109.99	110.01	80.35	80.07
	(17.12%)	(20.27%)	(11.35%)	(13.22)
Winnowing	51.99	51.96	57.87	56.04
	(8.09%)	(9.57%)	(8.18%)	(9.25%)
Total	**642.38**	**542.74**	**707.66**	**605.55**

Total labor requirement for production of one hectare rice transplanting was 642-708 man-hr for transplanting by hand and 542-606 man-hr for mechanical transplanting. Labor requirement in hand transplanting ranged from 123-150 man-hr per hectare. It indicated that hand transplanting appeared as labor intensive works in rice production. Labor requirement in hand transplanting showed higher in Jhenaidah site due to maintain exact line to line and plant to plant spacing. It is not the common scenario whole over the country. In mechanical transplanting, labor requirement ranged from 9.5-10.5 man-hr per hectare in both sites. The labor requirement from seedling establishment to transplanting showed 179-187 man-hr/ha in HT and 81-87 man-hr/ha in MT i.e. 53-55% labor can be saved in mechanical transplanting if all other applications remain same. Traditional seed preparation required 5-9% labor whereas 12-13% required in seedling raised in tray suitable for mechanical transplanting. Among the crop production stages, manual harvesting using sickle required highest (20-25%) labor. Hand transplanting required the second highest labor requirement (19-22%) in crop production whereas 1.65-2% labor required in mechanical transplanting. Mechanical intervention in crop production drastically reduced the labor requirement which can offset the peak labor demand.

Economic analysis

Table 4 showed the item wise costs of crop establishment and total production costs. Price of the inputs and outputs collected from the local market. Land preparation, irrigation, weeding, fertilizer, harvesting, carrying, threshing and winnowing costs were nearly same for both the transplanting method on both sites. Seed costs and transplanting cost varied depending on the transplanting method. Seedling raising cost showed 10% higher in tray type than traditional method.

Table 4a. Cost of production under different transplanting methods in Rangpur

Activity	MT, Tk/ha	HT, Tk/ha
Seedling raising	4516	4061
Land preparation	7956	7956
Transplanting	986	6179
Machine rental charge	2594	-
Fuel	433	-
Basal fertilizer	11419	11419
Urea application	184	184
Insecticide application	3779	3779
Weeding	5000	5000
Irrigation	10500	10500
Harvesting	6498	6498
Carrying	2250	2250
Threshing	5500	5500
Winnowing	2600	2600
Subtotal	**64215**	**65926**
Land value	20000	20000
Interest on investment	2123	2149
Subtotal	**22123**	**22149**
Total production cost	**86338**	**88075**

Table 4b. Cost of production under different transplanting methods in Jhenaidah

Activity	MT, Tk/ha	HT, Tk/ha
Seedling raising	5602	3174
Land preparation	7767	7767
Transplanting	1059	7496
Machine rental charge	2786	-
Fuel	1051	-
Basal fertilizer	9600	9600
Urea application	200	200
Insecticide application	432	432
Weeding	8500	8500
Irrigation	1500	1500
Harvesting	7500	7500
Carrying	2100	2100
Threshing	3210	3210
Winnowing	1993	1993
Subtotal	**53300**	**53472**
Land rental charge	20000	20000
Interest on investment	1833	1837
Subtotal	**21833**	**21837**
Total production cost	**75133**	**75309**

Cost of hand transplanting was higher than the cost of mechanical transplanting. Mechanical transplanter reduced the transplanting cost.

Effect of transplanting method on labor and material cost

The input cost in the form of labor and material from seedling establishment to winnowing for mechanical and hand transplanting are shown in the Table 5. In Rangpur site, labor and material cost was almost similar in hand transplanting whereas in mechanical transplanting, labor cost is 12% lower than material cost. In Jhenaidah, labor cost of both system showed highest compared to material cost due higher labor requirement in weeding and higher labor price.

Table 5. Cost comparison of mechanical and hand transplanting in two locations

Parameter	Rangpur		Jhenaidah	
	Hand	Mechanical	Hand	Mechanical
Labor cost (Tk/ha)	33070	28629	35157	31148
	(50.16)	(44.58)	(65.75)	(58.44)
Material cost	32855	35586	18315	22152
(Tk/ha)	(49.84)	(55.42)	(34.25)	(41.56)
Total cost	**65973**	**63887**	**53819**	**52950**

*Figure in the parentheses indicate the percentage

Effect of transplanting methods on gross return, net return and benefit cost ratio

Table 6 shows effect of transplanting method on gross return and benefit cost-ratio (BCR). The gross return was calculated based on the market price of paddy and straw. The gross returns, net return and BCR obtained the highest in mechanical transplanting than hand transplanting method in both sites. The lowest BCR was obtained in the hand transplanting method and it was due to higher labor cost, higher seed rate and higher planting cost for labor crisis. BCR of MT showed 13-15% higher than HT due to lower input cost and higher grain yield. From these results it could be concluded that Tk 11,357-11,441 per hectare will be saved for mechanical transplanting method over the hand transplanting method.

Table 6a. Effect on transplanting method on gross return, net return and benefit cost ratio (BCR) at Rangpur

Treatment	Input cost, Tk/ha	Return from grain, Tk/ha	Return from straw, Tk/ha	Gross return, Tk/ha	Net return, Tk/ha	Benefit Cost Ratio (BCR)
	A	B	C=A+B	D	E	F
MT	86338	90513	12525	103038	16700	1.19
HT	88075	82063	11355	93418	5343	1.06

Table 6b. Effect on transplanting method on gross return, net return and benefit cost ratio (BCR) at Jhenaidah

Treatment	Input cost, Tk/ha	Return from grain, Tk/ha	Return from straw, Tk/ha	Gross return, Tk/ha	Net return, Tk/ha	Benefit Cost Ratio (BCR)
	A	B	C=A+B	D	E	F
MT	75133	78750	10125	88875	13742	1.18
HT	75309	68775	8835	77610	2301	1.03

Conclusion

Mechanical transplanting increase grain yield, reduce the production costs and improve labor efficiency. It can be concluded that mechanical transplanting method is economic than the hand transplanting method.

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