Validation of walking and riding type rice transplanter in different location of Bangladesh

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Abstract

This study was conducted during the periods of 2011 to 2013 in different location of Bangladesh covering three rice seasons. Walking (DP480) type and riding (S3-680) type rice transplanter were evaluated in different locations to identify the problems and develop troubleshooting mechanisam during field operation. In research station based trials, the field capacity of walking and riding type transplanter was found to be 37.5 and 90 decimal/hr. The percent of total missing hills were 12.5 and 10%. A total of 01 research station based trials and 59 farmers field based trials were conducted during the study period whereas 01, 11, 13, 14 and 21 trials were conducted during Aus/11, Aman/11, Boro/12, Aman/12 and Boro/13 seasons respectively. It was observed from 60 trials that mechanical transplanting gave more yield advantages compare to manual transplanting resulted of higher productive tiller as well as higher grains/m^2. Average yield advantages in Aman and Boro seasons were 0.12 and 0.35 t/ha respectively. Average field capacity and transplanting speed of the walking type transplanter were found to be 39.42 decimal/hr and 0.67 m/s respectively. Total percentages of missing hills considering missing, floating, buried and damage hills were 15.43% whereas 10.5, 19.0 and 16.8% were found in Aus, Aman and Boro seasons respectively. A total of 47 large scale validation trials of rice transplanter were conducted during the period of Boro/2013. Field trials of rice transplanter also conducted to evaluate the field performance in both puddled and un-puddled conditions during Aman/2012 season. Yield and yield contributing characters have no significant different in puddled and un-puddled field. BCR of rice production under puddled and un-puddled conditions gave 1.49 and 1.56 respectively. Both the transplanter were found suitable which could be replaced the manual transplanting of rice in Bangladesh.

Keywords: Rice transplanter, field trials, location, season, field performance and yield

Introduction

Bangladesh is predominantly an agricultural country. Rice is the major agricultural product in Bangladesh, capturing the 75% and 63% of the total crop production and sales, respectively and 75% of the total cultivated area in 2005 (Klytchnikova and Diop, 2006). However, rice is the staple food for nearly half of the world's population; most of them live in Asia (Sattar, 1994). It is the main source of energy and cash income of the farmers in Bangladesh (BARC, 1983).

In Bangladesh, manual transplanting of rice in puddled is conventional practice which creates soil physical condition detrimental to the following crop in rice based cropping system (Hobbs and Morris, 1996). Rice production increase must be achieved at a faster rate than in most other countries, while the land planted to rice is not expanding. In addition, Bangladesh is faced with production constraints such as drought, lack of irrigation facilities, flooding and salinity of soils, coupled with fluctuating commercial rice prices. Historically, rice cultivation is a labor-intensive task that could not be accomplished easily. Labor cost accounts the highest input cost for rice production (Clayton, 2010). Bangladesh agriculture has been facing serious challenges of scarcity of agricultural labor not only in peak period but also in normal time. This is mainly for increased non-farm job opportunities having higher wage, migration of labor force to cities and low status of agricultural laborer in the society (Zia uddin, 2010). Mechanization is the only option to minimize the crisis of labor during peak and normal time of rice cultivation. Okurut and Odogola (1999) reported that besides land, farm power is the

second most important input to agricultural production. Mechanization is also essential for both rice production and processing as main sources of farm power. It plays a vital role in enhancing sustainable food production, thereby boosting food security in Bangladesh. The ultimate objective of farm mechanization is to boost up the overall productivity and production with the reduction of production cost and labor requirements. Agricultural mechanization using small scale machinery to agricultural production has been one of the outstanding developments in the developed countries (Osunbitana *et al.,* 2005).
To meet up the food requirements of the ever growing population of the country, an additional food grain need to be produced from the continuously decreasing agricultural lands. Increasing production per unit of land as well as cropping intensity is the only options to achieve the additional food gain. Thus, to increase production and cropping intensity, it is essential to ensure agricultural mechanization. Irrigation, land preparation, weeding and threshing are already successfully mechanized in Bangladesh. Although some operations like transplanting, harvesting, drying are still under development. In Bangladesh and other developing countries in Asia, manual transplanting of rice is conventional practice but relies on access to cheap readily-available labor. Labor shortages for rice transplanting across Asia are stimulating interest in mechanical transplanting.

Due to high cropping intensity, there is a very limited time between harvesting of one crop and sowing/transplanting of the next one. Transplanting and harvesting of crops are the most important agricultural operations which demand considerable amount of labor. The total labor requirement for rice production in 1 hectare of land was 156.2 man-days of which 44.5 man-days were consumed by seeding raising and transplanting which is 28.24% of the total labor requirement (Rahman, 1997). For manual transplanting in rows approximately 400 man-hr/ha labor is required which is roughly 30% of the total labor requirement for rice production (Islam, 1998). The yield loss due to delayed planting were 60.0, 55.4 and 9.0 kg per ha/day in the Boro, Aman and Aus seasons, respectively (Satter, 1999).

Shortage of labor and draught power in agriculture has become serious problem during peak period of planting and harvesting. In this context, farm mechanization with small, low cost and easily operable farm machinery could lead to make cultivation more profitable and to maximize production.

Shortages of human labour, farmers are compelled to practice delayed planting which results in yield loss. It is therefore essential to adopt the mechanical transplanter to ensure the timeliness in planting. So far, no meaningful attempt has been made to adopt the rice transplanter at farmers' field. Under the proposed plan, 4-row walking type and a 6-row riding type rice transplanter will be collected, modified and tested it in the FMPHT workshop for Bangladesh context and tested in the research field.

Power transplanters were manufactured and marketed in Japan since 1965 (Miura, 1966). A two-row Japanese rice transplanter (AP200) is almost 20 times faster than hand transplanting method and capable of transplanting rice seedling with almost 100% accuracy and negligible missing hills. It needs to rise seeding in trays adaptable for 15-18 days old seedlings. The seedling height, density and soil thickness in seed tray is very important for mechanical transplanting. The seedling height should be 120 mm with 3-4 leaves, 2-4 seedling per square cm and a 2-2.5 cm soil thickness are appropriate for mechanical transplanting. If adequately introduced it may be an appropriate rice transplanting technology for the farmers of the country. Therefore, test and adaptation of mechanical rice transplanter having faster work rate is essential.

Objectives

- To validate the rice transplanter to the end users
- To observe yield performance of mechanical transplanted rice compared to traditional practices.
- To increase labor efficiency and reduce human drudgery

Methodology

Approaches

Two walking and two riding type's rice transplanter were collected under NATP, Phase-1

project. Seedling raising techniques were developed for rice transplanter before field trials. Research station based trials were conducted to identify the operational conditions, machine performance in terms of field capacity, fuel consumptions, spacing of transplanting, missing hills, number of seedling per hills etc. Hands on training on seedling raising were conducted in the farmers' condition for field trials of mechanical rice transplanter. Field trials of mechanical rice transpolanter were conducted in the farmers' field using the farmers' raised seedling. Studies on un-puddle transplanting were also conducted with mechanical rice transplanter. Total number of trials in different locations under different seasons was shown in Table 1.

Table 1. Field trials in different location under different season

Season	No. of trials	Comments
Aus/2011	01	Research trials
Aman/2011	11	Research and Validation trials
Boro/2012	13	Research and Validation trials
Aman/2012	11	Research and Validation trials
Aman/2012	03	Trials for un-puddled condition
Boro/2013	21	Large scale validation trials
Boro/2013	47	Validation trials

Research station based trials: Aus/2011

Korean made walking and riding type mechanical rice transplanter was tested in BRRI research field during T. Aus, 2011 using BR26 rice variety. During test, flexible plastic tray (58 x 28 x 2.5 cm) was used to raise seedling for the transplanter. 12 days older seedling with 3-4 leaves was used in this experiment. Land size of the experimental plot was 375 m^2. After land preparation, the field was kept two days for soil settlement. 1-2 cm standing water was maintained during field operation. The technical specifications of the rice transplanters are presented in the following Table 2 and 3. The following data were collected during trials.

- Seedling per hill
- Missing hill
- Floating seedling
- Walking speed
- Planting depth
- Age and number of leaves of seedling
- Field capacity

Field trials: Aman/2011

Korean made walking and riding type mechanical rice transplanter was used in this study. Seedling was raised in plastic tray (58 x 28 x 2.5 cm). 18-25 days older seedling with 3-4 leaves was used in this experiment. Land was prepared and leveled by power tiller. After land preparation, the field was kept two days for soil settlement. 0.5 to 1.0 cm standing water was maintained during field operation.

Mechanical rice transplanter, seedling raised on tray and polythene sheet, scale, rope, tape, stopwatch, calculator, weight balance etc were used during the study.

- Varieties : BRRI dhan49 and BRRI dhan32
- Seedling age : 20 to 26 for machine transplanting and 30 days for hand transplanting
- Spacing: 30 ×15 cm for machine and 20 x 15 cm for hand.

During performance study in different locations, the following treatments were applied:

- T_1 = Mechanical transplanting
- T_2 = Manual transplanting

Fertilizer and management practices were the same for all treatments.

Data were collected

- Performance parameters of the mechanical rice transplanter
- Yield and yield components

Location/site

Total number of 10 field trails was conducted in different location to observe the field performance of the applicator. The locations were Kumarkhali, Kushtia ; Sadar, Kushtia; Rajendrapur, Sadar, Netrakona; Challisha, Sadar, Netrakona; Laksam, Comilla; Purbadhala, Netrakona; Burichang, Comilla; Sadar, Rangpur; Paba, Rajshahi and Mithapukur, Rangpur.

Field trials: Boro/2012

Seedling was prepared in the farmers' field/yard with proper instruction to conduct the trials. Farmers prepared their seedling both on polythene sheet and plastic tray. Seedling from polythene sheet was cut using metallic frame

Table 2. Specification of Walking Type Rice Transplanter

Country of Origin			South Korea
Model			DP480
Dimensions	Overall dimension (mm) L×W×H		2385×1530×870
	Overall weight (kg)		160
	Type		4-stock, air-cooled OHV gasoline
	Displacement (CC)		147
	Maximum output (kW/rpm)		3/1800
	Starting method		Recoil
Traveling Section	Steering		Hydraulic power steering mode
	Wheel type		Rubber lug wheel
	Gearshift	Forward	2 speeds
		Reverse	1 speed
Transplanting Section	Transplanting mechanism		Rotary
	Number of rows		4
	Transplanting distance (cm) (row to row)		30
	Transplanting distance (cm) (plant to plant)		11,13,15
	Planting pitch control		Adjustable
	Transplanting speed (m/sec)		0.6 to 1.0

Table 3. Specification of Seating/Riding Type Rice Transplanter

Country of Origin			South Korea
Model			S3-680
Type			Ride on Type
Dimensions	Overall dimension (mm) L×W×H		3120×2140×1665
	Overall weight (kg)		620
	Type		4-stock, air-cooled OHV gasoline
	Displacement (CC)		437
	Maximum output (kW/rpm)		10.5/3600
	Starting method		Electric motor start mode
Traveling Section	Steering		Hydraulic power steering mode
	Tires	Front	Anti-puncture tire
		Diameter (mm)	650
		Rear	Solid rubber
		Diameter (mm)	900
	Gearshift	Forward	2 speeds (Steeples variable speed)
		Reverse	1 speed
Transplanting Section	Transplanting mechanism		Rotary type
	Number of rows		6
	Transplanting distance (cm) (row to row)		30
	Transplanting distance (cm) (plant to plant)		14,16, 18, 20
	Planting pitch control		Adjustable
	Planting depth control		Adjustable
	Planting depth (cm)		0.8 – 4.4
	Number of spare seedling rack		6
	Transplanting speed (m/sec)		to 1.36

similar with plastic tray in size. Before field operation, discussion session was arranged.

- Varieties : BRRI dhan29 and BRRI dhan28
- Seedling age : 20 to 28 for machine transplanting and 40 days for hand transplanting
- Spacing: 30 ×15 cm for machine and 20 x 15 cm for hand.

During performance study in different locations, the following treatments were applied:

- T_1 = Mechanical transplanting
- T_2 = Manual transplanting

Fertilizer and management practices were the same for all treatments.

Data were collected

- Field performance parameters of the transplanter
- Yield and yield components

Location/site

Total number of 11 field trails was conducted in different location to observe the field performance of the applicator. The locations were Kumarkhali, Kushtia; Rajendrapur, Sadar, Netrakona; Challisha, Sadar, Netrakona; Laksam, Comilla; Purbadhala, Netrakona; Burichang, Comilla; Richi, Sadar, Habiganj; Sadar, Rangpur; Mithapukur, Rangpur; Gopalpur, Godagari, Rajshahi and Paba, Rajshahi

Field trials: Aman/2012

Same as Boro/2012 except following

- Varieties : BRRI dhan49, BRRI dhan33 and BINA dhan7
- Seedling age : 18-22 for machine transplanting and 35 days for hand transplanting

Location/site

Total number of 11 field trails was conducted in different location to observe the field performance of the mechanical rice transplanter. The locations were Laksam , Comilla; Burichang, Comilla; Nakla, Shrerpur; Sadar, Kushtia; Kumarkhali, Kushtia; Purbadhala, Netrakona; Sadar, Netrakona; Sadar, Rangpur; Mithapukur, Rangpur; Sadar, Habiganj and BRRI, Gazipur.

Field trials in un-puddle condition: Aman/2012

The experiment was conducted in Laksam and Burichong Upazila of Comilla district and Kumarkhali Upazila of Kushtria district during Aman 2012 season representing the sandy loam, clay loam and clay soil respectively with the following treatments.

Treatments

T_1: Conventional tillage (Transplanting in puddle condition)

T_2: Zéro tillage (Transplanting in un-puddle condition)

RCBD design was used with four replications. Seedling was raised in both plastic tray and polythene sheet. Walk behind type 4 rows mechanical rice transplanter was used to conduct the study. BRRI dhan49 was transplanted in Laksam and Burichong, Comilla and BINA dhan7 was in Kumarkhali, Kushtia. 20 days old seedling was transplanted with the spacing of 30×15 cm.

Experimental characteristics

BRRI recommended fertilizer dose was applied for BRRI dhan49 and BINA dhan7 to conduct the study (BRRI, 2013). Triple super phosphate (TSP), muriate of potash (MoP), zinc sulphate (ZnSo4) and Gypsum fertilizer was used as basal dress fertilizer. Urea fertilizer was used as top dress in three different times as follows.

Transplanter setting during operation

There have three options in the walk behind type mechanical rice transplanter to adjust plant to plant spacing. 15 cm plant to plant spacing was adjusted during transplanting. There have also three options for depth of seedling placing. In the puddle field, transplanting depth control lever was set at slight mode where as it was set at deep mode in un-puddle field. Number of seedlings/hill was adjusted considering seedling density for maintaining same number of plants/hill. There have nine options to select number of seedling per hills. During transplanting, option 5 was adjusted for transplanting.

Yield and yield contributing data collection

10 m^2 area was selected randomly from each plot to collect yield and yield contributing data. Yield data was collected from 10 m^2 area and adjusted to 14% moisture content. Straw yield, number of tillers/hill and number of panicles/hill was counted from 1 m^2 area outside of 10 m^2 pre-selected areas. Number of hills/m^2 was counted from total number of hills in 10 m^2 pre-selected area. Plant height, panicle length, number of

filled grains/panicle, number of un-filled grains/panicle, 1000 grains weight were counted from three hills randomly taken from each 1 m^2 area. The straw of three hills also added with straw of 1 m^2 area for straw yield calculation.

Field trials during Boro/2013

Same as Boro/2012 season except following

- Varieties : BRRI dhan29, BRRI dhan28 and BRRI dhan50
- Seedling age : 22 to 28 for machine transplanting and 40 days for hand transplanting
- Spacing: 30 ×15 cm for machine and 20 x 15 cm for hand.

Location/site

Total number of 21 field trails was conducted in different location to observe the field performance of the mechanical rice transplanter. The locations were Jatrapasha, Habiganj; Hislakor Purbapara, Kumarkhali; Hislakor Pashim para, Kumarkhali; Hislakor Dakkin para, Kumarkhali; Hislakor Primary school area, Kumarkhali; Sutrapur, Rangpur; Gohalakanda, Purbadhala; Mohismara, Burichang, Comilla-1; Gazipur, Burichang, Comilla-1; Ratanpur, Sadar, Habiganj; Sutrapur, Rangpur; Challisha, Sadar, Netrakona; Paba, Rajshahi-1; Paba, Rajshahi-2; Battail, Sadar, Kushtia; Purbadhala, Netrakona; Shripur, Laksam, Comilla; Gazipur, Burichang, Comilla-2; Baniachang, Habiganj; Joyrampur, Mithapukur, Rangpur-1 and Joyrampur, Mithapukur, Rangpur-2.

Large scale validation trials of rice transplanter

Mechanical rice transplanters were operated in the project location under large scale validation program. Under this program validation program, farmers used the rice transplanter by themselves. Department of Agricultural Extension (DAE) personnel only collected information about variety, date of seeding, date of transplanting and area coverage etc. Under this activity, seedling was raised in the farmers' field on polythene sheet.

Results and discussion

Research station based trials: Aus/2011

The field performance data of the transplanter is presented in Table 4. Field operation was found suitable in terms of spacing, depth of placement and uniformity of transplanting.

Table 4. Field performance of the mechanical transplanter , Aus/2011

Parameters	WRT	RRT
Number of rows	4	6
Row to row distance (cm)	30	30
Transplanting speed (m/sec)	0.6 to 1.0	1.0 to 1.30
Field capacity (decimal/hr)	32.5 to 42.5	80 - 100
Fuel required (L/hr)	0.85	1.0
Transplanting width (cm)	120	180
Plant to plant distance (cm)	16	16
Transplanting depth (cm)	1.5-3.0	1.5-4.0
No. of plants per hill	3-6	3-6
No. of hill per m^2	20	20
Missing hill per m^2	1.0	1
Floating hill per m^2	0	0
Buried hill per m^2	1.5	1
Damaged hill per m^2	0	0
Total missing hills	2.5	2.0

The average field capacity of the transplanters (walking and riding type) was found 37.5 decimal/hr and 90 decimal/hr, respectively. The field operation of this machine was found satisfactory. Transplanting of seedlings, placement of seedlings and depth of seedling placement were found satisfactory. Row to row distance and plant to plant distance was found uniform. Total missing hills were found 3.5 and 3.0 nos/m^2 considering missing, floating, buried and damage hills of walking and riding type transplanter respectively. The percent of total missing hills were 12.5 and 10.0%. Missing hills was found more due to uneven seedling density.

Field trials: Aman/2011

Seedling was prepared in the farmers' field/yard with proper instruction. Farmers prepared their seedling both on polythene sheet and plastic tray. Plastic tray was supplied from project. Seedling from polythene sheet was cut using metallic frame similar with plastic tray in size. Raising seedling was carried in the field by making roll. Before field operation, discussion session was arranged with the help of DAE. Yield performance of rice transplanting by mechanical rice transplanter were compared with hand transplanting method. Machine transplanting plots gave more yields in all trials except Burichang, comilla. In Burichang, Comilla, 4.85 and 4.87 t/ha yield was found for machine and hand transplanting plots respectively. Average

yield of the machine transplanting plot and hand transplanting plot were 4.95 t/ha and 4.85 t/ha (Table 5).

Mechanical rice transplanter was evaluated in different ten locations of the country. During evaluation, average speed (m/sec), field capacity (deci/hr), fuel required (l/hr), transplanting width (cm), no. of plants per hill, no. of hill per m^2, missing hill per m^2, floating hill per m^2, buried hill per m^2 and damaged hill per m^2 were found 0.61, 41.0, 0.66, 120, 3-6, 20, 1.8, 0.8, 0.5 and 1.1 respectively. Average 4.2 nos/m^2 missing hills (19.5%) were observed during trials (Table 6).

Field trials: Boro/2012

Mechanical rice transplanter was evaluated in 11 different project locations during Boro/2012 season. Yield performance of rice transplanting by mechanical rice transplanter were compared with hand transplanting method. In all trials, machine transplanting plots gave more yield compare to manual transplanting plots except Paba, Rajshahi. Average yield of the machine transplanting plot and hand transplanting plot were 6.42 t/ha and 6.28 t/ha (Table 7).

Mechanical rice transplanter was evaluated in different 11 locations of the country. During evaluation, parameters on average speed (m/sec), field capacity (deci/hr), fuel required (L/hr), transplanting width (cm), no. of plants per hill, no of hill per m^2, missing hill per m^2, floating hill per m^2, buried hill per m^2 and damaged hill per m^2 were 0.62, 39.76, 0.72, 120, 3-5, 20, 1.36, 0.73, 0.45 and 0.82 respectively (Table 8).

Field trials: Aman/2012

Yield variation was observed in 11 studied locations between mechanical and manual transplanting. In case of BRRI dhan49, average yield was found 4.46 and 4.32 t/ha in mechanical and manual transplanting plots respectively whereas 3.84 and 3.77 t/ha yield was observed in BRRI dhan33 respectively. BINA dhan7 also gave higher yield in the mechanical transplanting plots compared to manual transplanting which was 3.77 and 3.69 t/ha respectively (Table 9).

Table 5. Information of the trial plots, Aman/2011

Locations	Date of transplan	Age of seedling days	Variety	M.T. area (decimal)	H. T. area (decimal)	Harvesting	Yield (t/ha)	
							M. Trans.	H. trans.
Kumarkhali Kushtia	16/08/2011	24	BRRI Dhan49	50	20	04/12/11	5.03	5.00
Sadar Kushtia	17/08/2011	25	BRRI Dhan49	45	15	04/12/11	5.12	4.85
Sadar Netrakona	10/08/11	22	BRRI Dhan49	50	30	29/11/11	5.05	4.99
Sadar Netrakona	11/08/2011	23	BRRI Dhan49	45	20	30/11/11	5.10	5.01
Laksam Comilla	08/08/2011	18	BRRI Dhan49	30	15	04/12/11	4.98	4.95
Purbadhala Netrakona	10/08/2011	22	BRRI Dhan32	40	15	29/11/11	4.28	4.25
Burichang Comilla	14/08/2011	21	BRRI Dhan49	40	25	07/12/11	4.85	4.87
Sadar Rangpur	11/08/2011	24	BRRI Dhan49	33	10	29/11/12	4.90	4.75
Paba Rajshahi	16/08/2011	26	BRRI Dhan49	35	15	04/12/11	5.06	4.98
Mithapukur Rangpur	10/08/2011	26	BRRI Dhan49	35	15	27/11/11	5.13	4.88
						Average yield (t/ha):	4.95	4.853

Note: MT = Machine transplanting and HT = Hand transplanting

Table 6. Field performance of the mechanical transplanter , Aman/2011

Parameters	Area (decimal)	[1]Time (min)	Avg speed (m/sec)	Field capacity (decimal/hr)	Fuel (l/hr)	T. width (cm)	Missing hills/m²	Floating hills/m²	Buried hills/m²	Damaged hills/m²
Kumarkhali Kushtia	50	71.5	0.60	41.96	0.64	120	1	1	0	1
Sadar Kushtia	45	69	0.45	39.13	0.75	120	2	1	2	2
Sadar Netrakona	50	73.5	0.53	40.82	0.75	120	1	1	0	1
Sadar Netrakona	45	64.25	0.60	42.02	0.64	120	2	2	0	1
Laksam Comilla	30	40	0.53	45.00	0.64	120	0	1	0	1
Purbadhala Netrakona	40	64.5	0.60	37.21	0.64	120	2	1	1	1
Burichang Comilla	40	61.5	0.60	39.02	0.64	120	4	0	0	1
Sadar Rangpur	33	48.5	0.68	40.82	0.64	120	3	0	0	1
Paba Rajshahi	35	50	0.75	42.00	0.64	120	1	1	2	1
Mithapukur Rangpur	35	50	0.75	42.00	0.64	120	2	0	0	1
Average	-	-	0.61	41.00	0.66	120	1.8	0.8	0.5	1.1

[1]Transplanting time was counted considering turning, seedling feeding and operators personal times.

Table 7. General information of Rice Transplanter trials during Boro/2012

Locations	Date of trans.	Seedling age (days)	Variety	M. T. area (decimal)	H. T. area (decimal)	Harvesting	Yield (t/ha)	
							M. Trans.	H. trans.
Kumarkhali Kushtia	17/01/12	28	BRRI Dhan29	35	15	23/05/12	7.17	7.15
Sadar Netrakona	23/01/12	25	BRRI Dhan29	40	10	29/05/12	6.87	6.85
Sadar Netrakona	24/01/12	26	BRRI Dhan29	42	25	30/05/12	7.05	7.00
Laksam Comilla	28/01/12	25	BRRI Dhan28	35	30	13/05/12	5.40	5.18
Purbadhala Netrakona	31/01/12	22	BRRI Dhan28	36	12	26/05/12	5.95	5.74
Burichang Comilla	05/02/12	24	BRRI Dhan50	40	20	23/05/12	6.00	5.85
Sadar Habiganj	23/02/12	30	BRRI Dhan29	30	15	30/05/12	6.98	6.80
Sadar Rangpur	14/02/12	34	BRRI Dhan29	34	10	27/05/12	7.03	6.88
Mithapukur Rangpur	13/02/12	28	BRRI Dhan28	35	20	28/08/12	6.05	5.98
Godagari Rajshahi	24/01/12	26	BRRI Dhan28	35	20	10/05/12	5.97	5.50
Paba Rajshahi	16/01/12	28	BRRI Dhan29	32	10	15/05/12	6.12	6.14
						Average yield (t/ha):	6.42	6.28

Note: MT = Machine transplanting and HT = Hand transplanting

Table 8. Field performance of the mechanical transplanter , Boro/2012

Parameters	Area (decimal)	Time (min)	Avg. speed (m/sec)	Field capacity (decimal/hr)	Fuel (L/hr)	Missing hills/m^2	Floating hills/m^2	Buried hills/m^2	Damaged hills/m^2
Kumarkhali, Kushtia	35	51.47	0.64	40.80	0.67	1	1	0	1
Sadar, Netrakona	40	58.82	0.53	40.80	0.80	0	1	2	0
Sadar, Netrakona	42	60.00	0.49	42.00	0.78	2	1	0	1
Laksam, Comilla	35	48.61	0.56	43.20	0.74	1	2	0	1
Purbadhala Netrakona	36	48.65	0.56	44.40	0.78	0	1	0	1
Burichang, Comilla	40	66.67	0.62	36.00	0.66	2	1	1	1
Sadar, Habiganj	30	48.39	0.64	37.20	0.68	4	0	0	1
Sadar, Rangpur	34	55.74	0.64	36.60	0.69	1	0	0	1
Mithapukur, Rangpur	35	51.47	0.83	40.80	0.70	1	1	2	1
Godagari, Rajshahi	35	53.85	0.71	39.00	0.72	2	0	0	0
Paba, Rajshahi	32	52.46	0.64	36.60	0.69	1	0	0	1
Average	-	-	0.62	39.76	0.72	1.36	0.73	0.45	0.82

Mechanical transplanting gave around 0.15 t/ha more yields than manual transplanting. It might be due to produced higher effective tiller/m^2 as well as higher grains/m^2 resulted of higher yield (Table 10-12).

Trials in un-puddled condition: Aman/2012

Transplanter performance

Field performance of mechanical rice transplanter was measured in terms of field capacity and fuel consumption in both puddle and un-puddle field (Table 13). Field capacity of un-puddle transplanting was found less compare to puddle transplanting. Transplanter operation in un-puddle condition was new for the operator that might be the causes of less field capacity. Average, field capacity was found 0.14 ha/hr and 0.13 ha/hr in puddle and un-puddle field respectively. Average fuel consumption was found more in puddle field that was 5.28 L/ha whereas it was 4.77 L/ha in un-puddle field. Among the puddle and un-puddle field, fuel consumption was found more in clay type soil condition. More loads due to muddy soil during operation of mechanical rice transplanter in puddle field might be the causes of more fuel consumption.

Transplanting performance

Transplanting performance of the mechanical rice transplanter in both puddle and un-puddle conditions were measured in terms of number of plants/hill, plant to plant distance, depth of planting, number of hills/m^2, number of trays/ha, missing hills/m^2, floating hills/m^2, buried hills/m^2 and damage hills/m^2. In puddle field, average plant to plant distance was found 14.42 cm whereas it was found 14.85 cm in un-puddle field. Slippage was the cause of reduced plant to plant distance in puddle field. On the other hand, transplanting depth almost same in both condition because of control depth of placing. Average total missing hills considering missing, floating, buried and damaged hills was found 3.60 and 4.92 hills/m^2 in puddle and un-puddle field respectively. Floating hills were observed more and buried hills less in un-puddle field. Total percent of missing hills were found more in un-puddle field in all locations due to more floating and damage hills. Floating hills

may be reduced by operating the rice transplanter in the field with minimum standing water. Percent of missing hills in puddle and un-puddle conditions were 14.94 and 21.04. In both puddle and un-puddle conditions, % of total missing hills was observed more in clay soil condition and less in sandy loam condition (Table 14).

Yield performance

There was no significant yield variation observed in two tilling condition transplanting by mechanical rice transplanter in studied three locations except Burichong, Comilla (Table 15). In Burichong, yield was significantly higher when land was puddle conventionally before transplanting. In all the cases, higher yield was obtained in puddle condition than un-puddle condition. Although there was no significant difference in studied other two locations but puddle field gave around 0.13 t/ha more yield than un-puddle field. It might be due to produce higher effective tiller/m^2 as well as higher grains/panicles resulted of higher yield (Table 17 to 19).

There was no significant straw yield variation observed in three studied locations. However, in Laksam and Burichong, straw yield was obtained more in puddle field than un-puddle field. Average straw yield in puddle and un-puddle field was found 5.21 and 5.20 t/ha (Table 16).

Table 9. Yield performance of BRRI varieties in different locations as affected by different method of transplanting

Treatment	Average yield (t/ha)		
	BRRI dhan49	BRRI dhan33	BINA dhan7
T_1	4.46	3.84	3.77
T_2	4.32	3.77	3.69

Table 10. Performance of yield and yield contributing parameters of BRRI dhan49 in different locations

Place	Treat.	3-hills information						1000 grain wt. (gm)	Tiller /20m^2	Paddy wt. of 20 m^2 (kg)	M.C. (%)	Yield at 14% m.c. (t/ha)
		Plant height (cm)	No. of plant	No. of panicle	Panicle length (cm)	No. of grains /panicle	Sterile grains /panicle					
Laksam	T_1	94.5	41	30	22.5	108	32	20.65	425	9.5	19	4.47
Comilla	T_2	94	39	29	21.8	105	39	20.5	435	9.25	18.5	4.38
Burichang	T_1	98	44	31	21.6	106	29	20.78	420	10.25	20	4.77
Comilla	T_2	98	40	30	21.2	109	32	20.65	435	10.1	19.5	4.73
Nakla	T_1	102	42	28	21.5	111	37	20.42	425	9.5	19.5	4.45
Shrerpur	T_2	99.5	38	27	21	109	42	20.35	440	9.25	19	4.36
Sadar	T_1	100	40	30	22.4	102	35	20.5	425	9	20	4.19
Kushtia	T_2	99.5	37	27	22	106	32	20.45	430	8.5	20	3.95
Purbadhala	T_1	102.5	42	31	20.8	99	26	20.65	420	9.5	18.75	4.49
Netrakona	T_2	102.25	39	27	19.2	98	33	20.43	435	8.08	18.5	3.83
Sadar,	T_1	98.75	38	30	22.5	98	29	21.2	430	10.4	19.5	4.87
Rangpur	T_2	98	35	29	22.5	99	21	21.15	445	10.2	19	4.80
Mithapukur,	T_1	99	45	30	22	106	19	20.75	420	9.5	20	4.42
Rangpur	T_2	99.5	44	29	21.6	99	21	20.65	436	9.25	20	4.30
Sadar,	T_1	100	41	30	21.5	94	20	21.03	420	8.85	21	4.06
Habiganj	T_2	101	35	27	21	92	29	21	440	8.45	21	3.88
BRRI,	T_1	102	41	30	20.8	100	33	21.1	425	9.2	18	4.39
Gazipur	T_2	100.5	39	29	19.3	99	36	21	445	9	18	4.29

Table 11. Performance of yield and yield contributing parameters of BRRI dhan33 at Sadar, Netrakona

Place	Treat.	3-hills information						1000 grain wt. (gm)	Tiller /20m²	Paddy wt. of 20 m² (kg)	M.C. (%)	Yield at 14% m.c. (t/ha)
		Plant height (cm)	No. of plant	No. of panicle	Panicle length (cm)	No. of grains /panicle	Sterile grains /panicle					
Sadar	T_1	92	39	28	24	86	26	23.52	425	8.35	21	3.84
Netrakona	T_2	94	33	27	22	83	27	23.48	440	8.2	21	3.77

Table 12. Performance of yield and yield contributing parameters of BINA dhan7 at Kumakhali

Place	Treat.	3-hills information						1000 grain wt. (gm)	Tiller /20m²	Paddy wt. of 20 m² (kg)	M.C. (%)	Yield at 14% mc (wb) (t/ha)
		Plant height (cm)	No. of plant	No. of panicle	Panicle length (cm)	No. of grains /panicle	Sterile grains /panicle					
Kumarkhali	T_1	112	40	27	22.9	91	29	22.85	420	8.2	21.0	3.77
Kushtia	T_2	94	37	26	22.5	87	32	22.95	450	8.0	20.8	3.69

Table 13. Field performance of the mechanical rice transplanter in both puddle and un-puddled condition

Parameters	Puddle field				Un-puddle field			
	Sandy loam soil	Clay loam soil	Clay soil	Avg.	Sandy loam soil	Clay loam soil	Clay soil	Avg.
Area under trials (ha)	0.142	0.129	0.154	0.14	0.073	0.081	0.061	0.07
Time of operation (hr)	0.95	0.9	1.25	1.03	0.58	0.62	0.45	0.55
Field capacity (ha/hr)	0.15	0.14	0.12	0.14	0.13	0.13	0.14	0.13
Fuel consumption (mL)	703	621	938	-	336	384	302	-
Fuel consumption (L/hr)	0.74	0.69	0.75	0.73	0.58	0.62	0.67	0.62

Note: Average of three replications

Table 14. Transplanting parameters of the transplanting in both puddled and un-puddled condition

Parameters	Puddle field				Un-puddle field			
	Sandy loam soil	Clay loam soil	Clay soil	Average	Sandy loam soil	Clay loam soil	Clay soil	Avg.
Plant to plant distance (cm)	14.75	14.5	14.0	14.42	15	14.80	14.75	14.85
Depth of transplanting (cm)	1.5-2.5	1.5-2.5	1.5-3.0	-	1.5-2.0	1.5-2.0	1.5-2.5	-
No. of hills/m²	23.50	24.00	24.50	24.00	23.00	23.50	23.50	23.33
Missing hills/m²	1.00	1.50	1.00	1.17	0.00	2.00	1.00	1.00
Floating hills/m²	0.00	0.00	0.00	0.00	2.50	1.75	2.50	2.25
Buried hills/m²	1.30	1.50	2.50	1.77	0.00	0.00	0.00	0.00
Damage hills/m²	0.00	1.00	1.00	0.67	1.50	1.50	2.00	1.67
Total missing hills/m²	2.30	4.00	4.50	3.60	4.00	5.25	5.50	4.92
% of total missing	9.79	16.67	18.37	14.94	17.39	22.34	23.40	21.04

Yield parameters, Kumarkhali

There was no significance difference observed except 1000 grains within all yield contributing parameters. Plant height was found 102.6 and 102.3 cm for two treatments respectively. Average panicle length was 24.48 and 22.83 cm and tillers/m² was 361.7 and 404.3 nos. for T_1 and T_2 respectively. Average plant height, panicle length and tillers/m² were statistically identical in the both T_1 and T_2 . Number of effective tillers was 319.3 and 354.3 nos and filled grains/m² was 76.33 and 66.67 nos for T_1 and T_2 respectively whereas 1000 grains weight was 21.12 and 21.47 gm. 1000 grains weight was found significantly less in T_1. However, yield was 4.92 and 4.88 t/ha which was statistically identical for both in T_1 and T_2 (Table 17).

Yield parameters, Burichong

Significance difference was not observed in the yield contributing parameters. Plant height was found 104.7 and 96.33 cm for two treatments respectively. Average panicle length was 22.77 and 22.89 cm and tillers/m^2 was 395.3 and 333.7 nos. for T_1 and T_2 respectively. Average plant height, panicle length and tillers/m^2 were statistically identical in the both T_1 and T_2. Number of effective tillers was 277 and 253.7 nos and filled grains/m^2 was 98.0 and 99.33 nos for T_1 and T_2 respectively whereas 1000 grains weight was 20.50 and 20.53 gm. Effective tillers/m^2, filled grains/panicle and 1000 grains weight were found statistically identical in both cases. However, yield was observed significantly higher in T_1 compared to T_2 which was 5.4 and 5.03 t/ha respectively (Table 18).

Yield parameters, Laksam

There was no significance difference observed in all yield contributing parameters. Plant height was found 94.63 and 86.33 cm for two treatments respectively. Average panicle length was 24.50 and 23.43 cm and tillers/m^2 was 287 and 315 nos. for T_1 and T_2, respectively. Average plant height, panicle length and tillers/m^2 were statistically identical in the both T_1 and T_2 . Number of effective tillers was 235 and 239 nos and filled grains/m^2 was 102.3 and 100.3 nos for T_1 and T_2, respectively whereas 1000 grains weight 20.12 and 20.10 gm. Effective tillers/m^2, filled grains/panicle and 1000 grains weight were found statistically identical in both cases. However, yield was 4.80 and 4.76 t/ha which is statistically identical in T_2 than T_1 (Table 19).

Cost-analysis

Cost analysis of the mechanical rice transplanter was done to find out the operating cost in terms of Tk/hr and Tk./ha in both puddle and un-puddle conditions. Inputs cost for rice production in both puddle and un-puddle conditions are presented in Table 20. Benefit-cost ratio was computed based on total inputs cost including land rent and interest of investment, total production. Benefit-cost ratio computations are also presented in Table 21.

BCR of rice production under puddle and un-puddle conditions, transplanting by mechanical transplanter, was gave 1.49 and 1.56 respectively. BCR of rice production in un-puddle condition was more compared to puddle condition in Aman season.

Table 15. Yield in puddled and un-puddled conditions in three different locations

Treat	Yield (t/ha)			Average yield (t/ha)	
	Laksam Comilla	Burichong Comilla	Kumarkhali, Kushtia	BRRI dhan49	BINA dhan7
	BRRI dhan49	BRRI dhan49	BINA dhan7		
T_1	4.80a	5.40a	4.92a	5.1	4.92
T_2	4.76a	5.03b	4.88a	4.87	4.89
CV, %	8.22	1.71	6.08	-	-
$LSD_{0.05}$	1.374	0.31	1.048	-	-

Table 16. Straw yield in puddle and un-puddle conditions in different three locations

Treat	Straw yield (t/ha)			Average
	Sandy soil: Laksam	Clay loam soil: Burichong	Clay soil: Kumarkhali	
T_1	5.03	5.53	5.07	5.21
T_2	5.00	5.45	5.15	5.20
CV, %	1.63	6.82	1.06	-
Level of significant	NS	NS	NS	-

Table 17. Yield and yield contributing parameters, Kumarkhali, Kushtia

Treat.	Avg. plants height (cm)	Avg. Panicle length (cm)	Tiller/m²	No. of effective tiller/m²	Filled grain/ Panicle	Sterile grain/panicle	1000 grains weight at 14% m.c. (gm)	Yield at 14% m.c. (t/ha)
T_1	102.6a	24.48a	361.7a	319.3a	76.33a	30.67a	21.12b	4.92a
T_2	102.3a	22.83a	404.3a	354.3a	66.67a	25.67a	21.47a	4.88a
CV, %	1.70	3.30	13.22	4.60	4.67	11.50	0.44	6.08
$LSD_{0.05}$	6.113	2.742	177.9	54.48	11.74	11.38	0.3333	1.048

Table 18. Yield and yield contributing parameters, Burichong, Comilla

Treat.	Avg. plants height (cm)	Avg. Panicle length (cm)	Tiller/m²	No. of effective tiller/m²	Filled grain/ panicle	Sterile grain/panicle	1000 grains weight at 14% m.c. (gm)	Yield at 14% m.c. (t/ha)
T_1	104.7a	22.77a	395.3a	277.0a	98.0 a	20.67a	20.5a	5.40a
T_2	96.33a	22.89a	333.7a	253.7a	99.3a	17.33a	20.5a	5.03b
CV, %	3.61	5.07	14.65	7.61	5.08	15.04	0.20	1.71
$LSD_{0.05}$	12.75	4.06	187.60	70.98	17.62	10.04	0.33	0.31

Table 19. Yield and yield contributing parameters, Laksam, Comilla

Treat.	Avg. plants height (cm)	Avg. Panicle length (cm)	Tiller/m²	No. of effective tiller/m²	Filled grain/ panicle	Sterile grain/panicle	1000 grains weight at 14% m.c. (gm)	Yield at 14% m.c. (t/ha)
T_1	94.63a	24.50a	287.0a	235.0a	102.3a	30.33a	20.12a	4.80a
T_2	86.33a	23.43a	315.0a	239a	100.3a	29.00a	20.10a	4.76a
% of CV	4.81	1.51	3.00	2.88	7.29	13.13	0.90	8.22
LSD value	15.29	1.276	31.72	23.96	25.94	13.68	0.6382	1.374

Table 20. Input cost of rice production as affected by tillage for transplanting using mechanical rice transplanter

Inputs	Puddle condition (Tk/ha)	Un-puddle condition (Tk/ha)	Comments
Seedling preparation	4800.00	4760.00	Number of trays in puddle field: 238/ha and un-puddle: 233/ha
Land preparation	10500.00	3750.00	Power tiller hired for making puddle
Transplanting	1844.00	1898.00	Based on operating cost of transplanter
Weeding	8400.00	11200.00	30 man-day/ha for puddle and 40 man-day/ha for un-puddle field
Herbicide and pesticide	1800.00	1800.00	Same for all plots
Supplement irrigation	1500.00	1500.00	One supplement irrigation applied.
Harvesting, carrying, threshing and winnowing	12500.00	12500.00	Same for all plots
Land rent	15000.00	15000.00	Land rent for one crop season @ Tk/ha=15000.00.
Interest on investment at the rate of 12%	6761.00	6289.00	
Total input cost	63105.00	58697.00	

Table 21. Benefit-cost ratio (BCR) calculation

Tillage option	Input cost (Tk/ha)	Gross return (Tk/ha)	Gross margin (Tk/ha)	BCR
Conventional tillage (Puddle condition)	63105	93927	30822	1.49
Zero tillage (Un-puddle condition)	58697	91640	32943	1.56

Note: Values are the means of three replications. Market price of straw (Tk/ton):1200.00 and Paddy (Tk/ton): 17500.00

Table 22. Operational cost of rice transplanter for puddled and un-puddled transplanting

Fixed cost calculation

Sl. No.	Items	Tk.
1	Purchase price (P) (Tk)	300000
2	Salvage value (S) (Tk), Where S is 10% of P	30000
3	Working life (L) (yr)	8
4	[1]Average annual use (Au) (hr/yr)	560
5	Annual depreciation, D=(P-S)/L	33750
6	Interest on investment, I=(P+S)/2*I, where rate of interest is 12%	18180
7	Tax, insurance, T=3% of P	9000
8	Total fixed cost (D+I+T) (Tk/yr)	60930
9	Total fixed cost (Tk/hr)	108.80

Variable cost calculation

Sl. No.	Total variable cost	Puddle	Un-puddle
1	[2]Labour cost per hour (Tk/hr)	65	65
2	Fuel cost (Tk/hr)	63.75	52.7
3	Lubricant cost (Tk/hr) (lubricant cost is 3% of fuel const)	1.91	1.58
4	RPM/hr =3.5 % of purchase price	18.75	18.75
5	Total Variable cost (Tk/hr)	149.41	138.03
6	Total operating cost Tk/hr (Fixed cost+ Variable cost)	258.21	246.83
7	Field capacity of rice transplanter (ha/hr)	0.14	0.13
8	Time for transplanting (hr/ha)	7.14	7.69
9	Operating Cost for transplanting (Tk/ha)	1844	1898

Note:

1. Average annual use of rice transplanter in three rice season is considered 75 days where 15 days in Aus, 25 days in Aman and 30 days in Boro season. Considering 8 working hrs, Average annual use in hrs/year is 560.
2. Labor cost as operator, Tk/hr=37.5 and helper cost, Tk/hr=27.5. Total cost, Tk/hr=65.0 and Agril. Labor cost, Tk/hr=280.00
3. Fuel price (Octane), Tk/lit=85.00

Field trials: Boro/2013

Yield variation was observed in 21 studied locations between mechanical and manual transplanting. In case of BRRI dhan28, average yield was found 5.79 and 5.53 t/ha in mechanical and manual transplanting plots respectively whereas 6.92 and 6.41 t/ha yield was observed in BRRI dhan29 respectively. BRRI dhan50 also gave higher yield in the mechanical transplanting plots compared to manual transplanting which was 5.77 and 5.60 t/ha respectively (Table 23). Mechanical transplanting gave around 0.3 t/ha more yields than manual transplanting. It might be due to produce higher effective tiller/m^2 as well as higher grains/m^2 resulted of higher yield (Table 24-26).

Table 23. Yield performance of BRRI varieties in different locations as affected by different method of transplanting

Treatment	Average yield (t/ha)		
	BRRI dhan28	BRRI dhan29	BRRI dhan50
T_1	5.79	6.92	5.77
T_2	5.53	6.41	5.60

Table 24. Performance of yield and yield contributing parameters of BRRI dhan28

Place	Treat	3-hills information						1000 grain wt. (gm)	Tiller /20m²	Paddy wt. of 20 m² (kg)	M.C (%)	Yield at 14% m.c. (t/ha)
		Plant height (cm)	No. of plant	No. of pan icle	Panicle length (cm)	No. of grains /panicle	Sterile grains /panicle					
Jatrapasha	T_1	92	66	38	22.5	108	13	22.15	418	13.2	22.0	5.99
Habiganj	T_2	87	59	32	19.8	109	19	22.12	435	12	21.0	5.51
Sutrapur	T_1	87.5	62	35	20.8	102	26	22.65	412	12.8	23.5	5.69
Rangpur	T_2	84	59	37	19.2	100	43	22.43	427	13.25	21.8	6.03
Gohalakand	T_1	92	44	35	24	111	16	23.521	416	13.5	22.5	6.08
Purbadhala	T_2	94	33	31	21	94	17	22.63	468	11.85	24.0	5.24
Burichang	T_1	94	53	36	25.5	100	19	22.53	419	12.4	24.5	5.44
Comilla-1	T_2	93	50	32	25	104	21	22.43	427	11.8	23.5	5.25
Burichang	T_1	98	45	34	24	116	19	22.4	428	13.5	24.0	5.97
Comilla-2	T_2	91	44	33	23.6	109	21	22.06	436	12.25	23.5	5.45
Sadar	T_1	90	48	35	19	107	10	22.03	418	12.56	23.0	5.62
Habiganj	T_2	90	35	31	16	102	20	22.12	440	12.1	22.5	5.45
Sutrapur	T_1	89	46	39	20.8	106	23	21.1	396	12.9	22.0	5.85
Rangpur	T_2	84	42	37	19.3	100	36	22.32	389	12	22.0	5.44
Sadar	T_1	96.33	53	36	27.55	117	25	22.152	400	12.4	20.0	5.77
Kushtia	T_2	92	51	35	23.5	115	26	22.12	410	12.1	20.0	5.63
Laksam	T_1	90	34	29	26	127	7	22.4	437	13.2	22.5	5.95
Comilla	T_2	89	33	30	25.7	121	8	22.5	449	12.85	22.0	5.83
Burichang	T_1	96	48	33	24	116	16	22.4	412	13	22.8	5.84
Comilla-2	T_2	95	44	30	23	123	20	22.35	426	12.3	22.0	5.58
Joyrampur	T_1	87.5	42	37	20.7	102	31	22.15	418	12.7	23.0	5.69
Rangpur-1	T_2	83	41	35	19.1	92	35	22.39	439	12	22.8	5.39
Joyrampur	T_1	96	54	34	24	113	21	22.45	419	12.6	23.0	5.64
Rangpur-2	T_2	93	53	34	22	110	26	22.4	426	12.25	22.0	5.56

Large scale validation trials of rice transplanter during Boro/2013

Large scale validation trials of mechanical rice transplanter were conducted in five project location. Under this activity, a total of 47 trials were conducted with the help of DAE. A total of 47 farmers of the project locations were directly benefited under this activity. Total area of 2062 decimal equivalent of 8.35 ha areas were cultivated using mechanical rice transplanter (Table 27). During field trials of mechanical rice transplanter, the following preconditions were recorded for successful operation of the rice transplanter.

- The field should be leveled for better performance of rice transplanter and uniform crop establishment
- Settling time after preparing the field and water level in the field are the key factors for the success of the mechanical rice transplanting
- After final leveling, allow the soil to settle for 12–24 hours.
- Sufficient bearing strength of soil is necessary to carry the machine and support the planted seedlings
- Avoid use of transplanter in low land ecologies where water remains stagnant
- Maintain only 1 cm water or saturated condition while transplanting
- Immediately after transplanting irrigation sometimes disturbs the seedlings
- Seedling should be uniform density and standard height.

Table 25. Performance of yield and yield contributing parameters of BRRI dhan29

Place	Treat	3-hills information						1000 grain wt. (gm)	Tiller /20m²	Paddy wt. of 20 m² (kg)	M.C. (%)	Yield at 14% m.c. (t/ha)
		Plant height (cm)	No. of plant	No. of panicle	Panicle length (cm)	No. of grains /panicle	Sterile grains /panicle					
Hislakor Pu.	T_1	98	64	41	23.6	121	12	23.28	422	16.25	22	7.37
P Kumarkhali	T_2	92	53	36	21.2	119	16	23.02	438	14.9	21.5	6.80
Hislakor P.P	T_1	102	51	39	23	122	9	23.42	417	15.3	22.5	6.89
Kumarkhali	T_2	97	43	36	22.6	117	11	23.11	431	14	22	6.35
Hislakor D.P.	T_1	108	49	41	23.4	109	19	23.11	427	15.6	23	6.98
Kumarkhali	T_2	103	47	32	23	116	21	23.14	436	14.2	22.8	6.38
Hislakor	T_1	96	46	39	22.9	112	9	23.09	420	14.75	22.5	6.65
Kumarkhali	T_2	94	42	33	22.5	109	13	23.15	459	13.6	21.8	6.19
Sadar,	T_1	115	47	34	24	117	26	23.9	432	14.8	23	6.63
Netrakona	T_2	99	46	32	22.5	114	10	23.36	438	14.25	23	6.38
Purbadhala,	T_1	105	47	37	24	119	16	23.54	417	14.25	20	6.63
Netrakona	T_2	102	35	31	21	110	19	23.06	469	12.6	20	5.86
Mohishvanga,	T_1	95	51	36	26	128	24	23.25	424	16.3	23	7.30
Comilla	T_2	93	43	32	23	124	30	23.65	452	15.4	23	6.89

Table 26. Performance of yield and yield contributing parameters of BRRI dhan50

Place	Treat	3-hills information						1000 grain wt. (gm)	Tiller /20m²	Paddy wt. of 20 m² (kg)	M.C. (%)	Yield at 14% m.c. (t/ha)
		Plant height (cm)	No. of plant	No. of panicle	Panicle length (cm)	No. of grains /panicle	Sterile grains /panicle					
Paba-1	T_1	97	49	35	23	121	13	21	412	13.25	23.5	5.89
Rajshahi	T_2	94	57	37	23.5	113	15	21.02	409	12.8	23	5.73
Paba-2	T_1	93	48	39	22	106	16	21.5	417	12.7	23.6	5.64
Rajshahi	T_2	89	53	34	21.3	104	11	21.45	435	12.2	23	5.46

Table 27. List of large scale validation trials of rice transplanter

Sl. No.	Location	Number of trials	Number of farmers benefited	Area (decimal)
1	Hislakor, Kumarkhali	29	29	1399
2	Hasimpur, Kumarkhali	3	3	75
3	Moragacha, Kumarkhali	3	3	190
4	Burichang, Comilla	5	5	165
5	Sadar, Netrakona	4	4	128
6	Sadar, Rangpur	3	3	105
Total		47	47	2062

Preconditions of rice transplanter operation in the field: Lesson learned from different trials

Pre-requisites of mechanical transplanter operation

- The field should be leveled for better performance of rice transplanter and uniform crop establishment
- Settling time after preparing the field and water level in the field are the key factors for the success of the mechanical rice transplanting, after final leveling, allow the soil to settle for 12–24 hours.
- Sufficient bearing strength of soil is necessary to carry the machine and support the planted seedlings
- Avoid use of transplanter in low land ecologies where water remains stagnant

- Maintain only 1 cm water or saturated condition while transplanting
- Immediately after transplanting irrigation sometimes disturbs the seedlings
- Seedling should be uniform density and standard height.

Conclusion

Walking and riding type mechanical rice transplanter were evaluated in different soil condition to identify the problems and troubleshooting mechanisam were developed during field operation. Average field capacity of the walking and riding type transplanter was found 39.42 and 90 decimal/hr respectively. Total percent of missing hills including missing, floating, buried and mechanically damaged hills were 12.5% and 10% for the walking and riding type transplanter respectively based on different soil, water and seedling condition. Missing, floating, buried and damaged hills widely varied due to seedling density, seedling quality, field conditions, standing water and setling period of soil after final land preparation. The walking type rice transplanter was also evaluated in both puddled and un-puddled conditions. Total missing percentage of hills was found to be 14.94 and 21.04 and field capacity was found 34.58 and 32.11 decimal/hr for puddled and un-puddled conditions respectively. Farmers also found suitable to operate mechanical rice transplanter in both puddle and un-puddled conditions though they still faceing problems to raise seedling during Boro season because of heavy cold. Entrepreneurship development for seedling rising might be solved the problems of mechanical transplanter popularization in Bangladesh.

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