Performance of BARI Developed Planter for Establishment of Maize

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ABSTRACT

A multicrop power tiller operated inclined plate planter (IPP) was tested for maize establishment in winter and summer seasons of 2005 in three districts of Bangladesh. The performance of the planter was evaluated and profitability of using the planter was compared with traditional practice. The average field work rate capacity was 0.19 ha/h saving 32.8% total cost and 79.2% labour costs over traditional practice. In addition 18% yield increase was also observed in mechanical method. The price of the planter was US$ 200. The planter can be used profitably as attachment behind a power tiller for maize establishment in tilled soil.

Keywords: Power tiller, inclined plate planter, planter performance, maize establishment, Bangladesh

1. INTRODUCTION

Maize cultivation has been conducted in Bangladesh since 1975, but did not get popularity until 1992 due to low yield and no ensured market. With the introduction of hybrid varieties in 1993 yield increased from 1 tonne to 7 tonnes/ha. Again, expansion of poultry industry created a huge demand for maize in the preparation of poultry feed. Shelling of maize was also another barrier for maize cultivation and Bangladesh Agricultural Research Institute (BARI) developed a powered maize sheller that has eliminated the barrier by making the shelling easy and fast. Roy et al. (2007) reported that power operated maize sheller could overcome the shortage of expensive labour during peak harvesting season. In the last ten years (1993-94 to 2003-04) the maize area has expanded from 2,834 to 50,202 hectares occupying the third position among cereals (BBS 2005). There is still shortage of maize in Bangladesh and its cultivation area is increasing every year. The Bangladesh government is providing credit at 2% interest for maize cultivation which is further encouraging farmers.

In Bangladesh, maize is cultivated mainly in winter season as the crop fits well into rice based cropping pattern. Moreover, gross return is higher in winter maize (US$ 509/ha) than summer (US$ 352/ha) (Kabir et al. 2005). Farmers cultivate maize manually which is cumbersome, time consuming, and costly. After land preparation, they plant maize manually in lines behind the plow which takes up to 240 man h ha^{-1}. The furrows made by a country plough are deeper than recommended and seed germination percentage is low and it is delayed.

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Farmers practice broadcast sowing of cereals and pulses which costs less, but ultimate income is also less due to higher intercultural operation costs and lower grain yields. In the case of maize cultivation, farmers practice labour intensive line sowing method which is an advantage for the introduction of planters. Ahmmed et al. (2004) reported that using a well designed planter attachments to power tillers (two-wheel tractors) more area could be brought under maize, wheat, pulses and oil seeds cultivation. Singh (1984) designed and developed a two-row tractor drawn ridge planter for winter maize. The inclined plate metering mechanism was mounted on a commonly used three bottom ridger. The planter was tested in laboratory as well as in the field. Laboratory tests showed that 50 seeds could be delivered in a strip of 10 m maintaining recommended seed-to-seed spacing of 20 cm. However, the results varied in the field test. Lara-Lopez (1996) developed a single-row direct planter for maize and faba beans. The planter may be attached to a walking or riding type two-wheel tractor. The planter performance was in accordance with the recommended plant population for maize and faba bean. Pradhan et al. (1997) developed a power tiller operated groundnut planter-cum-fertilizer drill. The actual field capacity of the planter was 0.16 ha/h with field efficiency close to 81%. The planter saved Rs 237 per ha over manual dropping of seed behind the plough. Wohab (2003) developed a minimum tillage planter with effective field capacity of 0.1 ha/h. The planter saved 35% time and 27% cost when compared to traditional methods. Bamgboye and Mofolasayo (2006) tested a manually operated two row okra planter developed from locally available materials. The planter had a field capacity of 0.36 ha/h with a field efficiency close to 72%. The laboratory tests gave better spacing results than under field tests due to clogging of seeds and germination failure.

As power tillers are available in almost all villages in Bangladesh, BARI developed a power tiller operated inclined plate planter (IPP) in 2002. This is a multicrop planter for maize, wheat, soybean, groundnut and pulses available for a cost of US$ 200. The detail design of the planter is given by Ahmmed et al. (2004). The planter was evaluated in three locations for planting and earthing up of maize in two seasons in 2005 with the aims to test its performance and study the profitability of using the planter. Related results are reported in this paper.

2. MATERIALS AND METHODS

On-farm validation of the BARI developed power tiller operated inclined plate planter was conducted in the Bogra, Jamalpur and Sherpur districts with maize in both the summer and winter seasons of 2005. Field sizes varied from 0.10 ha to 0.40 ha. Each field was divided into two plots. In one plot maize was planted by IPP and in other plot by traditional method. Before planting, plots were cultivated and harrowed for uniform seed placement. Summer maize was planted between 27 and 30 March and winter maize between 18 and 29 December, 2005. In the traditional method, one person first marked lines using a bamboo made line marker (Fig. 1), two people made furrows by country plough (Fig. 2), one person placed seeds in furrows (Fig. 3), and one person covered seeds by tread (Fig. 4). At 45-50 days after sowing earthing up was done manually by spade (Fig. 5). The power tiller operated machine planted two adjacent rows at 75 cm spacing and aimed at 22-25 cm seed spacing on the row

@ 25-30 kg/ha, planted at 45-55 mm depth. Its typical speed of operation was 2.5 km/h. In the traditional method, seeds were planted on similar 75 cm x 25 cm grid spacing but deeper at 70-80 mm depth. In machine planting (Fig. 6), headlands were planted last from transverse direction. For earthing up with the machine, two ridgers were attached to the planter's frame after dismantling the furrow openers. The ridger set up also covered two rows (1+½+½) per pass (Fig. 7).

Seed rates in traditional method and machine planting were 21.7 and 26.5 kg/ha, respectively. Planting with the IPP, the line marker helped maintain the 75 cm row spacing. Two hybrid maize varieties (BARI hybrid maize 3 and Pacific 11) were planted which had similar grain sizes (1000 grain weight was 310 g). Appropriate metering plates (out of 3 sizes) were used to suit the seed size. It rotated at 25 rpm inclined at an angle of 30° with the vertical. The metering plate is shown in Fig. 8. The performance of the metering plates to meter seeds was observed based on germinated seedlings in test bed. In the field test, thinner metering

Fig. 1. Line marking in traditional method

Fig. 2. Row making in traditional method

Fig. 3. Seed placing in traditional method

Fig. 4. Seed covering in traditional method

Fig. 5 Earthing up by spade in traditional method

Fig. 6. Planting by power tiller operated IPP

Fig. 7. -Earthing up by power tiller operated IPP

Fig. 8. -Metering plate

Plate thickness = 5.5 mm
No. of cell = 10
Plate diameter (outer) = 114 mm
Plate diameter (cell bottom) = 90 mm
Rotational speed = 25 rpm

plates (5.5 mm) were used which reduced the seed rate without changing the percent failed hills. During planting one co-worker assisted the operator in filling seeds. But, in case of earthing up, no co-worker was required. Thinning and gap filling was done manually in the IPP planted plots, while only gap filling was required with the traditional method.

3. RESULTS AND DISCUSSION

Table 1 compares the maize crop yield and yield contributing factors obtained with the power tiller operated IPP and the traditional method. An average of 17.9% yield was increased in machine planting over traditional method. The main reason identified is that the deeper and varying depth of planting in the traditional method delayed germination by 3-4 days, relative to the mechanical planting method which resulted in uniform placement of seeds and seedling emergence. The yield contributing factors in the IPP plots were better than in the traditional method plots. The field work rate capacity of the mechanical planting method varied greatly with field size. The average work rate capacity of 0.19 ha/h which was close to the field capacity of 0.16 ha/h of a power tiller operated groundnut planter-cum-fertilizer drill reported by Pradhan et al. (1997). The earthing up work rate capacity was also 0.19 ha/h.

Table 1. Yield and yield contributing factors of maize in IPP and traditional methods

Season/ site	Treat-ment	Variety	Plants /sq.m	Average plant height, m	Cob length, mm	1000 grain wt., g	Grain yield, t/ha	Stover yield, t/ha	% yield increase over traditional	F.C., ha/h
Winter/ Bogra	IPP	BARI	6.3	2.62	204	284	7.74	7.43	8.6	0.26
	Tradl.	hybd. 3	5.3	2.46	192	282	7.13	6.47		
Winter/ Jamalpur	IPP	Pacific	4.0	2.03	177	342	7.22	4.00	57.6	0.12
	Tradl.	11	5.0	1.83	148	300	4.58	4.50		
Winter/ Sherpur	1PP	Pacific	6.4	2.31	167	330	10.90	6.72	1.1	0.19
	Tradl.	11	6.4	2.28	165	330	10.78	6.59		
Summer/ Sherpur	1PP	Pacific	5.00	2.00	NR	300	5.55	4.45	8.0	0.18
	Tradl.	11	5.40	1.98	NR	290	5.14	4.29		
Summer/ Jamalpur	1PP	Pacific	4.00	2.29	17.7	318	6.88	5.77	14.3	0.18
	Tradl.	11	5.30	2.15	16.6	299	6.02	5.00		
							Average		17.9	0.19

Note: NR= Not Recorded F.C.= Field Capacity

Table 2 shows the seeding performance of the metering plate in test bed for planting maize. The study was based on germinated seedlings and the 4.1 per cent failed hill was due to

combined germination failure and mechanical missing by the planter. To minimize failed hills, 66% more seeds were planted than number of hills. Based on the result, thinner (5.5 mm) plates were used in the field test which reduced the seed rate without increasing the failed hills. Seeds were germinated in 11-12 days in mechanical method, but in 14-15 days in traditional method. In traditional practice, 2% failed germination was observed against 5% failed hills in mechanical method. In the latter method, no additional seeds for gap filling were required as thinned out seedlings were used as transplants.

Table 2. Performance of the IPP planting based on germinated seedlings/hill

Variety	Metering plate thickness (mm)	1000 seed weight, g	Single seedling (%)	Double seedlings (%)	Triple seedlings (%)	Quadruple seedlings (%)	Missing (%)	Average seedlings /hill
Pacific11	6	310	43.5	36.23	14.97	1.20	4.07	1.66

The plant establishment costs of the two methods are compared critically and presented in table 3. The planter saved 31.82 of total costs (fuel, oil, labour, depreciation, interest, and ownership cost) including 79.24% save in labour cost (i.e. labour requirement) for maize establishment over the traditional method in addition to yield increase. Thus, the machine increased farmers' income and mitigated labour crisis. The assumptions in cost calculation, calculation of fixed cost and amount of labour required for different operations are given in Appendix 1, 2 & 3.

Table 3. Comparison of crop establishment costs (US$/ha)

Cost component		Mechanical	Traditional	US$/ha savings over traditional
Seed	-planting	45.36	37.14	(-) 8.22
	-gap filling	0.00	0.89	0.89
Fuel, oil	-planting	2.50	0.00	(-) 2.50
	-earthing up	2.50	0.00	(-) 2.50
Labour	-planting	2.50	28.57	26.07
	-thinning	4.29	0.00	(-) 4.29
	-gap filling	3.83	1.53	(-) 2.30
	-earthing up	1.56	28.57	27.01
Sub-total labour		*12.18*	*58.67*	*46.49 (79.24%)*
FC (PT + IPP)		2.34	0.00	(-) 2.34
Total crop establishment cost, US$/ha		64.88	96.70	31.82 (32.91%)

N.B. FC= Fixed Cost, PT= Power Tiller, IPP= Inclined Plate Planter

4. CONCLUSION

The power tiller operated inclined plate planter was developed from locally available materials which had an average field work rate capacity of 0.19 ha/h for maize. It saved 32% total operating cost of maize establishment and more specifically 79% of the labour cost component. The relative ease with which the mechanical planter was adjusted and maneuvered in the field suited the technical know-how of a power tiller operator. However, the profitability of using the planter as attachment to the power tiller instead of land preparation (i.e., tilling) by the same power tiller (with its rotary tiller attachment) should be studied.

5. REFERENCES

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Appendix I

Assumptions in cost calculation

Purchase price (US$), P = 1000 (PT) and 200 (IPP)
Expected life (yrs), L = 8
Salvage value, S = 10% of P
Annual operating hour, A = 1000 (PT) and 200 (IPP)
Annual interest or interest on investment (%), I = 10
Labour wage (US$/man-d) = 2.37 (skilled) and 1.43 (unskilled)
Fuel & oil cost (US$/h) = 0.475
Seed price (US$/kg) = 1.71

Appendix II

Fixed cost (FC) calculation in US$/h

Cost component	Formula	Power Tiller (PT)	IPP	Total
Depreciation	(P-S)/L/A	0.1125	0.1125	0.225
Interest	((P+S)/2)*I/100/A	0.0550	0.0550	0.110
Ownership cost	((P+S)/2)*I/100/A	0.0550	0.0550	0.110
Fixed cost (PT+IPP), US$/h				0.445

Appendix III

Labour requirement (man-d/ha) in different activities in maize cultivation

Activity	Mechanical method	Traditional method
Planting	1.32 (S+US)	20.00 (US)
Thinning	3.00 (US)	0.00 (US)
Gap filling	2.68 (US)	1.07 (US)
Earthing up	0.66 (S)	20.00 (US)

Note: S= Skilled labour, US= Unskilled labour