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ORIGINAL ARTICLE

## Improvement of power tiller operated seeder for maize planting

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### ABSTRACT

Prime energy source of agriculture in Bangladesh is two-wheel tractor (commonly known as power tiller). Power tiller operated seeder (PTOS) with fluted roller type metering device are adopting by the farmers. These seeders could not be used for planting maize. An initiative was taken to improve the seeder for maize planting during 2014-15 at RARS, BARI, Jamalpur. A simple maize conversion kit was developed and attached to the seeder for planting maize. The modified seeder was evaluated in the field and found that desired seed spacing (20 cm) and uniformity (98%) could be achieved. Modified PTOS was tested for full tillage (yield 8.62 t/ha) and strip tillage (yield 8.51 t/ha) comparing with conventional method where machine planting maize gave higher yield than the conventional (8.31 t/ha). Further study is needed to use this for other crops.

**Keywords:** Power tiller operated seeder, mechanization, maize planting, modified seeder, farm implement

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## 1 Introduction

Most potentially arable land of Bangladesh is already in production, and future food needs can only be met through intensification and vertical expansion (FAO, 2014). A new paradigm for agricultural development needs to adopt. Bangladesh is mostly mechanized mainly for tillage and threshing and saturated with Chinese two-wheel tractor (2WT) operated power tillers (700,000) (Rahman et al., 2017) mainly used for tillage operations. The conventional land preparation in the small farms involves two or more passes by a power tiller for seedbed preparation followed by manually broadcasting or hand planting/transplanting of seeds/seedlings. Recently, there is a growing trend of farmers adopting power tillers operated seeders which can achieve land preparation and seeding in

one pass. These seeding units fitted on two-wheel tractors are commonly known as power tiller operated seeders (PTOS).

The PTOS is a single-pass shallow-tillage seed and fertilizer drill with fluted roller seeding mechanism manufactured in China (model: 2BG-6A) that is being commercially selling in Bangladesh. The PTOS is 120 cm wide, allowing six rows of wheat at 20 cm spacing, or two rows of maize at 60 cm. Operating field capacity is typically 0.14–0.20 ha/h (Hossain et al., 2004). This seeder uses 48 rotary blades (bent C shape) accomplishes three operations in a single pass, including tillage (up to 5 cm), placement of seed and fertilizer in a furrow, and seed covering by a post-furrow opener roller bar (Hossain et al., 2004; Wohab et al., 2007; Islam et al., 2010).

About 70% of wheat growers grow wheat after

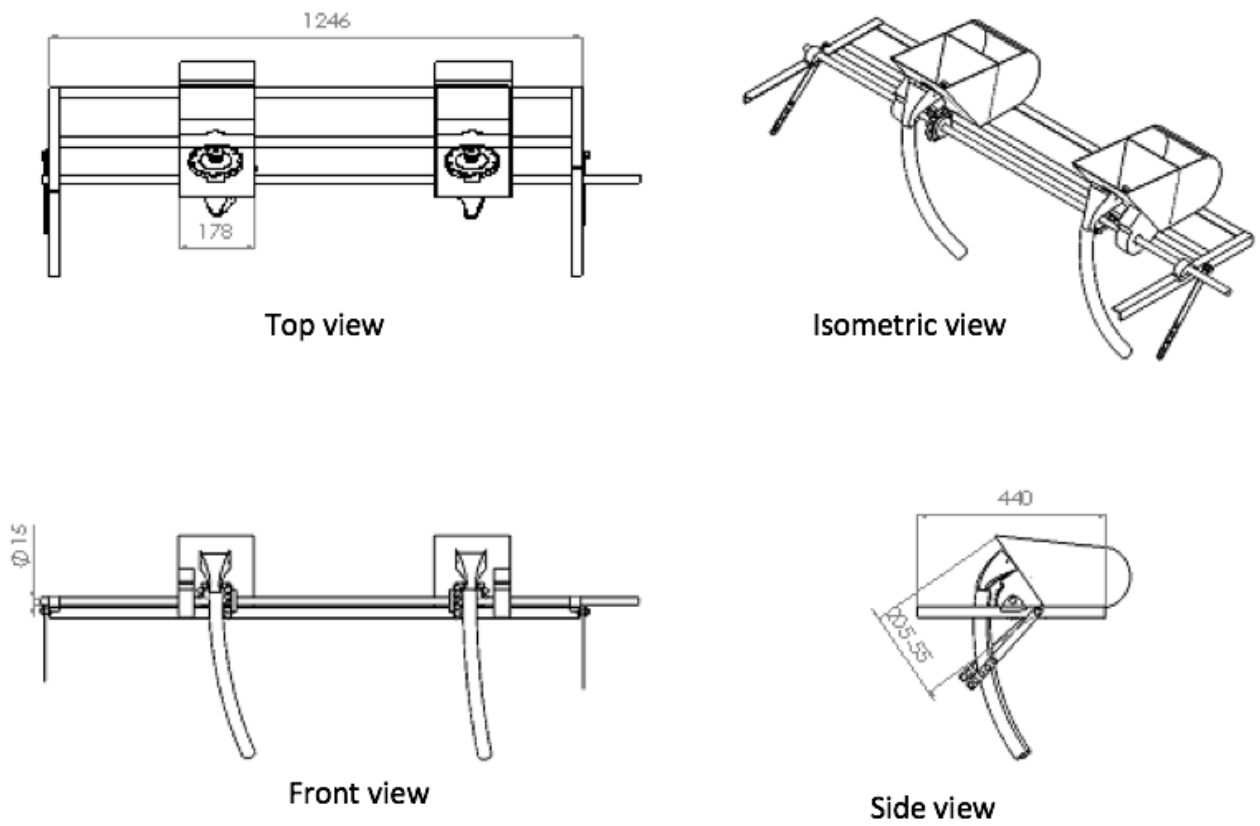


Figure 1. Schematic diagram of the conversion kit (all dimensions are in mm)



Figure 2. Pictorial view of PTOS with kit

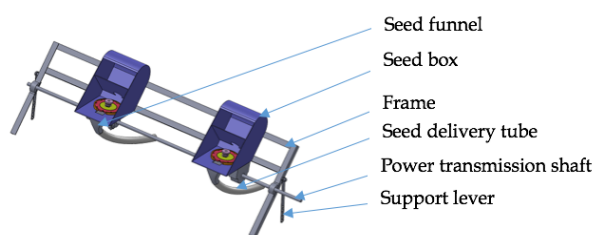


Figure 3. Pictorial view of PTOS with kit

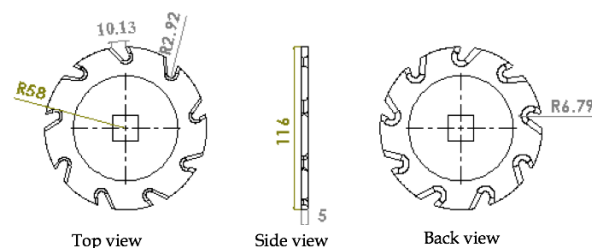


Figure 4. Schematic diagram of maize seed plate (all dimensions are in mm)

harvesting monsoon rice in Bangladesh and timely sowing of wheat was possible with this seeder (Roy et al., 2004). Whereas in conventional agriculture, land preparation takes about two weeks. The PTOS also showed better performance for sowing mung-bean (Hoque et al., 2009). BARI has developed inclined plate planter (Matin et al., 2008; Hoque and Miah, 2015) which can be used for small to large seed sowing and planting but imported seeders with fluted roller metering device could not be used for large seed planting like maize (Hoque and Karim, 2016). Maize is third most important cereal crop of the world after wheat and rice (Singh, 2017). Since the inception of commercial farming of maize in Bangladesh in mid-90's, its yearly output has grown from 65,000 ton in 1997-98 to 2.75 million ton in 2015-16 (Ahmad, 2016).

Thus, a research initiative was taken to develop simple device to use these Chinese PTOS for maize planting.

## 2 Materials and Methods

### 2.1 'Maize Conversion Kit'

The experiment was conducted during 2014-15 at Regional Agricultural Research Station (RARS), BARI, Jamalpur. A modification on available PTOS was done by adding additional device called 'Maize Conversion Kit'. Developed maize conversion kit was designed at BARI and fabricated at Mahbub Engineering Workshop, Jamalpur.

#### 2.1.1 Structures

Schematic diagram of the kit is shown in Fig. 1. A brief description of the maize conversion kit (Fig. 2) is given below.

**Frame** A frame was made of Mild Steel (MS) angle which hold the seed boxes and power transmission shaft. This also helps to attach with the PTOS. The overall dimension of the frame is 1246 × 440 mm.

**Seed box** Two seed boxes were fixed with the frame (Fig. 3). Each box contained one base plate on which inclined plate for maize was sited. The plate was pressed with a spring-loaded nut-bolt. There was two parts inside the box: one part for holding seeds only and release slowly to the next part where metering plate has usually taken seeds one by one to drop in the funnel.

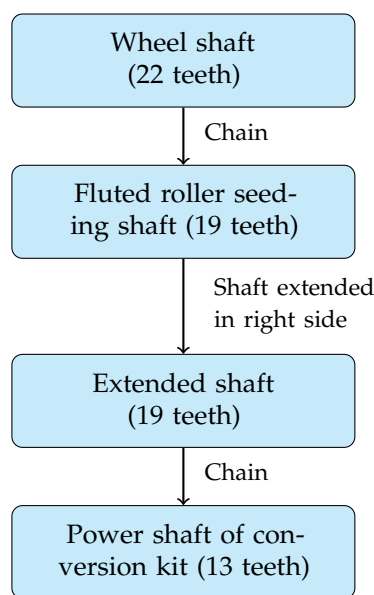


Figure 5. Flow diagram of the power transmission system

**Seed plate** Two seed plates were placed inside two seed boxes. Each seed plate was fitted with pressure plate and spring with a nut. The inclined plate seeding mechanism demand specific seed plate design. A seed plate was designed and fabricated with aluminum (Fig. 4). The thickness of the plate was 5 mm and number of cell was 09 (nine).

**Seed funnel** One seed funnel was placed in the delivery space of each seed box (Fig. 2). This funnel usually takes dispersed seed and convey to the seed delivery tube. This funnel was made of MS sheet.

**Seed delivery tube** Clear plastic pipe having metal wire inside was used to made seed delivery tube. This tube delivered maize seed from seed funnel to the furrow opener.

**Support lever** Two levers were used to fix and change the inclination of the seed plate in both side of the seed hopper.

**Power transmission shaft** A shaft of 15 mm diameter was used to transmit rotational power from the shaft of fluted ruler to the inclined plate through bevel gears. This shaft transmits the power to the seed plate through bevel gear-pinion. Power transmission flow diagram is shown in Fig. 5.

### 2.1.2 Performance evaluation

Performance evaluation of the PTOS after attaching conversion kit was done in the field of RARS, Jamalpur. The machine planting of maize was done in a 6 m × 12 m plot at a speed of 1.3 km/h. To see the seed dropping distance, randomly selected 2 m linear distance was carefully opened. Each seed to seed distance was measured with a steel scale. This procedure was replicated 5 times.

To calculate the coefficient of uniformity of seed distribution, an area of two rows with a length of one meter was randomly selected using a wooden frame in each replication. The planted seeds in this area were separated and seed to seed distance was measured with scale. The coefficient of uniformity of seed distribution was computed using the following equation (Senapati et al., 1992).

$$S_e = 100 \times \left(1 - \frac{Y}{D}\right) \quad (1)$$

where,  $S_e$  = coefficient of seed distribution uniformity (%),  $Y$  = average numerical deviation of number of plants per meter length of row from desired number of plants per meter run, and  $D$  = desired number of plants per meter length of row.

## 2.2 Experimental procedure

In this study, the field performance of the machine was evaluated under two conditions *i.e.* PTOS with full tillage and PTOS with strip tillage and compared with conventional tillage *i.e.* manual planting. During planting of maize, row to row distance and seed to seed distance was maintained at 60 cm and 20 cm, respectively in all treatment. BARI hybrid maize 9 was used as tested variety. Plot size was 10 × 10 m. In all treatments 250 kg of N, 45 kg of P, 130 kg of K and 5 kg of ZnSO<sub>4</sub> per ha was applied. Five irrigations were given *i.e.* first at 3 leaf stage (V3), second at 6 leaf stage (V6) after fertilizer application, third at V10 after fertilizer application, fourth at silking stage and

the fifth one at grain watery milking stage. For strip tillage, 1 kg active ingredient of glyphosate per ha was applied to kill all standing weeds before planting with a three-nozzle flat-fan spray boom. During harvesting of maize, the yield estimation area was selected avoiding border effects. All the ears from the harvest area (18 m<sup>2</sup>) were collected. The ear cover was removed. Then the maize was shelled with the help of a maize sheller. All the maize grains were collected and weighed.

## 3 Results and Discussion

The performance of inclined plate for maize planting is shown in Table 1. Grand average spacing of the maize seed was found to be 20.01±0.36 cm. Maximum and minimum seed to seed distances were varied from 20.9 to 20.3 cm and 19.3 to 19.5 cm, respectively. This variation might be due to vibration, multiple touching on the seed tube and lateral movement of the seeds on soil surface. This seed distribution is close to desired for planting 83,333 seeds per ha in 60 cm line spacing pattern. Similar results were also found by Hoque and Karim (2016) and Hossain et al. (2014).

Seed distribution uniformity of the seeder for full tillage as PTOS and strip tillage was 98 and 97%, respectively (Fig. 6). There was no significant difference among them. This finding also showed similar results with Hoque and Miah (2015) which indicate suitability of using the converter with Chinese PTOS for maize planting.

The modified seeder was evaluated in full tillage mode and strip tillage mode comparing with conventional methods. Yield comparison is shown in Fig. 6. Yield of maize was statistically similar between PTOS with full tillage (8.62 t/ha) and strip tillage (8.51 t/ha). Again, yield was significantly higher in full tillage than the conventional tillage cum manual seeding (8.31 t/ha), though there was no difference between strip tillage and conventional method. Straw yield was not varied for the treatments. The grain yield was varied for higher number of grain and thousand grain weight in full tillage with PTOS than the conventional (Table 2). Higher yield of maize for using PTOS was also reported for maize planting with BARI inclined plate planter by Hoque and Miah (2015) where 8.75 t/ha maize yield was reported. But, BARI inclined plate planter has only option of inclined plate for metering seed and have to purchase separately. On the other hand, attaching the simple conversion kit can facilitate to use the imported PTOS for maize planting. Thus, it revealed that modified seeder attaching a maize conversion kit is suitable for maize planting.

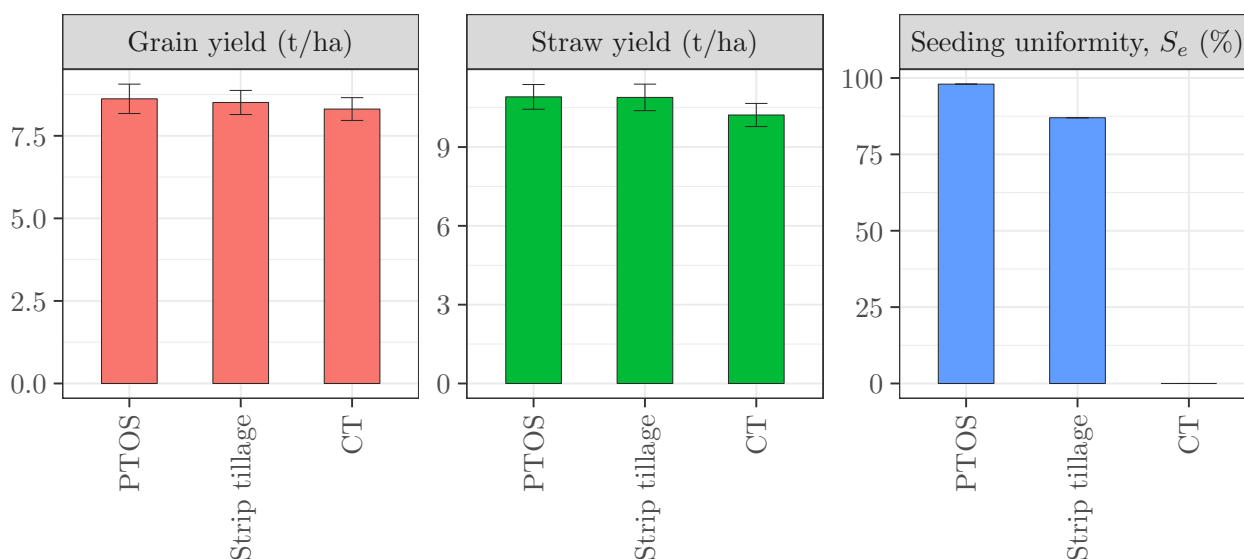


Figure 6. Yield comparison among the tillage systems. PTOS = Power tiller operated seeder (PTOS) with full tillage, Strip tillage = PTOS with strip tillage, and CT = conventional tillage

Table 1. Performance of inclined plate for maize seed placing

Trial No.	Successive seed spacing (cm)				
	Line 1	Line 2	Line 3	Line 4	Line 5
1	20	19.5	20.2	20	19.7
2	19.5	20.9	20.1	19.8	20
3	20.3	20.1	19.5	20.4	20.2
4	20.2	20.3	20.3	19.7	20.1
5	19.7	20.8	20	19.6	19.6
6	19.9	19.4	19.5	20.4	19.5
7	20.2	20.5	20.5	19.4	20.8
8	20	20	19.8	19.3	20.2
9	19.8	20.2	20.4	20.4	19.7
10	20	19.6	20	20.4	20.1
Average	19.96	20.13	20.03	19.94	19.99
Max	20.3	20.9	20.5	20.4	20.8
Min	19.5	19.4	19.5	19.3	19.5
SD	0.2	0.5	0.3	0.4	0.4

Table 2. Yield contributing characters of maize

Treatment	Plant height (cm)	Ear length (cm)	Ear diameter (cm)	No. of grain	TGW <sup>†</sup> (g)
Full tillage	183.33	15.56	4.75	347.67a	446.33a
Strip tillage	183.33	15.45	4.72	329.00ab	443.00ab
CT	179.67	15.39	4.45	308.00b	421.33b
HSD <sub>0.05</sub>	NS	NS	NS	27.43	24.49
CV	4.41	2.31	4.09	2.87	1.93

Same letter did not significantly vary; <sup>†</sup> Thousand grain weight; Full tillage = Power tiller operated seeder (PTOS) with full tillage, Strip = PTOS with strip tillage, and CT = conventional tillage

## 4 Conclusion

The PTOS could be used for maize planting attaching a simple maize conversion kit with it. The modified seeder can maintain desired seed spacing and seed distribution uniformity. In the field experiment, modified seeder also gave better maize yield than the conventional method. Thus, the modified seeder could be further used for other crops planting by designing seed plate and changing gear ratio for power transmission.

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