

Project ID: 774

Sub-project Completion Report

on

Development of a Low Cost Battery Operated Rotary Type Upland Weeder

Project Duration:
From May 2017 to September 2018

Farm Machinery and Postharvest Process Engineering Division
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701



Submitted to,
Project Implementation Unit-BARC, NATP-2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215



September 2018

Competitive Research Grant (CRG)

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Acronyms

BARC : Bangladesh Agricultural Research Council

BARI : Bangladesh Agricultural Research Institute

CRG : Competitive research grant

DC : Direct current

h : Hour

ha : Hectare

mm : Millimeter

NATP : National Agriculture Technology Project

DAS : Days after sowing

RPM : Revolution per minute

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Executive Summary

Weeds are plants which are considered undesirable in crop cultivation and gardening. The process of removal of these weeds from crops is called weeding. Chemical method of weed control is more prominent than manual and mechanical methods. However, its adverse effects on the environment are making farmers to consider and accept mechanical methods of weed control. Manual weeding is common practice in the farming system of Bangladesh. It is the most widely used weed control method but it is labor intensive. So, it is necessary to develop a mechanical weeder to reduce drudgery and cost which ensure a comfortable posture of the farmer or operator during weeding and to increase production. The costs associated with mechanical weeding such as operating cost can be lowered; as such mechanical weeding can represent a viable and cost effective option to majority of medium and small scale farmers in developing countries like Bangladesh. Weeding and hoeing is generally done 15 to 20 days after sowing. The weed should be controlled and eliminated at their early stage. Depending upon the weed density, 20 to 30 percent loss in grain yield is quite usual which might increase up to 80 per cent if adequate crop management practice is not followed. The overall objective of this project was to develop and evaluate the performance of a DC motor operated rotary type weeder intended for power operated mechanical weeding in upland crop production.

To fulfill the objective a rotary type DC motor operated dry land weeder was designed and fabricated at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during the project period. The weeder was designed and fabricated considering methodological steps. For performance verification of weeder, field trials were done and performance was found satisfactory for wide row crop. Field trials were conducted on maize, chili, eggplant at different locations of Bangladesh. Weeding indices of battery operated weeder for maize, chili and eggplant were 80.47%, 76.74%, 95.21% respectively. The effective field capacities of battery operated weeder for maize, chili and eggplant were .065 ha/h, 0.058 ha/h and 0.054 ha/h, respectively. Cost of weeding by battery operated weeder was almost one third compared to hand weeding and manual weeder and there were no significant differences in yields among these three methods.

CRG Sub-project Completion Report (PCR)

A. Sub-project Description:

1. Title of the CRG Sub-Project: **Development of a low cost battery operated rotary type upland weeder**
2. Implementing Organization: Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-1701
3. Principal Investigator (Full address with phone and e-mail):
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4. Sub-project Budget (Taka): **1971350.00** (Nineteen lac seventy one thousand three hundred and fifty only)
5. Duration of the sub-project:
Start Date: 14th May 2017
End Date: 30th September 2018

6. **Justification of undertaking the sub-project:**

Weeding is one of the major problems for upland crop production. Presence of weeds increases the cost of agriculture and hinders the yield of crops. Weeds are harbor of insects, pests, pathogen and parasites (RNAM, 1983; Frayer, 1970). Amongst total annual loss in agriculture produce, weeds account for 5% to 50% (Oni, 1990). Traditional weeding is laborious, costly and time consuming. **Manual weeding is common in Bangladesh but now a days chemical method of weed control is more prominent than manual and mechanical methods.** However, its adverse effects on the environment like water pollution, health hazard, air pollution, carbon emission etc. are making farmers to consider and accept mechanical methods of weed control **(Stevens, 2000).** But there is no suitable weeder available in our country. To address this problem, a rotary type DC motor operated upland weeder was developed and evaluated through this sub-project which is cost effective and environment friendly. The Rotary weeder can be made to operate

various working depths, widths and soil conditions. The rotating blades would uproot, chop and mix the weeds evenly throughout the soil. This weeder reduced the mechanical weeding cost and also reduced the drudgery of the farmers. This weeder would rid the farmers for using poisonous and costly herbicide to control the weed in the crops fields and thus it can represent a viable and cost-effective option of weeding to majority of medium and small scale farmers in developing countries like Bangladesh.

7. Sub-project goal:

The goal of this project was to develop an efficient and effective DC motor operated rotary type weeder for upland crop production.

8. Sub-project objectives:

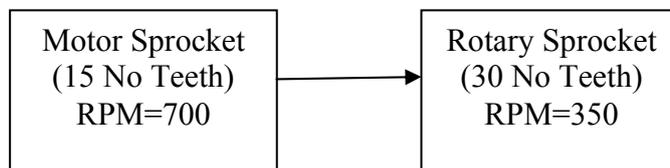
- To develop a cost effective rotary weeder for medium and small scale farmers;
- To evaluate the performances of weeder in research field;
- To disseminate the technology among the farmers by adaptive trial in farmers' field.

9. Implementing location (s): Gazipur, Sherpur, Rajshahi and Patuakhali districts.

10. Methodology:

10.1 Assumptions:

The assumptions were made in designing of the rotary weeder were presented in terms of field conditions, machine capacity and energy requirement required to power it. The power requirement of the motor was calculated based on soil resistance, depth of cut, speed of rotary blades, etc. The voltage of motor was selected on the basis of available battery voltage (12 V) so that by series and parallel connection combination, 48 volts can be achieved. The machine is to be powered by a 48 volt 750 watt motor which is operated by 48 volt rechargeable dry cell battery. Belt and sprocket arrangement shall be employed for transmission of power. According to Olaoye *et al.*(2012) motor speed is 700 rpm, number of teeth on sprocket = 15, number of teeth on sprocket of rotary shaft= $15 \times 2 = 30$, rotary shaft speed = 350 rpm, maximum soil resistance = 1.05 kg/cm^2 , coefficient of friction = 0.1, efficiency of transmission system = 90%. Transmission of power is shown in following flow diagram.



10.2 Design procedure:

In the design process, calculation of power requirement, motor selection, chain and sprocket selection and design and arrangement of tines are needed to be considered. There is no power in the wheel; so, weeder should be pushed manually but continuous pushing of tines makes weeder to go forward easily. The power supply on rotary shaft should be taken into consideration. There are two parts of the weeder, one is body and another is handle. Body part consists of motor, battery, wheel and rotary shaft but handle consists of auto

switch and converter. Figure 1 represents the drawing of weeder with dimension. Also Figure 2 represents the 3D drawing of weeder.

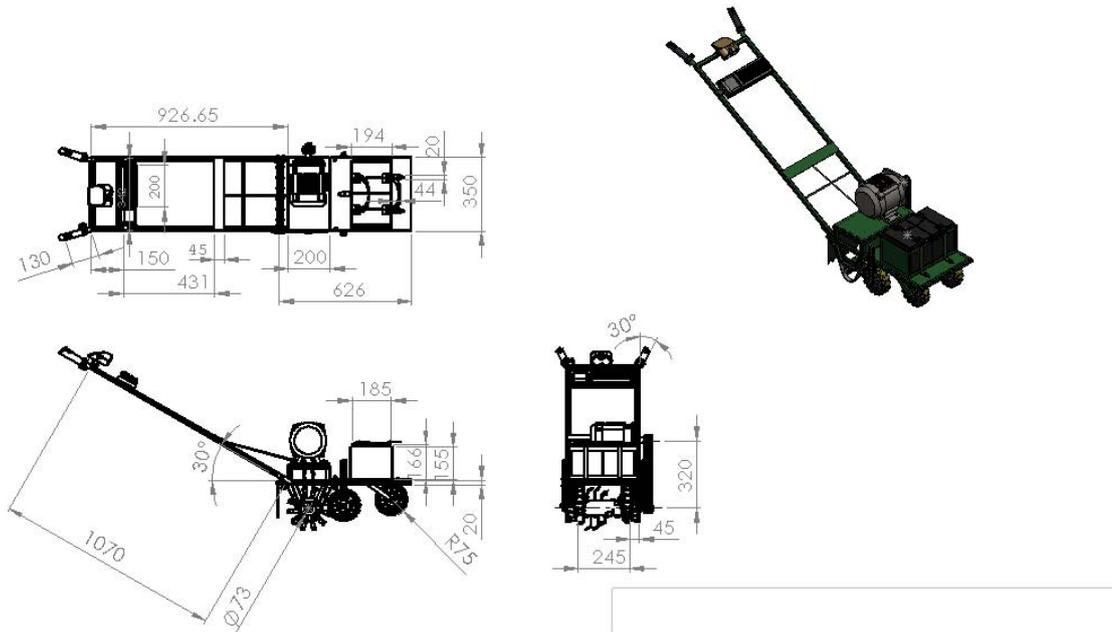


Figure 1. Battery operated dry land rotary weeder with dimension (mm)

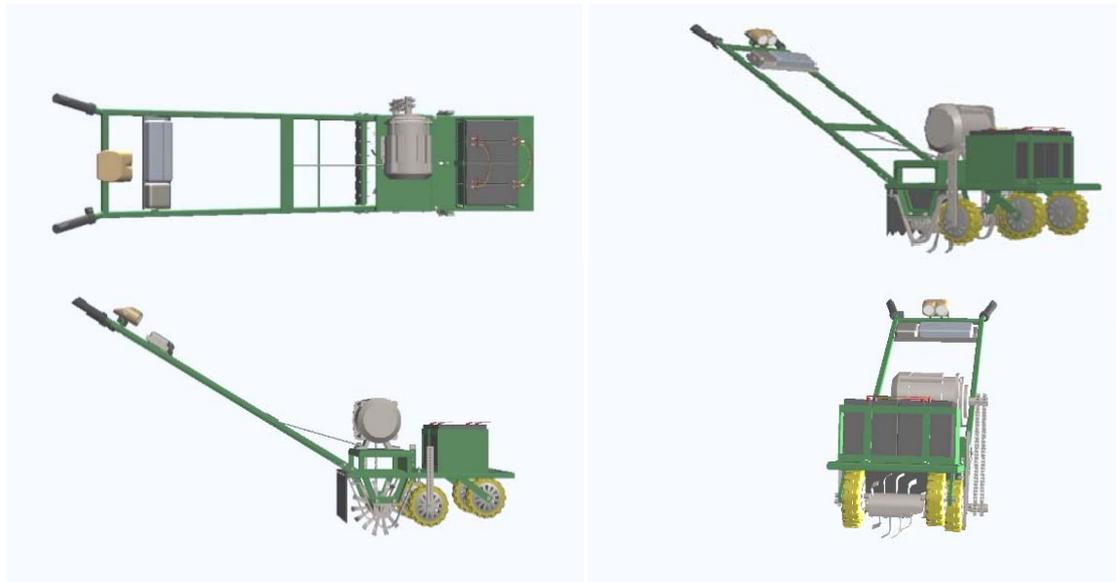


Figure 2. Top, isometric, side and front view of battery operated dry land rotary weeder

10.3 Power requirement:

The power requirement was calculated using the following equations (Hunt, 1983):

$$P_d = \frac{S_r \times d \times w \times v}{75} \text{ (hp)} \quad (1)$$

Where,

S_r = soil resistance, kgf/cm²;

d = depth of cut = 2.5 cm;

w = effective width of cut = 26 cm;

v = linear velocity of the tine at the point of contact with the soil = 1 cm;

Hence, power requirement is estimated as

$$P_d = \frac{S_r \times d \times w \times v}{75} = \frac{1.05 \times 2.5 \times 26 \times 1}{75} = 0.91 \quad (2)$$

10.4 Total power required:

The total power required was estimated as 1.89 hp as follows

$$P_t = \frac{P_d}{\eta} = 1.01 = 1 \text{ hp} \quad (3)$$

Where,

P_d = Power required to dig the soil

η = Transmission efficiency (0.90).

Thus, a prime mover of 1.0 hp was required for this weeder.

10.5 Chain and sprocket selection:

Chain and sprocket arrangement was adopted for transmission of power. The chain, sprocket and shaft selection was based on Agricultural Machinery Management Data. The size of chain is 60B and number of teeth of sprocket is 14. Chain and sprocket and shaft is shown in Figure 3.

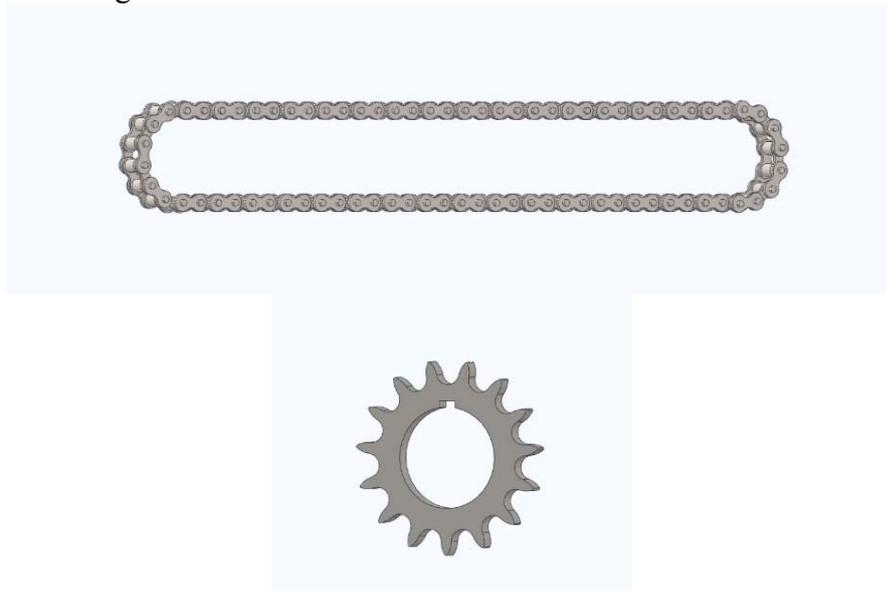


Figure 3. Chain and sprocket for dry land power weeder

10.6 Weeding tines and tines arrangement:

A J-shaped tine was designed because to receive of minimum soil resistance on the shaft due its shape. The engineering drawing of J shape tines are shown in Figure 4. Length and width of the tine was 80 mm, curve angle of tine was 120° and 18 mm respectively (Figure 4). Dimension of the shaft was 245 mm and 73 mm respectively. The shaft consist tines of equal lengths and arranged in spiral shaped determined as follows (Figure 5).

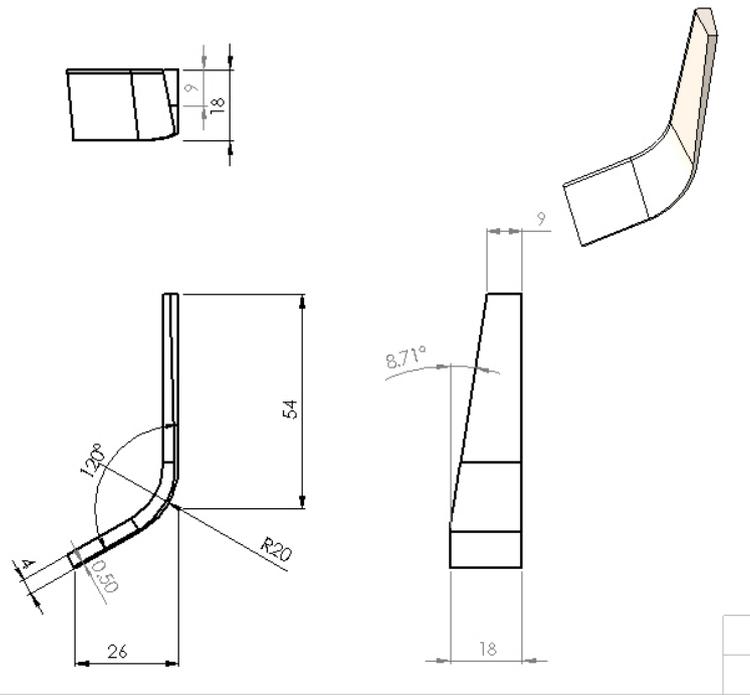


Figure 4. J-shaped tine for dry land power weeder

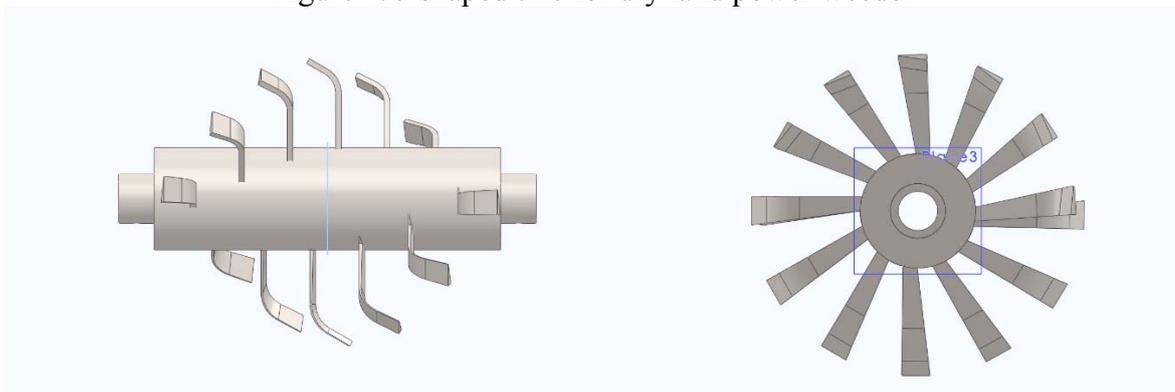


Figure.5. Spiral Arrangement of J-shaped tine for dry land power weeder

10.7 Machine description:

The powers to the rotary hoe are supplied from the motor through chain and sprocket. The various components of the machine were constructed while other standard components, such as prime mover and transmission elements were sourced locally and the parts were assembled at the fabrication workshop of the Farm Machinery and Post-harvest Process Engineering Division, Bangladesh Agricultural Research Institute (BARI). The pictorial

view of the rotary weeder is shown as Figures 6. The specifications of weeder is given in Table 1.



Figure 6. Pictorial view of Battery operated dry land rotary weeder

Table.1. Specifications of battery operated weeder

Sl no	Items with specification		Value
1	Power	Motor (hp)	1.0 (750 watt)
		Battery (Volt) (dry, rechargeable)	48
2	Dimension (with rotary tine) (mm)		1560 × 350
3	Weeder forward speed (km/h)		2
4	Rated motor speed (rpm)		700
5	Rated rotary speed (rpm)		350
6	Rotary Shaft	Length (mm)	245
		Diameter of shaft (mm)	73
7	Tine	Number of tine	14
		Type of tine (J-shape	
		Tine arrangement	Spiral
		Width of tine (mm)	18
		Length of tine (mm)	75
8	Diameter of wheel (mm)		160
9	Starting system (auto-switch)		
10	Total weight (kg)		27

10.8 Performance test and evaluation:

Laboratory test:

The laboratory test was conducted at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute (BARI), Gazipur. The laboratory test results are given in Table 2.

Table 2. The laboratory test result of battery operated weeder

Parameter	Value
Rated motor speed (rpm)	700
Rotary blade speed (rpm)	350
Theoretical field capacity (ha/h)	0.10

10.9 Site and experimental condition:

The experiment was conducted at Plant Breeding Research Farm of Bangladesh Agricultural Research Institute (BARI), Irrigation and water Management Research Farm of Bangladesh Agricultural Research Institute (BARI) Gazipur and Debiganj upazila under Panchagarh district during Kharif-1 season of 2017-18. The soil was clay loam according to BARC portal and soil penetration was recorded before each treatment imposed. The experiment plot was well pulverized and leveled with a tractor.

10.10 Crop and weeds

BARI Hybrid Bhutta-5 was planted manually in the experimental plot (6 x 4 m each) with 60 cm row to row spacing. Each plot accommodated 6 rows. The planting date was 6 December, 2017. Density of weed was recorded before and after treatment imposed. The weed sampling was done randomly in middle three rows in 1 m x 1 m quadrants. Width of cut was 28 cm, so double pass was done to cover 60 cm width. Number of plant damage was recorded and weeds partially damaged but not up rooted were counted as uncontrolled. Inter row weeds were not removed by mechanical method but all weeds are removed by manual method. The common species of weeds were recorded. The following weeds are significantly present in the testing plots which is shown in Table 3.

Table 3. Species of weeds available in the testing plot

Local Name	Specifications	Comments
Chapra	<i>Eleusine indica</i> L.	First three were dominant
Durba	<i>Cynodon dactylon</i> L.	
Chapra	<i>Elusine indica</i>	
Mutha	<i>Cyperus rotundus</i>	
Helench	<i>Enhydra fluctuans</i> L.	
Paddy seedlings	<i>Oryza sativa</i>	

10.11 Fertilizer, irrigation and earthing up:

Fertilizer and irrigation was applied as BARI recommended dose. Earthing up was done manually at 45 days after sowing.

10.12 Experimental design:

The study included three treatments replicated four. The experiment was designed in Randomized Complete Block. The treatments were:

T₁ - Weeding by battery operated weeder at 25-45 DAS (Days after sowing)

T₂ - Weeding by BARI push and pull weeder at 25-45 DAS

T₃ - Manual weeding at 25-45 DAS

10.13 Test procedure:

Performance indicators used for this experiment includes the following:

10.14 Weeding index

Weeding index is a ratio between the number of weeds removed by a weeder and the number present in a unit area and is expressed as a percentage (Rangasamy et al., 1993). Six plots of 6 m x 4 m each were marked out of the main plot for sampling. Weeds in each plot were counted before and after weeding using the constructed battery operated rotary weeder. The time taken to perform this operation was noted. Equation (4) was used to calculate weeding index.

$$\text{Weeding index, } I_w = \frac{W_1 - W_2}{W_1} \quad (4)$$

Where,

W₁ = Number of weeds per m² before weeding

W₂ = Number of weeds per m² after weeding

10.15 Plant damage:

Plant damage was observed in mechanical method and recorded. Plants damaged completely or uprooted were counted as 'damaged' and expressed as percent of each plot the plant damage percent was evaluated by using equation 5.

$$\text{Plant damage percent, } \Sigma = \frac{W_1 - W_2}{W_1} \times 100 \quad (5)$$

Where,

W₁ = number of plant before weeding,

W₂ = number of damaged plant after weeding,

Σ = Plant damage percent

10.16 Field capacity

The weeding tools were tested on the same plots to determine the field capacity of each of them. Field capacity is the amount of area that a weeding tool can cover per unit time as shown in equation 6 (Hunt, 1983).

$$\text{Field Capacity (ha/h)} = \frac{60}{t} \times \frac{A}{10000} \quad (6)$$

Where,

A = Area covered (m²),

t = Time taken in hour

10.17 Cost parameters for economic analysis

a. Depreciation cost:

The ratio between salvage values deducted from purchase price and life of a machine.

b. Benefit cost ratio (BCR):

It refers to the ratio of gross/total return to the gross cost or total cost. It indicated the amount of taka a farmer receives for every taka he spent.

c. Payback period:

The length of time required to recover the cost of an investment.

11. Results and Discussion:

11.1 Experimental factors:

Experimental factors used in the field evaluation of rotary power weeder were approximately equal speed in three blocks. The motor had the option for operating low, medium and high speed. So, the weeder was operated at medium speed in all the plots. The weeding performance was compared with the BARI manual weeder and traditional weeding method. Weeding experiments were conducted in maize, chili and eggplant fields.

11.2 Performance evaluation and experimental analysis:

11.2.1 Maize

The performance evaluations were done to investigate the effect of weed density on performance of three weeding methods such as battery operated weeder (T₁), BARI upland weeder (T₂) and hand weeding by hand hoe (T₃). Prior to each weeding schedule, weed density in each experimental unit was determined by laying-out a squared grid (1 m x 1 m) in the plot and weeds in the grid were counted. Three such determinations were made for each experimental unit.

Field capacity, weeding index, plant damage and grain yield in weeding by battery operated weeder, BARI weeder and hand weeding methods in maize fields are shown in Table 4. Significantly the highest field capacity was found battery operated weeder followed by BARI weeder and hand weeding. Almost similar weeding index was found between battery operated weeder and hand weeding method but significantly the lowest weeding index was found for BARI weeder. These results indicated that more than 80% weeds were damaged by battery operated weeder and hand weeding method and there was no significantly difference between them. No plant damage was observed for manual weeding method and very little (0.63%) plant damage was found for battery operated weeder. For BARI upland weeder, the plant damage (1.4%) was significantly higher than battery operated weeder. There were no significant differences in grain yields among the treatments. But battery operated weeder shown better performance among the treatments for weeding in maize field.

Table 4. Field performance of different weeding methods in maize fields

Treatment	Field capacity (ha/h)	Weed density (No/m ²)	Weeding index (%)	Plant damage ratio (%)	Yield of maize grain (t/ha)
T ₁ (Battery weeder)	0.071 a	461	80.47 a	0.63 b	4.60
T ₂ (BARI weeder)	0.021 b	431	66.44 b	1.40 a	4.50
T ₃ (Manual weeding)	0.017 b	426	81.86 a	0.0 c	4.60

Field capacity and field efficiency weeding in maize were 0.065 ha/h, 80% respectively for battery operated low cost weeder but for BARI push and pull weeder were 0.021 ha/h, 47% respectively. Plant damage ratio was very low which only 1% for battery operated weeder was. Cutting width was 260 mm and depth of cut was 41 mm of battery operated weeder. Weeding cost per ha battery operated weeder was Taka 1843 which was lower than manual and BARI push and pull weeder. The performance data of battery operated rotary type low cost weeder for maize is shown in Table 5. A linear relationship is found between weed density and effective field efficiency which is shown in Figure 1. Here, lower weed density indicates higher weeding efficiency.

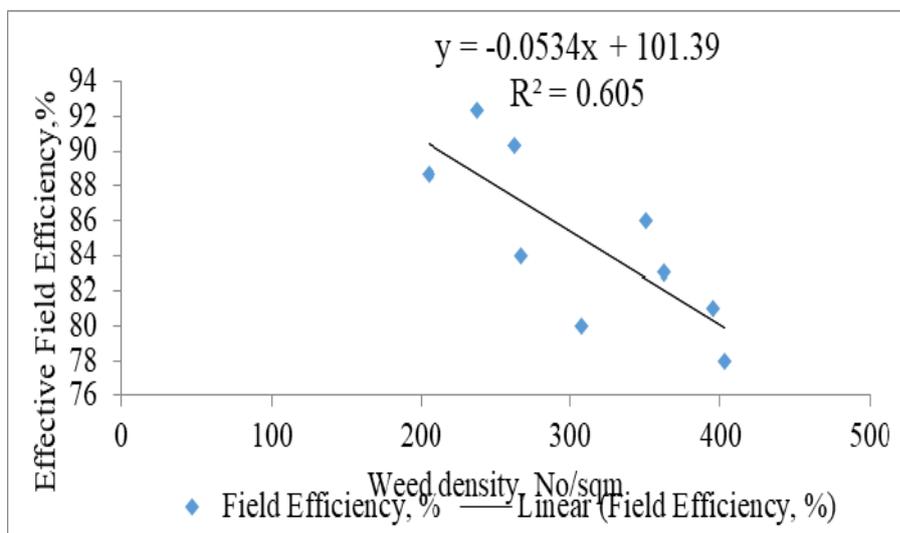


Figure 7. Relationship between weed density and effective field efficiency

Table 5. The performance of battery operated rotary type weeder for maize, compare to other weeding practices

Items	Weeding Method		
	Battery weeder	BARI weeder	Manual weeding
Row to row distance (cm)	60	60	60
Number of turns per row	2	4	N/A
Weeding depth (mm)	41	10-15	N/A
Soil penetration, psi (10 cm height)	94	94	94

Forward speed (km/h)	3	3	N/A
Theoretical field capacity (ha/h)	0.078	0.045	N/A
Effective field capacity (ha/h)	0.065	0.021	N/A
Field efficiency,(%)	80	47	N/A
Plant height (mm)	60.8	61	60.5
Cutting width (mm)	260	150	N/A
Grain yield (t/ha)	4.6	4.5	4.6
Cost of weeding (Tk./ ha)	1843	4818	7500

11.2.2 Chili

The performance evaluations were conducted to investigate the effect of weed density on performance of three weeding tools. Prior to each weeding schedule, weed density in each experimental unit was determined by laying-out a squared grid (1 m x 1 m) in the plot and weeds in the grid were counted. Three such determinations were made for each experimental unit.

Field capacity, weeding index, plant damage and grain yield in weeding by battery operated weeder, BARI weeder and hand weeding methods in chilli fields are shown in Table 6. Significantly the highest field capacity was found battery operated weeder followed by BARI weeder and hand weeding. There was no significant difference of field capacity between BARI upland weeder and hand weeding method. Significantly the highest weeding index was found from hand weeding followed by battery operated weeder and BARI weeder. Significantly the lowest weeding index was found for BARI weeder. No plant damage was observed for manual weeding method and very little (0.54%) plant damage was found for battery operated weeder. For BARI upland weeder, the plant damage (1.2%) was significantly higher than battery operated weeder. There were no significant differences in fruit yields among the treatments. But battery operated weeder shown better performance among the treatments for weeding in chilli field.

Table. 6. Field performance of different weeding methods **in chilli** fields

Treatment	Field capacity (ha/h)	Weed density (No/m ²)	Weeding index (%)	Plant damage ratio (%)	Yield of maize grain (t/ha)
T ₁ (Battery Weeder)	0.067 a	256	76.74 b	0.54 b	5.50
T ₂ (BARI Weeder)	0.018 b	308	65.17 c	1.20 a	5.60
T ₃ (Manual weeding)	0.016 b	375	90.18 a	0.0 c	5.50

The performance of different weeding methods for chilli is given in Table 7. Field efficiency of chilli weeding was 78.89% respectively for battery operated low cost weeder but for BARI push and pull weeder was 0.020 ha/h and 45.5% respectively. Plant damage ratio was very low which only 0.54% for battery operated weeder was. Cutting width was

260 mm and depth of cutting was 41mm battery operated weeder. Weeding cost per ha of battery operated weeder was Taka 1843 which was lowest than manual and BARI push and pull weeder.

Table 7. The performance of different weeding methods in chilli fields.

Items	Weeding methods		
	Battery weeder	BARI weeder	Manual weeding
Row to row distance (cm)	50	50	50
Number of turns per row	2	4	N/A
Weeding depth (mm)	41	10-15	N/A
Soil penetration, psi (10 cm depth)	90	90	90
Forward speed (km/h)	3	3	N/A
Theoretical field capacity (ha/h)	0.078	0.045	N/A
Effective field capacity (ha/h)	0.058	0.020	N/A
Field efficiency (%)	78.89	45.5	N/A
Plant height (mm)	45.9	45.6	46.0
Cutting width (mm)	260	150	N/A
Fruit yield (t/ha)	5.6	5.5	5.6
Cost of weeding (Tk/ha)	1843	4818	7500

11.2.3 Brinjal

The performance evaluations will conduct to investigate the effect of weed density on performance of three weeding tools. Prior to each weeding schedule, weed density in each experimental unit was determined by laying-out a squared grid (1 m x 1 m) in the plot and weeds in the grid were counted. Three such determinations were made for each experimental unit.

Field capacity, weeding index, plant damage and grain yield in weeding by battery operated weeder, BARI weeder and hand weeding methods in brinjal fields are shown in Table 8. Significantly the highest field capacity was found battery operated weeder followed by BARI weeder and hand weeding. There was no significant difference of field capacity between BARI upland weeder and hand weeding method. Significantly the highest weeding index was found from hand weeding followed by battery operated weeder and BARI weeder. Significantly the lowest weeding index was found for BARI weeder. No plant damage was observed for manual weeding method and very little (0.54%) plant damage was found for battery operated weeder. For BARI upland weeder, the plant damage (1.06%) was significantly higher than battery operated weeder. There were no significant differences in fruit yields among the treatments. But battery operated weeder shown better performance among the treatments for weeding in brinjal field.

Table 8. Field performance of different weeding methods in **brinjal** fields

Treatment	Field capacity (ha/h)	Weed density (No/m²)	Weeding index (%)	Plant damage ratio (%)	Yield of maize grain (t/ha)
T ₁ (Battery Weeder)	0.062 a	188	95.21 b	1.06 a	56
T ₂ (BARI Weeder)	0.017 b	164	85.03 c	0.98 a	55
T ₃ (Manual weeding)	0.015 b	177	100.00 a	0.0 b	55

The performance of different types of weeding method for brinjal is shown in Figure 9. Field efficiency of brinjal weeding is 72.65% for battery operated low cost weeder but for BARI push and pull weeder is 43% respectively. Plant damage ratio is very low which only 1.06% is for battery operated low cost weeder. Cutting width is 260 mm and depth of cutting is 41 mm battery operated low cost weeder. Weeding cost per ha battery operated low cost weeder was Taka 1843 per ha which was lower than those of BARI upland weeder and manual weeding method.

Table 9. The performance of different types of weeding method for brinjal

Items	Weeding method		
	Battery weeder	BARI weeder	Manual weeding
Row to row distance (cm)	50	50	50
Number of turns per row	2	4	N/A
Weeding depth (mm)	41	10-15	N/A
Soil penetration, psi (10 cm depth)	92	92	92
Forward speed (km/h)	3	3	N/A
Theoretical field capacity (ha/h)	0.078	0.045	N/A
Effective field capacity (ha/h)	0.054	0.019	N/A
Field Efficiency (%)	80	47	N/A
Plant height (mm)	69.9	70.2	70.15
Cutting width (mm)	260	150	N/A
Fruit yield (t/ha)	56	55	56
Cost of weeding (Tk/ha)	1843	4818	7500

11.2.4 Economic analysis:

For economic analysis, we need to consider that weeder is used for business purpose that is rental farming. Table 10 illustrates the economic analysis of different weeding methods.

Table 10. Economic analysis of different weeding methods of maize

Cost	Battery operated weeder	BARI upland weeder	Manual weeding
Purchase price of weeder (Tk)	25000	3000	
Salvage value (5% of Purchase price of weeder) (Tk)	1250	150	
Machine life (year)	5	5	
Depreciation cost per year (Tk)	4750	570	
Days of operation	30	30	
Depreciation cost per day (Tk)	158	19	
Operator required for machine Operation (No.)	1	1	25
Cost of operator (Tk)	800	800	7500
Total weeding cost for weeder per day (Tk)	958	819	
Average area covered per day (ha)	0.47	0.17	N/A
Number of weeder	1	1	N/A
Total weeding cost for weeder (Tk/ha)	1843	4818	7500
Return			
Weeding (decimal/h)	17	5	
Area (decimal) of weeding covered per day (8 h /day)	130	42	
Rent per decimal (Tk)	20	20	
Income per day (Tk)	2600	835	
Net income per day (Tk)	1642	16	
Net income per year (Tk)	49250	486	
BCR	2.00	0.16	
Payback period (day)	15.23	185.19	

The net benefit cost ratio (BCR) of battery operated low cost weeder was 2.00 which was greater than 1, so it is justified or acceptable of battery operated weeder. On the other hand, payback period of Battery operated low cost weeder was 15 that mean by using 15 days, farmer can get back his investment.

12. Research highlight/findings (Bullet point – max 10 nos.):

- Weeder was developed using locally available materials
- Field capacity of weeder was 0.065 ha/h (17 decimal/h)
- Mean value of weeding index (0.83) was close to hand weeding
- Plant damage (1%) was very few at low height and low canopy crop
- Yield difference among three weeding method was not significant
- Number of labor requirement was 20% compare to hand weeding
- Cost of weeding was almost 25% compare to hand weeding
- Farmers of Gazipur, Sherpur, Rajshahi and Patuakhali districts were highly influenced by this technology.

B. Implementation Position**1. Procurement:**

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	7	131,000	7	131,000	
(b) Lab & field equipment	15	168,000	15	168,000	
(c) Other capital items					

2. Establishment/renovation facilities: N/A

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

3. Workshop organized:

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
Completion Workshop	25	15	40	1 Day	

C. Financial and physical progress

Fig. in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	316520	308374	308374	0	100	
B. Field research/lab expenses and supplies	722480	724943	724943	0	100	
C. Operating expenses	235000	151570	151570	0	100	
D. Vehicle hire and fuel, oil & maintenance	160000	91872	91872	0	100	
E. Training/workshop/seminar etc.	98350	98350	98350	0	100	
F. Publications and printing	85000	50060	50060	0	100	
G. Miscellaneous	55000	11971	9890	2081.05	82	Bank Charge
H. Capital expenses	299000	299000	299000	0	100	
Total	1971350.0	1736140.0	1734059.0	2081.1	100	

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome(short term effect of the research)
To develop a cost effective rotary weeder for medium and small scale farmers	<ul style="list-style-type: none"> • Design of battery operated weeder • Drawing of battery operated weeder • Febrication of battery operated weeder 	A battery operated weeder was available with drawing	A battery operated weeder was available for marketing
To disseminate technology among farmers by adaptive trial in farmers' field.	<ul style="list-style-type: none"> • Farmer's field demonstration • Workshop • Booklet 	<ul style="list-style-type: none"> • Farmers' reactions were known • Different stakeholders were informed • Extension message was prepared. 	The battery operated weeder was ready for extension.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.		1 (Booklet)	Battery Operated Power Weeder
Journal publication			
Information development			
Other publications, if any			

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

A battery operated weeder suitable for wide row crops.

ii. Generation of new knowledge that help in developing more technology in future

Rechargeable battery may be used for operating other small power farm machinery.

iii. Technology transferred that help increased agricultural productivity and farmers' income

This technology (Battery operated weeder) would reduce the weeding time, weeding cost and enhance crop production

iv. Policy Support

- This Battery Operated Weeder may be disseminated to the farmers through different extension media
- This Battery Operated Weeder may be included in the subsidy program of Department of Agricultural Extension
- Adaptive research may be conducted

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):

SL No	Desk Monitoring	Dated	Remarks
1	Monitoring workshops	29/03/2018	Satisfactory

ii) Field Monitoring (time& No. of visit, Team visit and output):

SL No	Field Monitoring	Dated	Remarks
1	Monitoring workshops	14/03/2018	Satisfactory

H. Lesson Learned/Challenges (if any)

- i) Rechargeable battery may be used for other small farm machinery
- ii) Farmers' training is very important for sound operation of farm machinery
- iii) Farmers' should be awarded for maintenance of the battery as well as the machine

I. Challenges (if any)

- Frequent change of decision from the PIU, BARC hampered the execution of project activities
- Interrupted money flow made challenge for timely operation of the project works

Signature of the Principal Investigator
Date

Seal

Counter signature of the Head of the
organization/authorized representative
Date

Seal

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Appendix-1 Pictorial views of project activities



Figure a. Field data collection of Battery operated dry land rotary weeder



Figure b. Field trial and performance analysis of Battery operated dry land rotary weeder