ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2616-4302 (Online)
CODEN: AMMCFL

Acta Mechanica Malaysia (AMM)

DOI: http://doi.org/10.26480/amm.01.2026.01.06

RESEARCH ARTICLE

MODIFICATION AND PERFORMANCE STUDY OF POWER OPERATED HILLING CORN WITH DOUBLE WHEEL HOE

Arifa Sultana, Selina Banu, Kafi Rezwana Laaz, Milufarzana*

Department of Agricultural and Industrial Engineering, Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh
**Corresponding Author Email: milu.bau@gmail.com*

ARTICLE DETAILS

Article History:

Received 26 January 2026
Revised 20 February 2026
Accepted 25 February 2026
Available online 05 March 2026

ABSTRACT

Bangladesh is a small country having huge population. Day by day, it is required to produce more food to meet the demand of growing population. To fulfill the demand, we have to increase crop yield by adopting the high farming techniques. Maize is one of the most important cereal crops in the country and the leading crop of the world after rice and wheat. Maize has the highest potential for carbohydrate production. In Bangladesh, it occupies 1.68 lac hectares land and produces10.38 lac metric tons with an average yield of 6.27 t/ha. In Dinajpur district maize has been planted 79,402 hectares. For increasing corn yield we have designed a machine named power operated hilling corn with double wheel hoe. Corn hiller is farming implement used to create hills or ridges of soil around corn plants. It improves water drainage and prevents erosion. It can also help to conserve moisture in dry season. Manual weeding is common in Bangladesh, but this method is labor intensive and is one of the major farming problems in Bangladesh. The additional work of the machine is to remove weeds from corn field by allowing the soil working components to penetrate into the soil and cut or uproot the weeds between the crops rows and also bury the weeds. It is a useful tool for the improvement of soil health and maximizes the corn yield. The travelling speed of the machine was found 1.75 km/hr. The theoretical field capacity was found 0.08 ha/hr and the effective field capacity was 0.067 ha/hr. The field efficiency of the machine was 83.75%. The turning loss and weeding efficiency of the machine was 15.34% and 61.58% respectively.

KEYWORDS

Hilling corn, performance study, field capacity, efficiency, cost.

1. INTRODUCTION

Maize (Zea mays) now a common crop in agricultural production systems of Bangladesh, which has made significant contributions to food security, production of raw materials for industries and livestock feed. After rice and wheat, maize (Zea mays) is the third most important cereal in the world. It is significant for food, animal feed, and raw materials for industry (Hajong et al., 2024). Maize has a wide genetic variability and able to grow successfully in any environment in Bangladesh. It generally grows both in winter and summer time in Bangladesh. Maize, which is grown in an area of over 514,000 hectares, recorded an all-time-high production of 4.87 million tonnes in the fiscal year 2023–2024, representing an increase of 7% over the previous year Bangladesh Bureau of Statistics (BBS, 2024). The annual demand is estimated at 6-7 million tons, creating a shortfall that necessitates imports, though production is catching up. The primary driver is the booming poultry, livestock, and aquaculture sectors, which use maize for feed. Demand also comes from food processing and bakery industries (FAO, 2024). This demand can be meet up by two ways; they are either increasing the land under cultivation or by adopting the high farming technique which would increase the crop yield as per demand. As there is a little scope to increase the land under cultivation, We have to consider another option which is increasing the crop yield (BBS, 2023).

A corn hiller is a farming implement used to create hills or ridges of soil around corn plants. The hills or ridges can help to improve water drainage and prevent erosion, while also providing a small mound of soil around the base of the corn plants. The main benefit of using a corn hiller is improved soil drainage around the base of the corn plants (Li et al., 2024). This is especially important in areas with heavy rainfall or poorly drained soils, where excess moisture can lead to root rot and other diseases that can damage or kill corn plant. Nowadays in Bangladesh hilling corn with simple tools such as hoe, spade, manually operated hilling corn etc. is labor intensive and time consuming (Biswas et al., 2023). That's why we have designed the power operated hilling corn with double wheel hoe. It is a long-handled tools operated by power action. It can be operated by a single person. At the time of operation, the working depth of the tool and height of handle can be adjusted, and the wheel hoe is operated by repeated power action.

The additional work of corn hiller is to remove weeds from corn field by allowing the soil working components to penetrated into the soil and cut or uproot the weeds between the crops rows and also bury the weeds. It allows to weed between rows of corn plants, helping to reduce competition for nutrients and space. This can lead to healthier corn crops and increased yield (Milufarzana et al., 2024).

Weed infestation in Bangladesh soils is quite high, particularly during the rainy seasons when soil moisture is high and plant growth conditions are optimum. The higher competitive nature of weeds compared to crops is posing serious threat to corn yield. A farmer finds weed management as one of the tiresome works in agriculture. With a high cost of labor and more time needed, manual weeding is unfavorable (Binni et al., 2016). Using a double wheel hoe can be much faster than hand weeding, as it covers a larger area with each pass. This can save time and labor in the

Quick Response Code	Access this article online	
	Website: www.actamechanicamalaysia.com	DOI: 10.26480/amm.01.2026.01.06

Cite the Article: Mst. Arifa Sultana, Selina Banu, Kafi Rezwana Laaz, Milufarzana (2026). Modification and Performance Study of Power Operated Hilling Corn with Double Wheel Hoe. Acta Mechanica Malaysia, 9(1): 01-06.

field. Overall, a power operated double wheel hoe can be a valuable tool for corn cultivation, help to maintain weed control, improve crop health, and save time and effort. Absence of hilling corn with double wheel hoe increases the use of chemicals or herbicides to kill and remove weeds from the corn field as a result environmental degradation and pollution is caused. In light of the aforementioned issues, the study has established the following precise goals to provide clear guidance to modify and fabricate a power operated hilling corn with double wheel hoe and the determination of technical and economic performance of the machine.

2. Materials and Methods

2.1 Components of the previous and modified machine

The components of previous and modified machine is shown in Table 1 and Table 2 shows the schematic diagram of the both machines.

Table 1: List of components

Previous machine	Modified machine
Frame: The frame was made of steel. The length of the frame was 30 cm.	Frame: The frame was made of steel. The length of the frame was 30 cm.
Wheels: The wheels were made of mild steel. The diameter of the wheel was 40 cm. The width of the ring was 0.25 cm, which reduces the lateral thrust and the 8 x 0.19 cm flat spokes were used.	Wheels: The wheels were made of mild steel. The diameter of the wheel was 40 cm. The width of the ring was 0.25 cm, which reduces the lateral thrust and the 8 x 0.19 cm flat spokes were used.
Axle: An axle was made of metal and length of the axle was 26 cm.	Axle: An axle was made of metal and length of the axle was 26 cm.
Handle: The handle of a double wheel hoe was made of metal bar. The length of each handle was 115 cm.	Handle: The handle of a double wheel hoe was made of metal bar. The length of each handle was 115 cm.
Shaft: The length of each shaft was 27 cm.	Shaft: The length of each shaft was 27 cm.
Bearings: The ball bearing was fixed in the bushing provided at the two ends of the frame to support the shaft on which the wheels were attached.	Bearings: The ball bearing was fixed in the bushing provided at the two ends of the frame to support the shaft on which the wheels were attached.
Tynes: The height of the tyne was 16 cm. The distance between two tynes and the height of tyne from frame can be adjusted.	Tynes: The height of the tyne was 16 cm. The distance between two tynes and the height of tyne from frame can be adjusted.
-	Motor and Motor Controller: A 24 V DC Motor was used in modified model, and a motor controller was used to manage the power flow from the battery to the motor.
-	Battery: Two 12V rechargeable battery were used in this model. It supplies energy to the motor.
-	Switch: The Switch was attached between handles. It was turned on and off with a key.
-	Accelerator: Accelerator was attached to the handle and act as handle cover. It allows to control motor speed manually.
-	Chain and freewheel: Chain is a flexible connector that transmit power to the wheels. Freewheel is made of steel and has a long service life. Freewheel and chain work together to enable the wheel rotation.

Table 2: Schematic views of previous and modified machine

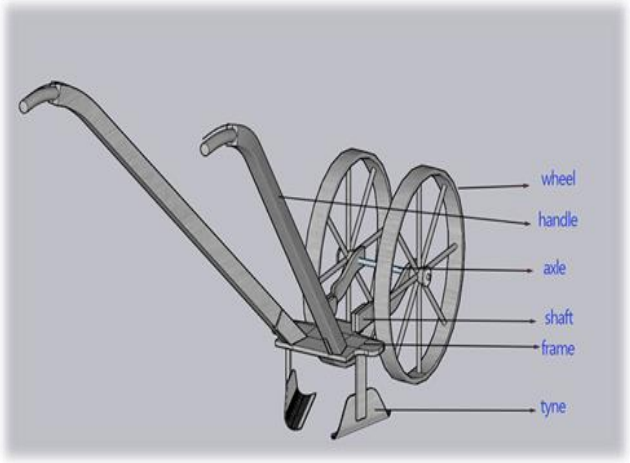
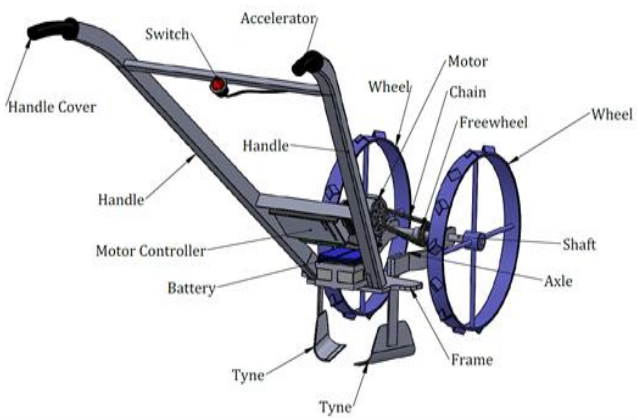
Previous machine	Modified machine
	

Figure 1 shows the Schematic diagram of the modified machine with dimensions (All dimensions are in cm).

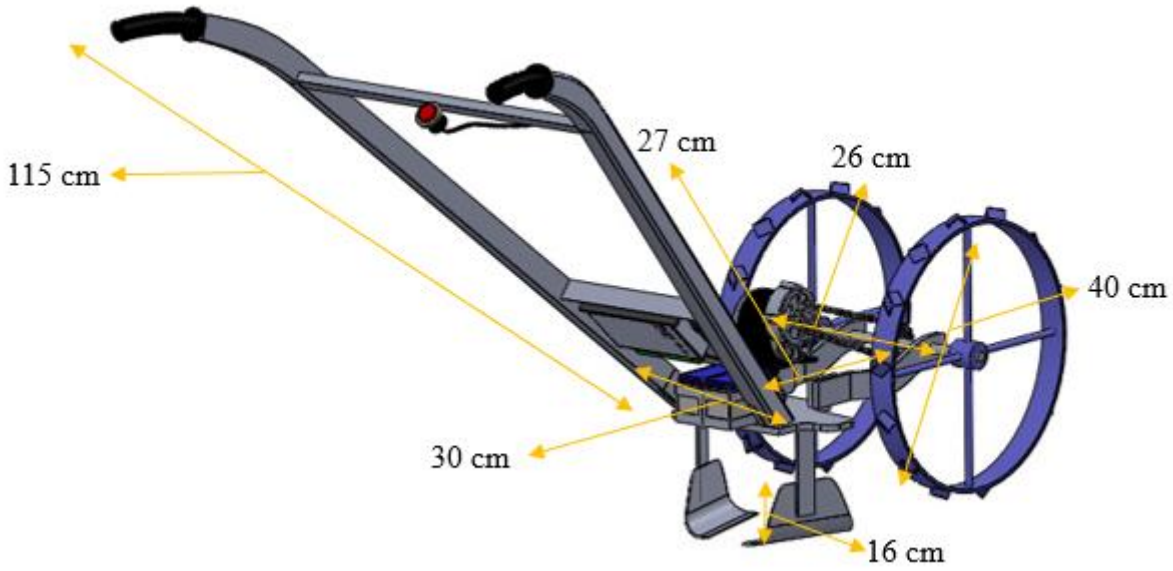


Figure 1: Schematic diagram of the modified model with dimensions

(All dimensions are in cm)

2.2 Construction of the modified machine

All the components of modified machine were joined by metal arc welding process. Two battery was mounted on frame. Battery was used to store energy. The motor was attached between the frame and shaft with the help of metal bar and motor plate. Switch was welded between two handle and accelerator was act as handle cover and control the motor speed. Switch, motor, accelerator and battery all components were connected to the motor controller that was attached behind the frame. Used bolts and nuts to secure them. The handles were comfortable to hold and at the right height for uses. It has to be regularly checked for wear and tear on the tyne and wheels. Lubricated the wheel axle to keep them rolling smoothly.

The purpose of the project was to fabricate a hilling corn with double wheel hoe for the corn field that was reduce the efforts in the hilling and weeding process of the farm. Locally available low-cost materials were used to fabricate the machine. The fabrication and the assembling of this machine did not require any special tools or any other skills.

2.3 Working principle of the modified machine

Corn plants were hilled using a double wheel hoe by following a systematic procedure. The operation was carried out when the plants reached approximately 15 cm in height and had developed several leaves. The operator walked at a slow and steady pace, guiding the machine along both sides of the plant rows. During this process, soil was heaped around the plants to about one-third of their height. The operation may be repeated after a few weeks to maintain adequate soil mounding at the base of the plants.

(a) Photographic view of the modified machine

(b) Front view (c) Top view (d) Side view

Figure 2 (a, b, c, d): Different views of the modified machine

2.4 Experimental site

The experiment was conducted beside the field of central farm, HSTU and behind BKSP, Kornai road, Dinajpur. The size of the experimental field was 16 m x 7 m.

2.5 Technical evaluation

2.5.1 Travelling speed

The working speed was calculated by using the following formula (1) (Rabbani et al., 2020).

$$S = \frac{d}{t} \quad (1)$$

Where **S** denotes the traveling speed (m/s), **d** represents the distance traveled (m), and **t** indicates the time taken (s).

2.5.2 Theoretical Field Capacity

According to Kepner et al., (1978), the following equation was used to determine the theoretical field capacity of the machine.

$$C_{th} = \frac{S \times W}{C} \quad (2)$$

Where C_{th} refers to the theoretical field capacity (ha/h), S denotes the forward speed, W represents the rated width (m), and C is a constant (10).

2.5.3 Effective field capacity

The effective field capacity is the actual average rate of field coverage by the machine, and it was determined by using the following formula (3).

$$C_{eff} = \frac{A}{T} \quad (3)$$

Where C_{eff} denotes the effective field capacity (ha/h), A represents the actual area covered (ha), and T indicates the total time required (h).

2.5.4 Field efficiency

Equation (4) was used to compute the field efficiency of the machine.

$$\text{Field efficiency} = \frac{Ceff}{Cth} \times 100\% \quad (4)$$

2.5.5 Turning Loss

Turning loss of the machine was calculated by using the following equation (5) (Milufarzana et al., 2021).

$$\text{Turning loss} = \frac{N \times t}{T} \times 100\% \quad (5)$$

Where N represents the total number of turns required to complete the operation, t denotes the time required for each turn (min), and T indicates the total time needed to complete the operation (min).

2.5.6 Weeding efficiency

The weeding efficiency was determined by using the following expression (6) (Remesan et al., 2007).

$$\eta_{eff} = \frac{W_1 - W_2}{W_1} \times 100\% \quad (6)$$

Where η_{eff} represents the weeding efficiency (%), W_1 defined as the ratio of the number of weeds counted in a unit area before operation, W_2 number of weeds counted in the same unit area after operation.

2.6 Cost analysis

A Simple cost analysis of the machine was done. The analysis included: the device's actual cost, and operating cost (fixed cost and variable cost). The fixed cost included: depreciation, interest on investment and TIS (Taxes, Insurance and Shelter). Variable cost included: repair and maintenance cost, labor cost etc. Interest 10%, repair and maintenance cost 0.0025%, 8 hrs. operation per day, 480 hrs. annual use and 5 yrs.. Using the following formulas, the cost was calculated:

The annual depreciation cost (Barnard and Nix, 1979).

$$D = \frac{P-S}{L} \quad (7)$$

Where **D** represents the annual depreciation (Tk/yr); **P** denotes the initial purchase price of the machine or implement (Tk); **S** refers to the salvage value at the end of its useful life (Tk); and **L** indicates the expected service life of the machine or implement (years).

Interest on investment was calculated by

$$I = \frac{P+S}{2} \times i \quad (8)$$

Where, i = Interest rate, percentage

The operating was computed by using the following formula.

$$\text{Operating costs in, Tk/ha= Fixed cost + Variable cost} \quad (9)$$

For determining operating cost (Tk/ha) of manual operation only the number of man-days and labor rates were considered.

3. Results and Discussion

3.1 Technical Performance

The travelling speed of the machine was found 1.75 km/hr. The theoretical field capacity was found 0.08 ha/hr and the effective field capacity was 0.067 ha/hr. The field efficiency of the machine was 83.75%. The turning loss was 15.34% and weeding efficiency was 61.58%. It seems too high due to the small experimental field. According to the study the field efficiency of the manually operated weeder was 80.42 % and field capacity of the machine was 0.0285 ha/hr (Bhavin et al., 2016). According to the study the field efficiency of power weeder was 56.25 %, field capacity was 0.15 ha/hr and weeding efficiency was found 93.72 % (Keshavalu et al., 2017).

Table 3: Technical performance of the machine

Particulars	Present Observations	Previous Observations
Travelling Speed (km/hr)	1.75	1.68
Theoretical field capacity (ha/hr)	0.08	0.077
Effective field capacity (ha/hr)	0.067	0.057
Field efficiency (%)	83.75	74.0
Turning loss (%)	15.34	25.7
Weeding Efficiency (%)	61.58	69.4

3.2 Fabrication cost of the machine

The total fabrication cost of the machine was 13,050 tk. It is inexpensive compared to other machines that are available in the market. The machine is motor power operated machine, so the fuel cost is zero. It is comfortable for everyone and can operate this machine efficiently and smoothly.

Table 4: Fabrication cost of the machine	
Material/ Instruments Name	**Cost (tk)**
Dc Motor set	5200
Battery	2100
Steel Sheet	3000
Iron	300
Wheels (2 Wheel)	600
Bearing	300
Nut bolts	100
Welding Edge	200
Making Charge	1250
	Total = 13,050

3.3 Operating cost of the machine

The fixed cost of the machine was 95.37 Tk ha^{-1} when the annual use of 480 hours. The total variable cost was 751.13 Tk ha^{-1} . The operating cost was 846.51 Tk ha^{-1} which is lower than the manual operation.

Table 5: Operating cost of the machine	
Item	**Amount**
Life of the Machine (Years)	5
Annual Use (Hours)	480
Fixed Cost Depreciation (Tk/yr) Interest on Investment (Tk/yr)	 2349 717.75
Total Fixed Cost Tk yr^{-1} Tk hr^{-1} Tk ha^{-1}	 3066.75 6.39 95.37
Variable Cost Labour (Tk hr^{-1}) Repair and Maintenance (Tk hr^{-1})	 50 0.326
Total Variable Cost Tk ha^{-1} Tk hr^{-1}	 751.13 50.326
Operating Cost Tk hr^{-1} Tk ha^{-1}	 56.716 846.51
Manual Operation (Tk ha^{-1})	10,800

3.4 Cost Comparison

The cost of operation of the machine was compared with manual operation in terms of field capacity. The result is shown in figure 3.

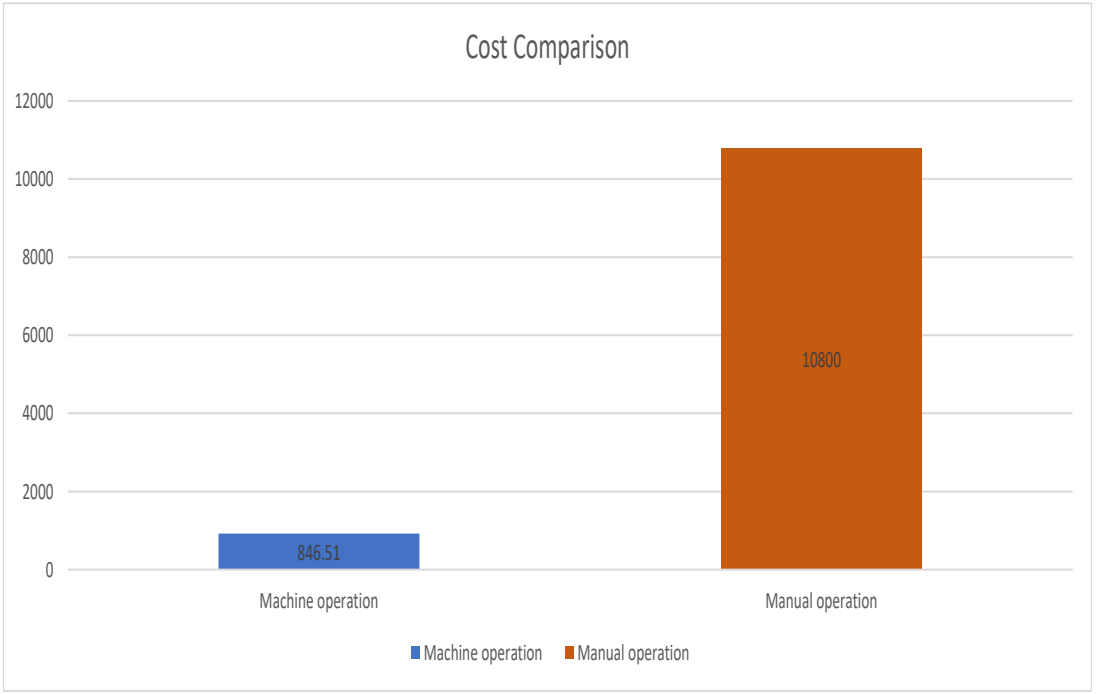


Figure 3: The cost of operation the machine in comparison with manual operation

Figure 3 indicates that double wheel hoe is the best in terms of cost of operation and it is more economical than manual operation. Therefore, the machine is the best suited for hilling and weeding operation in maize field.

4. Conclusions

A powered operated hilling corn with double wheel hoe was modified and evaluated. Based on the findings, the weight of the double wheel hoe was found 215 kg, and the field efficiency of the machine was 83.75%. The weeding efficiency and the operating cost of the machine were 61.58% and 846.57 Tk/ha respectively. It is simple in design and not required skilled person to handle the machine. This machine did not create any pollution because no fuel was used to operate it. Furthermore, it is a cheap machine that requires little upkeep while in use. In future this machine can be autonomous through the remote-control system. The shape and arrangement of tyne and frame can be changed.

Conflict of Interest

The authors declare no conflicts of interest.

References

Barnard, C.S., Nix, J.S., 1979. Farm Planning and Control, 2nd ed. Cambridge University Press, Cambridge, UK.

BBS, 2023. Yearbook of Agricultural statistics of Bangladesh, Bangladesh Bureau of statistics Ministry of Planning, Dhaka Bangladesh.

BBS, 2024. Yearbook of Agricultural statistics of Bangladesh, Bangladesh Bureau of statistics Ministry of Planning, Dhaka Bangladesh.

Bhavin, R., Khardiwar, M.S., Shailendra, K., Solanki, B.P., 2016. Performance evaluation of manual operated single row weeder for groundnut crop. Engineering and Technology in India, 7(1), Pp. 45-52.

Binni, I.M., Rabiu, A.L., Kabir, M.H., Jibril, A.N., 2016. A survey on performance evaluation of different types of weeders. Int. J. Appl. Eng. and Tech. 6 (3), Pp. 8-13.

Biswas, R., Molla, M.M.U., Faisal-E-Alam, M., Zonayet, M., Castanho, R.A., 2023. Profitability analysis and input use efficiency of maize cultivation in selected areas of Bangladesh. Land, 12(1), Pp. 23.

Food and Agriculture Organization of the United Nations (FAO), 2024. FAOSTAT statistical database: Crops and livestock products.

Hajong, P., Mondal, S., Islam, M. A., Ghosh, A., 2024. Economics of maize cultivation at selected intensive areas of Bangladesh. International Journal of Agricultural Research, Innovation and Technology, 13(2), Pp. 70–78.

Kepner, R.A., Bainer, R., Barger, E.L., 1978. Principles of Farm Machinery, 3rd ed. AVI Publishing Company, Westport, CT, USA.

Keshavalu, B., Prasan, P., Raghavendra, V., Shafat, K., 2017. Performance Evaluation of Wet Land Power Weeder for Paddy. Asian Journal of Agricultural Extension, Economics and Sociology, 18(3), Pp. 1-8.

Li, Y., Zhang, W., Bai, M., Wu, J., Zhu, C., Fu, Y., 2024. Impact of ridge tillage and mulching on water dynamics of summer maize fields under climate change in the semi-arid region of northwestern Liaoning, China. Agronomy, 14 (12), Pp. 3032.

Milufarzana, Banu, S., Sakib, M.N., Aktar, A., and Sultana, M.A., 2024. Development and Performance Evaluation of Push Type Manually Operated Hilling Corn with Double Wheel Hoe. Brilliant Engineering, 3, Pp. 4951.

Milufarzana., Jim, G.S., Banu, S., Hasan, M.R., Rahman, A., 2021 Development and evaluation of solar powered manually operated sprayer cum grasscutter. Fundamental and Applied Agriculture, 6(1), Pp. 35–42.

Rabbani, M.A., Basir, M.S., Rifat, S., Mona, N., 2020. Modification of boom for a lever operated knapsack sprayer. Journal of Science, Technology and Environment Informatics, 8(2), Pp. 595-605.

Remesan, R., Roopesh, M. S., Remya, N., Preman, P. S., 2007. Wet land weeding- A comprehensive comparative study from south India. The CIGR E-journal, 9, Pp. 1-21.