Development of an improved twin wheel weeder

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ABSTRACT
The existing twin wheel weeder was designed to minimize the high drudgery, time and high labor force required for the weeding. Modification of weeder was done to operate with adjustable height/length of rod, and to facilitates assembling and disassembling in less time to move very easily from one place to another. The modified weeder is tested on the field for weeding efficiency, field efficiency, soil mass manipulation, plant injury and compared with the existing twin wheel weeder. The moisture content of the testing field was found 19.3 % (w.b). Soil mass manipulation was found better in modified twin wheel weeder 3276 cm$^3$ than the existing one (2700 cm$^3$). It was 90.9% for modified weeder where as 86.67 % for the existing twin wheel weeder. It was 7.01% and 9.25% for modified twin wheel weeder and existing twin wheel weeder respectively. Field efficiency found 88.33 % and 85.29 % respectively for modified and existing twin wheel weeder. The modified twin wheel weeder was found easy to transport from one place to another due to adjustable accessories.

Key words: Field efficiency, Soil mass manipulation, Weeds, Weeder.

INTRODUCTION
Weeds: Weeds are unwanted, useless, prolific, and competitive adaptable to all adverse environments plant that grows in cultivated field competing with the crop for plant nutrients. Weeds are often called as plants out of place. They grow in the field and they compete with crops for water, soil nutrients, light and space and thus reduce crop yields. The weeds may account up to 50-70 per cent reduction in yield of crop and inadequate weeds control is one of the major causes of poor yield on small farms (Kouwenoven and Terparastra, 1981).

Weed Control: The weed should be controlled and eliminated at their early stage. Timely weeding is very much essential for a good yield and this can only be achieved by using mechanical hoes which can reduce the time spent on weeding (man-hours), cost of weeding and drudgery involved in manual weeding.

Weeder: A mechanical device or tools used to remove the weeds from the fields having crop. It may be manual, animal-drawn and tractor mounted or power operated. (Gite and Yadav, 1990; Gite and Yadav, 1985). Various types of cutting blades are used for manually operated weeders. V-shaped sweep is preferred where weeders are continuously pushed and tool geometry of these cutting blades is based on soil-tool-plant interaction (Bernacki et al., 1972).

Statement of Problems
➢ Weeding with the use of tools like cutlass and hoe requires high labour force in a commercial farming system hence modification weeder is necessary to reduce the labour force.
➢ Environmental degradation and pollution caused by chemical is reduced by the use of modification weeders.
➢ Low effective operation at capacity, high work effort and high time requirement for different types of hoe or cutlass can be overcome with the use of modification weeder.

Justification
Presently in India, weeding with simple tools such as cutlass, hoe etc is labour intensive and intensive and time consuming. Thus, there is a need for the improved design of manually operated weeder for intensive and commercial farming system in India. One of the problems in crops and vegetables production is poor weed control; hence there is need of good performance manual weeder to increase the production of these products. The cost for employing a labour force when using simple tools is very high in commercial farming system. This can be reduced using an improved manually weeder.

MATERIALS AND METHODS
Description of study area: The field experiment was supposed to conduct at a farmer’s field at Dholakuva, Godhra. This site is situated at 6 km far from Godhra; headquarter of Panchmahal district which is situated at 22° 45’ north latitude and 73° 40’ east longitude with elevation of 119.4 m mean sea levels. The experimentation site lies in the semi-arid region located in middle Gujarat. The area has sub-humid type of weather condition with winters, summers and rainy season with annual rainfall of about 907 mm.

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Modification of twin wheel weeder from existing twin wheel weeder

The force required to uproot some weeds determined by using rope was by pulling through twin wheel weeder and the weed removal per unit area was recorded. The machine was designed based on the principle of weed stem failure due to shear, and soil or root failure due to impact and abrasion. The machine design calculations was carried by principle of mechanics to determine the force requirement by the frame and the blade, bending moment, tensional requirement to determine the machine shaft size and other component parts. The component parts and assembly drawing of the machine was carried out. Fabrication which include metal cutting, bending, shaping and welding was carried out at the workshop. The machine was tested at average human being speed on different types of twin wheel weeder and various size of the modification twin wheel weeder.

Design analysis

The only design done on this machine was shaft design of the wheel. The design was base on shaft diameter which its tensional strength was considered by calculating the drive torque of rotating shaft which was subjected to both twisting and bending shown in (Fig 3). The modification made in new design is to eliminate the shaft by replacing two numbers of pieces of G.I. pipes. Similarly center of the connecting rod is made adjustable by the use of G.I pipe components (like pipe, t-joint, nipple, coupling etc.).

Testing of twin wheel weeder in field condition

After modification of the twin wheel weeder, it was tested in field condition along with the existing twin wheel weeder and following parameters were studied and Soil moisture content, Soil mass manipulation, Field capacity, Weeding efficiency, Plant injury were determined.

Soil moisture content

Soil moisture content was measured by TDR meter.

Soil mass manipulation

Soil disturbed by twin wheel weeder is called soil mass manipulation. The entire soil disturbed is removed from the furrow and mass of soil manipulated is calculated.

\[
\text{SMM} = W \times d \times 100
\]

Where,

- \(\text{SMM} = \) Soil mass manipulated, cm³,
- \(W = \) Width of operation, cm,
- \(d = \) Depth of operation, cm
Field efficiency: -
Field efficiency was calculated from following formula.
\[ e = \frac{\text{EFC} \times \text{TFC}}{100} \]
Where,
EFC = Effective Field Capacity,
TFC = Theoretical Field Capacity

Weeding Efficiency: -
The weeding efficiency was calculated from following formula.
\[ \text{WE} = \frac{W_1 - W_2 \times 100}{W_1} \]
Where,
WE = Weeding efficiency,
W_1 = Numbers of weeds present before weeding,
W_2 = Numbers of weeds present after weeding

Plant injury: -
Plant injury was calculated from following formula.
\[ \text{Percentage of plant injury(%) } = \frac{q \times 100}{p} \]
Where,
q = no. of plant in 10 m row length after weeding,
p = no. of plant in 10 m row length before weeding

RESULTS AND DISCUSSION

The twin wheel weeder was modified in the workshop and field operations were conducted to find out its performance along with the existing one and at least five observations were recorded. The average data was used to analyze the performance of the twin wheel weeder.

Design analysis
The design of frame of Modified Twin Wheel Weeder can bear the load of 6 kg, 8 kg and 10 kg based on pushing ergonomic study (behera et al., 2007).

Case 1 Study for shaft design
W=6 kg, W=R_A+R_B
Now taking moment at A from (Fig 3).
\[ M_A = W \times R_A - Y \times R_B \]
\[ = 6 \times 14 - 28 \times R_B \]
\[ R_B = \frac{84}{28} \]
\[ R_B = 3 \text{ kg} \]

Case 2 Study for shaft design
W=8 kg, W=R_A+R_B
Now taking moment at A from (Fig 3).
\[ M_A = W \times D_1 + W \times D_2 \]
\[ = 8 \times 14 + 3 \times 14 \]
\[ R_B = \frac{42+42}{84} \]
\[ R_B = 4 \text{ kg} \]

Case 3 Study for shaft design
W=10 kg, W=R_A+R_B
Now taking moment at A from (Fig 3).
\[ M_A = W \times D_1 + W \times D_2 \]
\[ = 10 \times 14 + 4 \times 14 \]
\[ R_B = \frac{56+56}{112} \]
\[ R_B = 4 \text{ kg} \]
Now taking moment at A from (Fig 3).
\[ M_A = 0 = W \times R_A - Y \times R_B \]
\[ = 10 \times 14 - 28 \times R_B \]
\[ R_B = 140/28 \]
\[ R_B = 5 \text{ kg} \]

Where,
\[ W = R_A + R_B \]
\[ 10 = R_A + 5 \]
\[ R_A = 5 \text{ kg} \]

For bending moment
Suppose bending moment is assume at point X
Distance of A from the X is \( D_1 = D_2 = 14 \text{ cm} \)
So taking bending moment at point X
\[ M_A = 0 = W \times D_1 + W \times D_2 \]
\[ = 5 \times 14 + 5 \times 14 \]
\[ R_B = 70 + 70 \]
\[ R_B = 140 \text{ kg} \]

Soil moisture content: The moisture content of soil strata was ranged between 11.2 and 16.4. The average moisture content of the soil strata was 14.3 % on wet basis show in (Table 3).

**Table 3: Depth of weeding (cm)**

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Twin wheel weeder</th>
<th>Existing</th>
<th>Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>1.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Average(cm)</td>
<td></td>
<td>1.5</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Soil mass manipulation: The average Soil mass manipulation was calculated as 2700 cc in 20 m run in existing weeder and 3276 cc in modified twin wheel weeder shown in (Table 4) and (Fig 4).

Field efficiency: The theoretical and effective field capacities were calculated as shown in the (Table 4) and (Fig 5). The effective time required per hectare is sum of the productive and unproductive time

Weeding Efficiency: Weeding efficiency of the twin wheel weeder was calculated using the number of weeds present in the field, pre and post twin wheel weeder operations. The weeding efficiency of the modified twin wheel weeder was 90.9 % which is better than the existing one 86.76 %.

**Table 4: Soil mass manipulation**

<table>
<thead>
<tr>
<th>Twin wheel weeder</th>
<th>Average Width(cm)</th>
<th>Length of run in one metre(cm)</th>
<th>Average Depth(cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>18</td>
<td>100</td>
<td>1.5</td>
</tr>
<tr>
<td>Modified</td>
<td>21</td>
<td>100</td>
<td>1.56</td>
</tr>
</tbody>
</table>

**Table 5: Field efficiency**

<table>
<thead>
<tr>
<th>Twin wheel weeder</th>
<th>Width(m)</th>
<th>Speed(m/s)</th>
<th>TFC=Sw/10(ha/hr)</th>
<th>EFC=w×l×t×10(ha/hr)</th>
<th>Field efficiency=(EFC\times100/TFC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>0.18</td>
<td>0.68</td>
<td>0.04406</td>
<td>0.03758</td>
<td>85.2927%</td>
</tr>
<tr>
<td>Modified</td>
<td>0.21</td>
<td>0.60</td>
<td>0.04536</td>
<td>0.040068</td>
<td>88.3333%</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Modifications by design Analysis in existing Twin Wheel Weeder were done at workshop of Farm Machinery and Power Engineering Department of College of Agricultural Engineering and Technology, Godhra and a new
Modified Twin Wheel Weeder was constructed. Modified Twin Wheel Weeder was tested in field condition. The field experiment was conducted at farmer’s field at Dholakuva, Godhra. This site is situated at 6 km far from Godhra; headquarter of Panchmahal district located at 22° 45’ north latitude and 73° 40’ east longitude with elevation of 119.4 m mean sea levels. Parameters like, Soil moisture content, Soil mass manipulation, field Capacity, Weeding Efficiency, Plant Injury were observed. The considerable amount of reviews for different weeders was referred for weeding. It was found from the reviews that the Twin Wheel Weeder gives the best performance to control weeds.

CONCLUSION

Following conclusions could be drawn from the present experiment based on the results obtained:

- Modified Twin Wheel weeder gave better performance than existing Twin Wheel weeder.
- Soil mass manipulation was found better in Modified Twin Wheel Weeder (3276 cm³) than Existing Twin Wheel Weeder (2700 cm³).
- The weeding efficiency of the modified twin wheel weeder (90.9%) was found higher than the existing one (86.67%).
- The plant injury was found less with modified twin wheel weeder (7.01%) than the existing twin wheel weeder (9.25%).
- The Modified Twin Wheel weeder was found easy to transport from one place to another place due to adjustable accessories.

REFERENCES


