International Journal for Modern Trends in Science and Technology
Volume: 03, Issue No: 07, July 2017
ISSN: 2455-3778
http://www.ijmtst.com

Manually Operated Dry Land Weeder: A Study

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To Cite this Article
P.Konda Babu and S.Govinda Rao, "Manually Operated Dry Land Weeder: A Study", *International Journal for Modern Trends in Science and Technology*, Vol. 03, Issue 07, July 2017, pp. 27-33.

ABSTRACT

Weed management is one of the tedious operations in crop production. Due to labor costs, time and fully manual weeding is unfavorable. Hence effort is made to design an efficient farm equipment to perform weeding without electric power. The conception and key characteristics of simulation based design and the advantage of using it to design the driving mechanism of three row weeding equipment were discussed.

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 observed. Rice and groundnut are sensitive to weed. Competition in the early stage of growth and failure to control weeds in the first three weeks after seeding, reduce the yield by 50 per cent. Manual weeding requires huge labor force and accounts for about 25 per cent of the total labor requirement which is usually 900 to 1200 man h/ha.

Functional efficiency the weeder is 87% and, Theoretical field capacity 0.0375ha/hr, Effective field capacity 0.03ha/hr, Field efficiency 81% Soil inversion 87% One man can weed 1 acre area in 42days. One man can weed one acre area in 25 days with manual weeder.

Keywords: *Weeding, Tynes, hand pulling, soil inversion, field capacity.*

I. INTRODUCTION

Weed management is one of the tedious operations in crop production. Due to labor costs, time and fully manual weeding is unfavorable. The conception and key characteristics of simulation based design and the advantage of using it to design the driving mechanism of three row weeding equipment were discussed. The word weed is commonly applied to unwanted plant seed human controlled settlings, such as farm fields, gardens, lawns and parks. Weed are an important factor in the management of all lands and water resources, but it affects is greatest on agriculture. The losses caused by weeds exceed the losses caused by the any other category agriculture pests. An important one is that they interfere with food and fiber production in agriculture, where in they must be controlled in order to prevent lost or diminished crop yield.

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 observed. Rice and groundnut are very sensitive to weed. Competition in the early stage of growth and failure to control weeds in the first three weeks after seeding, reduce the yield by 50 per cent.

In traditional method of rice cultivation, weeds are mostly removed from the field with manual process as they are seen more as a negative factor for crop growth. But in SRI (System of Rice Intensification), weeds are seen as growth

promoters when they are appropriately managed. As the weeds are more in SRI due to intermittent wetting, it is important to manage the weeds regularly. Animal power plays an important role in mechanical methods of weed control in India. Traditional animal drawn hoes made by village artisans from locally available material are used widely by farmers.

Weed classification according to weeding methods.

Weeds are being classified into three types which are:

1) Shallow rooted weeds
2) Deep rooted weeds
3) Rhyzomaters weeds

Weeding is the one of the critical stages in rice cultivation and affects yield and quality of rice .weeds decrease crop yields from 15 to 50 % depending on species, density and weeding time through competition with main crop for light, water and nutrition. One third of cost of cultivation is spent on weeding alone when carried out with manual labor. The arduous operation of weeding is usually performed manually with the use of traditional hand tools in upright bending posture, inducing back pain for majority of labors. Losses caused by weeding cotton ranges from40 to 75 % depending upon nature and intensity of weeds. Weed control is becoming an expensive operation in crop production.

In India farmers mainly follow the hand weeding though mechanical weeding is slowly becoming popular, in spite of it being costly. Use of herbicides will have residual affect and change in quality of soil an estimate of 400 to 600 man hour's requirement of hand weeding which amount to Rs.2200 per hectare, which also depends upon weed infestation. Hand weeding is overwhelming and hurts workers who are mostly women. Depending on weed density and species in the field, labor requirement for weeding varied to between 10 to 15 persons per hectare in paddy fields. Availability of labor is also scarce.

Moreover, the labour requirement for weeding depends on weed flora, weed intensity, time of weeding, and soil moisture at the time of weeding and efficiency of worker. Often several weeding operation are necessary to keep the crop weed free. Reduction in yield due to weed alone was estimated to be 16 to 42 % depending on crop and location which involves one third of the cost of cultivation.

Mechanical weed control methods include and pulling, hoeing and mowing. Majority of Indian farmers use and hand-hoe for weeding which requires 40 to 60 labors for weeding one hectare of land. For mechanical weeding, the easily available source is human source.

The field performance trials of different weeding methods namely hand weeding and manual weeding using weeder are compared with the following objectives given below:

Objectives:

- To design manually operated weeder.
- To test the developed proto type machine in the dry land area.
- To study the comparison of developed machine with hand weeding method.

DESIGN OF WEEDERS:

The different types of weeders were designed and developed in "System of Rice Intensification" are given below

1. CONO WEEDER:

It has two rotating cone shaped drums, with width adjustability, weighs nearly 7.5 kg. It has better soil working efficiency and operational simplicity. It is not suitable for black and loamy soils. The axle hole gets widened upon continuous use.

2. MANDAVA – single row weeder:

The float from the Cono-weeder, rod and handle from Kollur weeder, the wheel from the Star Weeder and the mechanism to remove soil from the drum-plates in the Raichur weeder were integrated and adapted in designing a new weeder, which is now popularly known as Mandava Weeder.

3. STAR WEEDER

It is a cylindrical drum with worker friendly handle. And it is low-cost, light-weight design. No provision for width adjustment

4. KOLLUR WEEDER:

It consists of Swastika-like arms fixed to an axle with a worker friendly handle. Simple design and fabrication, Low weight, Soil working depth is much deeper. It has a tendency to dig deeper into the soil than required thus becoming unworkable.

II. Materials and Methods

To complete the following work various materials and equipments were used to fulfill the objectives. The work has undergone in vishaka polytechnic of agricultural engineering.

MATERIALS:

The material used is galvanized iron pipes, mild steel, and high carbon steel.

Galvanized iron pipes:

The galvanized pipes are used to construct handle and handle frame. The pipes are cheap, light in weight, easy to handle & easy to join.. These pipes are manufactured conforming to IS-1239 (pt-I)1990.

Mild steel:

Mild steel is used to construct base frame, ground wheel and supporting bars. It has good welded ability. Mild steel bars are used at lightly stressed components bolts, nuts and shafts. It can be case-hardened to improve wear resistance which contains carbon content in mild steel is 0.16%-0.18%.

High carbon steel:

High carbon steel used to construct tynes. It contains over 0.8% carbon but less than 2.11% carbon in its composition. The material itself hard to use in form of tynes.

Base frame:

The base frame used to support the tynes. The tynes are attached to the frame by welding process**.** The rectangular base frame consists of 25× 12 cm size which joins the tynes with help of welding.

Fig-1.Base frame

Ground wheel:

The ground wheel was fitted at the front frame bracket of the machine to achieve economic weeding operation with reduced effort. A 44 cm diameter wheel is used because height of tynes is 18 cm for perpendicular transmission of human power. It is made of mild steel.

Fig -2.Ground wheel

Weeder tynes:

The tynes are made of high carbon steel. Five blades with 25 mm long and 8 mm thickness are used. Two tynes are mounted at front plate of frame. Three tynes are mounted at rear plate of frame. Tyne to Tyne distance at front side is 11cm .blade to blade distance at rear side is 10.5 cm.

Handle:

Handle is made of galvanized iron pipes with two individual rods for height adjustments. First rod is from wheel hub with 1.15 m long ,5 mm diameter and second rod is 40 cm long and 6mm diameter and a 5 mm bend is given from last 20 cm of second rod which is inserted into the first rod with different height levels**.**

Fig -3.Handle

Leveling blade: It is 25 cm long blade made of mild steel is placed rear side of weeding frame. It is used to level the soil after uproot the weeds.

Fig - 4. Leveling blade.

Forging Rake : It is replaceable part, with 20 cm long and no of fingers are present. It is used to collect the weeds after weeding simultaneously.

Fig -5.Forging rake

III. PROCEDURES

Cutting: Cutting is the process concerned with cutting of the required length for subsequent machining operations.

- The circular saw is used in this paper for cutting operations.
- The work is clamped in position and rotating cutter is fed through the work piece.
- The circular saw provides continuous cutting action and the cut made is very smooth and

accurate. It is used to cut work pieces very rapidly from bar stock for further machining.

Drilling: Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials.

- Drills are cutting tools used for making holes on work pieces.
- Drill is specified by the diameter (mm). An 8 mm drill bit is used.
- In drilling, hole position is commonly marked with center punch and the work is clamped in position on machine vice and a drill is fed into the work piece to make a hole. A sensitive drilling machine is used in this paper.

Grinding : Grinding is machining process in which material is removed by bringing the work piece into contact with a rotating grinding wheel (abrasive wheel).

- The grinder is used for shaping and sharpening the tools.
- The grinding machine consists of a bed with a fixture to guide and hold the work piece, and a power-driven grinding wheel spinning at the required speed.
- The grinding head can travel across a fixed work piece, or the work piece can be moved while the grind head stays in a fixed position.
- Grinding machines remove material from the work piece by abrasion.

Welding : Welding is the process of joining two pieces of metal.

- Arc welding is used in this paper.
- Metal joining process in which the ends of pieces to be joined are heated at their interface with a continuous arc to produce coalescence, with or without the use of a filler metal from a melting electrode is called arc welding.
- They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes.
- The electrode is a non-filler metal electrode used in arc welding or cutting, consisting of a carbon graphite rod which may or may not be coated with copper for other coatings.

Bending : Bending is a process in which a work piece is bend to specified shape.

- In bending, the stress applied should be greater than elastic limit to achieve plastic deformation.
- It is advisable to avoid sharp corners in bends.
- A bending machine is a forming machine tool. Its purpose is to assemble a bend on a work piece.
- A bends is manufactured by using a bending tool during a linear or rotating move.

Forging : Forging is defined as the shaping of a heated metal by hammering and pressing.

- The Forging process is usually carried at above re crystallization temperature. It is regarded as hot working.
- The desired shape is obtained by controlled hand hammering by blacksmith.
- The shape and accuracy obtained will depend largely upon his skills and experience.

Design calculations:

Ground wheel:

Diameter of ground wheel = 44 cm
Radius of ground wheel = 22 cm
Circumference of ground wheel = $2\pi r$ = $2\times3.14\times22$ = 138.16 cm
Thickness of ground wheel spokes = 3 mm
Distance between two spokes = 4.7 cm
Thickness ground wheel = 3 mm
Width of ground wheel = 3.2 cm

Diameter of ground wheel 44 cm used due to the of height of tyne is 18 cm, then the power transmits from wheel to tynes perpendicularly then it moves freely on field conditions. The width and thickness of ground wheel are 3.2 cm&3 mm respectively because it gives rigidity. A 3mm spokes gives efficient support to the ground wheel.

Main frame:

Length of the supporting bars = 69 cm
Thickness = 6 mm
Width = 2.5 cm
Gap between two successive holes on individual supporting bars = 5.3cm
Diameter of hole = 8 mm
Distance between two supporting bars = 20 cm

A 69 cm long supporting bars are taken because all parts of weeders are attached to this bars. The thickness of supporting bar is 6mm is taken, it gives rigidity.

Base frame:

Length of the frame = 12 cm
Width of the frame = 25 cm
Thickness of the frame = 10 mm
Length of the center supporting bar = 23 cm
Width of center supporting ba r = 2.5 cm
Thickness of center supporting bar = 6 mm

Distance from side to holes on center supporting bar = 6.4 cm
Distance between holes on center supporting bar = 4 cm
Diameter of hole on center supporting bar = 8 mm
The length and width of frame are 12 cm×25 cm is taken according to the row spacing of crops and power developed by man. The above dimensions of center supporting bar are taken to give support to the frame and easy to attach the main supporting bars.

Tynes:

Length of Tyne = 18cm
Width and thickness of Tyne = 8 mm

A length of 18cm tyne was taken to achieve proper depth for up root the weeds. The width and thickness of tynes are taken as 8 mm because it helps to give strength for tynes.

Arrangement of tynes:

Two tynes are attached at front with spacing of 11cm between them and spacing between side to tynes are 7cm, another three tynes are attached at rear side with spacing of 10.5 cm between them and spacing between side to tynes are 2 cm are taken for efficient soil inversion in field condition.

Handle:

Two different diameters of GI pipes are taken to construct handle.

Inner pipe:

Numbe r of pipes taken = 2
Length of the pipe = 1.15 m
Inner diameter of the pipe = 2.3 cm
Outer diameter of the pipe = 2.5 cm
Thickness of the pipe = 0.2 cm
Spacing between two pipes = 13.5 cm
Spacing between two holes at upper side = 3cm
Number of holes on upper side of the pipes = 7
Spacing between holes at bottom sid e = 4 cm
Number holes on bottom side of the pipes = 4
Diameter of the hole = 8 mm
Length of supporting bar between two pipes = 10.5 cm

Outer pipe:

Number of pipes taken = 2
Length of the pipe = 30.6 cm
Inner diameter of the pipe = 2.8 cm
Outer diameter of the pipe = 2.5 cm
Thickness of the pipe = 0.3 cm
Number holes on each pipe = 4
Diameter of the hole = 8 mm
Spacing between holes = 3.4 cm

Handle pipe:

Total length of pipe = 75 cm
Outer diameter of pipe = 2.5 cm
Inner diameter of pipe = 2.3 cm
Thickness of pipe = 0.2 cm
Length of the handle grip = 10.5 cm
Bending length = 5cm

The 2.5cm diameter of inner pipes is taken because it is easily inserted in to the 2.8 cm outer diameter of pipes. A rod of 10.5 cm length is taken for supporting the two inner pipes. The 8mm holes are given at bottom side of the inner pipe for adjusting inclination of the handle. Similarly 8mm holes are given by upper side of the inner pipe for different height adjustments. The holes given for outer pipe holes are contact with inner pipe upper side holes. The 2.5 cm diameter handle pipe is provided for better handle grip.

Vertical supporting stands:

Length of the stand = 48 cm
Thickness of the stand = 6 mm
Width of the stand = 2.5 cm
Number of holes = 04
Spacing between holes = 5.5 cm
Diameter of the holes = 8 mm
Spacing between two stands at top side = 10.2 cm
Spacing between two stands at bottom side = 11.5 cm

The above dimensions are taken for vertical supporting stands because it is placed for supporting the inner pipe of the handle and also for adjusting inclination of the handle.

Leveling blade:

Length of the leveling blade = 25 cm
Width of leveling blade = 2.5 cm
Thickness of blade = 6 mm
Length of hitching bar = 20 cm
Width of hitching bar = 2.5 cm
Thickness of hitching bar = 6 mm
Length of c section bars = 21 cm
Thickness of c section bars = 9 mm
Spacing between two c section bars =9 cm

The length of leveling blade 25cm is taken according to the width of the frame. A 20 cm length of hitching bar with two holes is used to attach to rear side of the base frame. The leveling blade is grinded at bottom side for cutting weeds remained after uprooting the weeds done by tynes. The C-section bars are used to attach hitching bar and leveling blade by welding process and it provides support and rigidity to the leveling blade.

Forging rake:

Width of forging blade = 20 cm

L-section length = 6 cm
Thickness of L section = 6 mm
No of fingers = 11
Length of fingers = 18 cm
Thickness of fingers = 5 mm
Spacing between fingers = 7 mm
Number of holes presented on L section = 2

A 6 cm length of L-section is taken because it is easy for hitching& welding purpose. Here 11 number of fingers are taken according to the width of the frame and effective collecting of weeds. Using the above measurements we can assemble the following manually operated weeder.

Fig - 6.Complete assembly of weeder

IV. RESULTS

Using manual weeder following parameters are calculated.

Width of cut = 25cm
Depth of cut = 5cm

S.No	Particulars	1st replication	2nd replication	3rd replication
1.	No. of weeds removed	45	51	57
2.	Time taken for weeding	3 min	3 min 20 sec	3min 50 sec

Average number of weeds removed = 51

Average time taken for weeding = 3 min 3 sec

$$\text{Number weeds removed per hectare} = \frac{51\times10000}{1}$$

= 510000plants.

Functional efficiency

$$= \frac{\text{Number of weeds removed by weeder}}{\text{Actual number of weeds removed manually}} \times 100$$

$$= \frac{51 \times 100}{58}$$

= 87%.

Soil inversion:

S.No	Particulars	1st replication	2nd replication	3rd replication
1.	No. of weeds before weeding	75	80	60
2.	No weeds after weeding	65	68	55

Average weeds before weeding= 75

Average weeds after weeding = 62.6

Soil inversion =

$$\frac{\text{(Number of weeds before weeding) - (Number of weeds after weeding) X100}}{\text{Number of weeds before weeding}}$$

$$\text{soil inversion} = \frac{75-62.6 \times 100}{75}$$

$$\text{Theoretical field capacity} = \frac{\text{width (m) x Speed (m/hr)}}{10000}$$

A man can operate the weeder 1.5 kmph speed.

$$= \frac{0.25X1500}{10000} = 0.0375 \text{ ha/hr}$$

Effective field capacity is the actual area covered by the implement based on its total time consumed and its width.

Effective field capacity

$$= \frac{\text{width (m) X speed (m/hr) X } \eta}{10000}$$

$$= \frac{0.25X1500X\ 0.80}{1000}$$

= 0.03 ha/hr

$$\text{Field efficiency} = \frac{\text{effective field capacity X100}}{\text{Theoretical field capacity}}$$

$$= \frac{0.03\ X100}{0.0375}$$

= 81%

Discussions:

Finally, by using weeder time consumption is less as compared to hand weeding. Because of 1 square meter area required about 3 minutes for

removing weeds by using weeder, as well as hand weeding requires about 5minutes. There is no need to require skilled labor to operate the weeder and it is easy to maintain.

Operation and Maintenance:

OPERATION

The operation of the machine is manually operated by a human being and the cutting

Was done with help of primary cutting edge and secondary cutting edge. The primary cutting

edge in front loose the soil and lifted the weeds and blade behind did the cutting.

MAINTENANCE

These are the proper maintenance of the machine:

1) Keep in cool and dry place.

2) Lubricate the machine implements when not use.

3) Clean all the part after used.

4) Re-paint the machine when need and dismantle the machine when not use for long period of time.

6) Do put anything on the machine.

V. Conclusion

In conclusion, it was found during observations after the design, construction and testing of this particular manually operated weeder that the overall benefits accruing and associated with the use of the equipment includes.

- It was faster than the traditional method of controlling weed
- High efficiency
- Different soils have different efficiency with sandy soil having the highest
- It cannot work where there was stone or any obstacle.

The Physical and operational characteristics are as follows:

Safety: It provides safety to users,

Life in service: The product will last approximately long duration,

Ergonomics: Easy to operate by everyone, of all physique conveniently,

Weight: The product must less in weight

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