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Modification, Fabrication and Performance Evaluation of Manual Weeder

Er. Rakesh Kumar Mishra[1], Er. Bhavna Singh[2]

[1]PhD Scholar Department of Agricultural Economics SHUATS Prayagraj Email
[2]Guest Faculty College of Agriculture ANDUAT Kumarganj Ayodhya Email

Abstract
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 percent if adequate crop management practice is not observed. The present study was conducted in Prayagraj district of Uttar Pradesh, The manual weeder was fabricated by using locally available material. The developed weeder is capable of reducing time wastage, labor requirement and power consumption. The performance evaluated in terms of weeding efficiency and capacity of weeder. The minimum losses, maximum efficiency and highest quality are achieved by the developed weeder. The average efficiency of weeder was observed for single point type shovel and duck type shovel as 88.51% and 85.043% respectively. The average capacity of weeder was observed for single point type shovel and duck type shovel as 0.0512 ha/day and 0.0492 ha/day respectively

Keywords: Weeder, Efficiency, Fabrication.

Introduction

The population growth rate is much faster than the growth rate in food grain production in the country. About 45% of the Indian farmers have small land holdings and are much below living standard. It is very difficult for them to have costly agricultural machinery and equipment.
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 percent if adequate crop management practice is not observed.
Manual and mechanical techniques such as pulling, cutting and otherwise damaging plants, may be used to control some invasive plants, particularly if the population is relatively small. These techniques can be extremely specific, minimizing damage to desirable plants and animals, but they are generally labor and time intensive. Treatments must typically be administered several times to prevent the weed from re-establishing, and in the process, laborers and machines may severely trample vegetation and disturb soil, providing prime conditions for re-invasion by the same or other invasive species. It is necessary to design the weeder which minimize the human effort and provide efficient work output.
Accordingly, the present invention is directed to an improved manual tilling, mulching and weeding tool since weeds can be killed easily when they are at early stages of growth. This practice can also reduce labor and cost substantially Small holder farmers need low cost implements which can be purchased or made locally. Therefore the objective of this project was to develop a small hand weeder to be used for getting rid of young weeds growing between crop rows and this implement must be relatively cheap and

could be made locally. Before the existence of chemical weed control, mechanical weed control was the best option to solve issues related to manual weeding.

In mechanized agriculture, there were times where weeding tools were pulled by draft animals such as buffaloes and horses, which now in the developed world have generally been replaced by tractors. There are various types of mechanical weeding implements in the market that use three main techniques burying weeds, cutting weeds and uprooting weeds. The burial of weeds through the action of tillage tools, and is usually done during land preparation.

The earliest and the simplest weed control method is manual weed control this method was accomplished by a person bending down and using their hands to pull weeds out of the soil. This method then advanced to hand tools, from using a stick to using a hand-hoe. Weed control is one of the most expensive activities in crop production **(Thorat 2013).**

To achieve a high yielding vegetable production, good agricultural practices are required. One of the most important practices is to properly manage weeds. Weeds affect crop yield due to competition to acquire plant nutrients and resources **(Slaughter *et al.* 2008)**.

Weeds have very fast growth rates compared to crops, and if not treated and managed, they may dominate the field. There are various methods for controlling weed infestation in crop production. Weed control within crop fields is one of the main problems in organic farming **(Preethi *et al.*2017).** Some farmers adopt agronomic practices that improve crop competitiveness such as Planting vigorous crop seeds at relatively shallow depths and planting right after a weed control operation. This method is used to prevent the weed seeds from germinating before the crop is planted and to ensure that crop plants emerge before the weed plants. This practice will not only ensure a maximized crop yield and reduce weed infestation, but also minimize any economic losses **(Maxwell *et al.* 2007).** So the objective was to evaluate the performance of manual weeder in vegetable crops.

MATERIALS AND METHODS

This chapter deals with the materials and methodology that will be used for designing of manual weeder and performances evaluation parameters. The project "Fabrication and Performance Evaluation of manual weeder" was fabricated in Farm machinery and power (FMP) lab, Department of Agricultural Engineering, Vaugh Institute of Agricultural Engineering and Technology, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad and experiment for performance evaluation was done at Krishi Vigyan Kendra, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad.

The methodology and procedure adopted in development of different components of machine are presented in this section under following subsections.

3.1. To develop and fabricate the manual weeder with different shovels.

3.2. To evaluate the performance of manual weeder in vegetable crops.

3.1 To Developed manual weeder

3.1.1 Working Principle

The manual weeder work on the principle of pulling and pushing forces.

Operation of the Machine

The machine was designed to suite the convenience of the operator. This is to provide comfort and enhances safety. These were therefore achieved by designing for the provision of an adjustable handle to suit variability in height of the operator. A ground wheel is provided to minimize the force required to push the machine on the field during operation.

3.1.2 Preliminary design concepts

The manual weeder was conceived to have multiple components that were expected to perform the following functions.

3.1.2.1 Manual weeder base

The base was bear and provides structural support/housing for all the component members of machine including a wheel, shovels, leveler and handle. The weeder base is made up of cast iron.

Fig 3.1 manual weeder base

3.1.2.2 Wheel

Wheel was fitted at the front frame bracket of the manual weeder to achieve economic weeding operation with reduced effort. The wheel is made up stainless steel having rubber on the rim.

Fig 3.2 wheel

3.1.2.3 Handle

The handle was fitted in base of the mannual weeder which is adjustable to suit the variability in height of the operator the handle is made up of cast iron.

Fig 3.3 Handle

3.1.2.4 Shovel

Shovels are the component which directly interact with soil and as such have major impact on the operation of the weeds. There are two types of shovel that was used in the manual weeder duck type and single point shovel type, there are five set of each shovel are used which is replaceable according to the soil condition three shovel are attached at the front following by two shovel. The shovel are also adjustable according to crop inter row distance.

(Single point shovel) **(Duck type shovel)**

Fig 3.4 Shovel

3.1.2.5 Leveller

The leveller was mounted on the end of the manual weeder it was made up of hollow cast iron cylinder which is automatically adjusted according to soil surface it level the soil surface which was break by the shovel it also buried the weeds into the soil by its weight.

Fig 3.5 Leveller

Table 3.1 Design specification

Component	Quantity	Length/Breadth/Thickness (mm)	Diameter (mm)
Manualweeder base	1	764mm/40mm /6mm	-
Wheel	1	-	498mm
Handle	1	1310mm/-/-	9mm
Shovels **Single point shovel** **Duck type shovel**	 5 5	 50mm/56mm/6mm 120mm/125mm/6mm	 - -
Leveler	1	415mm/-/-	360mm

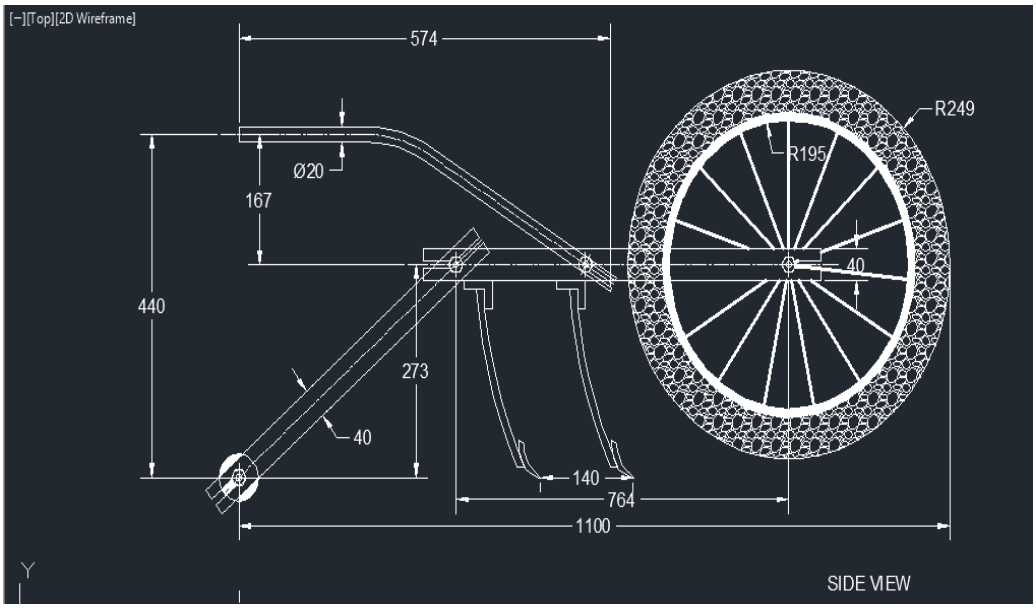

Fig 3.6 Side view of manual weeder

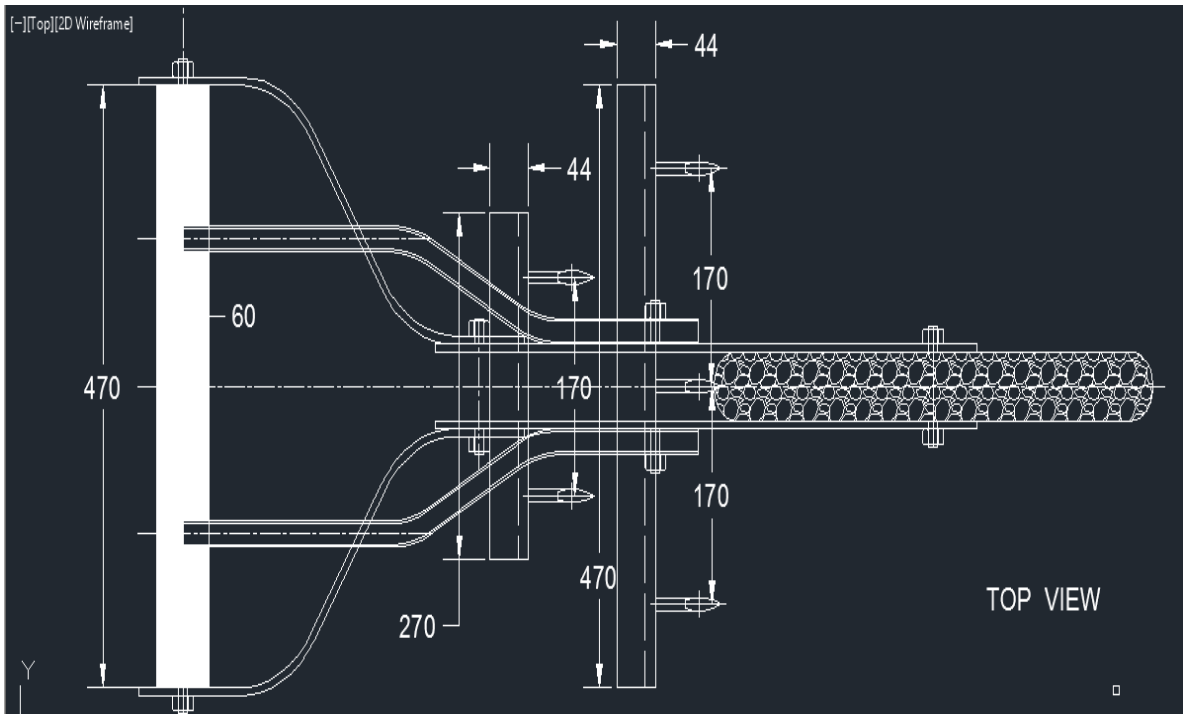

Fig3.7 Top view of manual weeder

3.2 Performance of Developed Machine

3.2.1 Determination of Soil parameters

3.2.1.1 Soil Moisture

The moisture content of the test farm was determined at various locations on the field firstly we take the sample from the field then weight on the digital balance meter (M_1)after that keep the sample in the oven for drying at 105ºC for 24 hours then again the weight the sample (M_2)and moisture content by the expression .

$$MC\,\% = \frac{M_1 - M_2}{M_2} \times 100$$

3.2.1.2 Soil Resistance, Rs

This is the average penetration resistance of the soil to implement, given by the relation below:

$$Rs = \frac{\text{weight of weeder (Kg)}}{\text{Total Area of Weeder in Contact with the soil}}$$

$$Rs = \frac{\text{weight of weeder (Kg)}}{(5 \text{ x L x B})}\ \text{Kg/cm}^2$$

Where,

L = Length of weeder blade (cm)

B = thickness of weeder blade (cm)

3.2.2 Width of cutting: Working width can conveniently be measured by measuring the distance between the shovel with steel rule or tape.

3.2.3 Forward speed:

$$\text{Average Speed} = \frac{\text{Distance (m)}}{\text{Time (sec)}}$$

3.2.4 Draft of the weeder

$$D = W \times dw \times Rs$$

Where,
D - Draft of the weeder, (N)
W- Width of cut (cm)
dw – Depth of cut (cm)
Rs – Soil resistance (Kg/cm^2)

3.2.5 Power required to push the weeder:

$$\text{Power (kW)} = \frac{\text{draft force (N)} \times \text{speed (m/s)}}{1000}$$

3.2.6 Weeding Efficiency: The weeding efficiencies at different moisture condition where calculated using the equation below:

$$E_w = \frac{W_1}{W_1+W_2} \times 100$$

Where E_w -weeding efficiency (%)
W_1- weight of cut weeds (g)
W_2 - weight of survived weeds (g)

3.2.7 Effective Field Capacity (FC_E):

$$FC_E = W_a \times E_w \times \frac{10^4}{24 \times 3600} \ (ha/day)$$

Where:

FC_E = Effective field Capacity (ha/day.)

W_a = Effective weeding width (m)

E_w = Weeding efficiency (%)

3.2.8 Theoretical field capacity:

Theoretical field capacity (FC_T) is calculated from the mean values of working width and working speed

$$FC_T = \text{working width} \times \text{mean speed}$$

Result and Discussion

To Develop and fabricate the manual weeder with different shovels.

4.1.1 Manual weeder base

The weeder base is made up of cast iron there are two parallel rod having
Length = 764mm, Breadth = 40mm and Thickness = 6mm.

4.1.2 Wheel

The wheel is made up of stainless steel having rubber on the rim; the diameter of the wheel including rubber is 498 mm

4.1.3 Handle

The handle is made up of cast iron it is hollow cylindrical pipe having the diameter of 9 mm which was bended on the bending machine for desirous shape which is comfortable for operator to operate the machine. The length of the pipe was 1310 mm

4.1.4 Shovels

There are two types of shovel that was used in the manual weeder duck type and single point shovel type, there are five set of each shovel are used which is replaceable and they are made up of cast iron the breadth of shovel are 470mm respectively.

4.1.5 Leveler

The leveler was made up of hollow cast iron cylinder. The outer diameter of cylinder was 360 mm and length of cylinder was 415 mm

4.2 To evaluate the performance of manual weeder in vegetable crops

4.2.1 Manual weeder with single point shovel

Table 4.1 Data calculated for single point shovel

Serial number	Content	singlepoint shovel
4.2.1.1	Soil Moisture content	29.26 %
4.2.1.2	Soil Resistance, Rs	0.077 kg/cm^2
4.2.1.3	Width of cutting	50 cm
4.2.1.4	Forward speed	0.143 m/sec
4.2.1.5	Draft of weeder	42 N
4.2.1.6	Power required to push the weeder	0.0068 KW
4.2.1.7	Theoretical field capacity	0.0715 ha/day
4.2.1.8	Effective Field Capacity	0.0512 ha/day

4.2.1.9 Efficiency of the weeder with single point shovel

The efficiency of the machine was calculated by the given formula and it was found that 85.71%, 86.78% and 93.06% for the area A_1, A_2 and A_3 respectively.

The average of the efficiency of weeder with single point shovel was found as 88.51%.

Table 4.2 Efficiency of machine with single point shovel

Area (m^2)	Weeding efficiency (%)	Average (%)
A_1	85.71	88.51
A_2	86.78	
A_3	93.06	

4.2.2 Manual weeder with single duck type shovel

Table 4.3 Data calculated for duck type shovel

Serial number	Content	Duck type shovel
4.2.2.1	Soil Moisture content	29.18 %
4.2.2.2	Soil Resistance, Rs	0.025 kg/cm^2
4.2.2.3	Width of cutting	50 cm
4.2.2.4	Forward speed	0.178 m/sec
4.2.2.5	Draft of weeder	6.25 N
4.2.2.6	Power required to push the weeder	0.001 KW
4.2.2.7	Theoretical field capacity	0.089 ha/day
4.2.2.8	Effective Field Capacity	0.049 ha/day

4.2.2.9 Efficiency of the weeder with duck type shovel

The efficiency of the machine was calculated by the given formula and it was found that 85.45%, 81.05% and 88.63% for the area A_1, A_2 and A_3 respectively. The average of the efficiency of weeder with duck type shovel was found as 85.043%.

Table 4.4 Efficiency of duck type shovel

Area (m^2)	Weeding efficiency (%)	Average (%)
A_1	85.45	85.043
A_2	81.05	
A_3	88.63	

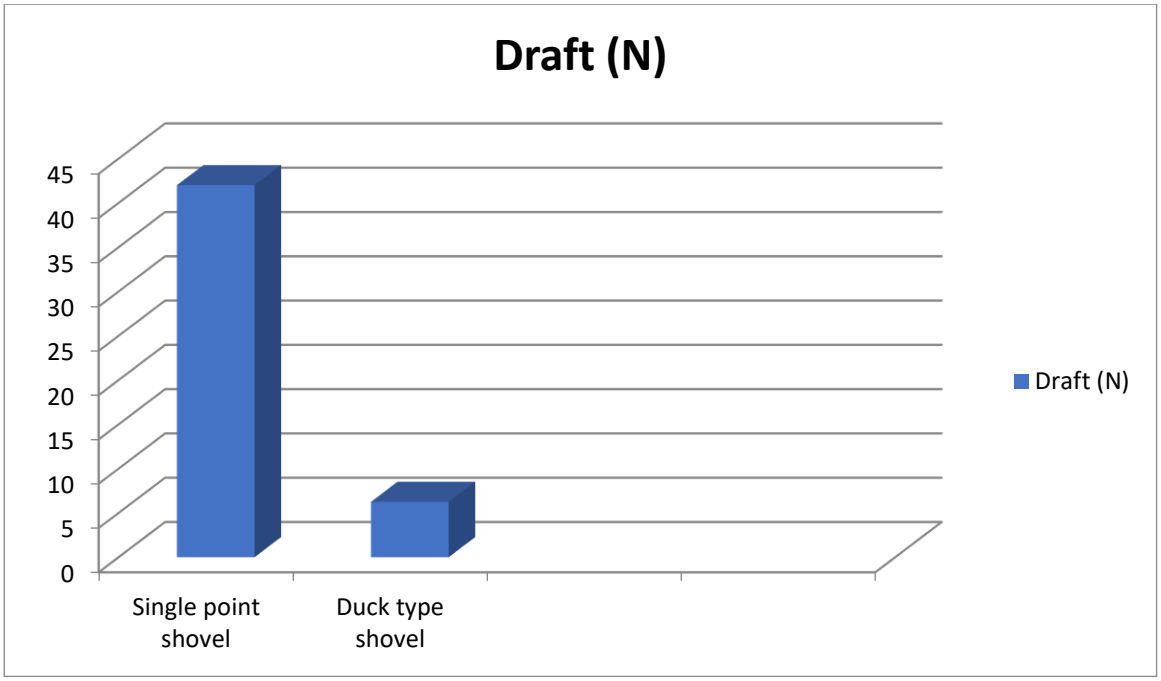

Fig 4.1 Draft comparison between single point shovel and Duck type shovel

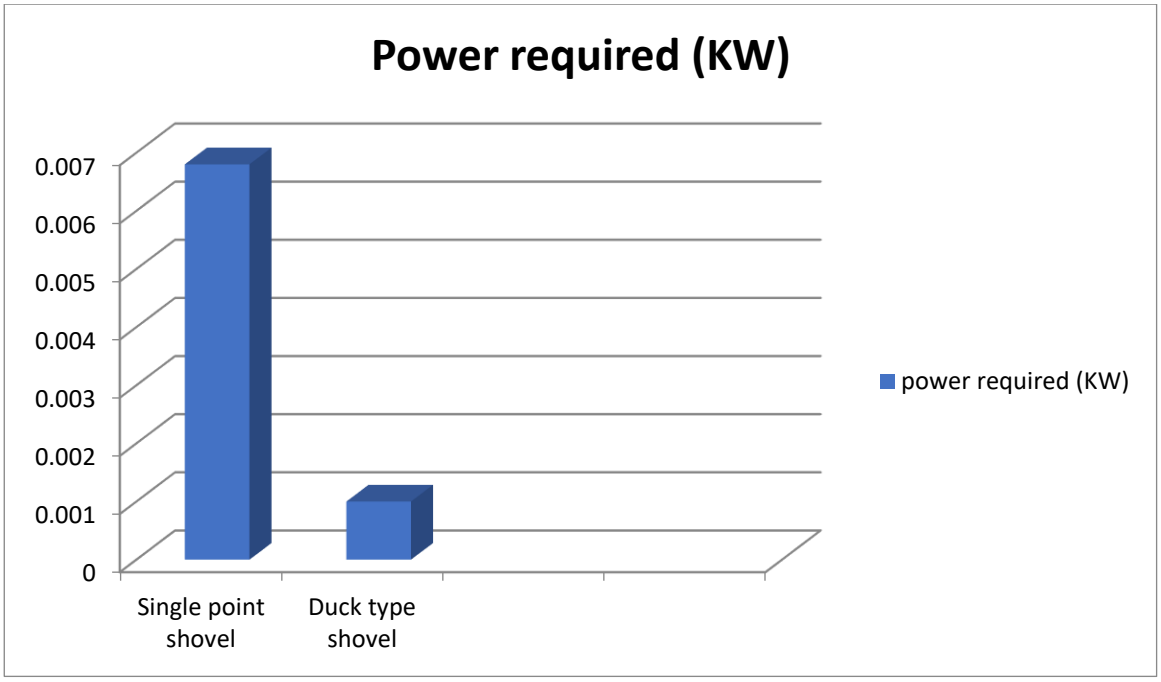

Fig 4.2 Power required comparison between single point shovel and Duck type shovel

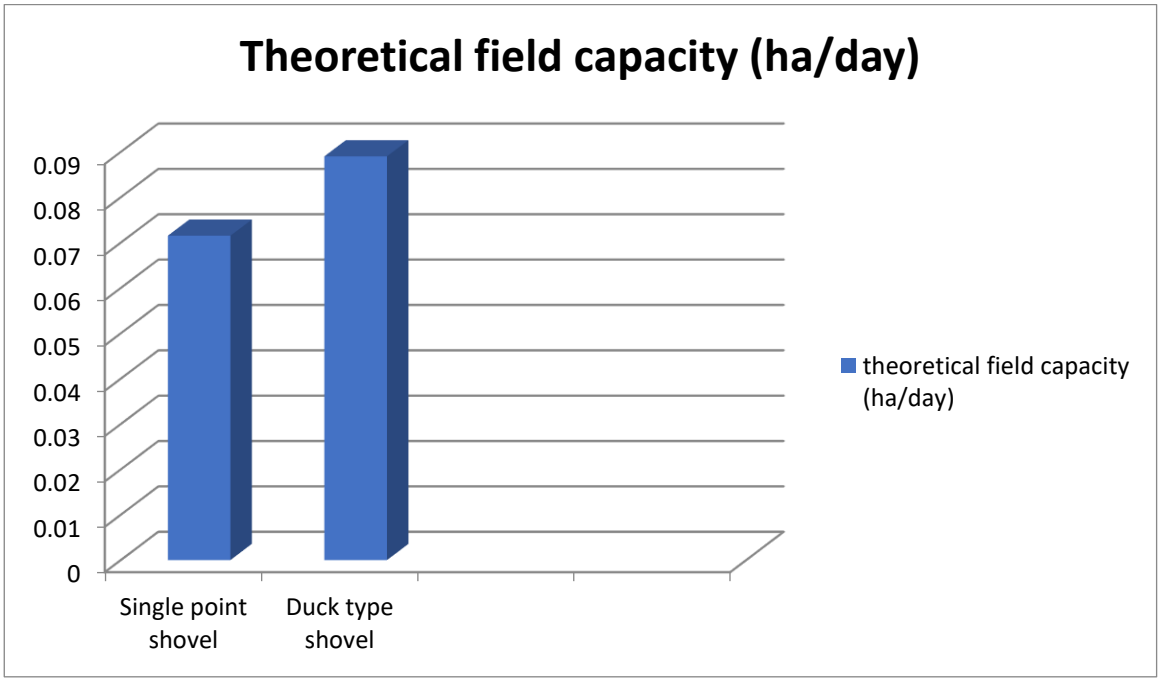

Fig 4.3 Theoretical field capacity comparison between single point shovel and Duck type shovel

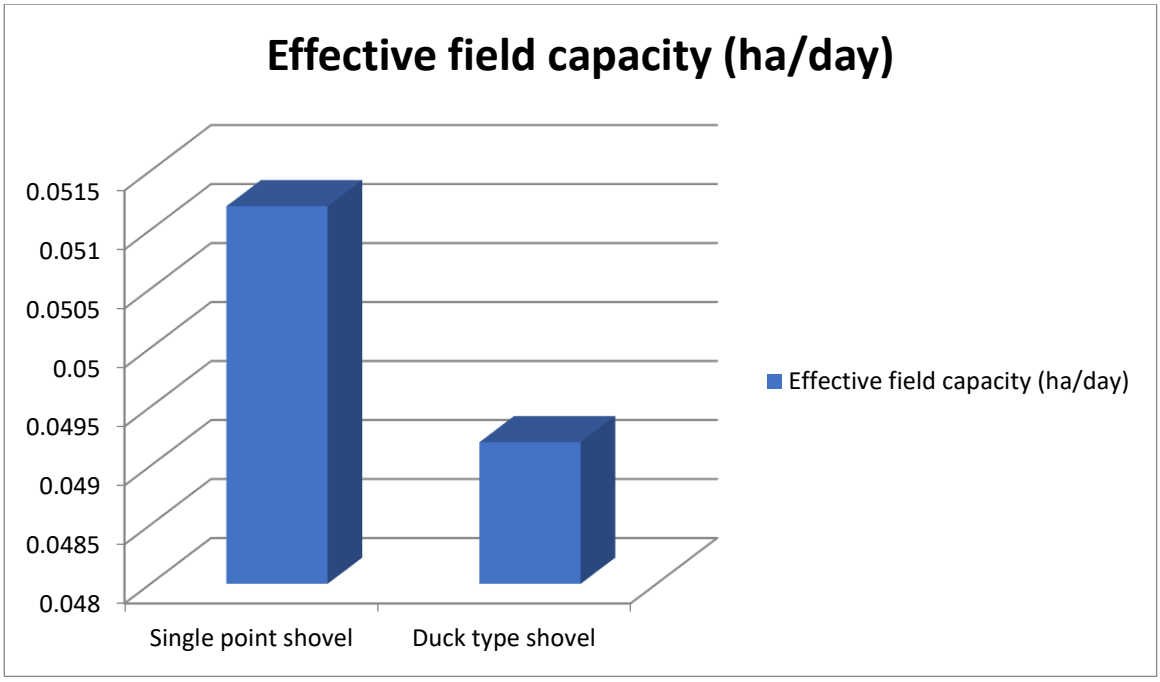

Fig 4.4 Effective field capacity comparison between single point shovel and Duck type shovel

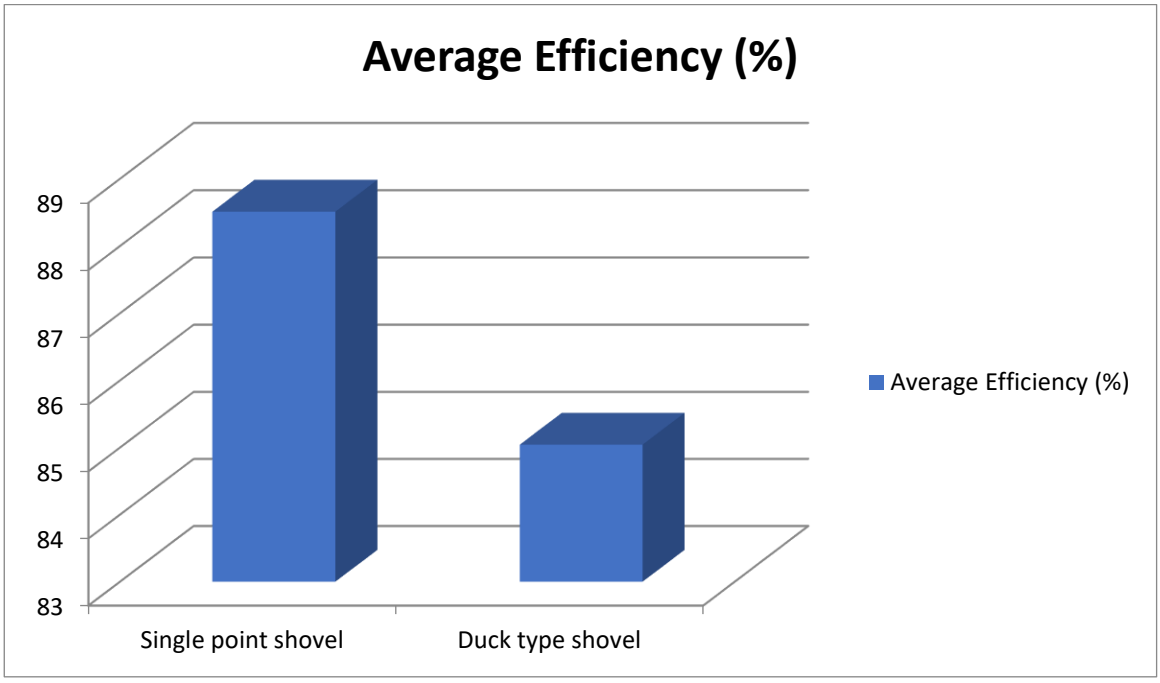

Fig 4.5 Average efficiency comparison between single point shovel and Duck type shovel

SUMMARY AND CONCLUSION

Traditional method of weeding employ nail peeling, and large scale power operated weeder is the most time consuming, small scale weeder are not efficient and drudgery, laborious and uneconomical. Above all, the method is inadequate and inefficient to deliver high output and often result in low quality product. In an effort to alleviate the above stated problems, a manual weeder was designed, manufactured and tested to evaluate its performance in terms of weeding, efficiencies, weeding capacities.

The manual weeder was fabricated by using locally available material. The developed weeder is capable of reducing time wastage, labor requirement and power consumption. The performance evaluated in terms of weeding efficiency and capacity of weeder. The minimum losses, maximum efficiency and highest quality are achieved by the developed weeder.

The average efficiency of weeder was observed for single point type shovel and duck type shovel as 88.51% and 85.043% respectively.

The average capacity of weeder was observed for single point type shovel and duck type shovel as 0.0512 ha/day and 0.0492 ha/day respectively.

1.1. Conclusions

Based on the performance evaluation made and results obtained, the following conclusions can be drawn:

1. The weeding average efficiencies for single point type shovel and duck type shovel 88.51% and 85.043% respectively.
2. The weeding efficiency of single point shovel is more than the duck type shovel
3. The performance of the weeder was affected by vegetable i.e. performance of machine is best for okra.
4. The capacity of weeder can increase with providing more shovels and reducing the draft.
5. The weeder is portable and single person can easily operate the machine.

1.3 Suggestion and recommendation

Based on the above conclusion drawn from the results and discussion of this study, the following recommendations will be suggested to improve the performance.

1. It was used in the soil having the moisture content around 30%.
2. The manual weeder was used at the initial age of weed so that it can be easily removed.
3. To increase the efficiency, reduction of soil resistance takes under consideration.
4. There should be a pulling force applied to overcome the resistance.

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