Design & Fabrication of Weeder & Cutter Machine

Sawpnil.V.Ghinmine[1], Abhishek.B.Tiwari[2], Aditya.V.Rao[3], Aditya.D.Shinde[4]
Pawan.A.Ghawghawe[5], Sagar.S.Girde[6], Vaibhav.D.Vakil

[1] *Assistant Professor, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*
[2] *Students, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*
[3] *Students, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*
[4] *Students, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*
[5] *Students, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*
[6] *Students, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*
[7] *Students, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*
[8] *Students, Department of Mechanical Engineering DMIETR Wardha, Maharashtra India*

ABSTRACT

Weed management is one of the tedious operations in vegetable production. Because of labor costs, time and tedium, manual weeding is unfavorable. A mechanical weeding actuation system was designed, and a prototype was constructed. This actuator was developed to mechanically control intra-row weed plants. The mechanical weeding actuator consisted of a belt drive system powered by an integrated engine and a rotating tine weeding mechanism powered by engine power. Weed control is one of the most difficult tasks on an agricultural farm. Three methods of weed control are commonly known in agriculture. These are mechanical, chemical and biological control. Mechanical weed control is easily adopted by farmers once they get convened of its advantages. Mechanical weed control not only uproots the weeds between the crop rows but also keeps the soil surface loose, ensuring better soil aeration and water intake capacity. Various types of mechanical weeders have been developed. In human operated weeders, muscle power is required and so it cannot be operated for long time. The traditional method of hand weeding is time consuming. In order to assess the possibility of mechanization of the weeding operation, the power operated single row active weeder is to be designed and developed.

Keyword: - *Mechanical Weeder, Weed remover, Analysis, Design, fabrication*

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1. INTRODUCTION

Weed is essentially any plant which grows where it is unwanted or in the wrong place at the wrong time and doing more harm than good. It is a plant that competes with crops for water, nutrients and light. This can reduce crop production and decrease the value of land, increase cost of cleaning. Weed control is one of the most difficult tasks in agriculture that accounts for a considerable share of the cost involved in agricultural production. Weeding is the removal of unwanted plants in the field crops. Mechanical weed control is very effective as it helps to reduce drudgery involved in manual weeding, it kills the weed and also keeps the soil surface loose ensuring soil aeration and water intake capacity. Farmers generally expressed their concern for effective weed control measures to arrest the growth and propagation of weeds. 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. A Manual weeding is common in Nigerian agriculture. Today the agricultural sector requires nonchemical weed control that ensures food safety. Consumers demand high quality food products and pay special attention to food safety. These mechanisms contribute significantly to safe food production.

Previous efforts in this area are quite appreciable but the research efforts are yet to be adopted by farmers in Nigeria. One of the major problems with existing designs is that the manual power required to move the machines and propel the operational components of these machines is high probably making these designs un-adoptable by farmers. Power requirement is generally high for soil engaging equipments. Yet manual power available on the farm is limited to 0.1.

1.1 EVOLUTION OF WEED CUTTER MACHINE

A weed can be thought of as any plant growing in the wrong place at the wrong time and doing more harm than good. Weed waste excessive proportion of farmer time, there by acting as a brake on development. Weeding is one of the most important farm operations in crop production system. Weeding is an important but equally labor incentive agricultural unit operation. Weeding accounts for about 25% of the total labor requirement (900-1200 man h/ha) during a cultivation season. The labor requirements for weeding depend upon on weed flora, weed intensity, time of weeding and efficiency of worker. Delay and negligence in weeding operation affect the crop yield up to 30 to 60 percent. In India about 4.2 billion rupees are spent every year for controlling weeds in the production of major crops.

2. AIM & OBJECTIVE

2.1 AIM: A mechanical weeding actuation system was designed, and a prototype was constructed.

2.2 OBJECTIVE:

1. Study weed control efficiency using different machine settings such as working depth, travel speed, rotational speed and number of tines.
2. Study the power consumption of the system with respect to different machine settings.
3. To modify soil working tool of power operated row wet land weedier for dry field condition.
4. To evaluate performance of modified weeder.
5. Ergonomic and economic evaluation of the modified weeder.

3. PROBLEM IDENTIFICATION

Following are the problem identified while weeding operation:

1. The machine which was designed before can perform 1 operation at time, now able to perform 2-3 operation at a time. (I.e. weed removing, cutting, cultivation).
2. The weeder machine has some adjustment according to use like cultivator at time of cultivation, weeder at time of removing weeder.
3. The previous weeder machine which is designed is Expensive.

4. DEVELOPMENT

4.1 MARKET SURVEY

The table 4.1 shows the type of weeding machine available in India. From this table we can come to know that the availability of machine at high cost around our country. The power consumed can also add to the monthly expenditure on the machines. The capacities of machines are also shown in table. The requirement of floral space is also more for the cheapest machine available which increases the weight of machine.

S.N	Machine Available	Machine Wt.(kg)	Power HP	Capacity	Price (Rs)
1.	Kissan Kraft (KK-IC-100P)	34 kg	1.88		27000
2.	Wonderland Prarthana weeder	55	7		38000
3.	Wonderland Mantis	15	2		49000

Table 4.1: Types of machines available

(a) Kisaan kraft (b) Wonderland Prarthana (c) Wonderland Mantis

4.2 MECHANISM

All the parts are assembled as per the concepts of our project. Vehicle moves in a forward direction and the blades enter into the soil between rows of crops. Firstly we start the engine manually, the power of the engine is transferred from the engine shaft to the main shaft on which the cutter blades is mounted through the belt and pulley arrangement in this way the cutter is start to rotate in the agriculture crop and remove the unwanted weeder from the crop and removing of weeds takes place. By this a huge amount of labor effort can be reduced and within less time more weeds can be removed with less cost and easy operation. Then finally one labor is required to remove the weeds which are not removed by weeder around the plants.

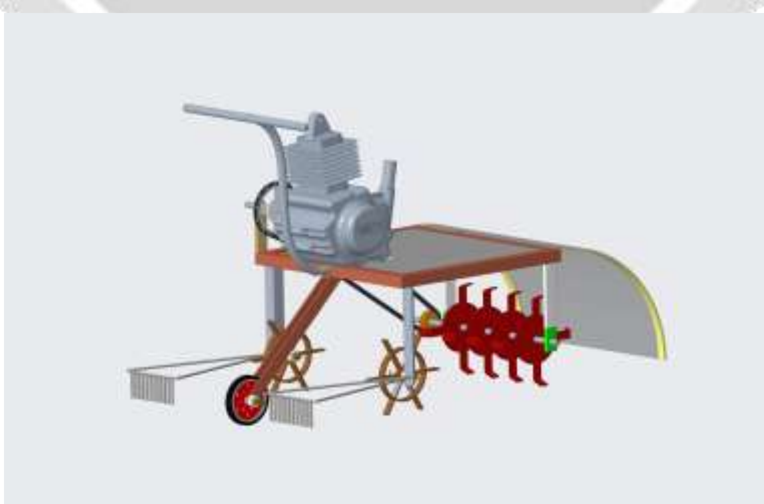

Fig 4.2 Project Model

4.3 COMPONENTS

1. Engine
2. Cutting Blades
3. Bearing Housing
4. Ball Bearing
5. Shaft
6. Chain
7. Sprocket

4.4 FABRICATION

The following table shows the list of operation performed for the fabrication of each components and its material.

SR NO.	DESCRIPTION	MATERIAL
1.	Shaft	Plain Carbon Steel
2.	Ball Bearing	High Carbon Chromium steel (SAE52100)
3.	Engine	Cast Iron
4.	Chain	Mild Steel
5.	Sprocket	Cast Iron
6.	Cutting blade	Stainless steel

5. WORKING

All the parts are assembled as per the concepts of our project. Vehicle moves in a forward direction and the blades enter into the soil between rows of crops. Firstly we start the engine manually, the power of the engine is transferred from the engine shaft to the main shaft on which the cutter blades is mounted through the belt and pulley arrangement in this way the cutter is start to rotate in the agriculture crop and remove the unwanted weeder from the crop and removing of weeds takes place. By this a huge amount of labor effort can be reduced and within less time more weeds can be removed with less cost and easy operation. Then finally one labor is required to remove the weeds which are not removed by weeder around the plants.

5.1 CALCULATION

5.1.1 POWER REQUIREMENT:

Assumption: -

Soil resistance has a considerable effect upon the power requirement of weeder. Also, width of cut and speed of operation influences power requirement of weeder. For calculating power requirement of the weeder, maximum soil resistance was taken as 0.5kgf/cm2. The speed of operation of the weeder was considered as 0.7 ms-1 to 1.0 ms-1. Total width of coverage of cutting blades was in the range of 12 to 30 cm. The depth of operation was considered as 5 to 8 cm, transmission efficiency is 82%.

Pd = (SR x d x w x v)/75 hp

Where,

SR = soil resistance= 0.049 N/mm2

d = depth of cut= 80 mm
w = effective width of cut = 300 mm
v = speed of operation, 1000 mm/s
Hence, power requirement is estimated as
Pd = (0.049 x 80 x300x1000)/75 hp = 0.02hp = 0.0149 KW

Total power required

The total power required is estimated as 0.02 hp as follows
Pt = Pd/η = 0.02/0.82 = 0.025 hp = 0.0186 KW
Where,
Pd = Power required digging the soil:
η = Transmission efficiency.
Thus, a prime mover of 0.0186 kW (0.02 hp) was required for this weeder.

5.1.2 DESIGN OF WEEDER SHAFT:

A shaft is a rotating machine element which is used to transmit the power from one place to another. The power is delivered to the shaft by some tangential force and the resultant torque (or twisting moment) setup within the shaft permits the power to be transferred machine or components linked up to the shaft.

5.1.2.1 Torque transmitted by the shaft

The torque transmitted through the shaft is worked out using the following formula (khurmi, R.S., 2012).
$T = (P \times 60 \times 10^3)/2 \times 3.14 \times N$
Where,
P = power, kW
T = torque transmitted by the shaft, Nm
N = revolutions per minute
Considering engine speed as 6000 rpm and engine power 0.0186 kW we get torque as
$T = (0.0186 \times 60 \times 10^3)/ 2 \times 3.14 \times 6000$
= 0.002 Nm
= 2 Nmm
Thus the torque of 0.002 Nm was obtained.

5.1.2.2 Diameter of the flexible shaft
For designing the rotor shaft, the maximum tangential force which can be endured by the rotor should be considered. The maximum tangential force occurs at the minimum of blades tangential speed is calculated by the following
$KS = 75 x C_s x N_c x M_c x M_z / U_{min}$
Where,

Ks = Maximum tangential force, kg,

Cs = Reliability factor (1.5 for non-rocky soils and 2 for

Rocky soils),

N_c = Power of engine, hp,

M_c = Traction efficiency for the forward rotation of rotor shaft as 0.9,

M_z = Coefficient of reservation of engine power (0.7-0.8),

And u_{min}= Minimum tangential speed of blades, $m.s^{-1}$.

U_{min} = (2 x3.14 xN x R)/6000
= (2 x 3.14 x 176 x 0.16)/6000
= 0.02 m/s

Where,
N = Revolution of rotor =176 rpm, and
R = Radius of rotor = 16 cm. = 0.16 m
After substituting values for revolution of engine rotor shaft (176 rpm) after the loading in land and its radius as 16 cm in equation tangential peripheral speed was obtained as 0.02 ms-1.Using the tangential peripheral speed and other parameters in equation, the maximum tangential force was determined to be 55.10 kg.
Ks = (1.5 x 75 x 0.9 x 2 x0.8)/0.02
= 88.59 Kg
The maximum moment on the rotor shaft (Ms) is calculated through the following:
Ms= Ks x R (3.15)
Ms =88.59 x 16
Ms =1417.5 kg-cm
In the above equation, R is the rotor radius (cm).
The yield stress of rotor made from rolled steel (AISI 302) was 520 MPa. The allowable stress on the rotor (τ_{all}) was calculated by the following equation:
τ_{all} = (0.577 X K X σy)/f = (0.577 X 0.75 X 520)/1.5 = 150 MPa

= 1530.6 $Kg\text{-}cm^{-2}$

Where,

τ_{all} = Allowable stress on rotor shaft, $kg.cm^{-2}$,

k = Coefficient of stress concentration (0.75),

f = Coefficient of safety (1.5), and

σ_y = Yield stress, 520 MPa.

By substituting above values in the following equation,

Rotor shaft diameter was calculated as:

D= $^3\sqrt{}16Ms/ \tau_{all}$ x 3.14

D =14.3 mm

D=16 mm

6. COST ANALYSIS

S.N	COMPONENTS	QUANTITY	COST
1.	Engine	1	4500
2.	Grub Screw	9	36
3.	Bearing	3	480
4.	Chain	1	450
5.	Shaft	1	500
6.	Cutting Blade	4	600
7.	Sprocket	1	500
8.	Labor		2000
	Total		9066

7. CONCLUSION

This Project will help people to understand the relevance of mechanized weeding, which is not a huge time consuming and significantly improves weeding efficiency as well as the quality of weeding.

8. FUTURESCOPE

- Adding the arrangement of cultivator at the base plate.
- Pumping operation is performed by use of engine.
- Seed sawing operation will also be performed.
- In future, Use of weeding machines will increase and it will reduce human efforts, time which will increase the productivity of crops.

9. ACKNOWLEDGEMENT

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