"Design and Development Of Automated Farm Weeding Machine"

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ABSTRACT

An engineer is always focused towards challenges of bringing ideas and concepts to life. Therefore, sophisticated machines and modern techniques have to be constantly developed and implemented for new products. At the same time, we should take care that there has been no compromise made with quality and accuracy. Agricultural area has been in the area of continuous research, and has made significant improvement in the recent period. Currently, standard cultivation removes weeds from the majority of the bed using sweeps, knives, coulters and blades. Typically a 4inch wide band is left around the seed line. Weeds in the uncultivated band are typically removed by hand, and the density of weeds that occur there, determines how laborious and costly subsequent hand weeding will be. Automatic weeding machine is a project used to remove unwanted plants/weeds, which grows around the crops. Technology will continue to develop and improve in the coming years. These technologies do not entirely replace the need for hand labor, but they can make subsequent hand weeding operations less costly and more efficient. So we are going to make a prototype which removes these unwanted plants more efficiently and at a considerable less cost. We have made a machine which removes weed from in the line and around the plants.

Keywords: *weed, sophisticated machines, standard cultivation, sweeps, knives, laborious.*

I. INTRODUCTION

India is a agricultural country. More than 70% of its population is dependent on agriculture for their living, still many of the farmers use conventional methods to remove weed. Thus there is a need to bring in new modern technologies to make farming easy and time saving. 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 Weeds have very fast growth rates compared to crops, and if not treated and managed, they may dominate the field. 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 The above practice should be applied for controlling weeds if the canopy closes and does not allow much light onto the ground surface where weeds will germinate and grow. However, weed control is still required during the crop production cycle.

Another weed control method that is practiced is to increase the crop density in the field. By filling the field with crops, weed seed germination rates are reduced. However, the distance between plants are reduced and might affect other field operations such as fertilizer spraying or harvesting. Weed management is a strategy that makes a desired plant population successful in a particular agro ecosystem using knowledge of the ecology of the undesired plants that is the weed. The most effective method of weed management is by making physical contact with the weeds themselves, which is weed control. Currently, there are several ways of controlling weeds, either by using manual, chemical, mechanical or biological means. The earliest and the simplest weed control method is manual weed control. Agriculture is the main occupation in majority of developing nations such as India, Brazil, etc. One major reasons for lack of yield per unit agricultural area in these nations are weeds. Weeds compete for space, nutrients, water and light with crops. The losses caused by weeds can be particularly significant in vegetable crops and cash crops such as sugarcane Majority of the population in developing nations depends on agriculture and agro-based industries and businesses. Lack of mechanization

or automation is one of the major road blocks to improving the productivity of agriculture. Major reason for lack agricultural productivity is weeds.

Day to day farmer's facing agricultural problems is weed effect, monsoon changes and time conception. The traditional forming method is unable to improve the crop yield and does not solve farmer's day to day problems. That's why the farmers start to implement the various technologies to achieve better yield, reduce the time conception and required man power. Weed are "any plant growing in wrong place at the wrong time and doing more harm than good". Weeds compete with the crop for water, light, nutrients and space and therefore reduce crop yield and also affect the efficient use of machinery. That's why we are trying to implementing manually operated automated farm weeding machine in lower cost. In that the sensor detects the crop and remove weed which is around the crop by using c-shape cutter. There battery is used to operate geared motor through controller. By this system we can efficiently reduce cost and manpower [1].

II. PROBLEM DISCUSSION

In order 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. Weeds have very fast growth rates compared to crops, and if not treated and managed, they may dominate the agro field [4].

III. OBJECTIVES

1) To reduce the man power in agricultural sector.
2) To reduce the power consumption during weeding.
3) To maintain the accuracy during weeding.
4) This type of weeding m/c provides work practically at low cost, low maintenance, low capital investment in less space.
5) To perform the most rigid operation with high speed weeding& to reduce time in Weeding.

IV. LITERATURE REVIEW

Dr. B. Paulchamy, et al.(2016)- This paper represents 3 in 1 prototype design based on automatic weed detection and sprayer system and automatic irrigation system with GSM protocol. This system mainly works on the purpose to implement a system that does the three given features more efficiently.

K. Sripriyan, et al.(2015)- This paper carried to investigate the influence of weeder machine with varying paddy field. Mainly focus on remove the tiny plants which grow along with paddy for weeding the agriculture land without damaging the crop is achieved. It also investigate the optimized design parameter to maximize the performance of machine.

Mr. Mahesh Gavali, et al.(2014)- The paper discuss about design develop and optimize blades used for these an efforts is made to reduce power required to drive these machines and to increase the life of these blades using the blades with lowest stress profiles. By increasing the life and lowering the power required the effectiveness of the mechanical weeders can be increased.

Mr. Vivek Raut, et al.(2013)- This paper is work towards analyzing weeding equipment aspects for economical cultivation which will help to minimize the working fatigue and to reduce labour cost. The main aim of this review paper is to have a proper understanding of different aspects or constraints of weeders.

V. METHODS OF WEED CONTROL

Methods of Weed Control:

1. Cultural Weed Control Method
2. Physical or Mechanical Weed Control Method
3. Chemical Weed Control Method

1. Cultural Weed Control:

Several cultural practices like tillage, planting, fertilizer application, irrigation etc., are employed for creating favorable condition for the crop. These practices if used properly, help in controlling weeds. Cultural methods, alone cannot control weeds, but help in reducing weed population. In addition, aspects like selection of variety, time of sowing, cropping system, cleanliness of the farm etc., are also useful in controlling weeds.

Fig.1 Conventional weeding tools [7]

- **Merits of Cultural Method**

1) Low cost for weed control
2) Easy to adopt
3) No residual Problem
4) Technical skill is not involved
5) No damage to crops

- **Demerits of Cultural Method**

1. Immediate and quick weed control is not possible.
2. Weeds are kept under suppressed condition.
3. Perennial and problematic weeds cannot be controlled.
4. Practical difficulty in adoption.

2. <u>Mechanical Or Physical Weed Control:</u>

Mechanical weed control may involve weeding the whole crop, or it may be limited to selective inter-row weeding. A mechanical weed control machine containing a sensing arrangement, control algorithm and dual mechanical end effectors was successfully developed and tested. More work is needed to identify the causes of misjudging the locations of the corn plants. According to [4] in this they are studied about, Mechanical or physical methods of weed control are being employed ever since man began to grow crops.

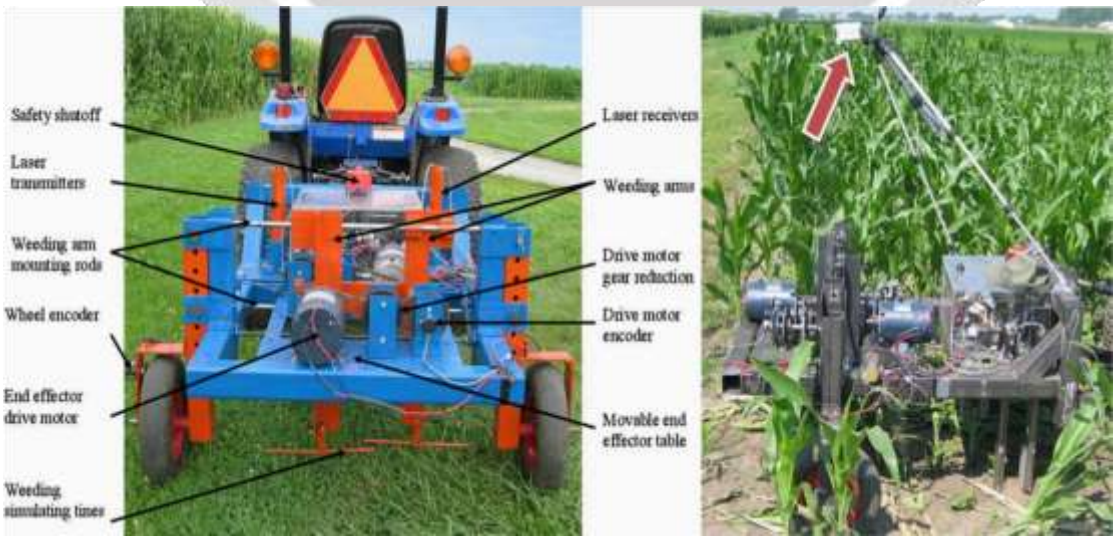

Fig.2 Mechanical weed control machine using sensor [8]

- **Merits of Mechanical Method:**

1) Oldest, effective and economical method
2) Large area can be covered in shorter time
3) Safe method for environment
4) Deep rooted weeds can be controlled effectively.

- **Demerits of Mechanical Method:**

1) Labour consuming
2) Possibility of damaging crop
3) Requires ideal and optimum specific condition required for Mechanical weeder
4) Practical difficulty in operation.

3. Chemical Weed Control:

1) Organic approaches:

Organic weed control involves anything other than applying manufactured chemicals. Typically a combination of methods are used to achieve satisfactory control. Sulphur in some circumstances is accepted within british soil association standards.

2) Herbicides:

The above described methods of weed control use no or very limited chemical inputs. They are preferred by organic gardeners or organic farmers. However weed control can also be achieved by the use of herbicides. Selective herbicides kill certain targets while leaving the desired crop relatively unharmed. Herbicides are generally classified as follows:

- Contact Herbicides destroy only plant tissue that contacts the herbicides. Generally, these are the fastest acting herbicides. They are ineffective perennial plants that can re-grow from roots or tubers.
- Systemic herbicides are foliar-applied and moved through the plant where they destroy a greater amount of tissue. Glyphosate is currently the most used systematic herbicides.
- Soil-borne herbicides are applied to soil and are taken up by the roots of the target plant.
- Pre-emergent herbicides are applied to the soil and prevent germination or early growth of weed seeds [6].

VI. DESIGN

Design parts & Parts to be purchased.

The designed parts are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified.

The process charts are prepared and passed to manufacturing stage. The parts to be purchased directly are selected from various catalogues and are specified so as to have case of procurement. In mechanical designed at the first stage selection of appropriate material for the part to be designed for specific application is done. This selection is based on standard catalogues or data books.

- **CUTTER SELECTION:**

Assume maximum force to be required to cut the weed is 5 kg, $(9.81 \times 5) = 49.05$ N

Torque required to cut the weed by force given,

$$T = F \times R$$

$$T = 49.05 \times 0.15$$

T = 7.3575 N-m

Let we have the motor range specifications given below,

Assume speed of motor =60 rpm.

We know that,

$$P = \frac{2 \times \pi \times N \times T}{60} = \frac{2 \times \pi \times 60 \times 7.3575}{60}$$

P =46.2285 watt

We have standard motor available in market of power **50 watt**

N =40 TO 60 rpm

$$50 = \frac{2\times\pi\times N\times T}{60}$$

$$50 = \frac{2\times\pi\times 60\times T}{60}$$

Torque (T) = 7.957 N-m

- **DESIGN OF SHAFT:**

For commercial steel shaft, Actual shear stress, $\tau_{act} = 55\ N/mm^2$

$$T = \frac{\pi}{16} \times \tau_{act} \times d^3$$

$$7.76 \times 10^3 = \frac{\pi}{16} \times 55 \times d^3$$

$d^3 = 737.089$ d=9.033mm

select d=20mm

- **MOTOR SELECTION:**

Thus selecting a motor of the following specifications

- Single phase AC motor
- Power = 1/15hp=50 watt (1 hp = 746.7 watt)
- Speed= 60 rpm

Power is transmitted from the motor shaft to the input shaft by means of a V-belt drive,
Motor pulley diameter = 20 mm
IP shaft pulley diameter = 60 mm
Reduction ratio = 3
IP shaft speed = 60/3 = 20 rpm
Torque at IP rear shaft = 3×7.96= 23.88 N-m

- **DESIGN OF V-BELT DRIVE:**

Motor pulley diameter d = 20 mm
IP _ shaft pulley diameter D = 60 mm
Coefficient of friction = 0.23
Let,
d= diameter of belt = 5 mm
Mass of belt per unit length is given by;
ρ= density of belt material = 950 kg/m^3 m= 0.0285 kg/m

Velocity of V-Belt is given by;

$$V = \frac{\Pi dn}{60\ X\ 1000} = \frac{\Pi x\ 20\ x\ 60}{60\ X\ 1000}$$

V = 0.0628 m/s ----------Linear velocity

To find out tension in the belt is;

$$P = \frac{(F1-F2)V}{1000}$$

$$50 \times 10^{-3} = \frac{(F1-F2)\ X\ 0.0628}{1000}$$

F1 − F2 = 795.78 N ---------- **(1)**

Center distance between two pullies of motor &pullies output **C=200mm**

$$\alpha = \sin^{-1}\frac{D-d}{2C} = \sin^{-1}\frac{(60-20)}{2 \times 200}$$

$\alpha = 5.739^0$ (In Degrees)

$$\alpha = 5.739 \times \left(\frac{\pi}{180}\right)$$

$\alpha = 0.10^c$

θ =Angle of lap of belt

$$\theta = \pi - 2\alpha$$

$$\theta = \pi - [2 \times 0.10]$$

$\theta = 2.94c$

$\theta = 168.54^O$

Now , $$\frac{F1}{F2} = e^{\frac{\mu\theta}{\sin\beta}}$$

$$\frac{F1}{F2} = e^{\frac{(0.23 \times 2.94)}{\sin 19^\circ}}$$

$$\frac{F1}{F2} = 7.97$$

F1= 7.97 F2 ---------- (2)

Put Eq. (2) in Eq. (1)

F1- F2 = 795.78

7.97 F2 - F2 = 795.78

6.972 F2 = 795.78

F2 = 114.14 N

Put in Eq. (3)

F1 = 681.64 N

Centrifugal force in belt is given by,

$Fc = mV^2$

$=0.0285 \times (0.0628)^2$

$Fc = 1.12 \times 10^{-}$ N

- **BEARING SELECTION:-**

As shaft dia.is 20mm so we have selection a pedestal bearing having shaft outer dia. is 20mm.

Motor power P=$\frac{1}{15}$ HP=50watt

N=60rpm.

Small pulley dia. d=20mm.

Big pulley dia. D=60mm.

Center distance between two pullies C=200mm.

Shaft dia. d=20mm.

Total load on bearing= Weight of shaft + Weight of rotor

W=5kg

W=49.05N

Load on each bearing,

F_a= w/2=24.52N

Equivalent dynamic load and rating life of bearing

$Pe = V \times Fa \times Ka$

Pe = 36.78 N

$$L_{10} = \frac{Lh_{10} \times 60 \times N}{10^6}$$

From graph 4.6 PSG Design data book for 16000 rpm.
Maximum speed of pedestal bearing is 31500 hrs.
L_{10}=113.4 million revolution.

Basic Dynamic Capacity,

$$L_{10} = \left(\frac{C}{Pe}\right)^{10/3}$$

C = 101.3688 KN<1000 ----------***Bearing is safe***

VII. ADVANTAGES AND DISADVANTAGES

- **Advantages:**

1) It approximately having higher efficiency that of old weeding machine.
2) Only simple support structures are required Design & fabrication is easy.
3) Faster weeding speed than conventional methods.
4) It increases the safety and working condition during weeding.
5) Effective for longer period Weeding Operations.

- **Disadvantages:**

1) Labour consuming.
2) Possibility of damaging crop.
3) Requires ideal and optimum specific condition required for Mechanical weeder.
4) Practical difficulty in adoption.

CONCLUSION

The main aim of this paper is to have a proper understanding of different aspects or constraints of weeders as well as different weeding techniques to reduce the efforts which were put in by farmers in terms of money, labour, time, physical efforts for economical cultivation. Sincere efforts must be made to design a suitable weeding equipment or method, in order to provide more profit, stability in terms of economical considerations. There are certain limitations for engine operated equipment. Like vibration. Vibration cannot be eliminated completely as it is needed to provide thrust (positive or negative) to take out unwanted weed. If we completely eliminate the problem of vibration, then it is not possible for equipment to perform the desired task of weeding. Adjustable blades, rotary blades can definitely influence the performance of weeder. Design consideration of equipment also has a greater impact over the performance of weeder.

FUTURE SCOPE

As we know that due to increase in demand for chemical free vegetable crop production, farmers have started using mechanical techniques to control weed. Only difference is that instead of using conventional methods i.e. manual operation of the system farmers have started using automated mechanical machines to achieve the goal. Our project is now manually operated weeder, but in future we can make it semi/fully automatic. We can use tractor drive to fully automatically actuate the weeder blades for its future working.

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